A

MANUAL

OF

GEOGRAPHICAL SCIENCE,

MATHEMATICAL,

PHYSICAL, HISTORICAL,

AND

DESCRIPTIVE.

LONDON:
JOHN W. PARKER AND SON, WEST STRAND.
MDCCCLIX.

LONDON:
SAVILL AND EDWARDS, PRINTERS, CHANDOS STREET,
COVENT GARDEN.

MANUAL OF GEOGRAPHICAL SCIENCE.

PART THE FIRST,

CONTAINING

MATHEMATICAL GEOGRAPHY,

BY REV. M. O'BRIEN, M.A., F.R.S.
PROFESSOR OF NATURAL PHILOSOPHY AND ASTRONOMY IN KING'S COLLEGE, LONDON.

PHYSICAL GEOGRAPHY,

BY D. T. ANSTED, M.A., F.R.S.
PROFESSOR OF GEOLOGY IN KING'S COLLEGE, LONDON.

CHARTOGRAPHY,

BY J. R. JACKSON, F.R.S.
LATE SECRETARY OF THE ROYAL GEOGRAPHICAL SOCIETY.

THEORY OF DESCRIPTION AND GEOGRAPHICAL TERMINOLOGY,

BY REV. C. G. NICOLAY, F.R.G.S.
LIBRARIAN OF KING'S COLLEGE, LONDON.

PREFACE.

AT the present time, when so many works on the subject are before the public, a MANUAL OF GEOGRAPHY may seem to require more than ordinary preface; nevertheless, a short one may explain the object of its publication.

Hitherto, those intended to be used in education have been rather compendious works of reference, than introductions to the study of a science, and are often overloaded with details, while general principles are omitted.

In the present work, an attempt has been made to avoid these evils, and so to classify, arrange, and systematize the information contained in it, that it may be immediately available both to the teacher and to the scholar; and by the omission of all non-essential details, whether political, statistical, or topographical, to confine the attention to the principal subject. How far the attempt has been successful, those must decide for whose benefit it has been made.

Although the First Part may appear to be composed of distinct and separate treatises, it is presumed that, on consideration, they will be found to form a consistent whole,—each part being, notwithstanding, complete in itself;—that Professor O'Brien's mode of working astronomical problems by construction, the explanation of the form and use of the more simple instruments, and other things not usually found in the mathematical portions of geographical works, will be readily accepted, by the unscientific reader, in the place of the barren outlines of astronomy and paradoxical problems in the use of the globes, which made this science so unpalatable in our youthful days. In the portion devoted to Physical Geography, Professor Ansted's classification of great leading facts may well compensate for the absence of minute details; while in the chapter on Chartography, Colonel Jackson's intimate acquaintance with the various modes adopted to portray the varying features of the surface of the globe, will enable the reader to peruse in a condensed form, information not easily accessible elsewhere; and in those on the Theory of Description and Geographical Terminology, the effort which has been made, on the one hand, to develop a system, and on the other, to pursue inquiries hitherto comparatively neglected, will, it may be hoped, not only facilitate the attainment of knowledge now, but lead to its extension hereafter.

The geographical knowledge of the ancients, the principal use of which is to illustrate ancient history, being limited in its extent, and derived from those who were, for the most part, entirely ignorant of geography, in the more enlarged acceptation of the term; "The world as known to the ancients" must of necessity be considered topographically; but the world as known at the present time, will be considered first as a whole, then in its larger divisions and minuter sub-divisions, whether natural or civil. In this, which forms the Second Part of the work, the less essential details have been omitted, as generally accessible in Geographical Gazetteers. Normal figures and sections have been introduced, in the belief that their general adoption, in the study of Geography, will much facilitate the acquirement of accurate knowledge.

In the Atlas attached to this work, all the principal facts of Physical Geography will be found compressed within less than ordinary limits, but, it is believed, well defined and without confusion, and fully sufficient for the purposes of elementary study. The compilers have freely availed themselves of the labours of their predecessors, yet the work has features peculiar to itself; among these may be mentioned the omission of names of places in the maps generally, and confining them to a Reference Map, so that the attention may not be distracted from the more immediate object; a comparative Chart of ancient and modern Geography and geographical discovery, and an attempt to express by reversed shading the vertical contour of the surface of the land, from which, at a glance, a general idea, not only of extent but of elevation, may be obtained.

C. G. N.

CONTENTS.

Mathematical Geography.

Chartography.

p. 143 — 184.

Physical Geography.

Part I. — Of the Earth's Surface.

Part III. — Organization.

CHAPTER XIII.

Theory of Description and Geographical Terminology.

CHAPTER I.

CHAPTER II.

MATHEMATICAL GEOGRAPHY.

INTRODUCTION.

THE importance of Astronomical and Optical knowledge to the practical Geographer is so obvious, that it will not be necessary to say anything on the subject here; and we shall therefore, without further preface, proceed to state briefly the nature and extent of the information which we propose to give the reader on the subjects of Astronomy and Optics.

In the first place, then, we must observe, that the space allotted to Astronomy in the present Geographical Treatise is, of necessity, very limited, and therefore we must follow one of two courses in treating of the subject; we must either give a general outline of the whole science, without entering into particulars, or we must select some portion of it of special importance to the Geographer, and develop that at some length, so as to make it practically useful.

We prefer taking the latter course, for two reasons: First, because the space to which we are restricted would only allow us to give a very unsatisfactory outline of Astronomy in general; and, secondly, because, though the greater part of Astronomy has some bearing, directly or indirectly, on Geography, there is one topic of paramount importance—namely, the means which Astronomy affords of determining *position on the earth's surface;* the great practical problem which the Geographer has to solve by means of his Astronomical information being—to determine the relative positions of the various places he may happen to visit.

We shall therefore devote the space here allowed us to the explanation of Astronomical Principles, so far as they have immediate reference to this important problem, and no farther. We shall suppose that the reader is a traveller who is anxious to know just enough of Astronomy to enable him to determine the *Meridian*, the *Latitude*, and the *Longitude* of any place, and that he has little or no acquaintance with the technicalities of mathematics. We shall, with this view, explain generally the *apparent* motions of the heavenly bodies, dwelling but little upon the *real* motions. We shall describe at some length the positions and appearances of the different groups of stars or constellations, this being a most essential part of the subject practically. As regards Optical science, we shall explain as much as is necessary, in order to understand the construction and use of the Astronomical Telescope, as employed to determine *direction*, and of the Astronomical Microscope, as employed to *subdivide space;* we shall show how the Portable Transit Telescope is to be adjusted, and how it may be made use of in determining everything the Geographer requires to know. We shall not have space to say much respecting other Astronomical instruments; but this will not signify, as the Transit instrument is capable of being used with the greatest advantage for every purpose the Geographer has in view, and requires, on his part, no knowledge of what are called the Astronomical corrections. It is on this account that we shall dwell more on the Transit Telescope, and say but little respecting other instruments.

The following is a brief outline of the subject, as we shall here treat of it:—

CHAPTER I. contains a preliminary statement of the more obvious celestial phenomena—The Fixity and Permanency of the Stars and Constellations—The Circumpolar Rotation—The Proper Motions of the Sun, Moon, and Planets.

CHAPTER II.—The Celestial Sphere and its Circles. The Constellations described, in order that the reader may make himself familiar with the localities and appearances of the principal stars. In this and the previous chapter we have thought it advisable to introduce a certain amount of information respecting the numerous allusions in ancient writers to the celestial phenomena, and especially the constellations; for a dry description of the stars, without something of this kind, would be scarcely readable, and our object, of course, must be to make the subject not only useful, but, as far as we can, interesting also.

CHAPTER III.—Astronomical Terms explained—Measures of Time.

CHAPTER IV.—A Method of solving Astronomical Problems by Geometrical Construction with Rule and Compass. This method consists of the Dissection, if we may so speak, of a solid angle or spherical triangle, so as to represent its six parts on flat paper by construction. All problems usually given in what is called the 'use of the globes,' may be solved by this method with considerable accuracy. It has also the advantage of requiring no mathematical knowledge on the part of the reader; at the same time it leads very simply to all the mathematical formulæ used in Astronomy.

CHAPTERS V. & VI.—The Telescope and Microscope, as used in Astronomy, with the optical principles upon which their construction depends, explained. The Micrometer and Vernier. In Chapter V. some account is given of the optical phenomena which have immediate connexion with Astronomy, such as reflection, refraction, stellar aberration.

CHAPTER VII.—The Transit instrument, its adjustments, and the method of observing with it.

CHAPTER VIII.—The Geographical Uses of the Transit instrument.

CHAPTER IX.—Hadley's Sextant, Altitude Instrument.

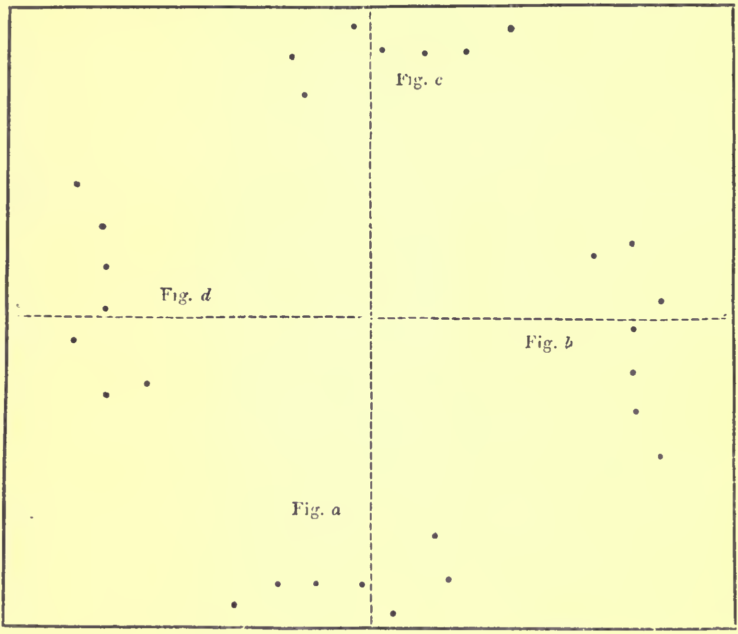
In Chapters V. & VI. we have introduced a little more optical matter than is usual in a treatise on Geography; because our object is, not to write a formal treatise on Astronomy, but to give such information to a person, ignorant of Astronomy and Optics, as will enable him to understand the instruments and principles by which the relative positions of places on the earth's surface are determined.

CHAPTER I.

GENERAL STATEMENT OF THE CELESTIAL MOTIONS.

I. *Of the Firmament.*

THE first fact that is noticed by any one watching the heavens at night is, perhaps, the fixity and permanency of the different groups of stars (or constellations as they are called), notwithstanding the gradual change of position which they all appear to undergo from hour to hour during the night. These constellations always exhibit the same form and appearance, though they are ever on the move. For instance, if the observer fix his attention upon the seven well-known stars, commonly called the Wain, the Plough, or the Great Bear, he will perceive that they always preserve the



same distances from each other, though the whole group is continually changing its position in the heavens. If he joins each of these stars with its neighbour by drawing imaginary lines, the figure he so forms will be always the same, though he will sometimes see it as is represented in fig. *a*, sometimes as in fig. *b*, sometimes as in fig. *c*, and sometimes as in fig. *d*.

2 If he continues to watch this or any other of the constellations for years, he will never perceive any change of form; and we may extend this statement to many centuries of past time, for we have evidence, from astronomical records, and the allusions of ancient writers, that the arrangement and grouping of the stars on the celestial vault has ever been the same, with a few remarkable exceptions hereafter to be noticed.

3 In ancient times, before calendars were known, the rising and setting of the constellations were the chief guides of the shepherd, and the tiller of the ground, in determining the progress of the seasons, and this made men in general much more familiar with the appearances of the stars than they are now. We therefore find continual mention of the constellations in the works of antiquity, and especially in the poets. To give a few examples, we find the following lines in *Hesiod, Opera et Dies*, which we shall quote at length, on account of their astronomical interest :—

'But when Orion and Sirius have come into the middle of the heavens, and the rosy-fingered Aurora has beheld Arcturus, then O Perses, gather all the grapes home.'*

'But when at length the Pleiades and the Hyades and the mighty Orion have set, then be mindful of ploughing in time.'†

'But if the desire of dangerous navigation has taken possession of you, when the Pleiades, flying the fierce strength of Orion, have at length set in the dark sea, then surely storms of wind will blow on every side.'‡

Another remarkable passage is found at the beginning of the Second Book, line 381 :—

'At the rising of the Pleiades the daughters of Atlas, begin to reap, but when they set, to plough. These stars become invisible for forty days and nights ; but they appear again, as the year rolls round, when first the scythe is sharpened.'§

4 The *Fasti* of Ovid, which is a poetical calendar, alludes to almost all the constellations of the heavens, making use of their risings and settings as marks and signs, not only of the four great divisions of the year, the seasons, but also of months and subdivisions of months. In fact, there is scarcely a week which is not marked in the *Fasti* by some particular astronomical note. Thus, in the month of May, we have, among several others, the following allusions to constellations :—

VI No. (2nd of May.)

Pars Hyadum toto de grege nulla latet.
Ora micant Tauri septem radiantia flammis,
Navita quas Hyadas Graius ab imbre vocat.

V No. (3rd of May.)

Nocte minus quarta promet sua sidera Chiron
Semivir.

II No. (6th of May.)

Scorpius in cœlo, cum eras lucescere Nonas
Dicimus, a media parte notandus erit.

II Id. (14th of May.)

Pleiadas adspicias omnes, totumque sororum
Agmen ; ubi ante Idus nox erit una super
Tum mihi non dubiis auctoribus incipit æstas ;
Et tepidi finem tempora veris habent.

VI Kal. (27th of May.)

Auferat ex oculis veniens Aurora Booten :
Continuaque die Sidus Hyantis erit.

5 We have still remaining a formal account of all the constellations, in a philosophical poem, formerly held in great repute, called the *Phænomena* of Aratus, the same quoted by St. Paul in his address to the Athenians. This poem was founded upon a description of the celestial sphere by Eudoxus, a work of much celebrity in ancient times, and probably compiled from earlier astronomical writers. The description of the constellations by Aratus is not very accurate, owing, not only to the imperfections of the work from which he drew his materials, but also probably from the fact that he either overlooked, or very imperfectly allowed for, the changes in the rising and setting of the constellations caused by a change in the observer's latitude. This poem was commented upon by many celebrated astronomers, and among the

* Εὖτ' ἂν δ' Ὠρίων καὶ Σείριος ἐς μέσον ἔλθῃ
οὐρανόν, Ἀρκτοῦρον δ' ἐσίδῃ ῥοδοδάκτυλος Ἠώς,
ὦ Πέρση, τότε πάντας ἀπόδρεπε οἴκαδε βότρυς.

† αὐτὰρ ἐπὴν δὴ
Πληιάδες θ' Ὑάδες τε τό τε σθένος Ὠρίωνος
δύνωσιν, τότ' ἔπειτ' ἀρότου μεμνημένος εἶναι
ὡραίου.

‡ Εἰ δέ σε ναυτιλίης δυσπεμφέλου ἵμερος αἱρεῖ,
εὖτ' ἂν Πληιάδες σθένος ὄβριμον Ὠρίωνος
φεύγουσαι πίπτωσιν ἐς ἠεροειδέα πόντον,
δὴ τότε παντοίων ἀνέμων θύουσιν ἀῆται.

§ Πληιάδων Ἀτλαγενέων ἐπιτελλομενάων
ἄρχεσθ' ἀμήτου· ἀρότοιο δὲ δυσομενάων.
αἳ δ' ἤτοι νύκτας τε καὶ ἤματα τεσσαράκοντα
κεκρύφαται, αὖτις δὲ περιπλομένου ἐνιαυτοῦ
φαίνονται τά πρῶτα χαρασσομένοιο σιδήρου.

rest, by Erastosthenes and Hipparchus. It was partially translated into Latin by Cicero, when a very young man, and this translation is still extant. Eudoxus died about 370 B.C. This work, though rough and imperfect, is a valuable relic of the ancient Greek astronomy.

6 But it is to Ptolemy, the Alexandrian astronomer and geographer, that we are indebted for nearly all the accurate information we possess respecting the state of astronomy before the Christian era. He was himself an observer, and, considering the imperfection of his instrumental means, his optical measurements deserve great praise. But the great service he did to astronomy was by compiling with accuracy the observations of previous astronomers, and especially of Hipparchus. In the 7th and 8th Books of his celebrated work, the *Megale Syntaxis*—or, as it was called by the Arabs, *Almagest*—we have the apparent places of the stars on the celestial sphere accurately put down from his own observations, compared with those of the great astronomer, Hipparchus. The catalogue of the stars by Hipparchus, who flourished about 150 years B.C., is lost, but its substance is preserved in Ptolemy's *Syntaxis*. Ptolemy flourished about A.D. 130. The Chaldeans made great advances in astronomy in early times, and Ptolemy often quotes their observations, though none earlier than B.C. 720.

7 From all these numerous sources of information as to the appearance of the heavens in early times, we derive ample evidence that the various groups of stars which we now see in the heavens have always exhibited the same appearances and configurations, that they occupy the same relative positions now as in olden time, and that no changes have taken place in the general arrangement of the stars, at least none but minute changes, which are not sensible to the eye unaided by instruments. Minute changes have indeed occurred in the places of the stars, but it requires the most perfect and delicate instruments to perceive them.

8 It is, in a great measure, this permanency and fixity of the stars in the heavens that renders astronomy of such importance in practice. When astronomers have once made accurate observations on any particular star, and entered its position in their catalogues, there it remains for centuries, an unchangeable mark in the heavens, for the use of future observers—a mark both of time and place, by which the sailor can guide his ship with perfect safety over the ocean, and the geographer construct his maps and charts with unerring fidelity. A star thus determined is a celestial time-piece, that knows no error or variation, not only marking minutes and hours, but years and centuries; serving, at the same time, to regulate a watch, and to guide the chronologer through the darkness of past ages.

9 It is not surprising that the fixity and permanency of the constellations should have led men to form the opinion that the expanse in which the stars appear to be placed is no empty space, but a vault of durable and firm structure. Hence the meaning of the Latin word, *firmamentum*, which has passed into our own language as *firmament;* and of the Greek word, *στερεωμα*, *stereoma*, which is derived from *στερεως*, *firmus*, or *firm*. Stereoma is the word in the Septuagint which is translated *firmament* in our version of the book of Genesis. The corresponding Hebrew word, however, contains no allusion to any firmness, but simply signifies space, or expansion. The word star (coming, as it does, from *αστηρ*) is not derived from the same root as *stereoma*, but from the negative, signifying *unsteady*, no doubt in allusion to the twinkling light of the stars.

10 The opinions of ancient philosophers as to the nature of the stars were very various. (*See* Plutarch's *Moralia de Placitis Philosophorum*, lib. II.) Many supposed them to be nothing but bright ornaments, or, as it were, nails fixed in the crystalline sphere, or firmament. (*ἥλων δίκην καταπεπηγέναι τῷ κρυσταλλοειδεῖ.*) Anaxagoras said that they were stones flung up from the earth, and kindled by the rapid whirling motion of the æther, (*τῇ δ' εὐτονίᾳ τῆς περιδινήσεως ἀναρπάζοντα πέτρος ἐκ τῆς γῆς, καὶ καταφλέξαντα τούτος ἠστερικέναι.*) Heraclides and the Pythagoreans said that each star was

a world, like the earth; and the same view was held by the followers of Orpheus. A great variety of opinions prevailed respecting the nature, distance, and magnitude of the heavenly bodies, most of which are stated in the work of Plutarch already referred to.

II. *Of the Circumpolar Motion of the Heavens.*

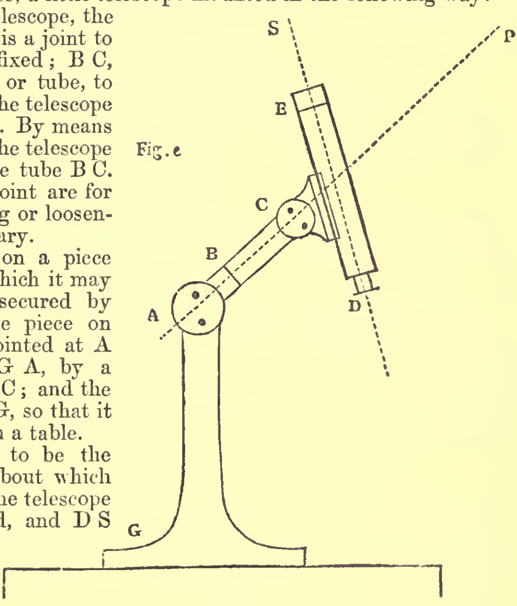
11 At the same time that an ordinary observer notices the permanency of form and relative position of the various groups of stars, he perceives that every star is moving slowly and steadily; an hour is sufficient to convince him of this. Let him fix his eye on any particular star—say, for instance, one of the seven, in the Great Bear—and let him mark its position with reference to some terrestrial object, (not too near him,) such, for instance, as the top of a tree or chimney, or the ridge of a roof, and he will soon perceive that the star does not continue in the same place. A look at the Great Bear at five or six o'clock of a winter's evening, and again at eleven or twelve o'clock, will show the motion of the heavens in a striking manner; at the first time it will be seen in the position represented by fig. *a;* at the second time, in that represented by fig. *b*. At five or six in the morning the figure will be inverted, as in fig. *c*. At 12 o'clock in the day, if the stars were seen, (as they can be through a telescope,) they would appear as in fig. *d*. At the same hour in the evening, the stars will come again into the same position.

12 With a little care, three facts may be noticed respecting the motion of the heavenly bodies:—*First,* That they all describe parallel circles about one point of the heavens, called the North Pole, (supposing the observer to be in the northern hemisphere of the earth.) *Secondly,* That they all complete their motion in the same time, coming back to the same positions every twenty-four hours. *Thirdly,* That this circular motion is perfectly uniform, each circle—i. e., each 360°, being described at the rate of 15° per hour, or 1° in every four minutes of time.

13 To observe the truth of these facts, some simple instrument will be necessary, as, for instance, a little telescope mounted in the following way:—

E D (fig. *e*) is the telescope, the eye-hole being at D; C is a joint to which the telescope is fixed; B C, a short hollow cylinder, or tube, to the extremity of which the telescope is jointed by the joint C. By means of this joint we may set the telescope at different angles to the tube B C. The two holes in the joint are for the purpose of tightening or loosening it, as may be necessary.

Fig. e

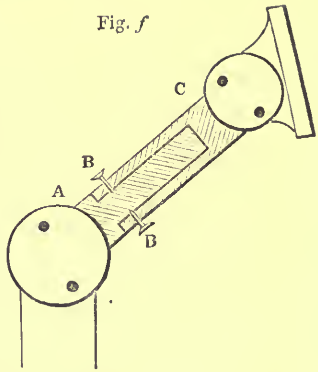


The tube B C fits on a piece shown in fig. *f*, round which it may be moved; and it is secured by little screws B B. The piece on which the tube fits is jointed at A to the upright stem G A, by a joint similar to that at C; and the stem has a heavy base, G, so that it may stand steadily upon a table.

14 Supposing A P to be the direction of the axis about which the tube B C (carrying the telescope with it) may be turned, and D S the direction in which the telescope looks, then by making the line A P point to the

pole, and the line D S to any particular star, it will be found, that by turning the tube B C round, without altering the inclination of the line D S to the line A P, we may always make the telescope point to the star. This evidently shows that the line D S, drawn in the direction of the star, always makes the same angle with the line A P drawn in the direction of the pole—i. e., that the star always preserves the same distance from the pole, and therefore that it describes a circle about the pole; and this being true, as will be found, for all the stars, it follows that they all describe parallel circles about the pole.

Fig. *f*



15 By pointing the telescope towards a star, leaving it in that position for twenty-four hours, and then looking again through it, it will be found that the star comes back to its original position in twenty-four hours.

16 This will be found true at all hours, and therefore it follows that the motion of the star is uniform—i. e., that it always moves at the same rate.

17 To use this instrument as above described, the position of the Pole in the heavens must be known in order to direct the line A P towards it. The method of finding the Pole by means of a star which is near it, called the Pole Star, will be explained in the next chapter. The Pole is about a degree and a half from the Pole Star. We shall show in the next chapter how the instrument is to be set, by means of the Pole Star and certain other stars of the constellation called the Little Bear, so that the line A P may point to the Pole—at least, sufficiently near the Pole for our purpose.

18 This instrument need not be made very accurately, as it is not capable of being used with any great nicety, but only in a rough way, to observe the general motions of the heavenly bodies, such as the diurnal rotation of the Stars, the annual motion of the Sun, the motions of the Moon and Planets. If a better instrument cannot be procured, such an instrument as this will be found very useful to the beginner, as the observation of celestial phenomena, even in a rough way, is not only highly interesting, but very instructive as far as regards practical astronomy.

19 Two graduated circles, which may be made of pasteboard or paper pasted on wood, ought to be added to the instrument as above described—one at C, to measure the angle which the line S D makes with the line P A, and the other at B, to measure the number of degrees through which we turn the tube B C about the polar axis A P. It will be sufficient to have these circles graduated to degrees, as they could not be expected to give smaller measures with any degree of accuracy.

20 Instead of the telescope, a rod with a pair of ordinary sights may be substituted, as is shown in fig. *g*, M and N being the sights. The sight M which is supposed to be next the eye, is a small flat piece of brass with a hole in it, as is shown in fig. *i*. The other sight is a similar piece of brass, only

Fig. *g*

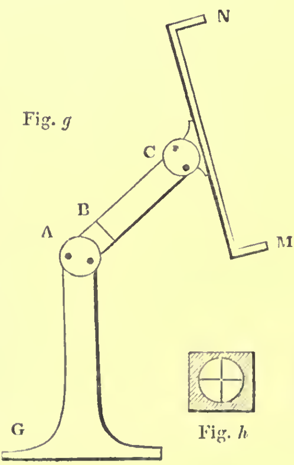


Fig. *h*

Fig. *i*

it has two pieces of thin wire drawn across the hole at right angles, as is shown in fig. *h*, in order to mark the centre of the hole. The eye being placed near M, sees these cross wires, and it should look in such a manner as to make the wires appear to divide the hole M into four equal parts—i. e., the point where the wires cross each other, or as it is called, the centre of the cross wires, should appear to coincide with the centre of the hole M.

When this is done, any object, such as a star, which is seen at the centre of the cross wires, is in the direction in which the sights point—i. e., the line joining the centre of the hole M, and the centre of the cross wires points to the star.

21 The line joining the centre of the hole M, and the centre of the cross wires, is called the *Line of Direction of the Sights,* and more frequently, the *Line of Collimation.* Collimation is derived from the Latin word *collineo,* or *collimo,* (from *con* and *lineo,*) which signifies, *to direct one thing in a straight line towards another*—i. e., *to aim at.* This is a line of great importance in astronomy, and we shall speak more of it presently.

22 The telescope (if the instrument have a telescope instead of sights) should be furnished with cross wires in the focus, to mark its line of direction or collimation. The magnifying power of the telescope may be very small. A single object-glass of three or four inches focus, and a single eye-glass of one or two inches focus, will form a sufficiently good telescope.

With an instrument of this kind, any person may satisfy himself respecting the uniform circumpolar motion of the heavenly bodies: first of all, that each heavenly body always keeps at the same distance from the pole, or, in other words, that it describes a circle about the pole; secondly, that it completes this circular motion in twenty-four hours; thirdly, that it always moves at the same rate, namely, 15° per hour, or 1° in four minutes.

23 To prove these facts with accuracy, it is necessary to employ much more perfect and delicate instruments than the above. Astronomers employ what is called a *Transit instrument,* which we shall presently describe at some length, to observe the time at which each heavenly body comes on a particular line called the *Meridian,* and for this purpose it is necessary to have a first-rate clock to subdivide time with accuracy to a fraction of a second. To determine how far any heavenly body is from the pole, astronomers use another instrument, called a *Mural Circle,* or an *Altitude Instrument.* Both these instruments are extremely simple as regards their motions, and are capable of wonderful accuracy when well made. A third instrument, called an *Equatorial,* is made use of for measuring small spaces and distances in the heavens. These three instruments, fixed in a convenient building, together with the clock, and some minor instruments, make an Astronomical Observatory. The rude instrument above described may be made to represent any one of these three great, or, as they are called, *capital* astronomical instruments. If the line A P be made vertical, and the tube B C fixed in such a position that the line D S may be in what is called the *meridian plane*—i. e., in the vertical plane which contains the pole, then the instrument represents a Transit telescope. If, in addition to placing the instrument thus, a graduated circle be fixed at C, to measure the inclination of the line D S to the line A P, it represents a Mural Circle. If A P be fixed so as to point to the pole, as originally supposed, then the instrument represents an Equatorial.

III. *The Earth's Rotation the Cause of the Apparent Circumpolar Motion of the Heavens.*

24 The circumpolar motion of the heavenly bodies may be either an actual and real motion, or it may be only apparent, being caused by an opposite motion of the spectator. If we suppose the Earth to be a round body, as it may be proved to be by observation and measurement, and to revolve from west to east once in twenty-four hours, about an axis passing through the two poles, this will sufficiently account for the apparent motion of the heavenly

bodies from east to west about the pole; for a motion of the earth round its axis from west to east would evidently make the stars appear, to any observer on the Earth's surface, to move about the same axis in the contrary direction, from west to east. The natural impression, on perceiving the circumpolar motion of the heavens, is, of course, that it is a real motion; and this was the opinion of mankind, with a few exceptions, for many ages. The inquisition compelled Galileo to abjure the Copernican doctrine, (which taught both the annual motion of the Earth about the Sun and its diurnal motion about its axis,) and decreed, 'that the proposition, that the Earth is not the centre of the world, nor immoveable, but that it moves, and also with a diurnal motion, is absurd, philosophically false, and theologically at least erroneous in faith.' The story that Galileo, on rising from his knees after the abjuration, whispered, 'E pur se muove'—'It moves nevertheless'—is well known.

25 The doctrine, that the Earth was the immoveable centre of the universe, which was the basis of the Ptolemaic system, was universally received until the time of Copernicus, who published his celebrated work, *De Revolutionibus Orbium Cœlestium*, in 1543, in which he refutes, but in a cautious and hypothetical manner, the complex system of Ptolemy, which taught that the stars were carried round the Earth daily by an enormous crystalline sphere, and that the motions of the Sun, Moon, and planets, were produced in the same manner. Considering the enormous distances and magnitudes of the heavenly bodies, and the unnatural machinery of cycles and epicycles by which the planetary motions were accounted for, Copernicus felt that some other hypothesis respecting the celestial revolutions was necessary to satisfy his mind. He found that some ancient philosophers had taught the motion of the Earth about its axis and its annual motion about the Sun. Carefully and cautiously considering these views, he at length came to the conclusion that the Sun is the centre of the universe, and that the Earth revolves not only about the Sun, but also about its own axis, whereby the apparent diurnal motion of the stars is produced. These views he published in the work above alluded to, which was dedicated to the pope, Paul III. After the time of Galileo, the Copernican system prevailed, and the Ptolemaic was neglected, though the works of both astronomers were still condemned as heretical by the Romish church. Mr. Drinkwater, in the *Library of Useful Knowledge*, states, that both were in the *Index Expurgatorius* for 1828, with the words 'Nisi corrigatur.' But on this point see Lyell's *Geology*, p. 58 (7th ed.)

26 The proof of the Earth's rotation about its axis is, in a great measure, derived from the fact that it simply, naturally, and reasonably accounts for the apparent diurnal motion of the heavens, which the Ptolemaic system does not. In addition to this, the peculiar figure of the Earth, which is found to be nearly spherical, but somewhat flattened at the poles and protuberant at the equator, indicates the existence of a centrifugal force, caused by rotation about an axis. Experiments on pendulums afford clear evidence of the existence of this centrifugal force. Experiments on falling bodies, which must be considered accurate and satisfactory, have been made, and it appears from them that a body let fall from a considerable height always falls a little to the east of the vertical; this can only be accounted for by the Earth's rotation. Observation shows that the Sun, Moon, and planets, revolve from west to east about their axes, and it is not unreasonable to conclude that the Earth is not an exception to what appears to be the rule of the planetary motions.

27 There is another proof that the Earth is not fixed, of the most convincing kind, derived from the phenomenon of the aberration of light, of which we shall presently speak. By this curious displacement, the Earth's motion is made visible in every star, as it were in miniature, each star describing an apparent orbit, similar to the motion of the Earth. This, however, applies to the motion of the Earth about the Sun.

28 One other consideration tends to confirm the truth of the opinion that the Earth revolves about its axis. It is this, that a most important end is

gained by the Earth's rotation—namely, the axis is thereby kept steady in one position. But for its rotation, the Earth's axis would be continually changing from one direction to another, and the effect of this would be extraordinary vicissitudes of seasons; we should be at one time in the polar regions—at another, in the tropics, subject to rapid and irregular changes of climate, and to violent disturbances of the atmosphere and the ocean. The example of a common spinning-top or hoop is sufficient to show the effect of rotation in keeping a body in one position. It would be a practical impossibility to balance a top by placing it with its point on the ground, without having first communicated to it a motion of rotation; but once make it spin rapidly about its axis, and it will stand steadily on its point—so steadily that it will require a considerable blow to upset it. The same thing is true of trundling a hoop; the rotation communicated to it keeps it so steady that the pressure of the stick upon it sideways does not upset it, but merely causes it to turn slightly out of its course.

29 It is, then, by a rapid motion of rotation that the 'round world is made so fast that it cannot be moved,' not absolutely fixed, it is true, but fixed with its axis in one position, by which means the changes from night to day, and from season to season, become uniform and regular. And no doubt the same important end is gained by the rotation of the Sun, and Moon, and planets, each about its axis, and by the revolutions of the planets about the Sun. It is by a wonderful combination of motion and attraction that the solar system is preserved unchanged, and each planet kept at its proper distance from the Sun. And the rotations and proper motions of the stars, now so clearly made out by astronomers, indicate that the same system pervades the universe. It is, most probably, by their motions and attractions that the stars are preserved, each in its place. Without that perpetual revolution and rotation, and that bond of attraction which unites the remotest systems, the whole universe, as far as we may presume to judge, would drift in confusion in the boundless ocean of space, and become a formless chaos.

IV. *Globular Form of the Earth.*

30 It is not necessary to say much on this point here; that the Earth is a globe may be, and has been, continually proved by actual observation and measurement. The most commonplace observation is sufficient to make the fact evident. In every part of the ocean, the horizon is visibly circular, this proves that the ocean, which covers a considerable portion of the Earth's surface, is globular. The same is true of the great inland lakes which are found in various parts of the world. The appearance of a ship approaching land—the masts first becoming visible, and then the hull, is a familiar proof of the Earth's rotundity. So also is the circular shadow of the Earth, cast by the Sun on the Moon, in an eclipse. The circumnavigation of the Earth, which is no uncommon occurrence, may also be adduced. The best proof is actual measurement; but we could not say anything satisfactory on this point without introducing mathematical technicalities.

V. *Proper Motion of the Sun, Moon, and Planets.*

31 We have stated above, that, *with a few exceptions,* the heavenly bodies always preserve their relative places unchanged, and appear to describe circles about the pole, at the invariable rate of 15° per hour, so completing the whole circuit of 360° in twenty-four hours. We shall now briefly explain what the exceptions are, commencing with the Sun, whose motion in the heavens is the cause of so many important changes to us: those changes from light to darkness, and from heat to cold, which give rise to day and night, and bring about in order the various seasons of the year. We shall then briefly consider the motion of the Moon, and the apparently irregular and anomalous wanderings of the planets which were so satisfactorily unravelled by Copernicus. The annual motion of the Sun, and the monthly revolution

of the Moon, are simple enough at least to ordinary observers, being always from west to east; but the motions of the planets seem to be governed by some complicated law—they sometimes move eastward, sometimes westward, and they sometimes remain stationary. They were supposed in ancient times to wander irregularly over the heavens, and hence they were called πλανηται, or wanderers, by the Greeks, and 'errantes' by the Latins, and sometimes 'vagæ.'

32 These motions and appearances of the Sun, Moon, and planets are beautifully described by Cicero, in the second book *De Natura Deorum*, which is so much to the point, that we cannot do better than transcribe it here:—

'There remains, last of all, and at the greatest altitude above our habitation, surrounding and keeping in all things, the expanse of heaven, which is also called the æther, the extreme region and boundary of the universe; in which, in the most wonderful manner, bodies of fire perform their appointed motions: among which the Sun, though much exceeding the Earth in magnitude, revolves about it. And he by his rising and setting makes day and night; and at one time approaching (towards the pole), and at another receding, he turns back twice every year, at opposite points of his course—(i. e., at the solstices at midsummer and midwinter); between which, during one period he chills the Earth, as it were, with sadness, and during another gladdens it so that it seems to rejoice with the heavens. The Moon also, which, as mathematicians show, is more than half the magnitude of the Earth, wanders over the same part of the heavens that the Sun does; at one time being in the same quarter with the Sun, and at another time in the opposite, she transmits to the Earth the light she receives from the Sun, and she undergoes various changes of brightness; also, at one time, she comes between us and the Sun, and obscures his light, and at another time, falling into the shadow of the Earth, which comes between her and the Sun, she becomes suddenly eclipsed. In the same part of the heavens also those stars, which we call wanderers, are caused to revolve about the Earth, rising and setting like the Sun and Moon; and the motions of these stars are sometimes direct and sometimes retrograde, and sometimes also they become stationary; and nothing is more wonderful, nothing more beautiful, than this spectacle. After these, comes an immense host of fixed stars,' &c. &c.*

He then goes on to describe the different constellations, and in so doing, he quotes a considerable portion of the astronomical poem of Aratus.

33 The motions of the Sun, Moon, and planets are twofold:—*first*, they partake of the same apparent circumpolar motion as the fixed stars, which, as we have explained, is caused by the Earth's rotation about its axis; *secondly*, they have other motions which the stars have not, and which are therefore called *Proper* (or peculiar) *Motions*. These motions we shall now describe.

---

* 'Restat ultimus, et a domiciliis nostris altissimus, omnia cingens et coercens, cœli complexus, qui idem æther vocatur, extrema ora et determinatio mundi: in quo cum admirabilitate maxima igneæ formæ cursus ordinatos definiunt. E quibus Sol, cujus magnitudine multis partibus terra superatur, circum eam ipsam volvitur. Isque oriens et occidens, diem noctemque conficit, et modo accedens, tum autem recedens, binas in singulis annis reversiones ab extremo contrarias facit: quorum intervallo tum quasi tristitia quodam contrahit terram, tum vicissim lætificet, ut cum cœlo hilarata videatur. Luna autem, quæ est, ut ostendunt mathematici, major quam dimidia pars terræ, iisdem spaliis vagatur quibus Sol: sed tum congrediens cum Sole, tum digrediens, et eam lucem quam a Sole accepit mittit in terras, et varias ipsa mutationes lucis habet: atque etiam tum subjecta atque opposita Soli radios ejus et lumen obscurat, tum ipsa incidens in umbram terræ, quum e regione Solis, interpositu interjectuque terræ, repente deficit. Iisdem spaliis hæ stellæ, quas vagas dicimus, circum terra feruntur, eodemque modo oriunter et occidunt: quarum motus tum incitantur, tum retardantur; sæpe etiam insistunt. Quo spectaculo nihil potest admirabilius esse nihil pulchrius. Sequitur stellarum inerrantium maxima multitudo,' &c. &c.

VI. *Proper Motion of the Sun.*

34 The proper motion of the Sun may be easily observed and made out, by means of the instrument above described, in the following manner. Let the axis A P be directed to the pole, and fixed in that position; then, at different times of the year, let the line D S be pointed to the Sun. It will be easy to see when the telescope, or the rod with sights, points to the Sun, by the shadow it casts on a piece of card fixed at the extremity D, at right angles to the telescope or rod. We may, then, by means of the graduated circle, which we have stated should be fixed at C, measure the angle which the line D S makes with the line A P, and so find how far the Sun appears to be from the pole; i. e., if the angle is 80°, then the Sun is 80° from the pole, if 90°, the Sun is 90° from the pole, if 100°—100°, and so on. We may here observe, that when a heavenly body is 90° from the pole it is said to be in the *equator*, because, if it be 90° from the North pole, it must also be 90° from the South pole—i. e., it is half way between the two poles, its distances from each are *equal*, and it is said to be in the *equator*. The equator is, in fact, that circle every point of which is at equal distances—i. e., 90° from each pole.

35 Now, if we observe the Sun, as we have just stated, we shall find, about the third week in March, that the Sun is 90° from the North pole; and at the corresponding periods of the following months, we shall find that the Sun's distance from the pole will be exhibited, in round numbers, by the following table:—

MONTH.	Sun's distance from North pole.	Sun's distance from Equator.	MONTH.	Sun's distance from North pole.	Sun's distance from Equator.
March . .	90°	0°	October .	102°	12° South.
April . .	78°	12° North.	November.	110°	20° South.
May. . .	70°	20° North.	December .	$113\frac{1}{2}$°	$23\frac{1}{2}$° South.
June . .	$66\frac{1}{2}$°	$23\frac{1}{2}$° North.	January .	110°	20° South.
July. . .	70°	20° North.	February .	102°	12° South.
August . .	78°	12° North.	March . .	90°	0°
September	90°	0°			

36 The Sun's distance from the pole in this table may be obtained by using the instrument as above stated; his distance from the equator is of course immediately obtained by taking the difference between his polar distance and 90°. Thus, if the Sun is 70° from the pole, he is 20° above—i. e., north, of the equator, because 20° added to 70° make 90°, and 90° is the distance of the equator from the pole. In like manner, if the Sun is 110° from the pole, he is 20° below—i. e., south, of the equator, for 20° added to 90° make 110°.

37 By inspecting the above table, the Sun's motion towards and from the pole will be immediately evident. About the third week in March he crosses the equator; after this, he moves continually northward, until the corresponding period in June, when he attains his greatest altitude above the equator, about $23\frac{1}{2}$°. After this he begins to move southward, and continues to do so, till about the third week in September, when he again crosses the equator. He continues his motion southward till the third week in December, when he is at the most southerly point of his course, about $23\frac{1}{2}$° below the equator. After this, he returns again, and moves northwards, till he comes back to the equator, about the third week in March.

38 It is to this motion of the Sun towards and from the pole that Cicero alludes, in the words above quoted—'Et modo accedens, tum autem recedens, binas in singulis annis reversiones ab extremo contrarias facit.'

39 The Sun's motion towards or from the pole is quickest when he crosses

the equator, and slowest when he is at the greatest distance from the equator; in fact, about the third week in June, and the corresponding period in December, he is sensibly stationary for some days—i. e., his motion towards or from the pole is scarcely perceptible. This will be easily seen from the following table, in which his motions in March and June, 1849, are compared. A similar table would show his comparative motions in September and December.

Day of the Month.	Sun's distance from Equator.	Day of the Month.	Sun's distance from Equator.
March 15	2° 4′ South.	June 15	23° 20′ North.
„ 16	1° 40′ „	„ 16	23° 22′ „
„ 17	1° 16′ „	„ 17	23° 24′ „
„ 18	0° 53′ „	„ 18	23° 25′ „
„ 19	0° 29′ „	„ 19	23° 26′ „
„ 20	0° 5′ „	„ 20	23° 27′ „
„ 21	0° 19′ North.	„ 21	23° 27′ „
„ 22	0° 42′ „	„ 22	23° 27′ „
„ 23	1° 26′ „	„ 23	23° 27′ „
„ 24	1° 29′ „	„ 24	23° 26′ „
„ 25	1° 53′ „	„ 25	23° 24′ „
„ 26	2° 17′ „	„ 26	23° 22′ „
„ 27	2° 40′ „	„ 27	23° 20′ „

40 From this table we may see that in March the Sun moves northward at the rate of about 24′ per day, or 2° in five days; whereas, in June his whole northerly motion from the 15th day of the month to the 20th is only 7′; and from the 20th to the 23rd his motion is not perceptible.

The position of the Sun, when at his greatest distance from the equator was hence called *Solis Statio*, or the *Solstice*, because he became stationary for a short time at that point. In June, it was called the Summer Solstice, and in December the Winter Solstice. The times in March and September, when the Sun crosses the equator, were called the *equinoxes*, because then all over the world the length of the night is the same, which is not the case except at those particular periods of the year.

41 But the Sun has another proper motion besides that we have just explained, which may be made apparent by means of the instrument above described, and a watch.

The axis A P must be pointed towards the pole as before, and the tube B C must be fixed, so that the telescope or rod with sights, may be capable of moving only in one plane—i. e., about the axis C. If we make the axis C horizontal, the telescope will move in a vertical plane; in fact, in what is called the *Plane of the Meridian*, of which we shall speak more presently. We shall suppose the instrument to be thus disposed, the axis A P pointing to the pole, the tube B C fixed so as not to be capable of turning round, and fixed in such a position that the telescope may move in a vertical plane, or nearly so. Another plane would answer as well, but it will save circumlocution to suppose it to be a vertical plane—i. e., the plane of the meridian.

42 Now at night let the telescope, thus moving in the plane of the meridian, be placed so as to point to any particular star that happens to be at that time in the plane of the meridian. Let the hour and minute shown by the watch be immediately noted. Let a similar observation be made on the same star the next night, and of course about the same hour, and let the hour and minute shown by the watch be again noted. In this way the time, as shown by the watch, in which the star completes its revolution will be determined: for instance, suppose that at the first observation the watch shows twenty minutes past nine, and at the second seventeen minutes past nine; then it follows that the star completes its revolution in twenty-three

hours and fifty-seven minutes, as shown by the watch. We do not suppose the rate of the watch to be perfectly accurate; it should be of course a tolerably good watch, but it is no consequence if it gain or lose a few minutes in the day.

43 Again, let precisely the same observation be made upon the Sun on two successive days, and in this way let the time, as shown by the watch, in which the Sun completes his revolution be determined. In the example above supposed, it will be found that the Sun's time of completing his revolution will be very nearly twenty-four hours and one minute, as shown by the watch. And in all cases, whatever star we make our observations upon, it will be found that the Sun takes very nearly four minutes longer to complete his revolution than the stars do, for all the stars, as we have already stated, will complete their revolutions in exactly the same length of time. The Sun, therefore, is about four minutes later than the stars every day.

44 Now what is the cause of this? It is not the motion of the Sun towards or from the pole, because such a motion would not in any way affect the time of the Sun's coming into the plane of the meridian, it would only make him cross that plane nearer to or further from the pole, as the case might be. The cause must be, therefore, a backward transverse motion —i. e., a motion perpendicular to the motion towards or from the pole, which makes the Sun arrive at the plane of the meridian four minutes late every day—i. e., four minutes later than if the Sun were, like the stars, fixed in the heavens, and only subject to an apparent motion caused by the rotation of the Earth about its axis. If we suppose the watch to be regulated by the stars—i. e., if it shows twenty-four hours as the time of each star's completing its revolution, then, if the Sun crosses the meridian plane at twelve o'clock to-day, he will not cross it to-morrow till about four minutes past twelve. At twelve o'clock to-morrow, therefore, the Sun will be one degree behind the meridian; for in four minutes of time each heavenly body describes one degree of its apparent circular motion, and therefore as the Sun will arrive at the plane of the meridian at four minutes past twelve o'clock, he must be one degree behind that place at twelve o'clock.

45 We have now made out in a rough way the proper motions of the Sun; he has two proper motions, one towards or from the pole, as the case may be, the other a backward motion perpendicular to the former, at the rate of about one degree daily.

By the combination of these motions the Sun appears to describe an oblique circle in the heavens, moving backwards, (that is, from west to east.) Moving in this circle, he crosses the equator, at the time of the equinoxes, at an inclination to the equator of about $23\frac{1}{2}°$. This circle is called the *ecliptic*, because eclipses of the Sun and Moon occur only when the Moon crosses or comes near this circle.

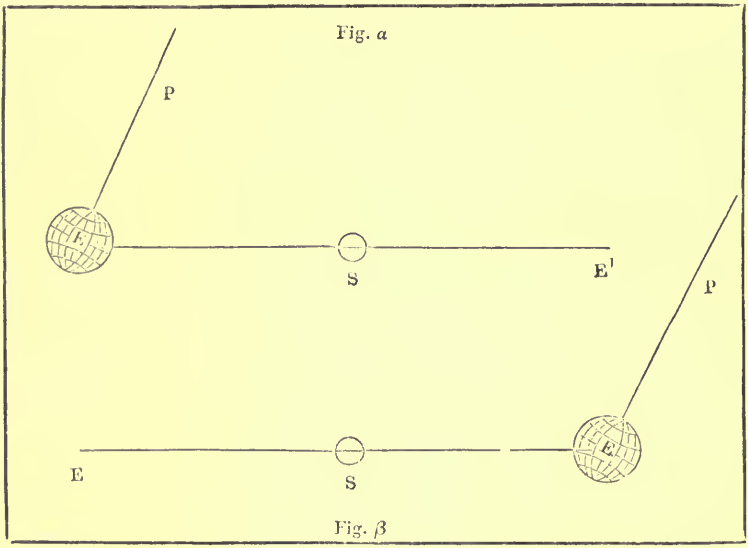
46 The proper motion of the Sun is only apparent, being caused by the Earth's real motion about the Sun. The Earth is one of the planets, being the third in order from the Sun; the planets all revolve round the Sun in planes, but little inclined to each other, and in nearly circular orbits. This is the Copernican theory, and it is the only rational way of accounting for the Sun's apparent proper motion, and the apparent proper motions of the planets—of which we shall speak immediately. Newton's theory of universal gravitation applied to determine the motions of the solar system, confirmed as it is in the most astonishing manner, by predictions of eclipses and occultations, and by solar, lunar, and planetary tables calculated from it, and verified with the greatest exactness by repeated observations, proves beyond doubt the truth of the Copernican theory, as also does the phenomenon of aberration, to which we have already alluded.

47 The apparent motion of the Sun towards and from the pole is caused by the inclination of the Earth's axis to the plane of the ecliptic—i. e., the plane in which the Earth moves round the Sun. If the Earth's axis were perpendicular to this plane, the Sun would always appear to be 90° from the

pole, as is manifest. But this not being the case, the Sun sometimes appears to be nearer to, and sometimes further from, the pole, as the Earth moves round.

48 To show this, we must observe that the Earth's axis remains parallel to itself, or very nearly so, during the year—i. e., it always points in the same direction; also its inclination to the plane of the ecliptic is $66\frac{1}{2}°$ in round numbers.

Now, this being the case, suppose E, fig. *a*, to be the Earth's centre, E P



its axis, and S the Sun, the angle P E S being $66\frac{1}{2}°$; then, in this position of the Earth with reference to the Sun—the polar distance of the Sun—i. e., the angle P E S, is $66\frac{1}{2}°$.

But in six months the Earth will describe half its orbit round the Sun, and therefore come into the position E′, just opposite E on the other side of S, as is represented in fig. β; also the axis E′ P will be parallel to its former direction E P, as is shown in the figure. Therefore the angle P E′ S, which is the Sun's polar distance, will be evidently greater than 90°—in fact, as much greater than 90° as P E S is less than 90°; in other words, the Sun will be $113\frac{1}{2}°$ from the pole.

49 It appears, therefore, that in one position of the Earth, the Sun will be $66\frac{1}{2}°$ from the pole, and in six months after $113\frac{1}{2}°$ from the pole. During the six months, the polar distance will gradually increase from $66\frac{1}{2}°$ to $113\frac{1}{2}°$ being 90° at the end of three months. In the remaining six months of the year, the polar distance will diminish till it becomes $66\frac{1}{2}°$ again—namely, when the Earth comes back to the position E.

The Earth in the above figures is supposed to move about S in a plane perpendicular to the plane of the paper. Hence it appears that the supposition of the parallelism of the Earth's axis, as it moves round the Sun, accounts for the changes in the Sun's polar distance.

VII. *Proper Motion of the Moon and Planets.*

50 The proper motion of the Moon is similar to that of the Sun, only about 13 times quicker, and rather irregular, at least, apparently irregular, but really obeying a regular, though complicated law. The Moon's proper motion may be observed by the instrument we have described, and exactly in the same way as the Sun's. It takes place in a circle inclined about 5° to the ecliptic, in which she moves from west to east in less than a calendar month. The following table will best explain the nature of her motion, which, like that of the Sun, is twofold—one motion towards or from the pole, the other a backward motion:—

Day of Month, 1849.	Moon's distance from equator.	Hour that the Moon comes to the meridian plane.
July 1	14° 10′ South.	$9^h\ 15^m$ afternoon.
„ 2	16° 28′ „	$10^h\ 1^m$ „
„ 3	18° 4′ „	$10^h\ 48^m$ „
„ 4	18° 53′ „	$11^h\ 36^m$ „
„ 5	18° 1′ „	$12^h\ 0^m$ „
„ 6	16° 20′ „	$0^h\ 24^m$ morning.
„ 12	1° 8′ North.	$5^h\ 7^m$ „
„ 13	5° 27′ „	$5^h\ 56^m$ „

The proper motion of the Moon is not apparent, but real; the Earth being the body about which the Moon actually revolves.

51 The proper motions of the planets may be observed in the same manner as those of the Sun and Moon; they are much more complicated, as the following table for Mercury will show:—

Day of 1849.	Number of minutes by which Mercury is too late or too soon in crossing the meridian plane each day.	Corresponding motion backward or forward.
January 1	7 minutes late.	$1\frac{3}{4}°$ backward.
„ 15	7 „ „	$1\frac{3}{4}°$ „
February 1	$5\frac{1}{2}$ „ „	$1\frac{3}{8}°$ „
„ 5	$4\frac{1}{2}$ „ „	$1\frac{1}{8}°$ „
„ 10	2 „ „	$0\frac{1}{2}°$ „
„ 11	$1\frac{1}{2}$ „ „	$0\frac{3}{8}°$ „
„ 12	1 „ „	$0\frac{1}{4}°$ „
„ 13	0 „ „	0° „
„ 14	0 „ „	0° „
„ 15	1 „ too soon.	$0\frac{1}{4}°$ forward.
„ 20	$3\frac{1}{2}$ „ „	$0\frac{7}{8}°$ „
„ 25	4 „ „	1° „
March 1	2 „ „	$0\frac{1}{2}°$ „
„ 5	1 „ „	$0\frac{1}{4}°$ „
„ 6	$\frac{1}{2}$ „ „	$0\frac{1}{8}°$ „
„ 7	0 „ „	0° „
„ 8	0 „ „	0° „
„ 9	$\frac{1}{2}$ „ late.	$0\frac{1}{8}°$ backward.
„ 10	1 „ „	$0\frac{1}{4}°$ „
„ 15	3 „ „	$0\frac{3}{4}°$ „
„ 20	4 „ „	1° „

From this table it is evident that in the first half of January, Mercury was continually moving backward among the stars, (i. e., from west to east,) at the rate of about $1\frac{3}{4}°$ per day. Up to the 13th of February, this daily backward motion became continually smaller, being $1\frac{3}{8}°$ on the 1st of February, $1\frac{1}{8}°$ on the 5th, only $\frac{1}{2}°$ on the 10th. Between the 13th and 14th, Mercury had no proper motion backwards or forwards, and so far became stationary. On the 15th, Mercury began to move forward (i. e., from east to west) at the rate of $\frac{1}{4}°$ per day; on the 20th, this forward motion had increased to $\frac{7}{8}°$ daily; on the 25th to 1°; on the 1st of March it had diminished again to $\frac{1}{2}°$; on the 5th to $\frac{1}{4}°$; and between the 8th and 9th, Mercury became stationary again; after this the motion became again retrograde.

52 From this description of the apparent proper motion of Mercury among the stars, which applies to Venus likewise, it is easy to understand the words of Cicero above quoted, 'quorum motus tum incitantur, tum retardantur, sæpe etiam insistunt.'

We have considered Mercury in the above description on account of his rapid motion, but it is difficult to see him on account of his proximity to the Sun. Venus would be the proper planet to make observations upon with the instrument above described, by the assistance of which, as in the case of the Sun, the proper motions of the planet may be made out.

VIII. *The Complicated Motions of the Planets are explained by supposing that they and the Earth move about the Sun as centre.*

53 The explanation which Copernicus gave of the apparently complex and irregular motion of the planets was, that they all, along with the Earth, move round the Sun as centre. This motion takes place nearly in one plane, (at least as regards the principal planets,) namely, the plane of the ecliptic. All the planets move the same way, which is from west to east—i. e., contrary to the apparent diurnal motion of the heavens, but in the same direction as the Earth's rotation about its axis, which causes that apparent motion.

54 It is the combination of the motion of the planet and that of the Earth, that makes the former appear sometimes to move forward, sometimes backwards, and sometimes to be stationary. To a spectator in the Sun, the motions of the planets would appear simple enough, the Sun being the centre about which they all move. But to a spectator on the Earth, which is not the centre of motion, and which moreover is itself moving round the Sun, the planetary motions must necessarily appear very complicated. To explain the fact that the planet's apparent motion is sometimes from east to west, sometimes from west to east, and sometimes ceases altogether, we have only to consider the different relative positions of the Sun, the Earth, and the planet.

55 Let us suppose the planet to be what is called *inferior*—i. e., nearer to the Sun than the Earth is, of which kind there are two, Mercury and Venus. In this case the motion of the planet about the Sun will be quicker than that of the Earth, for the nearer a planet is to the Sun, the faster it moves. In the first place, suppose the three bodies to be in the positions represented in fig. *j*, E denoting the Earth, S the Sun, and P the planet—say Venus, for example. The arrows show the directions in

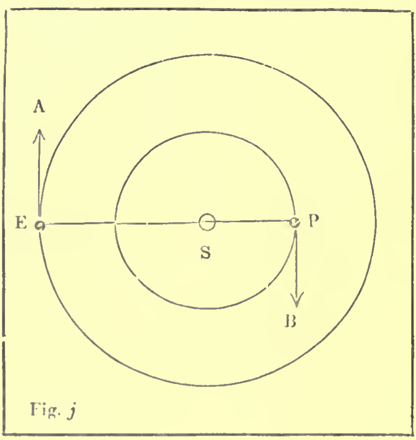


Fig. *j*

which E and P are moving in the circular orbits about S. While P is moving over a space of 10 miles along its orbit, E will describe a space of about 8½ miles, for the velocity of the Earth is, in round numbers, to that of Venus, as 8½ is to 10.

Now the effect of the Earth's motion of 8½ miles, will be to produce an apparent motion in Venus of 8½ miles, but in the opposite direction to that of the Earth*—i. e., in the direction of the arrow B. This apparent motion must therefore be added to the real motion of Venus—namely, 10 miles—which gives altogether a motion, in the direction B, of 18½ miles.

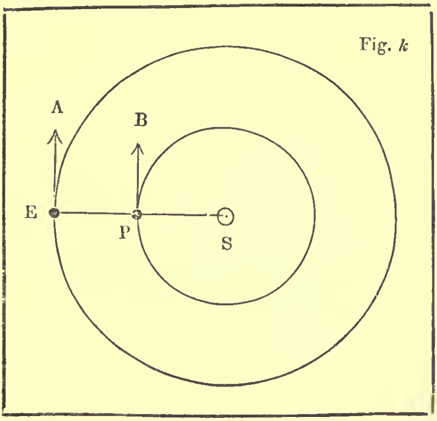


Fig. *k*

56 Secondly, suppose the three bodies to be in the positions represented in fig. *k*, then the motion of the Earth will, as before, communicate an apparent motion of 8½ miles to P, but now in the contrary direction to the arrow B, which shows the direction in which Venus describes her real motion of 10 miles. The apparent motion must therefore now be subtracted from the real motion, and this will leave altogether a motion of 1½ miles in the direction B.

57 Hence, to a spectator on the Earth, Venus, when situated as in fig. *j* with respect to the Earth and Sun, will appear to move with almost double her real velocity, from west to east, for that is evidently the direction in which B points in fig. *j*, being the direction in which the Sun will appear to move, in consequence of the Earth's motion about him. But when situated as in fig. *k*, Venus will appear to move, with not one-fifth of her real velocity, in the opposite to the former direction, that is, she will appear to move from east to west.

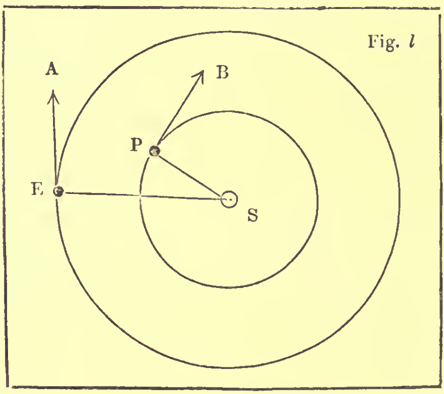


Fig. *l*

58 Thirdly, when the three bodies are situated as in fig. *l*, the real motion of Venus will be oblique to the line E P, and so will the apparent motion which arises from the Earth's real motion, and is equal and opposite to it. But the former motion will be more oblique than the latter, and therefore the former motion, which is the greater of the two, will appear more diminished in consequence of the obliquity of the line E P, than the latter, so much so, that supposing E and P to be in the proper relative positions in their orbits, the two motions will appear to counteract each other, and the planet will then seem to be stationary.

* A spectator in smooth and rapid motion, as for instance in a railway carriage, becomes insensible of his own motion, and fancies that external objects, trees, buildings, &c. are all moving backwards at the same rate that he is really moving forwards

59 Thus it is evident that the Copernican hypothesis (that the planets, with the Earth, move round the Sun as centre) clearly explains the otherwise unaccountable fact of the planets sometimes appearing to move from west to east, sometimes from east to west, and sometimes to be stationary.

60 The same reasoning as the above would apply to the *superior* planets, or those farther than the Earth from the Sun, of which the principal are Mars, Jupiter, Saturn, Uranus, and the lately discovered Neptune. Only a slight difference must be made because of their real motions being always greater than the apparent motion produced in them by the real motion of the Earth.

61 We have now given a sufficient general statement of the principal celestial motions, to serve as an introduction to the subject of astronomy. In the following chapters we shall confine our attention to the practical part of astronomy, as far as it is important to our present purpose, and space will permit.

CHAPTER II.

THE CELESTIAL SPHERE AND ITS CIRCLES. THE CONSTELLATIONS.

I. *Importance of a knowledge of the Constellations.*

A KNOWLEDGE of the manner in which the stars are grouped together and distributed over the heavens, and some degree of familiarity with the names and positions of the different constellations, and of the principal stars composing them, are highly desirable, not only as matters of deep interest, but also of practical importance. It is true, indeed, that an astronomer in his observatory may make his observations without ever having looked upon the heavens with the naked eye, he may, by means of his catalogues, his tables, and his clock, point his telescope to any particular heavenly body without looking out for it beforehand; and so far the knowledge we speak of is of no importance to him. But, if he wishes to compare his observations with those of others in past times, and to study the records of astronomers, both ancient and modern, he must be perfectly familiar with the classification of the stars into constellations which has prevailed over the whole civilized world for centuries, and which has the sanction of every great astronomer since the earliest times.

63 But there are very few who have an observatory to make use of; the great majority of persons who study astronomy practically must make their observations with portable instruments, in unknown latitudes; indeed, the object such persons have in view is to determine where they are on the Earth's surface, and it is chiefly for this purpose that they study astronomy. Now to such persons, catalogues and tables can be of no use, as far as finding any particular star is concerned; for an astronomer cannot point his telescope by such means except he knows his exact position on the Earth's surface. A sailor who wishes to direct his course over the ocean by astronomical observations, must know where to look for each heavenly body he makes use of for that purpose; and the same is true of every observer in an unknown locality; he must be perfectly familiar with the different groups of stars, the names they are called by, and their relative positions in the heavens; otherwise, however well versed he may be in the theory of astronomy, he will not be able to make any use of it practically.

64 But it may be said that the classification of the stars which has been so long in use, is perfectly arbitrary, having no absolute relation to their actual distribution and arrangement; that a much better, and less absurd system of

grouping might be adopted than the monsters and figures of the celestial globe. This may be true, to a certain extent, but exactly the same thing might be said of the division of England into counties. If any one proposed to make a new and more convenient division of England, by forming it into squares, or rectangles, or any other regular figures, it would be easy to show the uselessness and inconvenience of such a proposition, by saying that the present division into counties has been in existence for a long period of time, that it is recognised in our laws, our historical records, and our literature, and that it is in many cases well suited to the natural divisions of the country. We may make a similar answer to any one objecting to the present division of the heavens into constellations. It has been in existence for centuries. Astronomers have always made use of it in describing celestial phenomena, and in recording their observations; and ancient writers are full of allusions to it, not only astronomical and geographical writers, but poets, historians, chronologers, and even the writers of the inspired volume. Besides, the division is by no means unsuitable to the actual grouping of the stars, and makes a much more lasting impression on the memory than a more regular division, as, for example, into zones and segments of zones, would do.

65 To the geographical student, a perfect acquaintance with the constellations is absolutely necessary, if he wishes to make any practical progress in the scientific part of the subject. We shall therefore devote the present chapter to this part of astronomy, and endeavour to give a fair general idea of the manner in which different constellations are distributed over the heavens, and the positions of the principal stars composing them.

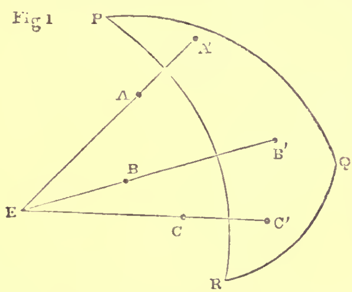
II. *Preliminary Observations respecting the Celestial Sphere and its Circles.*

66 Before we proceed to the description of the constellations, we must first say a few words respecting the celestial sphere and its circles, as we shall have to refer to these points constantly in all that we say respecting the constellations.

67 *Celestial Sphere.*—A sphere is the surface in solid geometry, which corresponds to the circle in plane geometry. Every point of a spherical surface is equally distant from the centre, and every part of the surface has the same degree of curvature. The distance of any point on the surface of a sphere from the centre is called the radius of the sphere, in the same manner as in the circle.

The Celestial Sphere is a sphere described about the eye of the observer as centre, with a radius of very great length. On the surface of this sphere all the heavenly bodies are *projected*, by lines drawn from the eye—that is to say, if P Q R be supposed to represent a portion of the spherical surface, E, the eye of the observer—i. e., the centre, and A B C any heavenly bodies at different distances from E; then, if lines be drawn from E through A B and C, to meet the spherical surface at the points A′ B′ C′, these points are said to be the *projections* of the heavenly bodies A B C *upon* the spherical surface, and the heavenly bodies are said to be *projected by* these lines *upon* the spherical surface.

Fig 1



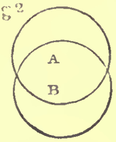
68 In point of fact, the heavenly bodies are so far off that the eye cannot appreciate their different distances, and they appear as if they were all at the same distance from it—i. e., we view them as if they were all projected on a sphere of immense extent, described round the eye as centre.

69 It is very convenient to make use of an imaginary sphere as a means

of representing the apparent positions of the heavenly bodies. The common celestial globe is intended to exhibit this sphere in miniature, with the various stars and constellations placed upon it, as they actually appear to the eye to be placed in the heavens.

70 It is important to explain for what reason we suppose the radius of the celestial sphere to be of immense length. It is not merely because it appears to be so, but because, by such a supposition, we avoid the necessity of defining very exactly the position of its centre. It would be very inconvenient if we considered this sphere to be described with a radius equal to the Moon's distance from us, great as that distance is; for then a change of the observer's position would sensibly alter the position of the celestial sphere. Even the Sun's distance, and we may, in the present perfection of astronomical science, say, even the distance of the nearest fixed star, would be too short a radius for our purpose. As this is a point of considerable importance, especially as it relates to what is called *Parallax*, we must endeavour to make our meaning clear by means of a figure.

Fig 2



71 Let A and B, (figs. 2 and 3,) be two centres, about which two circles of equal radius are described. The distance between A and B, in fig. 3, is the same as in fig. 2, but the radius of the circles in fig. 3 is much longer than in fig. 2. It is easy to see, by a simple inspection of the two figures, that the two circles in fig. 3 are much more nearly coincident with each other than the two circles in fig. 2. This is made more manifest by fig. 4, which represents the two circles in fig. 2 magnified so much as to become the same size as the circles in fig. 3.

Fig. 3

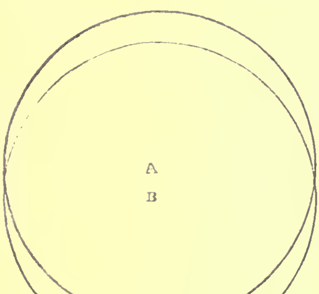
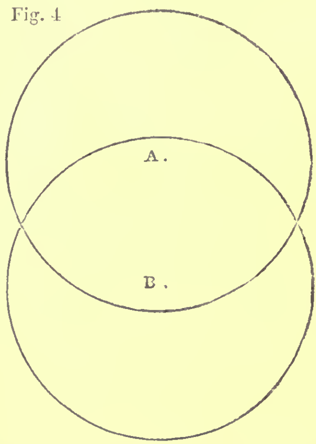


Fig. 4



72 Now, we may suppose A and B to be the positions of two observers on the Earth's surface, and the two circles to represent celestial spheres described about A and B as centres. If the radius with which the spheres are described be so small (compared with the distance of A from B) as is represented in fig. 2, it is clear that the observer at B will employ a celestial sphere sensibly different in position from that employed by the observer at A. But if the radius of the spheres be as large (compared with the distance of A from B) as is represented in fig. 3, then the two spheres will not differ, as regards their position, in anything like the same degree as in the former case. If we had space on this paper to represent two spheres described with a radius immensely exceeding the distance between the centres A and B, it is easy to conceive, by comparing figs. 3 and 4, how little the two spheres would differ from each other in position.

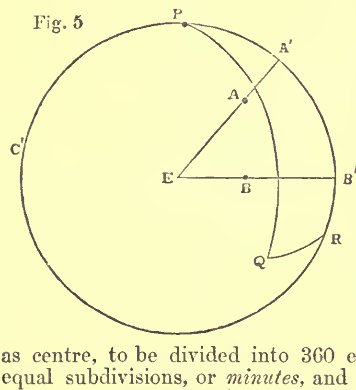
73 Hence the importance of supposing the radius of the celestial sphere to be very great, compared with the greatest distance at which two places of observation on the Earth's surface may be from each other; for then we may suppose that the celestial sphere at both places is the same both in magnitude and position, at least, we may consider the change of position of the celestial sphere, in consequence of the observer's change of place, to be practically insensible, compared with the magnitude of the sphere. We may, in fact, assume, without any error worth taking into account, that observers at different places on the Earth's surface, however distant from each other, project the heavenly bodies on the same celestial sphere.

We must remember that, in cousequence of the Earth's motion round the Sun, an observer changes his place in every half year, by a distance of 190 millions of miles, in round numbers. Therefore, we must consider the radius of the celestial sphere to be immensely greater than 190 millions of miles. The simplest thing to say on the subject is this—that the imaginary celestial sphere is of such enormous dimensions, that the whole space occupied by the solar system is a mere point compared with it, just as the hole made by the point of a compass in describing a large circle on paper is considered as a mere point, though in reality it is of sensible magnitude, and might be made to appear large enough if magnified.

74 *Circles of the Celestial Sphere.*—Circles described on the celestial sphere, with the observer's eye as centre, are employed very conveuiently to measure the angles, made by lines drawn from the observer's eye, in the following manner:—

Let E, fig. 5, be the observer's eye, P Q R a portion of the celestial sphere, A and B two heavenly bodies, which are projected upon the celestial sphere by the lines E A and E B, which meet the sphere at A′ aud B′. With E as centre, describe on the sphere a circle, A′ B′ C′, passing through the points A′ and B′, and divide the whole circumference of this circle into 360 equal parts or *degrees.* Then, if the portion A′ B′ of its circumference contains 10 of these equal parts, it is clear that the angle A′ E B′ is an angle of 10 degrees; if it contains 20 of the equal parts, A′ E B′ will be an angle of 20 degrees, and so on If, therefore, we conceive every circle described on the spherical surface about the eye as centre, to be divided into 360 equal parts, each of these parts iuto 60 equal subdivisions, or *minutes,* and each subdivision into 60 equal subdivisious, or *seconds,* again; these divisions and subdivisions will show how many degrees, minutes, and seconds there are in the angle contained by any two lines drawn from the eye. By producing the two lines to meet the sphere, and then connecting the points of meeting by a circular arc, described about the eye as centre, the divisions and subdivisions of this arc will show how many degrees, minutes, and seconds there are in the angle made by the two lines.

Fig. 5



75 This method of exhibiting the angles, which lines drawn from the eye make with each other, by means of circular arcs described on the surface of the celestial sphere, is very convenient, as it greatly helps the mind to understand and make out how such angles are related to each other. This is the foundation of what is called *Spherieal Trigonometry,* of which we shall speak more hereafter.

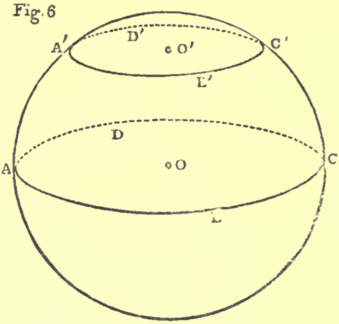
76 *Small and Great Circles of the Sphere.*—The circles we have just spoken of are called *Great Circles of the Sphere,* the distinguishing property of which is—that they are described about the centre of the sphere (i. e., the

eye) as centre. A circle described on the sphere, about any other point as centre, is called a *Small Circle.*

It is easy to see that a great circle divides the spherical surface into two equal parts (which are therefore called *Hemispheres*); but a small circle divides it into two unequal parts.

In fig. 6, A B C D shows a great circle, and A′ B′ C′ D′ a small circle of the sphere, the centre of the former circle being O, which is supposed to be the centre of the sphere, and the centre of the latter being O′, which does not coincide with the centre of the sphere.

Fig. 6



77 If we make a section of a sphere by a plane, the section will be circular. If the centre of the sphere be in the cutting plane, the section will be a great circle, as is shown in fig. 7; if not,

Fig. 7

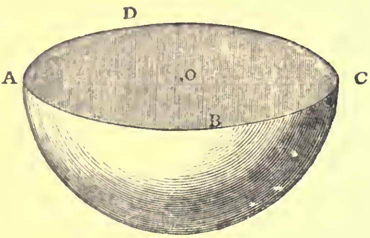
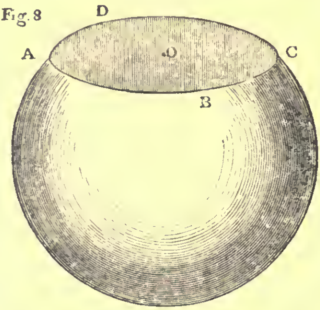


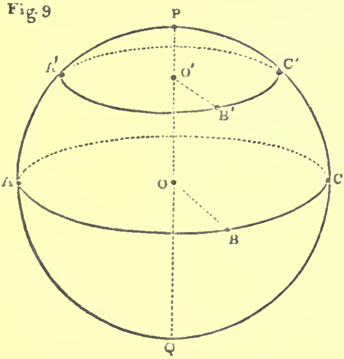
Fig. 8



it will be a small circle, as is shown in fig. 8; A B C D showing the cutting plane, and O the centre, in both figures.

78 We may therefore define a great circle to be the section resulting from cutting the sphere into two equal parts by a plane, and a small circle to be the result of cutting it into two unequal parts.

Fig. 9



79 *Pole of a Circle of the Sphere.*— Let O, fig. 9, be the centre of the sphere; draw any line P Q through O to meet the surface of the sphere at the points P and Q; and let O B be a line drawn from the centre O, perpendicular to the line P Q, to meet the spherical surface at the point B.

Now suppose P and Q to be two points, or pivots, about which the line P Q may turn, carrying the line O B with it; in fact, let P Q be an axis, and O B a perpendicular rod firmly attached to it. Then, if this axis be turned round, it is clear that the extremity B of the rod O B will trace a circle C B A on the spherical surface, which circle, since its centre is evidently at O, is a great circle.

80 If O′ B′ be another line, or rod, perpendicular to the axis P Q and firmly fixed to it, and if B′ be the point where it meets the spherical surface, then the point B′ will trace out another circle, C′ B′ A′, when the axis is

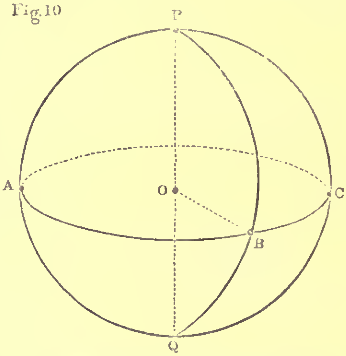
turned round about its pivots P and Q; and this circle will be a small circle, because its centre, O′, does not coincide with the centre of the sphere.

81 P and Q are called the *Poles* of these circles; the word Pole being derived from the Greek, which signifies a hinge, pivot, or bearing, about which a body may smoothly turn.

82 All circles described about the same poles are called *Parallel Circles*, or *Parallels*, because they are at all points equidistant from each other. Thus the two circles, C B A and C′ B′ A′, being described about the same poles, P and Q, in the manner above described, are parallel circles. An infinite number of circles parallel to C B A, may be described by assuming the point O′ in different positions along the axis P Q.

Every point *of a great circle* is 90 degrees from its pole; for if B (fig. 10) be any point of the great circle C B A, and if we draw another great circle P B Q, connecting the points P B and Q, it is clear that P B Q is a semicircle, and therefore measures 180°, and, since B is half way between P and Q, P B and Q B must each measure 90°.

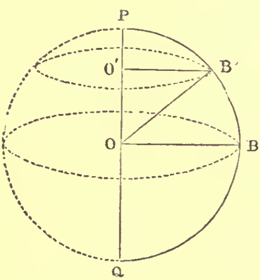
Fig. 10



Every point of a small circle is less than 90° from one pole, and more than 90° from another pole.

83 *Comparative Magnitudes of Small and Great Circles.*—Let P B Q (fig. 11) be a semicircle, P Q its diameter, O its centre, O B and O′ B′ lines perpendicular to P Q. Then if we conceive this semicircle to be turned about P Q as an axis, P and Q being the pivots or poles, the semi-circumference P B Q will evidently describe, or, as it is said, *sweep out* a spherical surface, the point B will describe a great circle, and the point B′ a small circle, O and O′ being the respective centres of the two circles. Our object is to compare the magnitudes of these two circles.

Fig 11



Now it is well known, that the greater the radius of a circle is, the greater is the circumference in proportion; if the radius of one circle be twice that of another, the circumference of the former will be twice as long as that of the latter; if three times, three times; if four times, four times, and so on. Hence, whatever be the proportion of O′ B′ to O B, the same will be the proportion of the small circle (which is described with O′ B′ as radius) to the great circle (which is described with O B as radius.)

The circular arc P B′ shows the distance of every point of the small circle from its pole P; if P B′ contain 10°, or 20°, or 30°, the small circle is accordingly said to be 10°, or 20°, or 30° from the pole. P B′ is commonly called the *Polar Distance* of the small circle.

84 The fraction which O′ B′ is of O B, is called in trigonometry the *sine* of the circular arc P B′; thus, if O′ B′ be $\frac{1}{2}$ of O B, the sine of P B′ is said to be $\frac{1}{2}$; if O′ B′ be $\frac{1}{3}$ of O B, the sine of P B′ is said to be $\frac{1}{3}$, and so on. Tables are calculated, by which the sines of arcs of every magnitude, from 0° to 90°, may be found immediately; so that by simple inspection of these tables we may find what fraction O′ B′ is of O B, if the number of degrees in P B′ be given

85 Now, whatever fraction O′ B′ is of O B, the same fraction is the small circle described about O′ as centre of the great circle described about O as

centre. Hence we have the following rule for finding what fraction the former circle is of the latter.

To find what fraction the circumference of a small circle of the sphere is of a great circle, look in a table of sines for the sine of the polar distance of the small circle, and that will be the fraction required.

If the length of the great circle be given, that of the small circle is found by multiplying the length of the great circle by the proper fraction—i. e. by the sine of the polar distance of the small circle.

86 The following short table shows the sines of circular arcs for every five degrees, from 0° to 90° :—

Circular Arc	Sine.	Circular Arc.	Sine	Circular Arc.	Sine	Circular Arc.	Sine.
0	0	25°	$\frac{423}{1000}$	50°	$\frac{766}{1000}$	75°	$\frac{966}{1000}$
5°	$\frac{87}{1000}$	30°	$\frac{500}{1000}$	55°	$\frac{819}{1000}$	80°	$\frac{985}{1000}$
10°	$\frac{174}{1000}$	35°	$\frac{574}{1000}$	60°	$\frac{866}{1000}$	85°	$\frac{996}{1000}$
15°	$\frac{259}{1000}$	40°	$\frac{643}{1000}$	65°	$\frac{906}{1000}$	90°	1
20°	$\frac{342}{1000}$	45°	$\frac{707}{1000}$	70°	$\frac{940}{1000}$		

87 If we suppose the small circle, like the large circle, to be divided into 360°, a degree of the small circle will be the same fraction of a degree of the large circle that the whole circumference of the small circle is of the whole circumference of the great circle Hence the length of a degree of a small circle is to be found by multiplying the length of a degree of a great circle by the sine of the polar distance of the small circle.

Thus, if we suppose a small circle described on the Earth's surface at 40° from the north pole (which is the polar distance of the southern extremity of England), the circumference of that circle will be (the sine of 40° being $\frac{643}{1000}$) $\frac{643}{1000}$ of the whole length of the equator; and the length of a degree of this small circle will be got by multiplying $69\frac{1}{2}$ miles (the length of a degree of the equator in round numbers) by $\frac{643}{1000}$.

Having dwelt sufficiently on these points, we shall now go on to describe the appearance and arrangement of the stars on the celestial sphere.

III. *Classification of the Stars with respect to Brightness.*

88 The apparent brightness of the stars is very different; some shine with considerable brilliancy, some are less bright, others almost invisible to the naked eye, and multitudes to be seen only by the aid of the telescope. As the apparent brightness of a star is, to a certain extent, a distinguishing mark of it, it is important to have some classification of the stars with respect to the quantity of light they emit to the eye.

89 Stars visible to the naked eye are divided into six classes; those of the first class are the brightest, and are about twenty in number: they are called stars of the *first magnitude.* The second class includes about seventy stars which, though clear and bright, are not so remarkable as those in the first class; they are called stars of the *second magnitude.* The third class consists of about 220 stars, fainter, of course, than the former, but still very obvious to the eye, these are said to be of the *third magnitude.* There are about 500 stars of the *fourth magnitude*, 690 of the *fifth*, and 1500 of the *sixth.* The stars of the fifth and sixth magnitude are not visible on a clear moonlight night to the naked eye, and therefore on such a night those of the fourth magnitude will be the faintest visible without telescopic aid. Altogether, there are, in round numbers, about three thousand stars that are visible to the naked eye.

90 Stars which can be seen only through a telescope are called *telescopic* stars. They are spread over the whole expanse of heaven, in some places close together, as in the Milky Way, in other places far apart. Where they are close together, they are seen by the naked eye like cloudy spots or streaks in the heavens, which, when examined by a powerful telescope, completely change their appearance, and become assemblages of innumerable bright points of light sprinkled, as it were, over a dark ground. The Milky Way, which appears like a faint, narrow cloud of irregular shape encircling the whole celestial sphere, is well known. Besides this, there are a number of small cloudy spots of various shapes called Nebulæ seen by means of a telescope of moderate power, many of which, on using a higher power, are resolved, as it is said, into assemblages of stars. Some of them have never been resolved even by the magnificent instrument of Lord Rosse, seen through which they still present the same indistinct and hazy appearance as in a less powerful telescope.

91 The classification of the stars visible to the naked eye into six classes or magnitudes is very convenient in a general way; but for accurate purposes it is too rough, and subject to great uncertainty; so much so that many stars, which are considered in some maps as of one magnitude, are in other maps put down as of a different magnitude. Thus, for instance, in Littrow's maps (Atlas des gestirnter Himmels) the seven stars in the Great Bear are represented to be all of the second magnitude, except the star marked δ, which is put down as of the third. But in the maps published by the Society for the Diffusion of Useful Knowledge, the star α is considered to be of the first magnitude, β, γ, and η of the second, and δ, ϵ, ζ of the third.

92 There is, however, a good reason for uncertainty with respect to the magnitudes of several stars, in the fact that they appear to change their magnitude from time to time, being subject, from some cause or other, to a periodical variation of brightness. Thus, for example, the remarkable star *Algol* (β Persei) suffers a considerable change of brightness in a period of not quite three days, being at one time during that period of the second magnitude, and at another time only of the fourth.

93 The most probable way of accounting for this change of brightness is by the supposition that it is caused by the revolution of spots on the star's disk, as in the case of the Sun, or by large planetary bodies moving round the star as their Sun. The manner in which the brightness of Algol varies makes this very likely, for it changes rapidly from the second to the fourth magnitude, and then as rapidly back again to the second, after which it remains unchanged for the remainder of the period. The change from the second magnitude to the fourth and back again occupies only seven hours; while the time during which the star retains its brightness unchanged is about sixty-two hours. This is accounted for easily, if we suppose a spot or opaque body to revolve round the star in about sixty-nine hours, during seven hours of which time it is between the eye and the star.

For full information respecting this interesting point, we may refer the reader to Captain Smyth's *Celestial Cycle*, in the second volume of which complete and accurate information is given respecting almost every star and object of interest in the heavens. This is a most valuable, and we may say amusing book, and ought to be in the hands of every one who takes an interest in astronomy.

94 A good method of getting an idea of the magnitudes of the different stars is to watch them as they become visible in succession after sunset. As the daylight fades away, those of the first magnitude are seen first; soon after, those of the second come out, then those of the third, and so on. The light of the Moon may also be used as a test of the comparative brightness of the stars. For more accurate methods, *see* Smyth's *Celestial Cycle*, vol. i. p. 272.

It is scarcely necessary to observe that the word magnitude, as applied to the stars, is not used in its proper signification; it has, of course, no reference to the real magnitudes or dimensions of the stars, but only to their apparent brightness.

95 We shall now proceed to describe the principal constellations, and show how and where they are to be found in the heavens. As we go on, we shall explain the meaning of various astronomical terms which have relation to the celestial sphere, and to the apparent motion of the Sun.

In describing the constellations, we shall endeavour to do so in such order, and to classify them in such a manner, that any one may, in a short time, make himself quite familiar with their appearance and relative positions in the heavens.

IV. *Of the North Circumpolar Region of the Heavens.*

96 *Method of finding the Pole Star by means of the Great Bear.*—If we observe the motion of the stars for four or five hours, we shall perceive, as has been already stated, that they all revolve about a particular point of the heavens, which is called (in these latitudes) the North Pole. Near this point is a tolerably bright star, which is known by the name of the *Pole Star.* There is no other star of equal brightness in the immediate vicinity of the North Pole, and therefore the Pole Star, once pointed out, is easily recognised again, especially as it is always to be seen in the same direction on account of its nearness to the Pole; for the circle it describes about the Pole is so small, that its motion is not sensible to the eye without the assistance of some instrument.

97 To find the Pole Star, we must have recourse to the remarkable and well-known group of stars commonly known by the name of the Great Bear, of which imaginary animal they form the tail and hind quarter. They are often called Charles' Wain, and sometimes the Plough, and this latter name gives the best idea of the form of this group of stars.

Their Latin name was Septem Triones, or the Seven Oxen; Trio signifying an Ox. The Greek name, αρκτος, (*arctos*,) signifies a bear, and hence the northern region of the heavens is called the *Arctic* region. The Latin name of the whole constellation of the Great Bear is Ursa Major.

The group consists of seven rather bright stars, which are usually denoted by the Greek letters, α β γ δ ε ζ η, as is shown in fig. 12. The three stars, ε ζ η, form the tail of the Great Bear, α β γ and δ the hind quarter. The whole constellation, with the imaginary figure of the Bear, is shown in fig. 13, (on next page,) which includes all the stars as far as the fourth magnitude.

98 The star α is called *Dubhe*, (an Arabic name, signifying the Bear;) it is the brightest star of the seven, and may be considered as of the first magnitude.

The star δ is the faintest of

Fig. 12

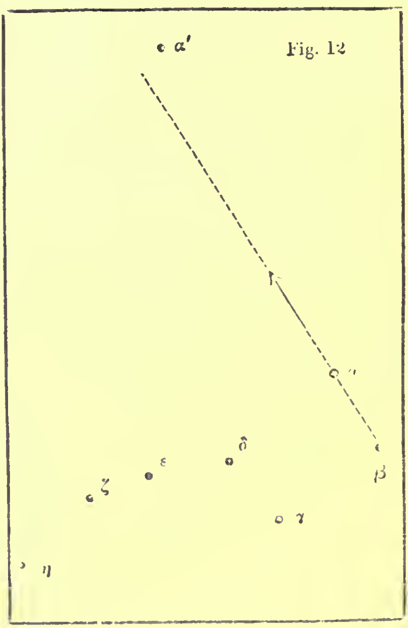
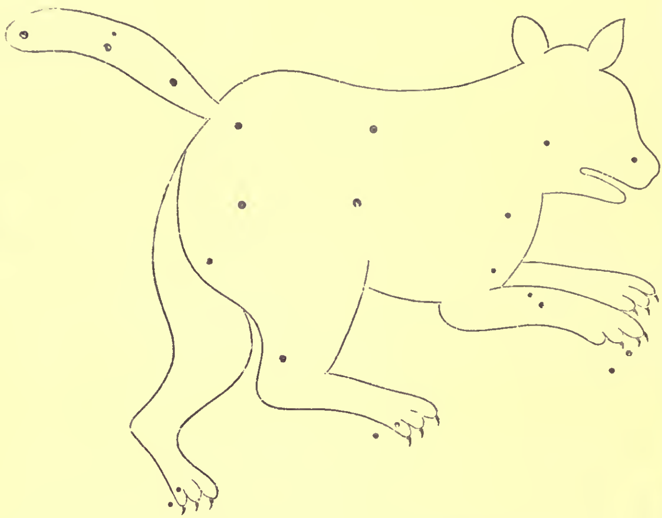


Fig. 13



the group, and is of the third magnitude; the other stars may be considered as of the second magnitude.

This constellation is constantly alluded to by ancient writers. In Homer (*Od.* v. 272) we find the following lines:—

οὐδέ οἱ ὕπνος ἐπὶ βλεφάροισι ἔπιπτεν
Πληϊάδας τ' ἐσορῶντι καὶ ὀψὲ δύοντα Βοώτην
Ἄρκτον θ' ἣν καὶ Ἄμαξαν ἐπίκλησιν καλέουσιν
ἥτ' αὐτοῦ στρέφεται καί τ' Ὠρίωνα δοκεύει
οἴη δ' ἄμμορός ἐστι λοετρῶν Ὠκεανοῖο.

'Nor did sleep fall upon his eyelids as he watched the Pleiades, and the late-setting Bootes, and the Bear, which also is commonly called the Wain, which revolves in that part of the heavens, and watches Orion, and alone is never bathed in the ocean.'

99 The stars a and β are commonly called the *Pointers*, because they point nearly towards the Pole Star. If an imaginary line be drawn in the heavens through the Pointers, it will pass near the Pole Star, as is represented in fig. 12, where a' denotes the Pole Star.

In finding the Pole Star by means of the Pointers, it is important to remember that this line is to be drawn in the direction represented by the arrow, i. e., from β to a, not from a to β. From a' to a is about five times the distance between a and β, a' is on the *off side* of the line of direction of the Pointers, with reference to the seven stars, i. e., *not* on the same side as the tail. We may therefore give the following rule for finding the Pole Star :—

100 Draw an imaginary line in the heavens from β to a, and produce it on till the produced part is about five times the length of the distance from β to a; then near the extremity of this line, on the contrary side to the Bear's tail, will be seen a star, with no other equally bright in its vicinity, which is the Pole Star.

101 *Of the Little Bear, or Ursa Minor.*—The Pole Star, or *Polaris*, as it is often called, forms the extremity of the tail of what is known by the

name of the *Little Bear*. This constellation is by no means so obvious to the eye as the seven stars of the Great Bear, the stars composing it being fainter, with the exception of Polaris. The Little Bear is represented in fig. 14, with the form of the animal traced out. The relative positions of the Great Bear and Little Bear are shown in fig. 15.

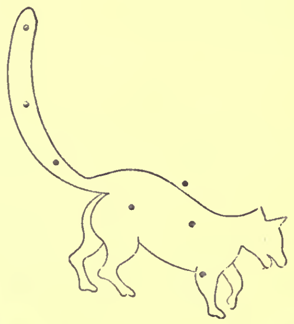


Fig. 14

The stars of the Little Bear form a figure not unlike that of the seven stars of the Great Bear. It may be well to observe, that the tails of the two Bears are on contrary sides. The stars of the Little Bear are denoted by Greek letters, as is represented in fig. 15, and the same plan is adopted in all the other constellations. The Pole Star is α of the Little Bear, and in most cases α denotes the brightest star of a constellation. It is usual to specify any particular star by prefixing the Greek letter by which it is denoted to the Latin name of the constellation to which

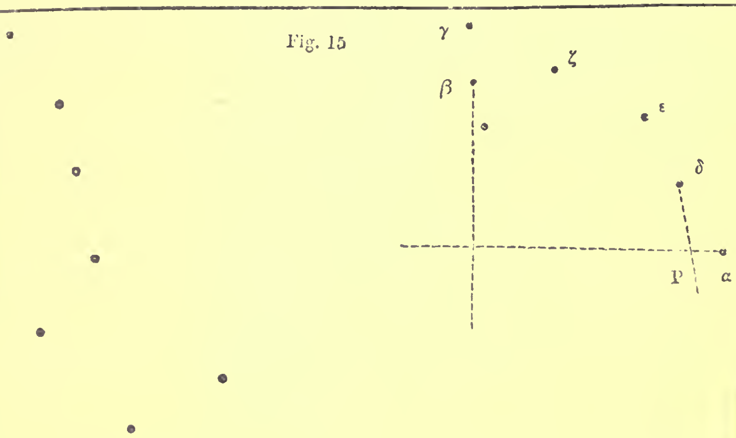


Fig. 15

it belongs in the genitive case. Thus, Polaris is spoken of as α Ursæ Minoris, β of the Great Bear as β Ursæ Majoris, and so on. Sometimes stars are marked by Roman letters and by numbers; for instance, we have 61 Cygni, m Ursæ Majoris.

102 The use which was made of Polaris in navigation is well known, and is very ancient. Polaris is often called the *Lode Star*—i. e., the leading or guiding star. It was formerly called *Cynosura*, or the *Dog's Tail*, Ursa Minor having been figured as a dog in those times.

The word cynosure has passed into our language, denoting whatever is a centre of attraction to the eye: thus, in Milton's *L'Allegro* we have—

> Where perhaps some beauty lies,
> The Cynosure of neighbouring eyes.

In the Latin translation of the poem of Aratus we have—

Ex his altera apud Graios Cynosura vocatur

. . . .

Hac fidunt duce nocturna Phœnices in alto.

Probably this line explains why Polaris was often called Phœnice.

103 The two stars β and γ of the Little Bear were called the *Guards*, from a Spanish word signifying 'to watch,' because they were used by sailors to mark the hour of the night before watches and chronometers were invented. The star β was nearer to the pole than Polaris two thousand years ago, and it was the North Star of the Arabian astronomers, whence it was called *Kocab.*

104 The position of the pole may be nearly found by means of the Pole Star and the Guards, in the following manner:—

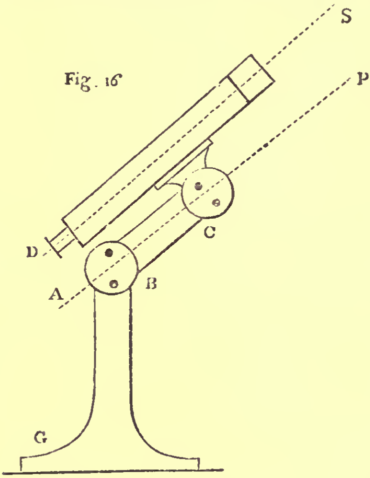
In fig. 15, draw a line through Polaris (a) perpendicular to the line joining the two Guards β and γ, and in that line, about $1\frac{1}{2}°$ from Polaris, is the North Pole, represented by P in the figure.

105 To get an idea of the distance of the Pole from Polaris, we may observe that the Pole is about twice as far from the star δ as it is from a, and that the line drawn from δ to P is inclined, as is represented in the figure, to the line drawn from a perpendicular to that passing through β and γ.

At present the Pole is getting nearer to the Pole Star; in about 140 years the Pole will be about $\frac{1}{2}°$ from Polaris, afterwards it will recede from it.

106 *Method of Setting the Instrument described in the former Chapter.*—We shall here explain the manner in which the instrument, described in the former chapter, may be placed with the axis A P (fig. *e*) pointing towards the Pole nearly.

Fig. 16



First, the telescope (or the rod with sights) must be turned round its pivot C, until it points in the same direction as the line A P, as is represented in fig. 16. This may be easily done by pointing the telescope, placed as in fig. 16, towards any distant object, S, and then turning the tube B C round. If, on doing this, the object S does not appear to change its position in the telescope, then it is easy to see that the line D S must be parallel to the axis A P, about which the tube has turned. If, however, the object S appears to change, the telescope must be slightly turned about its pivot C, until the apparent position of the object S, in the telescope, is not affected by the motion of the tube about its axis.

107 When the telescope is thus adjusted, the graduated circle, which is attached to C, to measure the angle made by the lines A P and D S, ought to show zero, since the two lines are then parallel. This gives us a method of finding whether the graduated circle is properly placed or not, and if not, of making the necessary adjustment.

108 Now, supposing the telescope to be placed with its line of collimation, D S, parallel to the axis A P, let the whole upper portion of the instrument be turned about the joint A, and the vertical stem A G also if necessary, until the telescope points to the Pole, the position of which must be guessed by the eye, by drawing from Polaris an imaginary line, perpendicular, as nearly as can be judged, to the line joining the two Guards, and taking a point on that line twice as far from the Star δ as from Polaris. This may

be easily done without losing more than a half of a degree from the true place of the Pole, and this will be sufficiently accurate, considering the rudeness of the instrument. The axis A P, having been once directed to the Pole, should be fixed in that position, which may be done by tightening the joint A, and by putting three marks on the circumference of the base of the instrument G, and three corresponding marks on the pedestal out of doors upon which the instrument is placed, so that the instrument may be put back in its proper place, should it have been removed.*

109 With the instrument thus placed, the general facts stated in the former chapter, respecting the circumpolar motion, and the proper motions of the Sun, Moon, and Planets, may be easily observed according to the method described in the case of the Sun.

110 *Cassiopea's Chair.*—If an imaginary line be drawn from any one of the three stars forming the tail of the Great Bear (ϵ, ζ, or η, Ursæ Majoris) through Polaris, it will lead to the constellation *Cassiopea*, the five principal stars of which form Cassiopea's Chair, which is something like a distorted M or W The Pole is about half-way between the tail of the Great Bear and Cassiopea's Chair. Fig. 17 shows the five principal stars of this constellation.

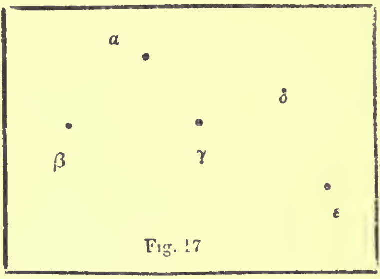
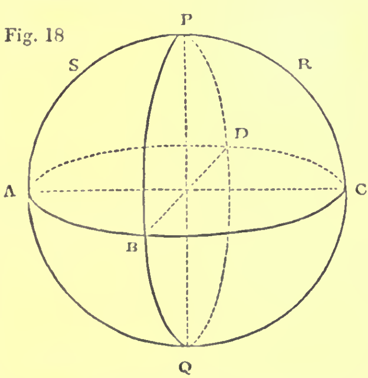


Fig. 17

111 It is worth remembering, that the five stars of the Chair form two triangles, one nearly a right angled triangle, consisting of α, β, and γ, and the other a very obtuse angled triangle, consisting of γ, δ, and ϵ. We make this observation, because, without it, it is not easy to distinguish β from ϵ, and it is of some importance to remember which of the five stars is β.

112 β Cassiopeæ is a star of the second magnitude, and is the extreme, on the side of the right angled triangle, of the five stars. If a great circle be drawn through Polaris and β Cassiopeæ, it coincides very nearly with the great circle called the *Equinoctial Colure*—i. e., the great circle passing through the poles and the two equinoctial points of the Equator. All great circles passing through the Poles were formerly called Colures, (κόλουροι,) because, as the word signifies, they were partly cut off, or, as it were, maimed, by the horizon. The name is now restricted to *two* great circles passing through the Poles, one cutting the Equator at the equinoctial points, the other at points 90° from the equinoctial points. The former was called the Equinoctial Colure, the latter the Solstitial, because, as we have already explained, the points where the Sun becomes stationary for a short time (as far as his motion towards or from the Pole is concerned) are in the latter great circle.

Fig. 18


113 In fig. 18, which is supposed to represent a sphere, these circles are shown. A B C D represents the Equator, P the North Pole, Q the South Pole, A the Vernal Equinoctial point, C the Autumnal, B and D the points of the Equator which are 90° from A and C: then the great circle P A Q C is the Equinoctial Colure, and the great

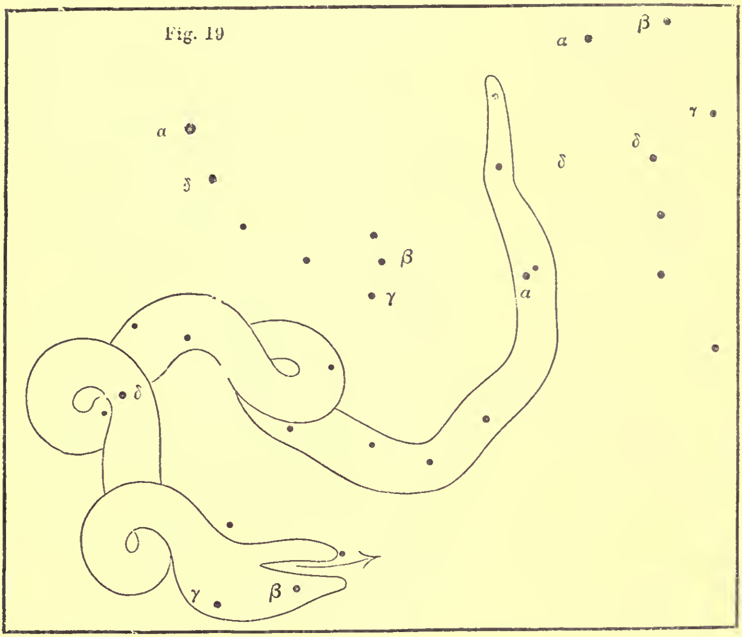
* A projecting piece at A, with a clamp and screw, would make it easy to point A P to the Pole, and keep it fixed at the proper inclination.

circle P B Q D the Solstitial Colure. The Equinoctial Colure is marked by the Stars δ Ursæ Majoris, Polaris, and β Cassiopeæ; the position of δ Ursæ Majoris is about at R, and that of β Cassiopeæ at S.

The star *a* of this constellation is one of those remarkable stars, the brightness of which is continually changing. *a* generally appears fainter than β, but sometimes it becomes brighter. What the cause of this change of splendour may be we can only guess. It is likely, as we have already stated, that there are spots on the star's disc, and that they sometimes appear and sometimes disappear, in consequence of the star's rotation about its axis, so causing a variation in the quantity of light emitted from the star; or the change of brightness may be caused by large planetary bodies revolving about the star as their sun, and sometimes intercepting the light of the star.

114 *The Dragon.*—The constellation *Draco*, the Dragon, commences between the Great Bear and the Little Bear, runs almost half way round the latter, and then turns off in the opposite direction. It is represented in fig. 19, with the form usually given to the Dragon traced out, Ursa Minor on one

Fig. 19



side of the tail, and the Septemtriones on the other. It is worth observing, that this constellation, commencing not far from *a* Ursæ Majoris, (the first of the Pointers,) lies on the *tail side* of the Septemtriones, and on the same side as the body, not the tail, of the Little Bear. In the 1*st Georgic* of Virgil, the position of Draco between the two Bears is described—

> Maximus hic flexu sinuoso elabitur Anguis
> Circum perque duas in morem fluminis Arctos,
> Arctos Oceani metuentes æquore tingi.

'Here the enormous Dragon glides round with winding flexure, like a river, between the two Bears, the Bears that fear to dip in the ocean.'

115 The star *a* Draconis, which is not far from half way between the two

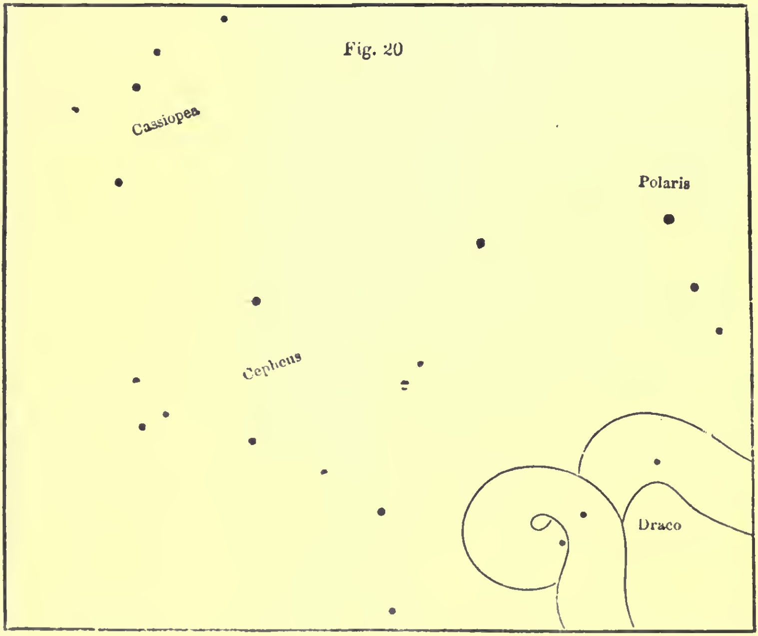
Guards in the Little Bear and the tail of the Great Bear, was formerly the Pole Star, the Pole having been very near it (not a quarter of a degree from it) in the times of the Chaldean observers.

116 The two principal stars of this constellation are those marked β and γ in the head of the Dragon, and their position should be well remembered; they are of the second magnitude. To find them, we have only to draw an imaginary line through α and δ Ursæ Minoris, near which they will be found, or, what is the same thing nearly, a line from Polaris, perpendicular to the line from Polaris to γ Ursæ Majoris, will find them. They are about at the same distance from the Pole as the second of the Pointers (β Ursæ Majoris). A line through the Guards (β and γ Ursæ Minoris), goes nearly through the head of Draco.

γ Draconis is a most remarkable star in the history of astronomy; it passes nearly vertically over Greenwich, and was on that account chosen by the great astronomer, Bradley, as the most suitable for his observations, which led him to the twofold discovery of the Aberration of Light and the Nutation of the Earth's axis.

117 *Cepheus.*—Between the Dragon and Cassiopea will be found the stars of this constellation; they are not easily distinguished from the stars of Draco, but, by remembering, that an imaginary line through γ Ursæ Majoris and β Ursæ Minoris, (the inner Guard,) separates Draco from Cepheus, there will never be any difficulty in making out the limits of Cepheus. Fig. 20 shows Cepheus.

Fig. 20

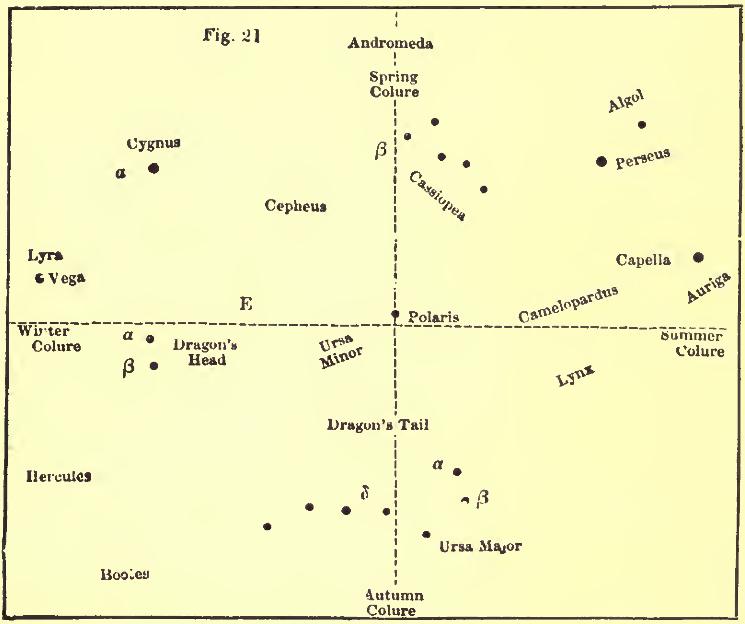


118 *Camelopardus.*—This constellation is by no means remarkable; it occupies the space on the opposite side of the Dragon beyond Polaris, and between the head of the Great Bear and Cassiopea.

119 *Position of the Colures with reference to the Circumpolar Stars.*—We have described the constellations in the immediate vicinity of the Pole at

some length, because, when their positions with reference to the Pole and to each other are well understood and remembered, they form so many guides and points of departure, whereby the other constellations may be readily found.

We have already stated that the Equinoctial Colure nearly coincides with the great circle passing through β Cassiopeæ, a Polaris, and between γ and δ Ursæ Majoris, nearer to δ than to γ. The *Solstitial Colure* runs through the Pole at right angles to the Equinoctial, close by γ Draconis. It is always worth remembering that the Colures are marked by Polaris, near which they intersect, by β Cassiopeæ and δ Ursæ Majoris, which show the direction of the Equinoctial Colure, and by γ Draconis, (in the Dragon's Head,) which shows the direction of the Solstitial Colure. In fig. 21 the colures and the circumpolar constellations are represented.



120 *Pole of the Ecliptic and the Sun's Motion.*—The position of the Pole of the Ecliptic is shown at E, fig. 21. It is nearly in the imaginary line joining Polaris and γ Draconis, half way between the Pole and the Dragon's Head, which is worth remembering. The Ecliptic is, as has been stated, the great circle along which the Sun appears to move from west to east at the rate of nearly one degree daily, so completing the entire circle in 365 days in round numbers. The sun is therefore always 90° from a point of the heavens about half way between Polaris and the Dragon's Head.

121 About the third week in March and September the Sun crosses the great circle, passing through Polaris and β Cassiopeæ, and at the corresponding period in June and December he crosses the great circle, passing through Polaris and γ Draconis. We shall find it convenient to divide each of the two Colures into semicircles, and consider that there are four Colures, which we shall call *Vernal*, *Summer*, *Autumnal*, and *Winter* Colures. The half great circle drawn from pole to pole through β Cassiopeæ nearly is the Vernal Colure, because the Sun crosses it in spring. The other half of the Equinoctial

Colure is the Autumnal Colure, because the Sun crosses it in autumn. The half great circle drawn from pole to pole through γ Draconis nearly is the Winter Colure, because the Sun crosses it in winter; and the other half of the Solstitial Colure is the Summer Colure, because the Sun crosses it in summer.

The four Colures, therefore, are marked as follows :—

The Vernal Colure—by Cassiopea.
The Summer Colure—by Camelopardus.
The Autumnal Colure—by the Septemtriones.
The Winter Colure—by the Dragon's Head.

The Sun's distance from the Pole is, when he crosses

The Vernal Colure, 90°.
The Summer Colure, about 66½°.
The Autumnal Colure, 90°.
The Winter Colure, about 113½°.

Having dwelt at some length on the circumpolar constellations for the reason above mentioned, we must now allude only briefly to the other constellations, at least the principal of them.

V. *Region of the Heavens along the Vernal Colure.*

122 In fig. 22 (see next page) this region is shown extending from Cassiopea to the Equator, and some way south of it. The first group of stars that catches the eye in this region is the square formed by the four stars, Alpherat, Algenib, Markab, and Scheat, shown in the figure. The Vernal Colure, which, it will be remembered, is drawn from the Pole through β Cassiopeæ nearly, passes through Alpherat and near Algenib, the two eastern stars of this square.

123 *Andromeda.*—The constellation Andromeda comes next after Cassiopea, as we go from the Pole to the Equator along the Vernal Colure, lying on the *east* side of the Colure: Alpherat is α Andromedæ.

124 *Pegasus.*—This constellation is on the western side of the Colure, Markab, Sheat, and Algenib, are α, β, and γ Pegasi.

125 *Pisces, the Fishes.*—This constellation is figured as two fishes tied together by a long string. One fish is marked by three small stars a little west of the Colure, just below Algenib and Markab. The other fish is higher up, near Andromeda, on the east of the Colure. This is one of the twelve constellations, called the Signs of the Zodiac.

126 *Aries, the Ram.*—The head of Aries is marked by two stars of the third magnitude, easily recognised, situated some way east of the Colure. Aries is one of the signs of the Zodiac.

127 *Vernal Equinoctial Point.*—The figure shows the equator and ecliptic meeting the Colure at the vernal equinoctial point, which is about as far below Algenib, as Algenib is below Alpherat. The Sun's proper motion takes place along the ecliptic in the direction represented by the arrow, contrary to the diurnal rotation of the heavens, the direction of which is represented by the arrow pointing along the equator.

128 The equinoctial point is continually but very slowly moving along the ecliptic, in a direction contrary to that of the Sun's proper motion. This point was formerly in Aries, and was called the First Point of Aries. It is now in Pisces, and is moving towards Aquarius. It still, notwithstanding, retains the name of the First Point of Aries.

129 *Aquarius, the Waterman.*—This is another of the signs of the Zodiac, next to Pisces, but lower down, on the western side of the Colure.

130 *Cetus, the Whale.*—Opposite Aquarius, on the other side of the Colure, is a large constellation, called Cetus, the stars of which, near the tail, are shown in the figure.

131 *Piscis Australis, the Southern Fish.*—A bright star of the first mag-

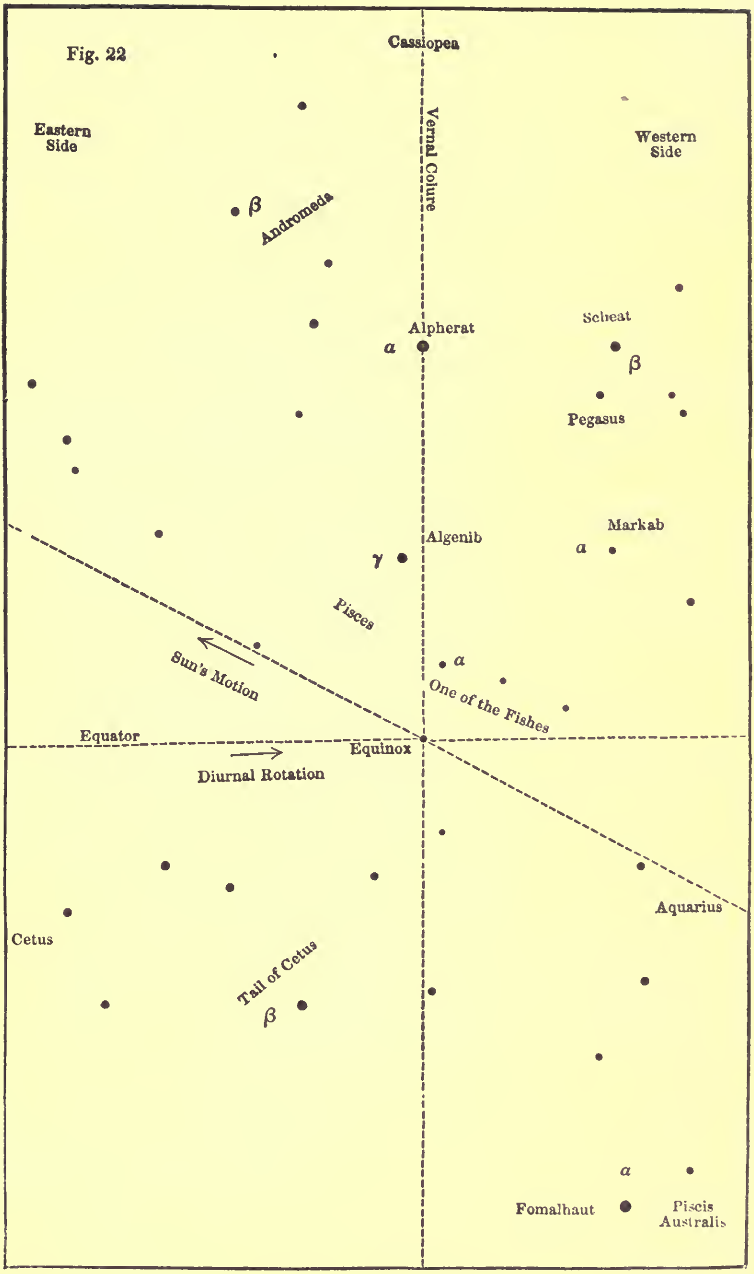


Fig. 22
Cassiopea
Eastern Side
Western Side
Vernal Colure
β
Andromeda
Scheat
Alpherat
a
β
Pegasus
Markab
Algenib
a
γ
Pisces
a
Sun's Motion
One of the Fishes
Equator
Equinox
Diurnal Rotation
Aquarius
Cetus
Tail of Cetus
β
a
Fomalhaut
Piscis Australis

nitude, called Fomalhaut, which means the Fish's Mouth, being a corruption of an Arabic word, marks the mouth of the Southern Fish, which lies immediately below Aquarius. This star being so much to the south of the equator, is never seen much above the horizon in these latitudes, and is therefore seldom visible, the stars near the horizon being generally obscured by mists and clouds; besides, the more to the south a star is, the shorter time is it above the horizon each day.

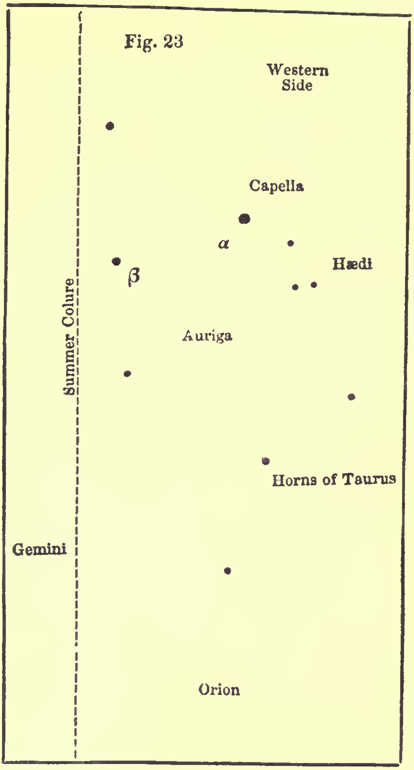


Fig. 23

VI. *Region of the Heavens along the Summer Colure.*

132 *Auriga, the Charioteer.*—The first remarkable group that catches the eye as we go from the Pole along the Summer Colure, is the beautiful constellation of Auriga, shown in fig. 23, which lies close to the Colure, on the western side. The brilliant star, *Capella,* or the Goat, is the Lucida of this constellation, near which lie three little stars, called *Hædi,* or the kids. The two stars below Auriga, in the figure, are the tips of the horns of *Taurus,* the Bull, one of the signs of the Zodiac. The upper of these two stars, together with α and β of Auriga, form an isosceles triangle, or with two other smaller stars, shown in the figure, make an irregular pentagon. This pentagon is a remarkable object in the heavens, on account of Capella and the Hædi, which, once pointed out, are always recognised again immediately.

133 *Taurus, the Bull. The Hyades and Pleiades.*—The horns of Taurus, as we have stated, lie below Auriga, a little west of the Colure. Taurus contains the two groups, the Pleiades and Hyades, so often alluded to in the ancient poets (see fig. 24, on next page); the Hyades form the face of Taurus, and the Pleiades the shoulder. The star, Aldebaran, is one of the Hyades; it is of the first magnitude, but not brilliant. The Pleiades are very small and close together, but they glisten with a remarkable degree of brightness; only six of them can be seen by most persons, but a good eye detects a seventh, and sometimes one or two more, and hence the story of the lost Pleiad. The Pleiades derive their name from πλειν, to sail, because they were supposed to indicate the season favourable to navigation; they were called Vergiliæ by the Latins. In Cicero's translation of Aratus we find:—

> Parvas Vergilias tenui cum luce videbis
> Hæ septem vulgo perhibentur more vetusto
> Stellæ cernuntur vero sex undique parvæ.

'You will behold the little Vergiliæ faintly shining. These are commonly said to be seven in number, after the ancient tradition, but only six small stars can be seen.'

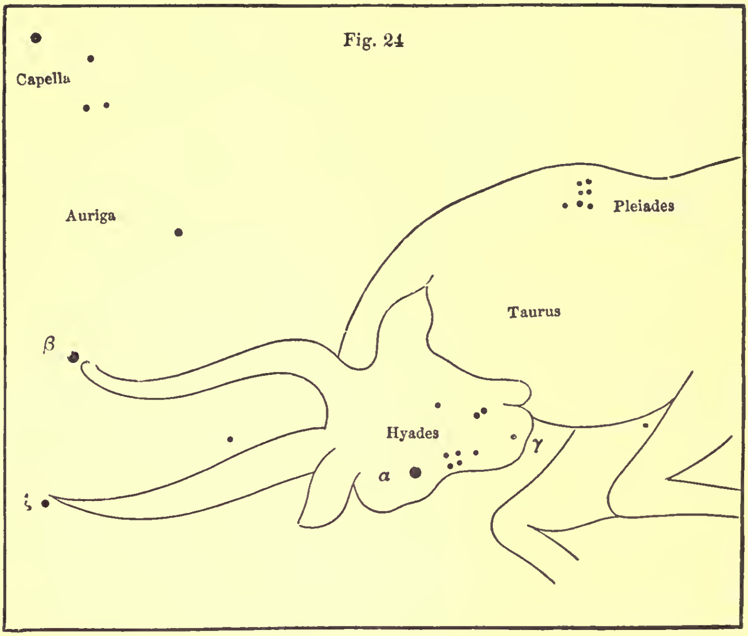
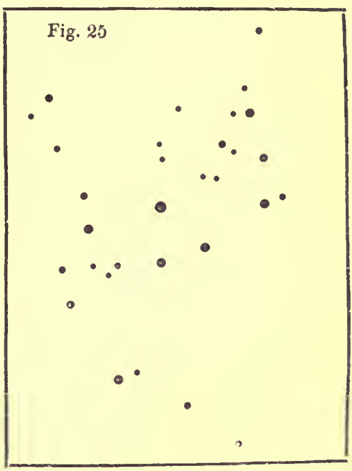


Fig. 25 shows a telescopic view of the Pleiades.

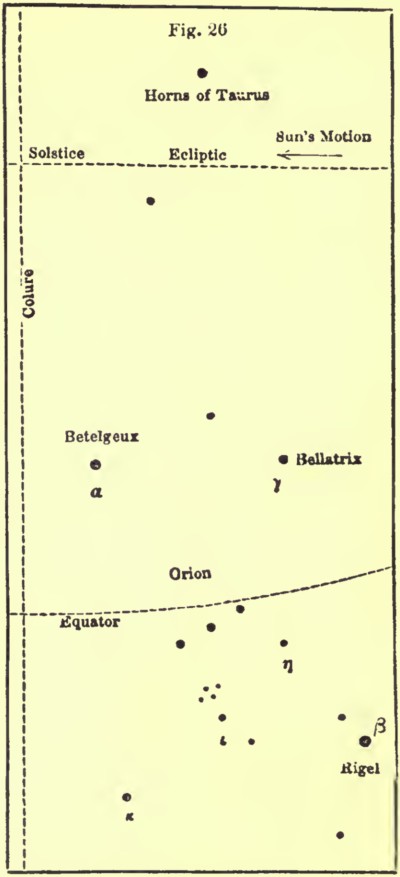


The Hyades were supposed to indicate rain, and hence their name, from ὕειν, to rain; they were, by a mistaken translation, called Suculæ, or little pigs, by the Latins, (*Cicero de Nat. Deorum*, lib. ii. cap. 43.)

134 *Orion.*—This splendid constellation lies below the horns of Taurus,

close on the western side of the Colure; it is represented in fig. 26; like the Hyades and Pleiades, it is continually alluded to by the Greek and Roman writers. The stars *a* and *β*, *Betelgeux* and *Rigel*, are of the first magnitude; *γ*, or *Bellatrix*, and the three stars which form Orion's Belt, are of the second magnitude. The stars *η*, *ι*, and *κ* form the sword; close to *ι* are a great number of small stars, and a most remarkable nebula, which had never been resolved into stars until Lord Rosse's telescope was brought to bear upon it.

Fig. 26

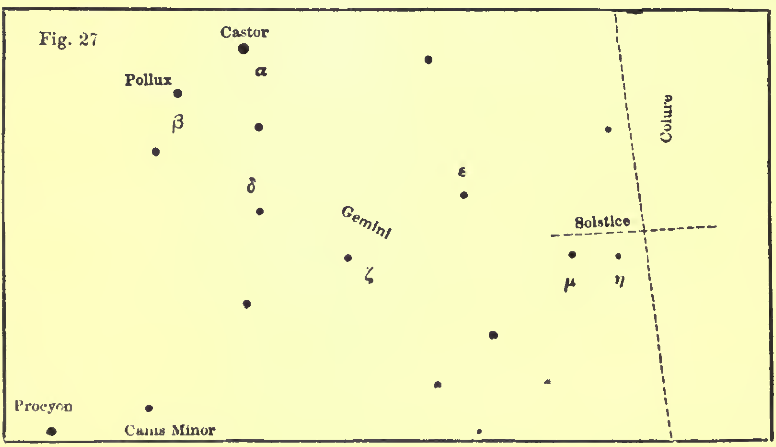


135 *Gemini, the Twins.*—We shall now briefly mention the constellations on the eastern side of the Summer Colure. The constellation Gemini, shown in fig. 27, is opposite the horns of Taurus, close to the Colure on the eastern side. The bright stars, *a* and *β*, *Castor* and *Pollux*, were anciently much noticed, especially by mariners. Gemini is one of the signs of the Zodiac.

136 *Canis Minor, the Little Dog.*—Under Gemini, but more to the east, is Canis Minor, which contains only two stars that are readily noticed by the eye. One of these, *a*, or *Procyon*, is a brilliant star of the first magnitude. See fig. 27.

137 *Canis Major, the Great Dog.*—Some way farther downwards, close to the Colure, and on the eastern side, is the celebrated constellation, Canis Major, containing the brightest star in the heavens,

Fig. 27



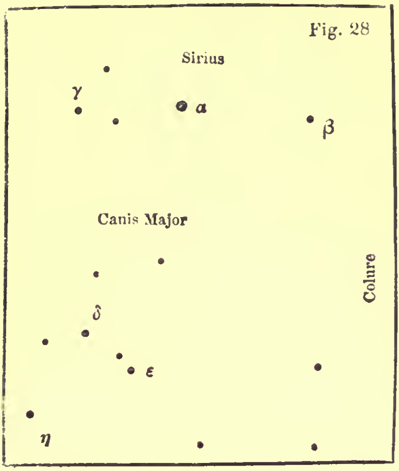


Fig. 28

Sirius, or the *Dog Star*. See fig. 28. The star Aldebaran of the Hyades, the Belt of Orion, and Sirius, are nearly in the same straight line. There is no possibility of missing Canis Major, if we look a little below Orion, and somewhat to the east of it.

138 In ancient times, the dog days, which commenced when Sirius rose at the dawn of day, were considered to be most fatal in producing fevers and madness; but these days are chiefly to be noticed on account of their chronological importance with reference to the *Annus Magnus*, or *Great Year*, of the Egyptians. We have the following passage from Censorinus, (*Cory's Ancient Fragments*):—

'Ad Ægyptiorum vero magnum annum luna non pertinet, quem Græci Κυνικὸν, Latine Canicularia vocamus. Propterea quod initium illius sumitur, cum primo die ejus mensis, quem vocant Ægyptii Θὼθ, Caniculæ sidus exoritur,' &c. &c.

The substance of what he says is this:—That the *Great Year* of the Egyptians was not determined by the Moon, but by the fact of their civil year containing always 365 days, without any leap year, which caused a slow change of the seasons, in consequence of the year being nearly six hours shorter than it ought to have been. This change was completed in 1461 years, at the end of which period the seasons all came back to their proper places in the year. This period of 1461 years was called the Great Year; also, by the Greeks, the *Cynic*, or Dog Year; and by the Latins, the *Canicular* Year, because it began when the Dog Star rose at dawn, on the first day of the Egyptian month *Thoth*. But the year which Aristotle calls *the Greatest*, rather than *the Great*, is that in which the Sun, Moon, and planets all return and come together in the same sign of the Zodiac from which they originally started. The winter of this year is the *Cataclysm*, or Deluge, the summer is the *Ecpyrosis*, or Conflagration of the World.

Theon of Alexandria gives an example of a formula for finding the rising of the Dog Star, entitled, ΠΕΡΙ τῆς τοῦ κυνὸς ἐπιτολῆς ὑπόδειγμα.

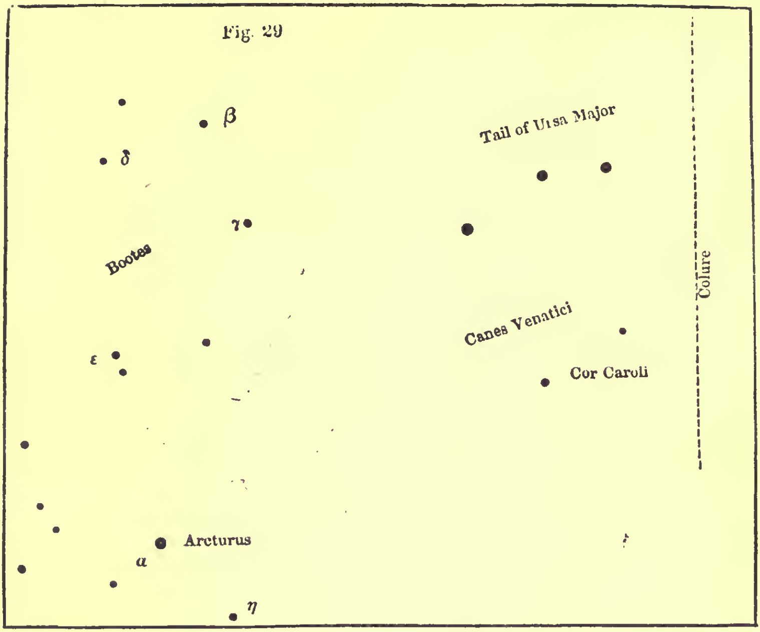
The connexion between astronomy and chronology that is thus established by the numerous references of ancient writers to astronomical phenomena, is most interesting and important, inasmuch as astronomy can as accurately tell the past, as predict the future motions of the heavenly bodies, and therefore it becomes an instrument for penetrating through the dimness of antiquity.

139 *Summer Solstice—Ecliptic—Equator.*—The ecliptic runs midway between the Hyades and Pleiades, also between the horns of Taurus. The solstitial point is close to the stars η and μ Geminorum. The equator runs through the top star of Orion's belt very nearly, a little beyond which, towards Procyon, is the point of the equator which is 90° from each equinox.

VII. *Region of the Heavens along the Autumnal Colure.*

140 *Canes Venatici, the Hounds.*—The Autumnal Colure is drawn from the Pole towards the tail of Ursa Major; it runs between γ and δ Ursæ Majoris, close by δ. On the eastern side of this Colure, and immediately below the tail, are the two Hounds of Bootes, fig. 29, in the neck of one of which is the star often called *Cŏr Caroli*, the Heart of Charles (II). These hounds do not belong to the ancient constellations.

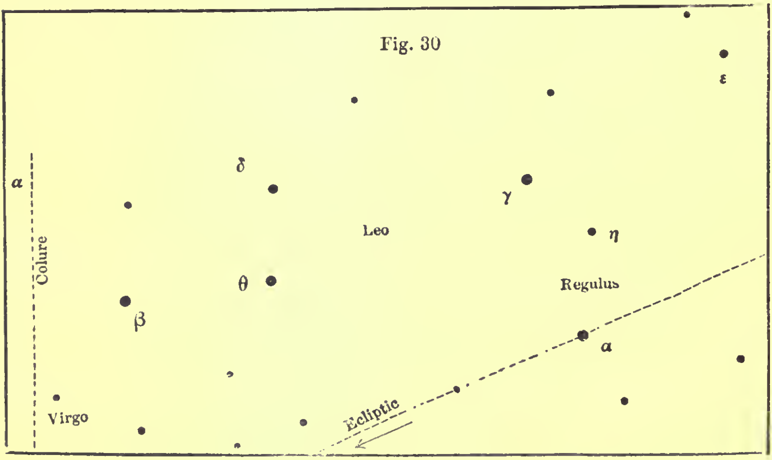
Fig. 29

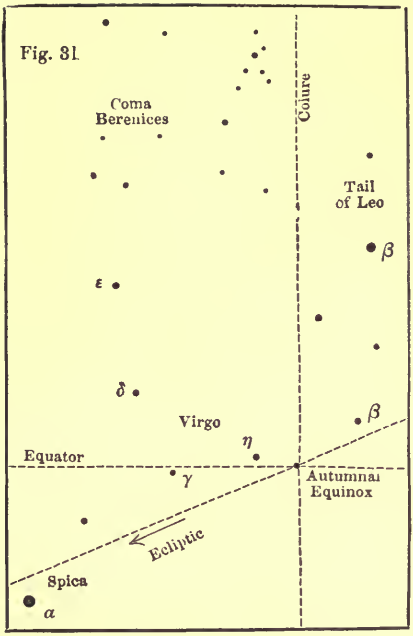


141 *Bootes, the Herdsman,* is made up of the bright stars to the east and south east of Cor Caroli, among which *Arcturus* shines conspicuously. (See fig. 29.) Arcturus is found by drawing an imaginary line through β Ursæ Majoris, which runs a little above Cor Caroli, and, farther on, a little below Arcturus.

142 *Coma Berenices, the Hair of Berenice.*—A group of small, bright stars close on the eastern side of the Colure, and due west of Arcturus. See fig. 31.

Fig. 30





143 *Leo, the Lion.*—One of the signs of the Zodiac on the west of the Colure, and opposite Arcturus. (See fig. 30.) α Leonis, (which is also called Cor Leonis, the Lion's Heart, and Regulus,) is a star of the first magnitude. β Leonis is called *Deneb*, or the Tail; it is within 5° of the Colure.

144 *Virgo, the Virgin.*—Another of the signs of the Zodiac, immediately under Coma Berenices, and all, except a few stars, lying on the east of the Colure—see fig. 31. The star α of this constellation is called *Spica*, or the ear of corn, and is of the first magnitude.

Arcturus, Regulus, and Spica being joined by imaginary lines, form a right-angled triangle, having the right angle at Spica: which fact being remembered, will prevent any mistake about the position of these stars.

145 *Autumnal Equinox—Ecliptic—Equator.*—The autumnal equinoctial point is close to η Virginis, fig. 31. The ecliptic runs through Regulus, and nearly through, but a little above, Spica. The equator is shown in the figure, passing through η Virginis nearly.

VIII. *Region of the Heavens along the Winter Colure.*

146 *Lyra, the Lyre; and Cygnus, the Swan.*—The winter Colure is drawn from the Pole nearly through γ in the Dragon's Head; farther on, we come upon Lyra, in which is the bright star Vega, of the first magnitude. Lyra is near the Colure on the eastern side; Cygnus is east and somewhat north-east of Lyra, not far from Cepheus. The five brightest stars of Cygnus form a cross, of which α, or *Deneb*, the tail, is of the first magnitude. Lyra and Cygnus are shown in fig. 32.

147 *Hercules, and Corona Borealis, the Northern Crown.* — Hercules includes the stars opposite and a little south of Lyra on the other—i. e., the western side—of the Colure. West of these is Corona Borealis, which is nearly a circlet of stars, one, α, being of the second magnitude, (see fig. 33,) α Herculis is a variable star.

148 *Aquila, the Eagle; and Delphinus, the Dolphin.*—Somewhat south of Cygnus and Lyra, on the eastern side of the Colure, we find Aquila and

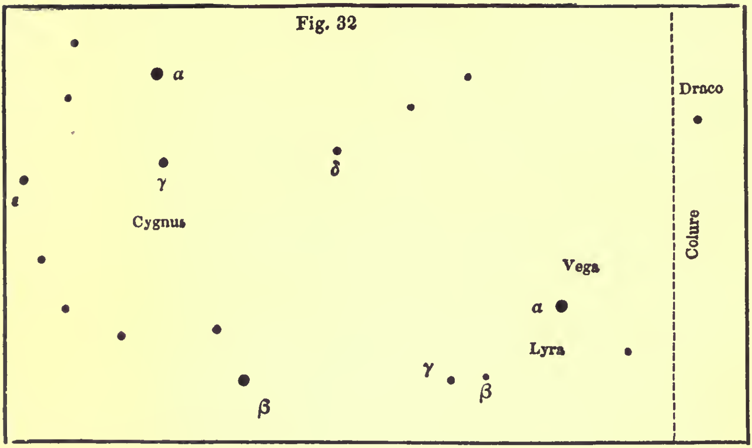


Fig. 32
Draco
Cygnus
Colure
Vega
Lyra

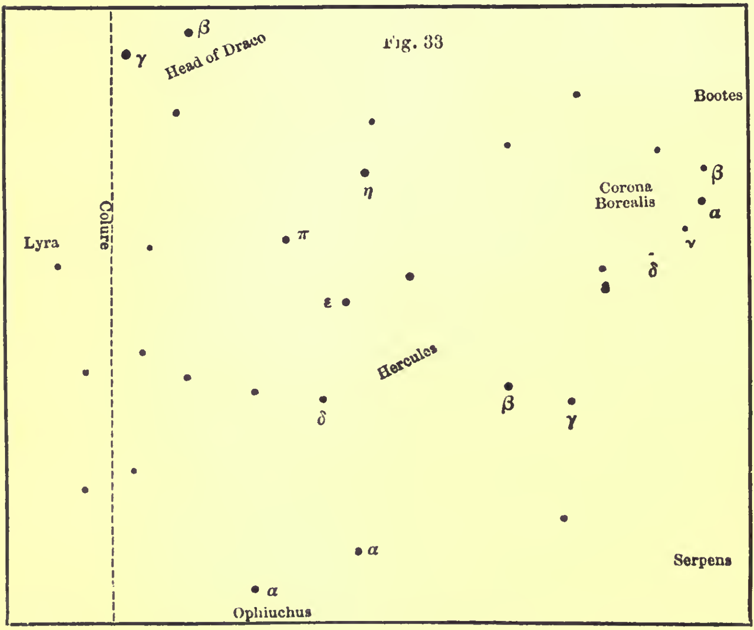
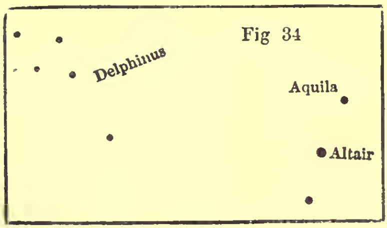
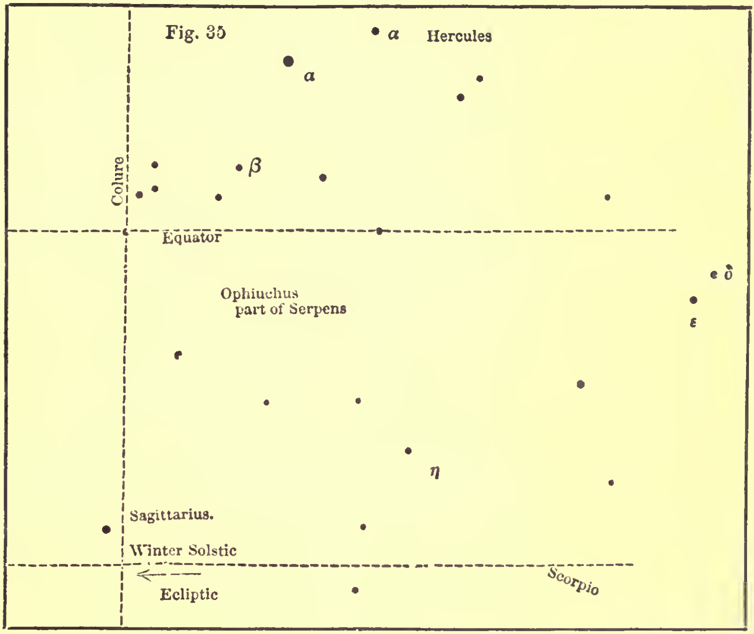


Fig. 33
Head of Draco
Bootes
Corona
Borealis
Lyra
Colure
Hercules
Serpens
Ophiuchus



Delphinus, fig. 34. The stars of Delphinus are very bright, though small, and form a diamond-shaped figure. *a* Aquilæ, is a star of the first magnitude; it is called *Altair.* The three stars, *β a* and *γ* Aquilæ, (which are in a line,) with the diamond-shaped and glistening Delphinus, are remarkable objects in the heavens, and not likely to be forgotten when once seen.

149 *Ophiuchus, the Snake Holder; and Serpens, the Snake.*—These two constellations lie on the east of the Colure below Hercules, and include a number of bright stars. See fig. 35.



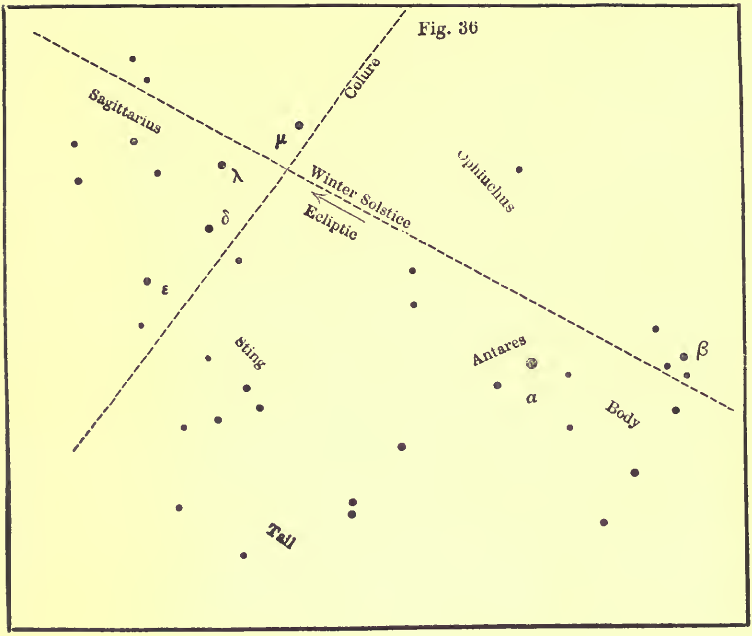
150 *Libra, the Balance; Scorpio, Sagittarius, and Capricornus.*—These are four of the signs of the Zodiac. Scorpio and Sagittarius are shown in fig. 36. *a* Scorpionis is a star of the first magnitude, called *Antares.*

Sagittarius is close on the east of the Colure, and Scorpio somewhat farther off on the west. Scorpio is a remarkable constellation, and easily recognised.

151 *Winter Solstice—Ecliptic—Equator.*—The ecliptic runs between *β* and *δ* Scorpionis, and a few degrees below *μ* Sagittarii, immediately under which star is the winter solstitial point. The equator lies about 8° below Altair.

152 We have now sufficiently pointed out the position and appearances of a sufficient number of the principal constellations, in such an order that it will be easy to find them out and remember them. We have dwelt at some length on this part of the subject, because mere maps or figures of the con-

Fig. 36



stellations, without any remarks respecting them, do not produce much effect on the memory. For complete and accurate information, we may refer the reader to the six maps of the stars published by the Society for the Diffusion of Useful Knowledge, and to Smyth's *Celestial Cycle*, vol. ii. We shall conclude this chapter with a few words on the stars and constellations which come on the meridian at certain hours at different times of the year.

IX. *Constellations visible on the Meridian at different Hours of the Night, and at different Seasons of the Year.*

153 It is easy to make out what stars are on the meridian at midnight at any particular time of the year, by considering the position of the Sun in the heavens: thus, at the Vernal Equinox, the sun is on the Vernal Colure, and therefore at midnight, when the Sun is on the meridian *below* the horizon, the Vernal Colure must be so also, and therefore the Autumnal Colure must be on the meridian *above* the horizon. Hence all the stars lying along the Autumnal Colure will be on the meridian at midnight at the Vernal Equinox.

It is also easy to make out what stars are on the meridian at any other hour, by making the proper allowance for the diurnal rotation of the heavens.

154 The following table exhibits the constellations visible on or near the meridian at nine o'clock, (three hours before midnight,) at different times of the year

Third week in March.	Head of Ursa Major. Cancer. Head of Leo. Regulus. Cor Hydræ.	A
" April.	The Pointers. Deneb. Tail of Leo. Coma Berenices. Head of Virgo.	B
" May.	Tail of Ursa Major. Cor Caroli. Bootes. Arcturus. Coma Berenices. Virgo. Spica.	C
" June.	Body of Ursa Minor. Bootes. Corona Borealis. Head of Serpens. Libra.	D
" July.	Tail of Ursa Minor. Head of Draco. Hercules. Ophiuchus and Serpens. Scorpio.	E
" August.	δ Draconis. Cygnus. Lyra. Vega. Aquila. Altair. Sagittarius.	F
" September.	Cepheus. Tail of Cygnus. Delphinus. Head of Pegasus. Aquarius. Capricornus.	G
" October.	β Cassiopeæ and Head of Cepheus. Scheat. Markab. Pegasus. Pisces, (western fish.) Tail of Cetus. Aquarius. Fomalhaut.	H
" November.	δ and γ Cassiopeæ. Andromeda. Aries. Pisces, (eastern fish.) Alpherat. Algenib. Tail of Cetus.	I
" December.	Perseus. Algol. Pleiades. Aries. Head of Cetus. Eridanus.	J
" January.	Capella. Auriga. Hyades. Gemini. Canis Minor. Orion. Canis Major.	K
" February.	Gemini. Castor and Pollux. Canis Minor. Procyon. Canis Major. Sirius.	L

155 We have chosen nine o'clock in the above table as a convenient hour for observing the stars, instead of midnight, which would be rather late for most people. The table may, however, be easily adapted to any hour by means of the following, in which A B C &c. denote the constellations in the above table.

Table showing the Constellations on or near the Meridian at different Hours in different Months.

	EVENING.				MORNING.			
	5 o'clock.	7 o'clock.	9 o'clock.	11 o'clock.	1 o'clock	3 o'clock.	5 o'clock.	7 o'clock.
March . .	K	L	A	B	C	D	E	F
April . .	L	A	B	C	D	E	F	G
May. . .	A	B	C	D	E	F	G	H
June . .	B	C	D	E	F	G	H	I
July. . .	C	D	E	F	G	H	I	J
August . .	D	E	F	G	H	I	J	K

TABLE—*continued.*

	EVENING.				MORNING.			
	5 o'clock.	7 o'clock.	9 o'clock.	11 o'clock.	1 o'clock.	3 o'clock.	5 o'clock.	7 o'clock.
September.	E	F	G	H	I	J	K	L
October .	F	G	H	I	J	K	L	A
November.	G	H	I	J	K	L	A	B
December.	H	I	J	K	L	A	B	C
January .	I	J	K	L	A	B	C	D
February .	J	K	L	A	B	C	D	E

For example: What constellations will be on or near the meridian at seven o'clock in February? Looking in the column under seven o'clock, we find K opposite February; and therefore, referring to the former table, to see what constellations are represented by K, we find that Capella, Auriga, the Hyades, Gemini, Canis Minor, Orion, Canis Major, will be on or near the meridian at the time specified.

X. *Signs of the Zodiac.*

156 As the motions of the Sun, Moon, and Planets take place among these constellations, it is necessary to say something respecting them. The Zodiac is the celestial region lying along the Ecliptic; its name is derived from *ζῴδιον, zodion,* a little animal, because its different parts are marked by figures of animals. Fig. 37 shows the animals as represented on the ceiling of

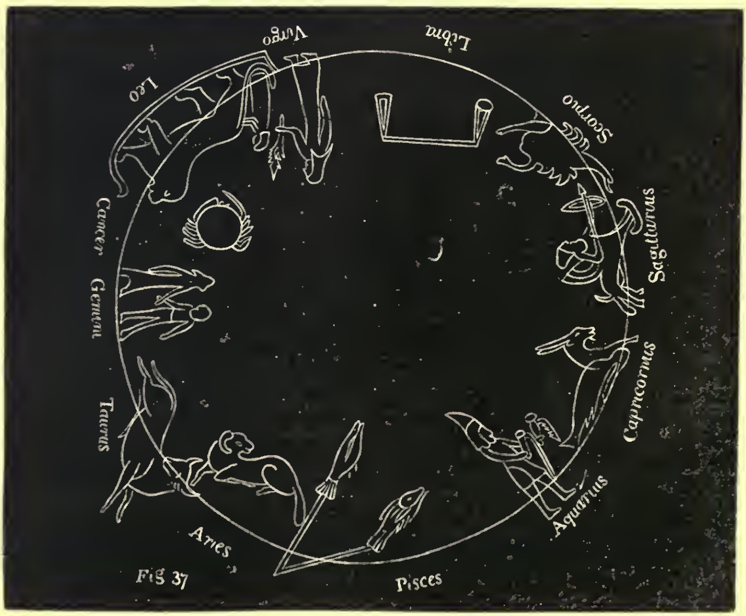
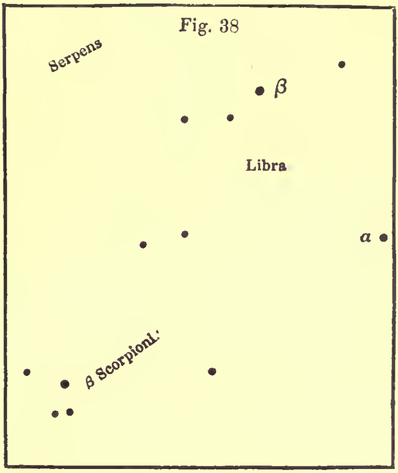


Fig 37

an apartment in the Temple of Denderah in Egypt, which we may conclude, from inspecting the ceiling, was adorned with these curious figures about 700 B.C. See *Penny Cyclopædia*, Art. *Zodiac*, where an account of the ceiling is given, together with information respecting the ancient constellations.

Fig. 38

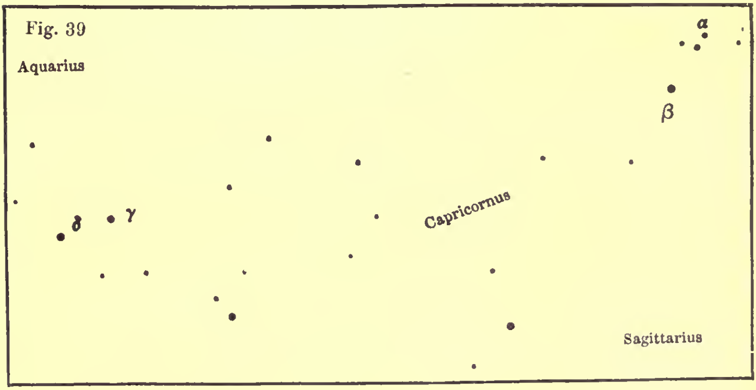


157 The order of the Zodiacal signs, and the symbols by which they are represented, are as follows:—

Aries, the Ram	♈
Taurus, the Bull . . .	♉
Gemini, the Twins . . .	♊
Cancer, the Crab . . .	♋
Leo, the Lion	♌
Virgo, the Virgin . . .	♍
Libra, the Balance . . .	♎
Scorpio, the Scorpion . .	♏
Sagittarius, the Archer .	♐
Capricornus, the Goat .	♑
Aquarius, the Waterman .	♒
Pisces, the Fishes . . .	♓

We have already spoken of the stars composing all these constellations, except Cancer, Libra, and Capricornus, which are shown in figs. 38, 39, and 40.

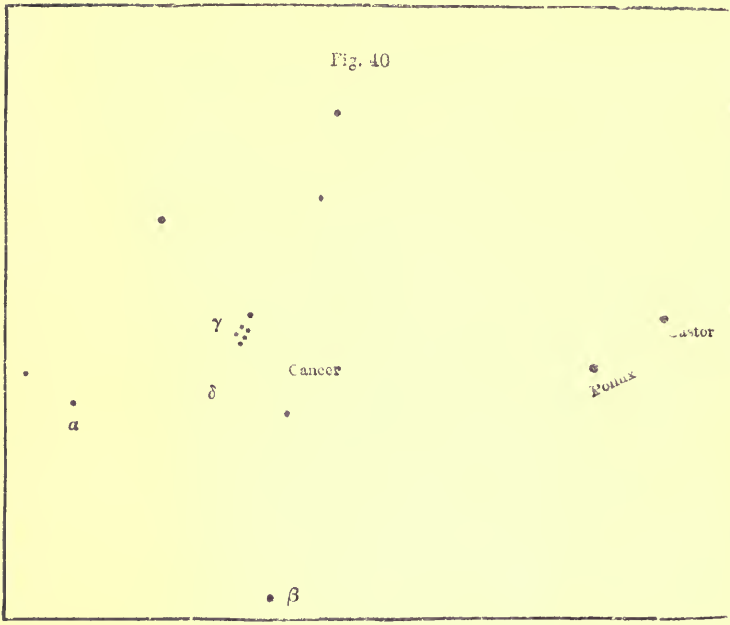
Fig. 39



158 In all the above figures of the constellations we have represented the principal stars only, generally all as far as the fourth magnitude, but sometimes as far as the fifth, where such stars were necessary to be put down, in order to make it easy to find out the constellation in the heavens.*

* The different magnitudes of the stars are not represented as accurately as in the drawings sent to the engraver, but there are no errors of any consequence. In a few of the figures the constellations are a little distorted in shape.

Fig. 40



CHAPTER III

ASTRONOMICAL TERMS EXPLAINED.—MEASUREMENT OF TIME.

BEFORE we proceed to the practical application of Astronomy, it will be necessary to explain the meaning of certain terms constantly made use of in the science, whereby the positions and the motions of heavenly bodies are defined, and to describe the different measures and periods of time, which is so important an element in astronomical observations and calculations.

I. *Terms relating to Vertical and Horizon*

160 *Vertical.*—When a body is allowed to fall towards the Earth's surface, it describes a straight line tending towards the centre of the Earth nearly. We say nearly, because, on account of the Earth not being exactly spherical, bodies do not fall exactly towards the centre. The motion of falling bodies is produced by the attraction of the Earth, or the attraction of *Gravity*, as it is called. If the body, instead of being allowed to fall, is suspended by a string ,the string shows the direction in which the body would fall, if allowed to do so, because it shows the direction in which the force of gravity pulls the body.

The straight line which a falling body describes is called the *Vertical* or *Vertical Direction*. This direction is determined by suspending a heavy body, such as a piece of lead, by a string, and then the string will show the vertical. A string thus used is called a plumb line (from *plumbum*, lead).

161 The vertical is, then, the direction in which the force of gravity acts, and therefore Astronomers always determine or observe the vertical

direction by means of the force of gravity. We must remark, however, that in the neighbourhood of large mountain masses, especially where there is a flat country on one side, and mountains on the other, the direction of the force of gravity is sensibly, though very slightly, affected by the attraction of the mountains. In this case the plumb line is said to be drawn out of the proper vertical, which is considered to be the direction in which the force of gravity would act, if the ground were on all sides perfectly level. We must, therefore, in defining the vertical to be the direction in which a plumb line hangs, add, that the Earth's surface is supposed to be perfectly level, or, in other words, to be the same as the surface of the ocean would be if it covered the whole Earth.

162 We must also observe, that when a body is allowed to fall from a very considerable height, it falls a little eastward of the true vertical (as shown by a plumb line), in consequence of the Earth's rotation about its axis. The deviation from the vertical is, however, extremely small.

163 *Horizontal.* The plane to which the vertical line is perpendicular is called the *Horizontal Plane.* The surface of still water, or any other fluid, such as mercury, shows the horizontal plane, provided it be of limited extent: for fluid surfaces of considerable extent are sensibly curved, as we see in the case of the ocean. Astronomers employ this property of fluids to determine the horizontal plane, as we shall presently explain when we come to speak of the Spirit Level, and the method of observing heavenly bodies reflected in a trough of mercury.

164 Every plane containing the vertical line, or, what is the same thing, every plane perpendicular to the horizontal plane, is called a *Vertical Plane.* The intersection of two vertical planes is therefore a vertical line.

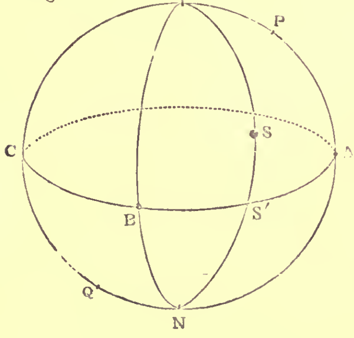
165 *Zenith and Horizon.*—We have, in the previous chapter, explained what the celestial sphere is, and what great circles and small circles are. The points of the celestial sphere, where the vertical line produced meets it, are called the *Zenith* and *Nadir* (terms of Arabic origin), the zenith being the point of the celestial sphere exactly over the observer's head, and nadir the opposite point beneath his feet.

166 The horizontal plane cuts the celestial sphere in a great circle, which is called the *Horizon.* The word was originally applied to the circle which sensibly bounds the view of a spectator at sea, or on a height, and hence the word is derived from the Greek *ὁρίζω*, to bound or limit.

The Horizon is therefore a great circle of the celestial sphere, the poles of which are the zenith and nadir. Every point of the Horizon is 90° from the zenith.

167 *Meridian.*—That vertical plane in which the Earth's axis of rotation lies is called the *Meridian Plane*, or *Plane of the Meridian*: and the great circle in which this plane cuts the celestial sphere is called the *Meridian.* The Meridian is therefore the great circle which passes through the North and South Poles and the Zenith. The name is derived from the Latin word signifying half-day, or mid-day, because it is mid-day when the Sun crosses the Meridian.

Fig. 41



168 *Altitude and Azimuth.*—Let A B C, fig. 41, represent half the Horizon, P and Q the North and South Poles, Z and N the Zenith and Nadir, and A P Z C Q N the Meridian: let S denote the position of any star on the celestial sphere, and let a great circle be drawn through Z and S meeting the horizon at S′. Then the circular arc S S′ expressed in degrees, minutes, and seconds, is called the *Altitude* of the star S, and the circular arc A S′, expressed similarly, is called the *Azimuth* of the star.

The arc Z S, in degrees, minutes, and seconds, is called the *Zenith Distance* of the star; Z S is the *complement* of S S′—i. e., Z S added to S S′ *completes* or makes up 90°.

Since the circular arc S S′ shows how high the star is on the celestial sphere above the horizon, it is properly called the Altitude of the Star. The word Azimuth is a corruption of an Arabic word signifying 'the way' or 'distance,' meaning thereby the number of degrees, minutes, and seconds we must go along the horizon A B C, from the point A, in order to get to S′, which point marks the vertical plane in which the star is.

169 The position of a star on the celestial sphere is completely defined by stating its altitude and azimuth; for example, if the altitude of the star be 30° and its azimuth 50°, we find the place of the star by measuring along the horizon from A, a circular arc A S′ equal to 50°, then from S′ drawing a great circle to Z, and measuring S′ S equal to 30°, which will give the place of the star S.

170 It is important to remember that the great circle Z S S′ N shows on the celestial sphere the vertical plane in which the star is; for this circle, since it passes through the zenith and nadir, Z and N, lies in a vertical plane, and therefore shows on the celestial sphere the vertical plane in which the star is. We shall speak of this plane as the plane Z S S′ N.

171 The arc A S′ shows the angle which this vertical plane makes with the meridian plane Z A N; for, if we conceive the semicircle Z S′ S N to turn about the points Z and N, the point S′ starting from A and moving towards B, it is clear that the number of degrees, minutes, and seconds through which the point S′ moves along the horizon, show the number of degrees, minutes, and seconds through which the vertical circle or plane Z S S′ N turns about the points Z and N, or, what is the same thing, the angle of inclination of the plane Z S S′ N to the plane of the meridian.

The angle at Z, which the two circles Z P A and Z S S′ make with each other, also shows the inclination of the plane Z S S′ N to the plane of the meridian; for, conceiving the plane Z S S′ N to turn as before, it is clear that the number of degrees, minutes, and seconds, in the angle at Z, which the arc Z S S′ makes with Z P A, shows the number of degrees, minutes, and seconds through the plane Z S S′ N turns about Z—i. e., its inclination to the plane of the meridian.

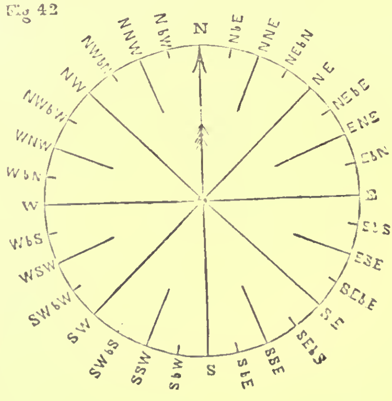
Hence the azimuth of a star shows the inclination of the vertical plane in which the star is to the meridian plane, or, what is the same thing, the angle which the zenith circle of the star makes with the meridian.

By the zenith circle of a star, we mean the great circle passing through the zenith and the star.

172 *Prime Vertical.*—The vertical plane, which is perpendicular to the plane of the meridian, is called the *Prime Vertical Plane,* and the great circle in which this plane cuts the celestial sphere is called the Prime Vertical; in other words, the Prime Vertical is the zenith circle, Z B N, which cuts the horizon half way between A and C, B being supposed to be 90° from A.

173 *Points of the Compass.*—A, fig. 41, is called the North Point of the horizon, C the South Point, B the East Point, and the point opposite B (on the other half of the horizon) the West Point. These are generally known as the *Points of the Compass,* which are represented in fig. 42, the circle being the horizon, and N E S and W being the north,

Fig 42



east, south, and west points respectively. There are altogether thirty-two points of the compass, at equal distances from each other, dividing each quadrant of the horizon into eight equal parts, each part being therefore one-eighth of 90°—i. e., 11° 15′. Each of these divisions is supposed to be further subdivided into what are called *Quarter Points,* each containing 2° 48′ 45″, which make the fourth part of 11° 15′. It may be well to remember the following table for one quadrant, which will apply to the other quadrants by a simple change of points and corresponding letters.—

Azimuth.	Corresponding Point of Compass.		
0°	N.	North Point.	
	N. by E.	North by East.	One point (i. e., 11° 15′) East of North.
22° 30′	N.N.E.	North North East.	Half way between North and North East.
	N.E. by N.	North East by North.	One point North of North East.
45°	N.E.	North East.	Half way between North and East.
	N.E. by E.	North East by East.	One point East of North East.
67° 30′	E.N.E.	East North East.	Half way between East and North East.
	E. by N.	East by North.	One point North of East.
90°	E.	East Point.	90° from North.

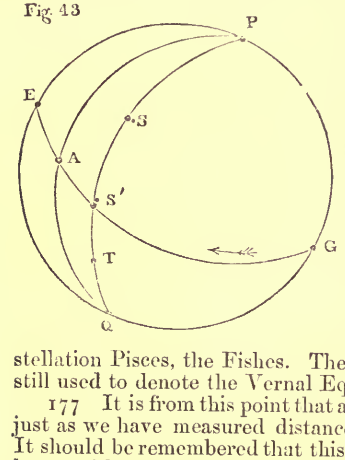
174 It should be borne in mind, that when a star is rising or setting, it is 90° from the zenith; and that the circumpolar motion of the heavens causes all the heavenly bodies which are at a sufficient distance from the Pole to cross the horizon twice in twenty-four hours, ascending or rising on the eastern side, and descending or setting on the western side.

II. *Terms relating to Pole and Equator.*

175 In the same manner that we define the place of a star with reference to the zenith and horizon, we may do also with reference to the Pole and Equator, by means of what are called *Right Ascension and Declination,* as we shall now explain.

176 Let P and Q (fig. 43) represent the north and south Poles, E A S′ G half the Equator, P E Q G the meridian, S any star, A the Vernal Equinoctial point of the Equator, P A Q a great circle passing through P A and Q, P S S′ Q a great circle passing through P S and Q, and cutting the Equator at S′. Every point of the Equator is 90° from each Pole. A is the point where the Sun crosses the Equator in spring, at which time he is moving northward. A is usually called *the first point of Aries,* because in former times, when these names were brought into use, the Vernal Equinoctial point was at the beginning of the constellation Aries, the Ram.

Fig. 43



At present the Vernal Equinoctial point, in consequence of its slow motion, called the *Precession of the Equinoxes,* is in the constellation Pisces, the Fishes. The name—‘First point of Aries’—is, however, still used to denote the Vernal Equinoctial point.

177 It is from this point that all distances along the Equator are measured, just as we have measured distances along the horizon from the north point. It should be remembered that this point moves round the Pole in twenty-four hours with the rest of the heavens, crossing the meridian when it comes to E, and again when it comes round on the other side to G, the motion being in the direction represented by the arrow in the figure. The imaginary

circles P A Q and P S S′ Q are of course supposed to be carried round by the circumpolar motion, always keeping at the same distance from each other.

178 The great circles P A Q and P S S′ Q, may be called *Polar Circles*, since they pass through the Poles; and the planes in which these circles lie may be called Polar Planes. The polar circle P A Q is the Vernal Colure, which, as we have already stated, is the great circle passing through the Poles and the Vernal Equinoctial point, or First Point of Aries, as it is called.

179 *Right Ascension and Declination.*—The circular arc A S′ is called the *Right Ascension* of the star S, and the circular arc S′ S is called its *Declination*. The arc P S is the complement of the declination, and is called sometimes the co-declination, but more frequently the *North Polar Distance* of the star.

Right Ascension and Declination completely determine the positions of heavenly bodies on the celestial sphere; thus, for example, if the right ascension of a star be 20° and the declination 40°, we find its position by measuring from A an arc A S′ of 20° along the Equator, then drawing a great circle from S′ to P and measuring upon it an arc S′ S of 40°, which will give S, the place of the star.

180 It is important to remark that right ascension is always measured from A, not in the direction of the arrow (fig. 43), but in the contrary direction. The reason of this is, that the Earth and planets move round the Sun and round their axes in the same way that we measure right ascension—i. e., contrary to the way in which the arrow points, which, as we have stated, indicates the direction of the apparent motion of the heavens caused by the real motion of the Earth round its axis in the opposite direction.

181 Declination is always expressed in degrees, minutes, and seconds; it is, so to speak, the altitude of the star above the Equator, or, we may say, the number of degrees, minutes, and seconds by which the star *declines* from the Equator, using the word ‘decline’ in its original signification of ‘turning aside.’

182 If the star is below the Equator, as at T (fig. 43), S T is the declination of the star, and it is called *south declination*, because measured towards the South Pole, the declination of S being called north declination, because it is measured towards the North Pole.

183 The right ascension of a star is the distance, from the first point of Aries, of the point where the polar circle, in which the star is, cuts the Equator. The right ascension of a star shows also the angle which the polar plane, in which the star is, makes with the plane of the Vernal Colure. The angle at P, which the two circular arcs A P and S P make with each other, contains the same number of degrees, minutes, and seconds that the arc A S′ does (which may be easily seen as in the case Azimuth, previously explained): hence the angle, which the polar circle passing through the star makes, at the pole, with the Vernal Colure, shows the right ascension of the star. The polar circle passing through a star is often called its declination circle.

184 The right ascension of a heavenly body is often, or rather, generally, expressed in time, at the rate of one hour for 15°—(i. e., twenty-four hours for 360°), since the heavens turn round the Pole at this rate, every star describing 15° of its circular course in an hour. The reason of expressing right ascension in time will appear as we go on, especially when we come to speak of the transit instrument.

Thus, if we say that the right ascension of S is four hours, we mean that A S′ corresponds to four hours—i. e., that A S′ contains four times 15°, or 60°. A right ascension of six hours is 90°, of twelve hours 180°, of eighteen hours 270°, and of twenty-four hours 360°, which brings us round the whole equator.

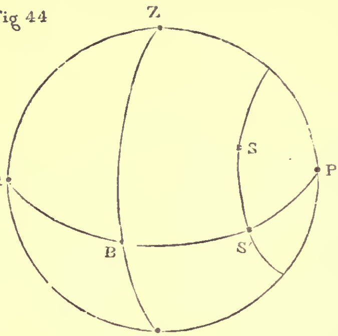
185 If the right ascension of S be four hours, A will evidently come on the meridian at E four hours before S′, for the space A S′ will be described in four hours, in consequence of the circumpolar rotation. Hence, observing that S and S′ come on the meridian at the same instant, we may define right ascension as follows:—

The right ascension of a star (expressed in hours, minutes, and seconds,) is the time that elapses between the transits across the meridian of the first point of Aries and the star. If the star crosses the meridian two hours, ten minutes, and eight seconds after the first point of Aries, its right ascension is two hours, ten minutes, and eight seconds, or briefly, $2^h\ 10^m\ 8^s$.

The Transit Instrument, of which we shall speak fully in a future chapter, is nothing more than an instrument for observing the times at which heavenly bodies cross the meridian, or, as it is said, the *transits* of heavenly bodies. It is perhaps the most accurate and important instrument used by astronomers.

186 *Origin of the terms Right and Oblique Ascension.*—These terms often occur in astronomical books, but the latter has now fallen into disuse. They have reference to the times of rising of heavenly bodies, as shown by the celestial sphere in what are called its *right* and its *oblique* positions. When the poles are in the horizon, as is the case when the observer is on the Earth's equator, the sphere is said to be a *right sphere*, for then all the heavenly bodies rise at right angles to the horizon. Fig. 44 represents a right sphere, P and Q being the poles, P B Q the horizon, S′ S the circular course of any star, which is evidently at right angles to the horizon at the point S′, where the star rises. In this case, the time elapsing between the rising of the first point of Aries and that of the star, was called the right ascension,—i. e., the time of the ascension of the star above the horizon in the right position of the sphere.

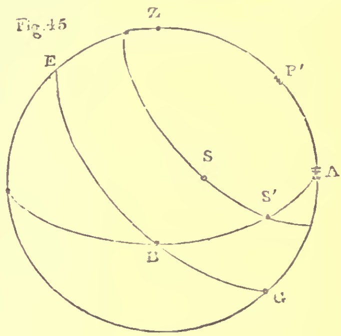
Fig 44



When the poles, P and Q, are not in the horizon, A B C, fig. 45, the stars cross the horizon obliquely when they rise. In such a case the sphere is said to be *oblique*, and the time of ascension was called oblique ascension.

187 *Hour Angle.*—The angle which the polar circle, P S S′, fig. 43, makes at the pole, with the meridian, P E, is called the hour angle of the star S′, because, if reduced to time, at the rate of 1 hour for 15°, it shows what time must elapse before the star crosses the meridian. The number of degrees, minutes, and seconds, in this angle, is evidently the same as in the arc S′ E.

Fig 45



188 *Latitude and Longitude of a Place.*—The terms latitude and longitude, with reference to a place on the Earth's surface, correspond to declination and right ascension, with reference to the celestial sphere. The Earth's surface, supposed to be spherical, is called the terrestrial sphere; the terrestrial equator is the great circle of the terrestrial sphere, every point of which is 90° from each of the terrestrial poles. The latitude of a point on the terrestrial sphere is the same thing as its declination; the longitude the same thing as its right ascension, with this difference, that the longitude is not measured from the first point of Aries, but from some fixed point of the terrestrial equator.

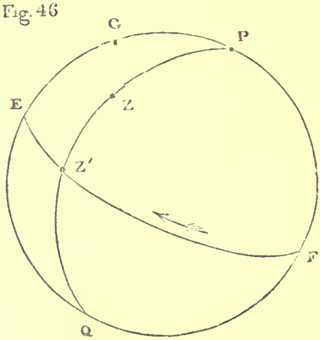
189 But this way of defining latitude and longitude is not sufficiently exact, taking into account the fact that the Earth's surface is not spherical. We must define these terms with reference to the celestial sphere in the following manner:—

Every place on the Earth's surface may be considered as marked upon the celestial sphere, by that point of the celestial sphere which is vertically over the place,—i. e., by the zenith of the place. The zenith of London marks the position of London, that of Paris the position of Paris, and so on; in fact, a correct map of the Earth's surface would be formed on the celestial sphere by marking the zenith of every place, and so tracing out on the celestial sphere the various coasts and boundaries of countries, the various towns, &c. &c., by their zeniths.

190 Taking, then, the zenith of a place as the point representing that place on the celestial sphere, we define latitude and longitude as follows:—

The latitude of a place is the declination of its zenith; the longitude of a place is the right ascension of its zenith, measured, however, not from the first point of Aries, but from some particular meridian, such as the meridian of Greenwich. Longitude is not measured from the first point of Aries, because that point is always moving over the Earth's surface, and longitude measured from it would be an ever varying quantity.

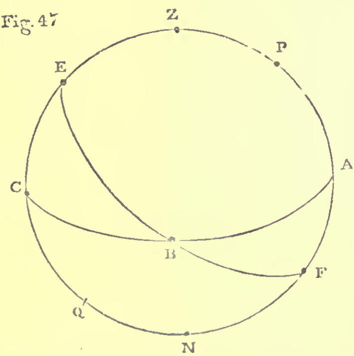
Fig. 46



191 In fig. 46, P and Q represent the poles; E Z′ F, the equator; G, the zenith of Greenwich; P G E F, the meridian of Greenwich; Z, the zenith of any other place; P Z Z′ Q, the meridian of the place; then the arc Z Z′ is the latitude of that place, and E Z′ is its longitude.

192 The apparent motion of the heavens takes place in the direction of the arrow, and it must be remembered that the meridians P Z Q, and P E Q F, must be supposed to be fixed, while all the heavenly bodies appear to be carried round by the circumpolar motion. Since this motion takes place at the rate of 15° per hour, it is evident that, if the longitude of the place be 15°,—i. e., if E Z′ be 15°, every star will cross the meridian of the place, E Z Z′ Q, one hour before it crosses the meridian of Greenwich, P G E Q; if the longitude be 30°, every star will cross the former meridian two hours before the latter; if 45°, three hours, and so on.

Fig. 47



193 Longitude, thus considered, is measured towards the east, and is called east longitude. If measured towards the west, it is called west longitude.

194 *The Altitude of the Pole at any place shows the Latitude of that place.*—For let P, fig. 47, be the pole; Z, the zenith; A B C, the horizon; E B F, the equator: then E Z is the latitude of the place; E P is 90°, also Z A is 90°; therefore E Z=90°—Z P, and P A=90°—Z P; therefore P A=E Z.

Now, P A is the altitude of P above the horizon A B C; hence the altitude of the pole is equal to the latitude of the place.

195 The circular arc Z P is called the *co-latitude*, or the complement of the latitude, because with the latitude it makes up or completes 90°.

III. *Of Time, Sidereal and Solar.*

196 *Sidereal Time.*—The most accurate observations show that the apparent circumpolar motion of the heavens is perfectly uniform, always taking place at the rate of 15° in an hour, 15′ in a minute, 15″ in a second. Indeed, we may conclude from mechanical considerations, that the Earth's motion about its axis, and therefore the circumpolar motion of the heavens, is uniform. From this uniformity of motion, every star may be used as a clock to indicate and measure time, provided we have proper instruments for observing the motion of the star.

197 Time, measured by the motion of the stars, is called *sidereal time;* the interval of time in which a star completes its revolution is called a *sidereal day;* the twenty-fourth part of that interval, a *sidereal hour.* We must, of course, choose some particular star or point of the heavens to mark the sidereal hours by its motion; the first point of Aries is that fixed upon for this purpose. When the first point of Aries is on the meridian, it is 0 o'clock, sidereal time; when the first point of Aries has moved 15° west of the meridian, it is 1 o'clock, sidereal time; when it has gone 30° west, it is 2 o'clock; 90°, 6 o'clock; 180°, 12 o'clock: 270°, 18 o'clock. Astronomers generally go on from 12 o'clock to 13 o'clock, 14 o'clock, &c., up to 24 o'clock, when a new day commences.

198 Hence the sidereal time at which a star crosses the meridian is evidently the right ascension of the star expressed in time; for, as we have shown above, the right ascension of a star, expressed in time, is the number of hours, minutes, and seconds that elapse between the transit of the first point of Aries and the transit of the star; therefore, when the star is crossing the meridian, the first point of Aries is that number of hours, minutes, and seconds past the meridian,—i. e., the sidereal time is that number of hours, minutes, and seconds past 0 o'clock.

199 *Solar Time.*—Solar time is time measured by the Sun's motion, in the same manner as sidereal time by the motion of the first point of Aries. The interval of time in which the Sun completes his revolution is called a solar day, the twenty-fourth part of it a solar hour. Also the solar day commences when the Sun comes on the meridian.

200 Hence sidereal and solar time differ in two respects: *First.* The sidereal and solar days commence at different instants of time, for the Sun and the first point of Aries never cross the meridian together, except at the vernal equinox, when the Sun coincides with the first point of Aries. We have already explained the nature of the Sun's proper motion, which carries him backwards among the stars (i. e., contrary to the apparent motion of the heavens) about 1° each day, which corresponds to 4′ of time. Let P and Q, fig. 48, represent the poles; P E Q G, the meridian; E A G, the equator; A, the first point of Aries; S, the Sun; P S S′ Q, the polar circle in which the Sun is, intersecting the equator at S′. Then S and S′ will cross the meridian at the same instant, and therefore, with respect to solar time, we may consider the Sun to be at S′; in fact, it will be 0 o'clock, solar time, when S′ comes on the meridian, and the solar day will be the interval of time in which S′ completes its revolution.

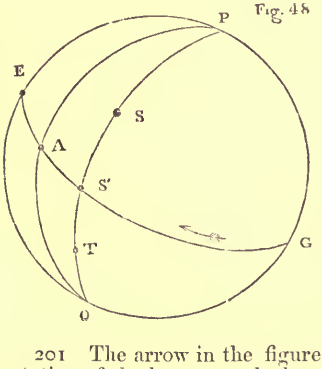


Fig. 48

201 The arrow in the figure shows the direction of the apparent diurnal rotation of the heavens, which carries A and S′ round and through 15° every hour. But we must remember that, as the year goes on, the point S′ is con-

tinually moving backwards, (i. e., contrary to the arrow,) in consequence of the Sun's proper motion, completing the whole 360° in a year. The distance of S′ from A is therefore continually increasing at the rate of about 1° daily; for 1° is very little greater than the 365th part of 360°, and therefore the daily increase of the distance, A S′, is about 1° daily.

202 About the third week in March, S′ will coincide with A, and therefore, since both points cross the meridian together, it will be 0 o'clock, sidereal time, at the same instant that it is 0 o'clock solar time.

In a quarter of a year afterwards,—i. e., in June, A S′ will be 90°, or 6^h, in time; therefore A′ will cross the meridian 6 hours before S′; in other words, it will be 6 o'clock, sidereal time, when it is 0 o'clock, solar time.

In September A S′ will be 180°, or 12^h in time; therefore it will be 12 o'clock sidereal time, when it is 0 o'clock solar time.

In December A S′ will be 270°, or 18^h in time; therefore it will be 18 o'clock sidereal time, when it is 0 o'clock solar time.

203 *Secondly.* Solar time is longer than sidereal. For since S′ moves back about 1° every day, it will cross the meridian about 4^m late every day—i. e., 4^m later than it would do if it remained stationary in the heavens. It is clear, therefore, that the solar day will be about 4^m longer than the sidereal day. This may also be shown by considering what has just been stated—namely, that in a quarter of a year (i. e., 90 days in round numbers) after the equinox, it will be 6 o'clock, sidereal time, when it is 0 o'clock, solar time. Hence 90 days, solar time, are equivalent to 90 days and 6 hours, sidereal time; and therefore, taking the 90th part of 90 days and 6 hours, which is 1 day and 4 minutes, it appears that 1 day solar time is equivalent to 1 day and 4 minutes sidereal time—i. e., the solar day is about 4^m longer than the sidereal day.

204 *Apparent and Mean Solar Time.*—Solar time, defined as above by the Sun's motion, is not regular and uniform as sidereal time is. This arises from two causes—first, the oval form of the orbit in which the Earth moves round the Sun, which makes the Earth move sometimes quicker and sometimes slower, and therefore renders the apparent annual motion of the Sun irregular; and, secondly, the obliquity of the ecliptic to the equator makes the interval between two successive transits of the Sun across the meridian longer at the solstices and shorter at the equinoxes.

From both causes, the day shown by the Sun's motion is sometimes longer and sometimes shorter. It would, of course, be very inconvenient to employ the Sun's motion, subject to such irregularities, to mark time; and yet, for civil purposes, it would be quite as inconvenient to use sidereal time—e. g., in March it is two hours past mid-day at two o'clock, sidereal time; in July, it is two hours before midnight at two o'clock, sidereal time.

205 To obviate these inconveniences, we use for civil purposes, and in astronomical observations also, what is called *mean solar time*, which is nothing but regulated solar time, the irregularities of the Sun's motion being allowed for and corrected. The word 'mean' signifies 'average;' the length of the mean solar day is the average length of the solar day: which is determined as follows:—

It is found by observation that the backward motion of the Sun, or rather of the point S′, fig. 31, in the interval between two successive transits of the Sun across the meridian, is, taking its average or mean length, not quite 1°, but 59′ 8″, (we omit fractions of 1″;) on some days it is greater than this, and on some days less; but its average length in a great number of days is 59′ 8″. Therefore, considering the average motion of the Sun only, and supposing the Sun to be on the meridian now, it is clear that the heavens must turn round 59′ 8″ more than a complete revolution—i. e., 360° 59′ 8″, before the Sun comes on the meridian again; in other words, the average or mean length of the solar day corresponds to a revolution of the heavens through 360° 59′ 8″, which, expressed in sidereal time, at 15° per hour, 15′ per minute, 15″ per second, amounts to $25^h\ 3^m\ 56\frac{1}{2}^s$. Hence it appears that the mean or average solar day consists of $24^h\ 3^m\ 56\frac{1}{2}^s$ sidereal time, and is therefore longer than the sidereal day by 3 minutes $56\frac{1}{2}$ seconds.

206 A well-regulated clock shows mean solar time; a sun-dial shows the actual irregular solar time, or, as it is called, *apparent* solar time.

207 *Equation of Time.*—The equation of time is the number of minutes and seconds that must be added to or subtracted from the apparent solar time, or the time shown by a sun-dial, in order to make it equal to, or, as it is said, to *equate* it to the mean solar time, or the time shown by a clock. The equation of time is sometimes greater and sometimes smaller; sometimes it is *additive*—i. e., to be added to the apparent time—and sometimes it is *subtractive*. It is given in the almanac, often in columns headed 'Sun too slow,' 'Sun too fast,' or 'Clock after Sun,' 'Clock before Sun.' Thus, in White's *Ephemeris* for 1849, on March 30, in the column headed 'Clock before ☉,' we find $4^m\ 33^s$; which means, that $4^m\ 33^s$ must be subtracted from the apparent time to get the mean time. Again, on November 4, in the column headed 'Clock after ☉,' we find $16^m\ 16^s$, which means that $16^m\ 16^s$ must be added to the apparent time to get the mean time.

CHAPTER IV.

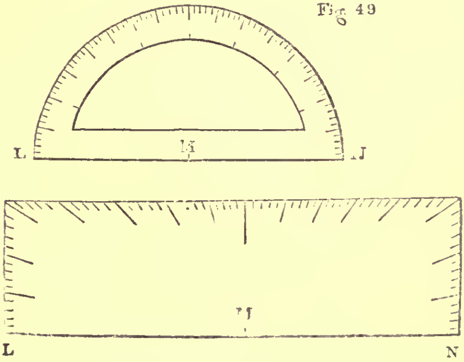
METHOD OF SOLVING ASTRONOMICAL PROBLEMS BY CONSTRUCTION ON PAPER.

I. *Instruments necessary.*

WE have now sufficiently explained the meaning of astronomical terms to enable us to proceed to the solution of a variety of interesting and useful problems. These problems may be solved in a rough way by means of a pair of globes, and they are the principal problems usually treated of in what is called the 'Use of the Globes.' They may be solved accurately by mathematical calculation, deduced from the formulæ and rules of that branch of mathematics called 'Spherical Trigonometry.' We shall now explain a method of solving astronomical problems, which is at the same time simple and exact, and requires no acquaintance with the technicalities of abstract science. All that is necessary for the immediate application of this method is a drawing-board, rule, compass, and graduated circle, or protractor, for laying down and measuring angles on paper.

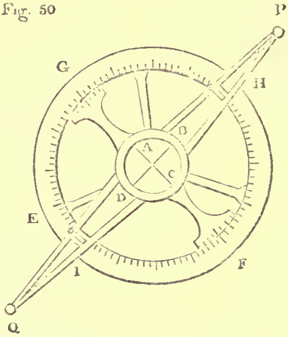
209 If a rough solution of astronomical problems, such as that attainable by the use of the globes, is all that is required, these instruments may be of a very ordinary description; a table will serve in place of a drawing-board, and a common graduated ruler or brass semicircle will answer perfectly well for laying down and measuring angles. See fig. 49.

Fig. 49



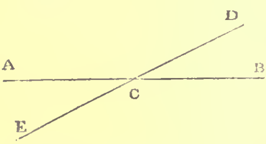
If, however, accuracy is required, a good flat drawing-board must be procured, and the paper must be strained upon it, having been previously damped; the ruler must be perfectly straight, and should be made of hard metal; the points of the compass must be fine, and one leg ought to have an adjusting-screw, for the purpose of opening the compass with great exactness to any required distance; and, lastly, the circle or protractor, which is shown in fig. 49, ought to be capable of measuring an angle accurately to a minute by means of a Vernier, (which we shall presently speak about.) Respecting the protractor, we may observe here that it consists of a graduated circle, E F G, fig. 50, and an arm P H I Q, which turns round about the centre of the graduated circle, carrying Verniers at G and F; the centre is marked by the intersection of two fine lines, A C and B D, generally drawn on a small piece of plate-glass, A B C D, fixed in the middle of the arm; at P and Q are two fine points, which may be pressed down on the paper so as to mark it slightly; the line joining these points passes through the centre of the circle.

Fig. 50



210 The use of this instrument is as follows:—Suppose it is required to draw a line through the point C, making an angle of 30° with the line A B. Place the protractor on the paper with the centre (i. e., the intersection of the two lines drawn on the piece of glass) exactly on the point C; bring the points (i. e., P and Q, fig. 50) exactly over the line A B; then, by looking at the graduations on the circle, turn the arm through 30°; this being done, mark the paper by pressing down the points, and suppose E and D to be the two marks; then join E and D, and E D will be the required line, making an angle of 30° with A B.

Fig. 51



In like manner we might apply the instrument to measure the number of degrees and minutes contained in any angle drawn upon the paper.

211 This instrument, if well made, is capable of great accuracy. We may observe that, by always using the two points and reading off at the two Verniers, we may entirely get rid of any error there may be, either in the position of the centre, or in placing the centre on the point C, fig. 51; but we have not space to say anything on this head.

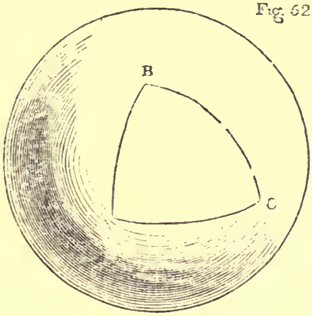
212 In using the simple instruments shown in fig. 49, we have only to place the point M, which is the centre of the graduations, upon C, fig. 51, and the line L N on A B; then by looking at the graduations we shall see what angle C D makes with C B.

The method we are about to explain has the advantage of giving, with great facility, and without supposing any knowledge of Trigonometry, the means of solving astronomical problems much more accurately than could be done by means of globes. It also gives very simply the various mathematical formulæ employed in astronomy.

II. *Of Spherical Triangles.*

213 We must say a few words, before we proceed, in order to explain what a spherical triangle is, and what its several parts represent. In the same way that an ordinary or plane triangle is formed by three straight lines drawn on a plane surface, and meeting at three angular points, so a spherical triangle is formed by three arcs of great circles drawn on a spherical surface, and meeting in three angular points.

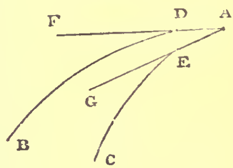
Fig. 52



214 Fig. 52 represents a spherical surface, with a spherical triangle, A B C, drawn on it; A B, B C, and C A represent arcs of great circles; they are called the *sides* of the spherical triangle. The angles of this triangle show the inclinations of the three sides to each other at their respective points of intersection; but we must explain more fully what the angles of a spherical triangle are.

215 *Angles of a Spherical Triangle.*—Let A B and A C, fig. 53, be any two circular arcs, or other curved lines meeting at a point, A; then we cannot speak generally of the inclination of the arc A B to the arc A C, as we could do if they were straight lines, because, being curves, they are differently inclined to each other at different parts. But we may speak of the inclination of these two curves to each other at the point A; for take two points, D and E, on A B and A C respectively, very near A, so near that the portions A D and A E may be too small for their curvature to be sensible, and we may regard them as two very small straight lines. These two lines make a certain angle with each other, whatever it may be, and that angle is the angle at which the two curves meet each other at the point A. This sufficiently explains what we mean by the angles of a spherical triangle.

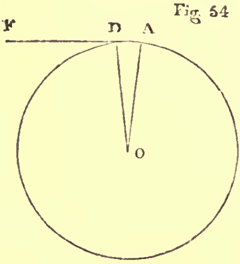
Fig. 53



216 If we produce the two small lines A D and A E to any points, F and G, the straight lines A F and A G are respectively coincident with the two curves A D B and A E C, in the immediate vicinity of the point A; these lines are therefore said to *touch* the curves at A; A F is said to be the *tangent* to the curve A D B at the point A, and A G is said to be the *tangent* to the curve A E C at the point A.

217 Hence, the angle which the two tangents make with each other is the same thing as the angle which the two curves make with each other at the point A.

Fig. 54

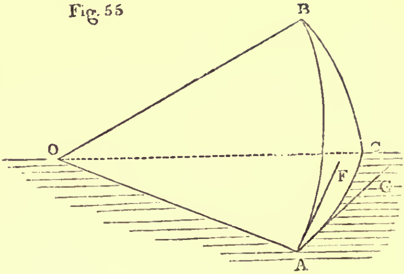


218 If A F, fig. 54, be the tangent at any point, A, of a circle, whose centre is O, it is easy to see that A F is perpendicular to the radius A O; for if A D be an extremely small portion of the circumference, so small that we may consider it a straight line, the tangent A F is simply A D, produced to any point F; now since, in describing a circle, the point of the compass always moves perpendicularly to the radius, A D must be perpendicular to A O, and therefore A F is so also.

219 It is important to remember, that the tangent at any point of a circle is perpendicular to the radius or line drawn from that point to the centre. We may also observe, that the tangent always lies in the same plane as the circle.

220 *A Spherical Triangle completely represents a Solid Angle.*—Let A B C, fig. 55, be a spherical triangle, O the centre of the spherical surface, on which the triangle is drawn, O A, O B, O C, the radii drawn to the angular points A B C. Then A B is a circular arc described with O as centre; therefore A B represents or measures the angle A O B, which the two radii A O and B O make with each other—i.e., the number of degrees, minutes, and seconds in A B, and in the angle A O B are the same, as has been fully explained in Chapter II. In like manner the circular arc B C shows the angle B O C, which the two radii drawn from B and C make with each other, and the circular arc C A, the angle C O A, which the two radii drawn from C and A make with each other.

Fig. 55



221 Again, if we draw from A the two lines A F and A G, touching the circular arcs A B and A C at A, the angle F A G which these two tangents make with each other, is the same thing as the angle A of the spherical triangle. But the angle F A G also shows the inclination of the two planes A O B and A O C to each other, as we may prove in the following manner.

222 By the plane A O B, we mean the plane in which the two radii, A O, B O, the circular arc A B, and of course the tangent A F, all lie; by the plane A O C, we mean the plane in which A O, C O, the circular arc A C, and the tangent A G, all lie. A O is the line of intersection of these two planes, and the tangents A G, A F, are perpendicular to the radius A O. Now the angle at which two planes are inclined to each other is shown by drawing from a point in their line of intersection, a line in each plane perpendicular to the line of intersection. That this is the case is easily seen, by marking with a knife a line E F, fig. 56, on a piece of card A B C D, and drawing a perpendicular line R P Q in pencil: then turn the two parts A E F D and B E F D about the cut line E F, so as to make them make an angle with each other, as in fig. 57; and it will be immediately seen, that, at whatever angle we incline

Fig. 56

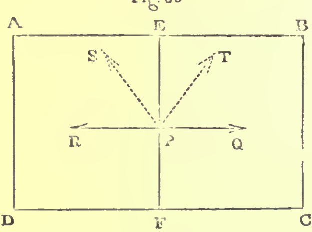
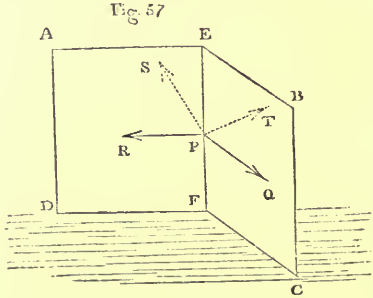


Fig. 57



the two planes A E F D and B E F C to each other, the two lines R P and P Q will always make the same angle with each other. But if we draw two lines, P S and P T, not perpendicular to E F, the angle these two lines make with each other will always be less than the angle at which the two planes are inclined.

223 Hence, returning to fig. 55, it is manifest, that the angle F A G, or, what is the same thing, the angle A of the spherical triangle, shows the angle at which the two planes A O B and A O C are inclined to each other. In like manner we may show that the angle B shows the angle at which the two

planes B O A and B O C are inclined to each other, and the angle C shows the angle at which the two planes C O A and C O B are inclined to each other.

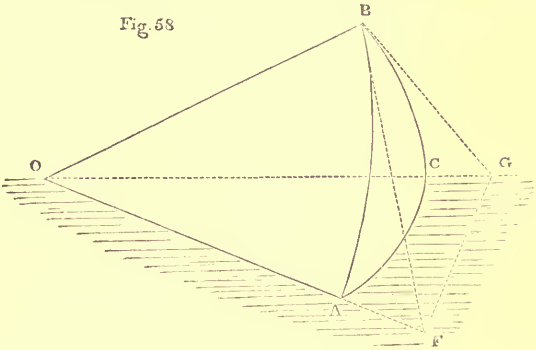
224 The triangular point O, which is formed by the meeting of the three planes A O B, B O C, C O A, is called a *solid angle*, the three planes are called the *planes, or faces, of the solid angle*, and the three lines O A, O B, O C, are called its *edges*.

225 Hence, it appears, that the spherical triangle A B C represents, in all its parts, the solid angle O, which is formed by drawing radii from the angles A B C to the centre O—namely, the three sides of the spherical triangle, A B, B C, C A, represent respectively the three angles, A O B, B O C, C O A, which the edges, O A, O B, O C, of the solid angle make with each other; and the three angles, A, B, C, represent the angles at which the planes A O B, B O C, C O A, of the solid angle are inclined to each other.

III. *Method of representing the different parts of a Spherical Triangle on Flat Paper.*

226 *First Construction.*—Let A B C, fig. 58, be the spherical triangle, O the centre of the sphere; draw B F, a tangent to the circular arc B A, at B,

Fig. 58



and B G a tangent to the circular arc B C at B; let these tangents meet O A and O C produced at F and G respectively, and join F G. Then, as we have explained, the angles B O F, B O G, and F O G, are shown by the sides of the spherical triangle—namely, B A, B C, and A C respectively; also the angle B of the spherical triangle is the same thing as the angle F B G.

Now let us conceive the solid figure O B G F to be formed of four triangular planes of thin board or card—namely, B O F, B O G, B G F, and F O G, fastened together by hinges along the edges O F, O G, and F G, and by a clasp of some kind at B, so that, if the clasp at B be unfastened, the plane O B F may be turned about the edge O F, the plane O B G about the edge O G, and the plane B G F about the edge F G. This being supposed, let the clasp at B be unfastened, and let the planes O B F, O B G, and B F G, be turned about the hinged edges, until they all form one plane with O G F, so that the four planes may be laid flat upon the table, as is represented in fig. 59, where O F G, G B F, and O B′ F, and O B″ G, represent respectively the planes O F G, G B F, O B F, and O B G, in fig. 58.

227 Hence, fig. 59 represents on flat paper the three sides and one angle of the spherical triangle—namely, the angles F O B′, F O G, and G O B″, show the sides A B, A C, and C B respectively, and the angle G B F shows the angle B. It is important to observe that the angles O B′ F, and O B″ G, fig. 59, being respectively equal to O B F and O B G, fig. 58, are right angles, that the lines O B′ and O B″, fig. 59, being each equal to O B, fig. 58, are of equal length, that G B″ and G B, fig. 59, being each equal to G B, fig. 58, are

of equal length, and that the same is true of F B′ and F B, fig. 59, which are each equal to F B, fig. 58.

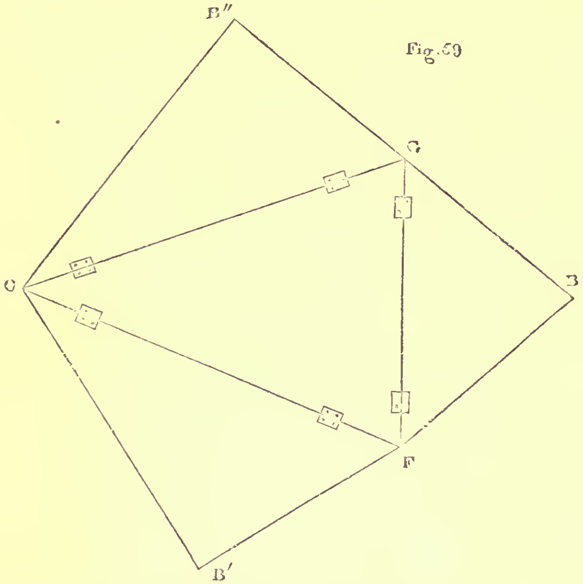


Fig. 59

228 We have, therefore, the following construction on flat paper for representing the three sides and one angle of a spherical triangle, whose angles we shall denote by A B and C, and the sides respectively opposite those angles by the small letters *a b c*.

Choosing a point O on the paper, draw the lines O B′, O F, O G, and O B″, fig. 60, making angles with each other equal to the three sides *a b* and *c*

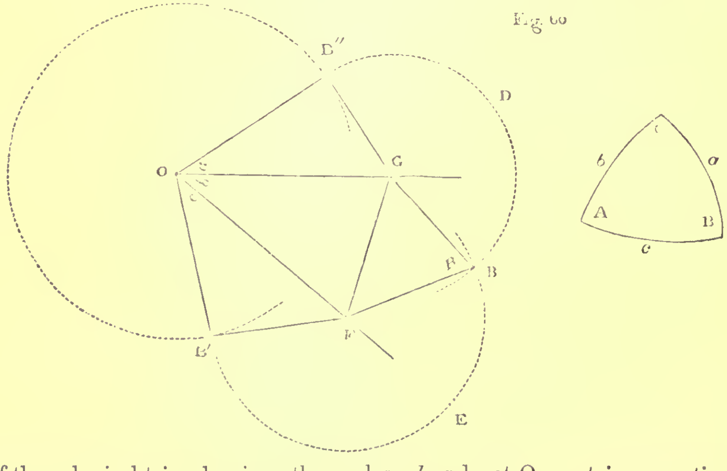


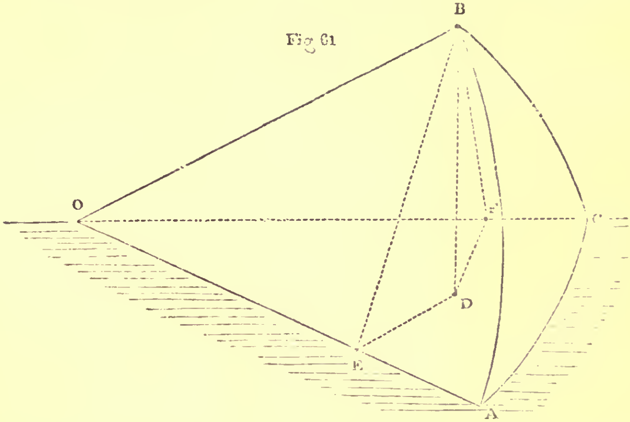
Fig. 60

of the spherical triangle—i. e., the angles *a b* and *c* at O, contain respectively the same number of degrees, minutes, and seconds, as the sides *a b* and *c* of the spherical triangle. Putting one point of the compass at O, strike off O B′ and O B″ equal to each other; draw B″ G perpendicular to O B″, and B′ F perpendicular to O B′, to meet the lines O G and O F, at G and F; with G as centre and G B″ as radius, and with F as centre and F B′ as radius, describe two circular arcs B″ D B and B′ E B, intersecting each other at the point B, and join B G and B F: then the angle G B F so formed, is equal to the angle B of the spherical triangle.

229 This construction will enable us to solve any astronomical problem in which we are concerned, with the three sides and one angle of a spherical triangle. We shall now give another construction for representing the two other angles of the spherical triangle, A and C.

230 *Second Construction.*—As before, let A B C be the spherical triangle, and O the centre of the sphere; draw the lines B E perpendicular to O A, and

Fig. 61



B F perpendicular to O C; in the plane O A C, draw E D perpendicular to O A, and F D perpendicular to O C, to meet in D, and join B D. The two planes B E D and B F D, being thus made perpendicular to the plane O A C, their line of intersection B D will also be perpendicular to the plane O A C, and therefore to the two lines E D and F D, which lie in that plane: the two angles B D E and B D F, are therefore each right angles.

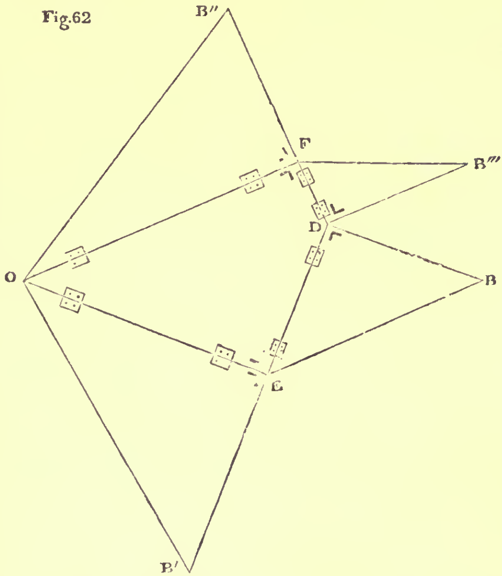
In this construction E B and E D are perpendicular to O A, the line of intersection of the two planes O A B and O A C, and therefore, as we have previously explained, the angle B E D shows the inclination of these two planes to each other, or, what is the same thing, the angle A of the spherical triangle; the angle B E D is therefore equal to the angle A; and in like manner, we may show that the angle B F D is equal to the angle C, of the spherical triangle.

231 Now, just as in the former construction, let us suppose the solid figure O B E D F to be formed by four triangular planes, O B E, O B F, B E D, B F D, hinged at their lower edges to the quadrangular plane O F D E, and fastened at B by a clasp. Let the clasp be unfastened, and the four triangular planes turned about their hinged edges, until they form one plane with the quadrangular plane O F D E, so that five planes may be laid flat on the table, as is represented in fig. 62, where O F D E is the quadrangular plane, and O F B″, O E B′, D F B‴, D E B, the four triangular planes—namely, O F B, O E B, D F B, D E B, in fig. 61.

232 Hence, fig. 62 represents on flat paper the three sides and the other two angles of the spherical triangle—namely, the angles at O show the sides of the spherical triangle, just as in the former construction, and the angles D E B, D F B‴, show the two angles A and C.

233 It is important to observe, as before, that angles marked thus ⌊, in figure 62, are right angles, because they are respectively equal to angles in fig. 61, which we know to be right angles. Also, as before, O B′ and O B″ are equal, F B″ and F B‴ are equal, D B‴ and D B are equal, and E B and E B′ are equal, each pair of lines being equal to O B, F B, D B, and E B, respectively, in fig. 61.

Fig. 62



234 We have, therefore, the following construction on flat paper for representing the three sides *a b* and *c*, and the other two angles A and C of the spherical triangle.

Draw OB′, OE, OF, and O B″, fig. 63, making, as before, angles, *a b c*, with each other; make O B″ equal to O B′; draw B″ F perpendicular to O F, and B′ E perpendicular to O E, and produce those perpendiculars to meet in D; draw D B‴ perpendicular to F D, and D B perpendicular to E D; with centre F and radius F B″, and with centre E and radius E B′ describe two circular arcs, cutting the perpendiculars last drawn in B‴ and B, and join B‴ F and B E; then the angle B E D will be equal to the angle A of the spherical triangle, and the angle B‴ F D will be equal to the angle C.

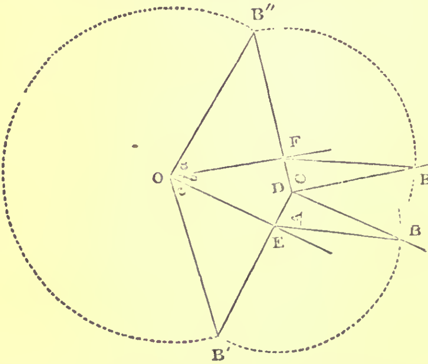
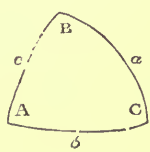


Fig. 63



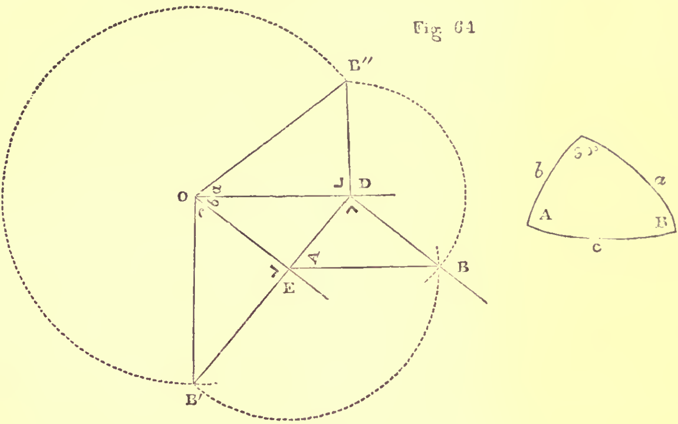
235 This construction is of considerable importance, and solves a great number of astronomical problems, only in practice it is much simpler than it appears to be here, stated as it is in all its generality.

This construction is also of importance, because it gives immediately all the mathematical formulæ of spherical trigonometry used in the most exact astronomical calculations.

236 *Application of the Second Construction to Right Angled Spherical*

Triangles.—When one of the angles of a spherical triangle is a right angle or 90°, it is called a right angled spherical triangle. Suppose C to be a right angle in the second construction; then B‴ F, fig. 62, is perpendicular to F D, and therefore, since B‴ D is also perpendicular to F D, the two lines B‴ F and B‴ D coincide; in other words, the points F and D coincide. Hence the construction becomes what is represented in fig. 64, in which O B′ and O B″ are equal, D B″ and D B are equal, E B′ and E B are equal, and the angles thus marked, ∟, are right angles.

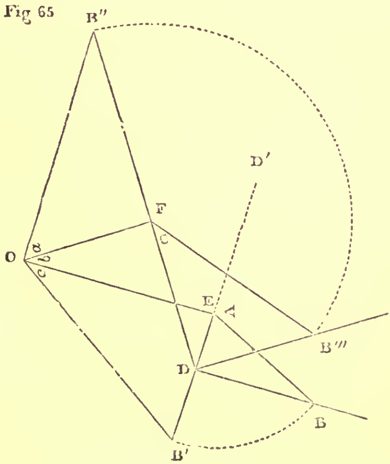
Fig. 64



237 Hence we have the following simple construction for a spherical triangle, one of whose angles, C, is 90°.

Draw from O lines, as before, fig. 64, making the angles *a b c* with each other; make O B″ equal to O B′, draw B″ D perpendicular to O D, and B′ E perpendicular to O E, which two perpendiculars produced will always meet at a point D of the line O D, when the angle C is 90°; with radius D B″ and centre D, and with radius E B′ and centre E, describe two circular arcs intersecting at B, and join B D and B E; then the angle B D E will be 90°, and the angle B E D will be equal to the angle A of the spherical triangle.

Fig 65



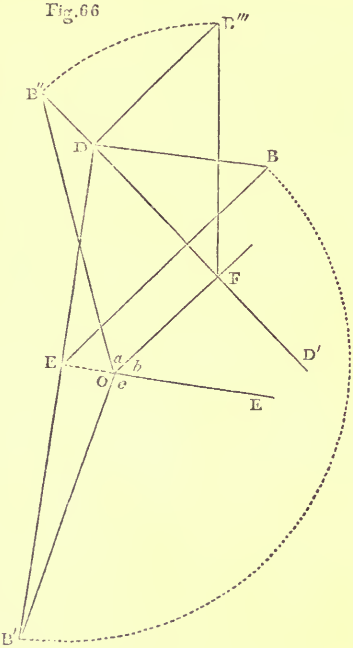
238 . This construction solves every case of right angled spherical triangles, and therefore, as will appear, a great number of practically useful astronomical problems. We might easily show that this construction gives immediately what are known as Napier's Rules, and obviates the necessity of the use of these rules, which is often very troublesome.

239 *Observations respecting the Second Construction.*—It sometimes happens, in making the second construction, that one of the two perpendiculars, B″ F and B′ E, when produced, meets the other in the manner shown in fig. 65, in which case the point D lies between E and B′, or, it may be, even beyond B′ in E B′ produced. In this case, the construction is precisely the

same as before; we must draw D B''' perpendicular to F D, F B''' equal to F B'', and D B perpendicular to E D, making E B equal to E B'. There is, however, a caution necessary respecting the angle A—namely, the angle B E D is not A, but B E D' is, where E D' is D E produced. It is therefore necessary to make the following statement respecting the angles A and B.

240 In all cases, wherever the point D may fall, the angle A is the angle which the line E B makes with the perpendicular B' E, *produced beyond* E—i. e., the angle contained between E B and the *produced part* of the perpendicular; and, in like manner, the angle C is the angle which the line F B''' makes with the perpendicular B'' F produced beyond F—i. e., the angle contained between F B''' and the produced part of the perpendicular. No mistake can be committed if it be remembered that the angles A and C are those made, not by the perpendiculars, but by the perpendiculars produced.

Fig. 66



241 When any of the angles *a b c*, as for instance *a*, happens to be greater than 90°, the point E will fall on the other side of the point O, as is shown in fig. 66. In this case, the construction is the same as before, without the least alteration, and the same rule holds with reference to A and C. A is the angle B E D which is contained between E B and the produced part E D of the perpendicular B' E, and C is the angle B''' F D', which is contained between F B''' and the produced part F D' of the perpendicular B'' F.

242 We have been particular in discussing the second construction on account of its importance, but no mistake can be made if the following points, which apply to all cases, be remembered.

O B' = O B'', F B'' = F B''', D B''' = D B, E B = E B';

O F B'', O F D, O E B', O E D, F D B''', and E D B, are right angles;

The three angles at O are the sides of the spherical triangle;

The angle of the spherical triangle which is opposite the side B' O E is the angle contained between F B''' and B'' F produced;

The angle opposite the side B'' O F is the angle contained between E B and B' E produced.

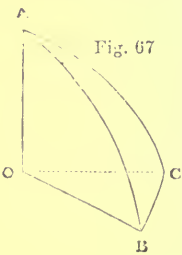


Fig. 67

243 *Observations respecting a spherical triangle, two of whose sides are each* 90°.—When this is the case, as in fig. 67, where *b* and *c* are each 90°, it is important to remember, 1st. that *a* and A are equal (i. e., they contain the same number of degrees, minutes, and seconds,) and 2ndly, that B and C are each right angles. To prove this, let O be the centre of the sphere, and join O A, O B, and O C; then, since *c* is 90°, A O B is a right angle, and since *b* is 90°, A O C is a right angle; therefore A O, being perpendicular to O C and O B, it is manifest that

the planes A O B and B O C are at right angles to each other, and that the same is true of the planes A O C and B O C; wherefore the angles B and C, which show the inclinations of these planes to each other, are right angles; also O C and O B being at right angles to the intersection O A of the two planes O A B and O A C, the angle C O B (which equals a) shows the inclination of these two planes—i. e., the angle A; therefore a and A are equal.

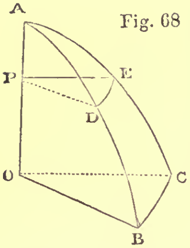


Fig. 68

244 It is also important to remember that, if from any point P of O A we draw P E and P D perpendicular to O A, as is shown in fig. 68, and describe the circular arc D E, (which is a portion of a small circle described about the pole A,) then the proportion of the arc D E to the arc B C is the same thing as the proportion of the line P D to the line O B. This will become evident if we consider the arcs C B and E D, to be described by the points B and D, when we turn the plane O A D B about the axis O A; for then if P D is half O B, the point D will only move half as fast as the point B, and therefore the arc E D will be always half of the arc B C; in the same manner, if P D be one-third of O B, B will move three times faster than D, and therefore C B will be three times E D, and so on. In whatever proportion, therefore, P D is less than O B, the arc E D will be less than the arc C B in the same proportion. See Chapter II.

Having now said enough of spherical triangles, we shall proceed to the solution of astronomical problems.

IV. *Solution of various Astronomical Problems.*

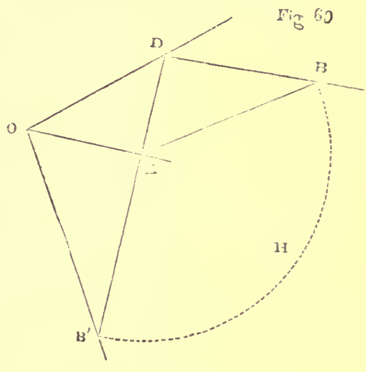
245 In the solution of the following problem, it will be necessary to have an Ephemeris, or almanack, with astronomical tables. White's *Celestial Atlas*, which only costs a shilling, and is published regularly every year, will answer every purpose.

Problem I.

To find the Time of Sunrise on any given day of the Year.

246 *Solution.*—Draw a line O B′, of any convenient length, fig. 69, and another O E, making the angle E O B′ equal to the Sun's north polar distance, which is given in the Ephemeris; and draw B′ E perpendicular to O E. Draw O D, making the angle D O E equal to the latitude of the place, (which is of course known,) and meeting B′ E produced at D. Draw D B perpendicular to E D, to meet a circular arc B′ H B, described with E as centre. Measure the angle D E B, and convert it into time, allowing one hour for every 15°; then that time is the hour of sunrise, as shown by the sun-dial.

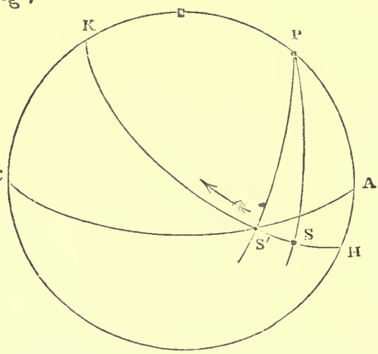
Fig. 69



247 *Proof.*—Let K Z P A H, fig. 70, be the meridian, A S′ C the horizon, P the Pole, S the Sun, and H S S′ K the circle which the Sun describes, (in consequence of the rotation of the heavens about P,) crossing the horizon at S′. When the Sun is at K, it is midday; when at H, midnight; and when he comes to S′ he rises; therefore the angle A P S′, being described about P by the polar circle P S in the interval between midnight and sunrise, is, when expressed in time at 15° per hour, the number of hours, minutes, and

seconds between midnight and sunrise, or, what is the same thing, the hour of sunrise.

Fig. 70



Now this angle is the angle at P in the spherical triangle A S′ P, in which triangle the angle at A is 90°, the side P S′ is the Sun's polar distance, and the side P A is the latitude of the place (see art. 194.) Hence, employing the *second construction*, (as it applies to a right-angled triangle, art. 236,) supposing A S′, A P, and P S′ to be a, b, and c, respectively, and therefore the angle at P to be A, we obtain immediately the above solution.

248 *Example.*—On the 2nd of May, 1849, at what hour will the Sun rise in London?

Looking in White's *Celestial Atlas* for 1849, we find—

Page 47. Latitude of London, 51° 31′.

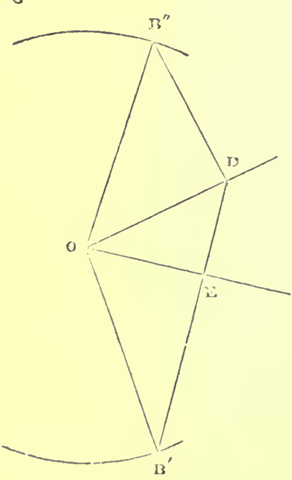
Page 10. Sun's declination 15° 26′ north, and therefore polar distance 74° 34′.

Therefore in fig. 69 we must make E O B′ 74° 34′, E O D 51° 31′, which if we do, we shall find the hour of sunrise to be twenty-nine minutes past four, as shown by the sun-dial.

249 It appears by the Ephemeris, that the Sun is about three minutes after the clock on the 2nd of May, therefore the time of sunrise by the clock will be thirty-two minutes past four.

250 If we examine the tables of the hours of sunrise and sunset in the Ephemeris, we shall find that twelve o'clock is not half way between sunrise and sunset; the reason of this is, that twelve shown by the clock, is not the same as twelve shown by the dial. Twelve, as shown by the dial, would be exactly half-way between sunrise and sunset, only for the motion of the Sun. In fact, in working out the above problem, we have for simplicity supposed the Sun to remain fixed in the heavens during the day. This is not true, and therefore our result is slightly erroneous.

Fig 71



251 We shall presently show that, in consequence of the refraction of light by the atmosphere, heavenly bodies appear to rise a little before, and to set a little after, they actually come on the horizon.

Problem II.

To find at what Point of the Compass the Sun rises.

252 *Solution.*—Draw the lines O B′, O E, and O D, (fig. 71,) exactly as in Problem I., making E O B′ equal to the Sun's polar distance, E O D equal to the latitude of the place, and B′ D perpendicular to O D. Draw D B″ perpendicular to O D, to meet a circular arc, B′ H B″, described about O as centre, at B″ Measure the angle D O B″, and the result will be the Sun's azimuth at rising, which, as we have explained in the previous chapter, shows the point of the compass at which he rises; for example, if D O B″

be 0, the Sun rises in the north; if 45°, in the north east; if 90°, in the east, and so on.

253 *Proof.*—In fig. 70, A S′ is the Sun's azimuth at rising, and A S′ is the third side of the right angled spherical triangle, A P S′, considered in Problem I.; therefore, employing the *second construction* as applied to a right angled triangle, we find the azimuth in the manner just stated.

254 By means of this problem, or rather, by a mathematical calculation equivalent thereto, the *variation* of the compass is often found at sea. The magnetic needle does not point truly to the north; the error is called the variation of the compass; and it is different at different points of the Earth's surface. It is, of course, necessary for the navigator to determine this error, and how it changes as he sails over the ocean; this he does by observing with the compass at what point the Sun rises,—i. e., the Sun's azimuth at rising; he then, by means of a mathematical calculation equivalent to Problem II., finds what the Sun's azimuth ought to be, and takes the difference between the result and the azimuth observed by the compass; which difference is manifestly the error or variation of the compass.

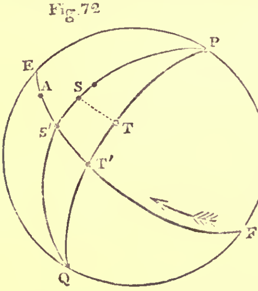
Problem III.

On a given Day of the Year, to find at what Hour any given Star crosses the Meridian.

255 *Solution.*—Look in the *Ephemeris* for the Sun's right ascension and that of the star; subtract the former from the latter, and the result will be the hour (i. e., the number of sidereal hours, minutes, and seconds, after mid-day by the dial) at which the star crosses the meridian.

If the Sun's right ascension should happen to be greater than that of the star, add 24^h to the latter before subtracting.

Fig. 72



256 *Proof.*—Let S, fig. 72, be the Sun; T, the star; E S′ T′ F, the equator; P S S′ Q and P T T′ Q being respectively the declination or polar circles of the Sun and star. Then S′ T′, reduced to time, is evidently the number of hours, minutes, and seconds between the transits of S and T; but if A be the first point of Aries, A S′ and A T′ are the right ascensions of S and T, and therefore S′ T′ is the difference between the right ascension of the star and that of the Sun. Hence the truth of the solution is manifest.

257 By adding 24^h to the right ascension of a heavenly body, we do not alter its position on the celestial sphere, since 24^h corresponds to 360°,—i. e., a complete revolution. We may therefore, if we please, add 24^h to the star's right ascension, should it happen to be less than that of the Sun, in order to make the subtraction of the former from the latter possible.

258 *Examples.*—At what hour does Arcturus cross the meridian on the 25th of September, 1849?

Looking in the *Ephemeris* we find, omitting seconds :—

Right Ascension of Arcturus (α Bootes) . . .	14^h	9^m
Ditto of Sun, (September 25th, 1849) .	12^h	8^m
Difference,	2^h	1^m

Therefore Arcturus crosses the meridian 2^h 1^m after apparent noon.

259 We have taken here the Sun's right ascension at mean noon, on the 25th of September, which is given in the *Ephemeris*. A small correction is necessary in this, to allow for backward motion of the Sun in the interval between noon and the transit of the star.

260 To determine the same for the 25th of December, we have:—

Right Ascension of Arcturus + 24^h	. . . . . .	38^h 9^m
Ditto of Sun (December 25th)	. . .	18^h 16^m
	Difference,	19^h 53^m

Therefore Arcturus crosses the meridian 19^h 53^m after apparent noon.

Problem IV.

To find at what Hour any given Star rises or sets on any specified Day of the Year.

261 *Solution.*—Precisely as in the case of the Sun, Problem I., find what time elapses between the rising of the star and its transit over the meridian; subtract this from the hour of the star's transit found by Problem III., adding 24^h to the latter if necessary; then the result is the hour of rising of the star.

To find the hour of setting, *add* instead of subtracting.

Example.— Supposing that we find by Problem I. that the star's transit takes place eight hours after its rising, and, by Problem III., that on the 1st of August the star crosses the meridian at 4 o'clock; at what hours does it rise and set?—

4 + 24 = 28	4
Subtract 8	Add 8
20	12

Therefore the star rises at 20 o'clock, (four hours before noon,) and sets at 12 o'clock.

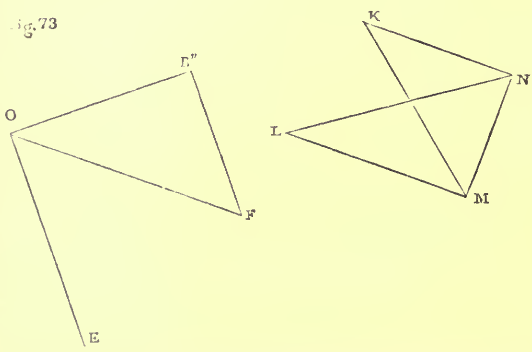
262 The hours in these and the previous examples are sidereal hours, which are a little shorter than mean solar, or the ordinary civil hours. In round numbers, we may consider that a mean solar hour is ten seconds longer than a sidereal hour.

Problem V.

Having given the Right Ascensions and Declinations of two heavenly bodies, to find the Distance of one from the other, in degrees, minutes, and seconds.

263 *Solution.*—Find the polar distance of each body, (by subtracting its declination from 90°, or adding, if the body be south of the equator,) and the difference of the right ascensions in degrees, minutes, and seconds; and then make the following construction, fig. 73:—

Draw O B″ (of any length) and O F, making the angle B″ O F equal to the polar distance of one body; and draw B″ F at right angles to O B″; draw also L M equal to O B″, M N perpendicular to L M and L N, making the angle N L M equal to the polar distance of the other body; draw N K equal to B″ F, making the angle M N K equal to the difference of the right ascensions of the two bodies; and with centre F, and radius M K, and with centre O, and radius L N, describe two circular arcs intersecting at E; then



the angle E O F being measured, gives the required distance between the two bodies, in degrees, minutes, and seconds.

264 *Proof.*—Let S and T, fig. 72, be the two bodies, and join S T by an arc of a great circle, which arc is the required distance between S and T; then, in the spherical triangle S P T, (P being the pole.) we have given the two sides P S and P T, which are the polar distances of S and T, and the angle S P T, which, as we have explained in the previous chapter, is the same thing as the arc S′ T′ (the difference of the right ascensions) on the equator, in degrees, minutes, and seconds. Hence we have given two sides and the included angle of a spherical triangle, and it is required to find the third side, S T. This can be done by means of the first construction; for, referring to it, suppose a e and B to be given: then, fixing upon any length we please for O B″, and therefore O B′, we may construct the two triangles, O B″ G and O B′ F, and so find the sides B″ G and B′ F, which are respectively equal to G B and F B; but B is known, and therefore. having found G B and F B, we can construct the triangle G B F, and so find G F: then, since we have thus determined O G, O F, and F G, we can construct the triangle O F G, and so find the angle b, which is the third side of the spherical triangle.

This is exactly what we have done in fig. 73, where the triangles L M N and K M N are the same as the triangles O F B′ and F B G in the first construction.

265 We might also solve this problem by the second construction, by supposing a b and C to be the given quantities, as follows :—

Draw O B″, O F, and O E, making a and b equal to the given polar distances, and B″ F at right angles to O B″, making O B″ of any length we please: draw F B‴, making C equal to the given difference of right ascensions: measure F B‴ equal to F B″, and draw B‴ D at right angles to B″ D: draw D E at right angles to O E, and produce it to meet a circular arc, described with O as centre and O B″ as radius, at the point B′: then E O B′, or c, the required third side of the spherical triangle, is found.

Problem VI.

Having given the Latitudes and Longitudes of two places on the Earth's surface, to find the distance between them in miles.

266 *Solution.*—Proceed exactly as in Problem V., putting latitude for declination, and longitude for right ascension, and then convert the result into miles, by allowing $69\frac{1}{2}$ miles for every degree, which will give the required answer.

267 It is not necessary to say anything to prove this, beyond observing that it is found by actual measurement, that a degree of a great circle on the Earth's surface is about $69\frac{1}{2}$ miles long.

268 To solve this problem accurately, we ought to take into account the fact that the Earth's surface is not an exact sphere; without, however, going to such a degree of accuracy, this problem is very useful geographically.

269 We might insert here a great number of useful and important problems, but, as our space is limited, we shall not dwell longer on this subject now.

The problems given here are chiefly with a view of showing generally how the two constructions may be applied in astronomy.

CHAPTER V.

OPTICAL PRINCIPLES REQUISITE IN ASTRONOMY.

ALL astronomical observations are made through the medium of light, and by means of instruments whose construction mainly depends upon optical principles; it is therefore highly important for an astronomer to understand something of the science of optics, in order that he may be able to make the best use of his instruments, and avoid many errors into which he is likely to fall from ignorance of the laws which regulate the transmission of light. It will not be possible to devote sufficient space here to the full development of the principles of optics; all that we can do is, to explain those phenomena of light which have immediate reference to astronomy, and the laws upon which the construction and use of astronomical instruments depend.

We shall, in the first instance, state everything of practical importance relating to the transmission of light from luminous bodies: we shall then explain briefly the laws of reflection and refraction, the dispersion of light into different colours by refraction, and certain other points of practical importance; and lastly, we shall show how these laws enable us to construct instruments for ascertaining direction, and subdividing space with the greatest possible accuracy.

I. *Of the Transmission of Light from luminous bodies.*

271 *The transmission of light is not instantaneous.* The common and natural notion respecting the transmission of light is, that it comes from luminous bodies to the eye instantaneously; but this is not the case, though the almost inconceivable speed with which light travels is such, that it might be considered instantaneous, only for the extreme accuracy of astronomical observations, which require us to take account of the velocity of light.

272 The fact that light travels with a certain velocity was ascertained by the Danish astronomer, Römer (to whom we owe the invention of the transit instrument) in the following manner.

The planet Jupiter is accompanied by four satellites, which move round him in the same manner that the Moon does round our Earth, but in shorter periods. As these bodies revolve round their central planet, they appear to us to move backwards and forwards on each side of Jupiter, never receding far from him. Sometimes they manifestly pass in front of him, which is perceived by their casting shadows on his disk; and at other times they pass behind him, which is perceived by their sudden disappearance after they have come close to his disk. Sometimes also they are eclipsed by their entering the shadow which Jupiter casts. All this may be seen by means of an ordinary telescope.

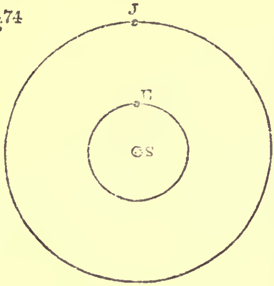
By watching these eclipses, occultations, and immersions, as they are called, of Jupiter's satellites, we may determine the rate at which they move round him. It is thus found that the following are their respective periods of revolution:—

The first satellite completes its revolution in about	$1\frac{3}{4}$	days.
The second	$3\frac{1}{2}$	,,
The third	7	,,
The fourth	$16\frac{3}{4}$	,,

It is important to notice the shortness of these periods, for upon that fact the discovery of the velocity of light in a great measure depended. In little more than a fortnight, it would be possible to ascertain these periods by watching the eclipses and occultations of the satellites; in fact, in that length of time the motion of the first satellite might be completely determined.

Having once made out these periods of revolution, we can of course always predict when the eclipses and occultations will occur during the lapse of a year or several years; and this Römer did. But he found that there was apparently a manifest error in his predictions; he observed that there was some unaccountable irregularity in the eclipses and occultations; at one period of the year they appeared always to take place too late, and at another period too soon.

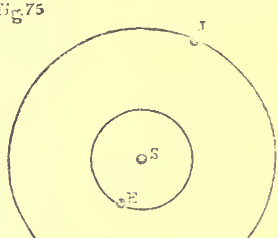
Fig. 74



All this seeming irregularity was, however, explained in the most satisfactory manner by Römer, by the supposition that light is transmitted, not instantaneously, but with a certain finite, though very great velocity. The following was his explanation:—

Let E and J, fig. 74, represent the Earth and Jupiter revolving in their orbits about the Sun, S; and suppose it to be that period of the year when the Earth is between the Sun and Jupiter, as is shown in the figure. Now, in somewhat more than six months, the Earth and Jupiter will have come into the positions shown in fig. 75, the Sun being between Jupiter and the Earth; for the motion of Jupiter being much slower than that of the Earth, the former describes but a small portion of his orbit while the latter performs half the whole circuit, so that in a little more than half a year the two bodies will have come into the position represented by fig. 75.

Fig. 75

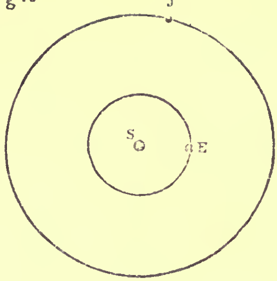


Now, Römer found that, in the position represented by fig. 74, the eclipses and occultations of the satellites appeared to take place eight minutes and thirteen seconds too soon, and in the position represented in fig. 75, they appeared to take place eight minutes and thirteen seconds too late. In fact, supposing the motions of the satellites to have been determined by observations made when Jupiter and the Earth were on the same side of the Sun, as in fig. 74, and the eclipses and occultations to have been predicted from the motions so determined, it was found, that in six months—i. e., when the Earth and Jupiter were on opposite sides of the Sun, as in fig. 75, the eclipses and occultations took place nearly sixteen minutes and a half later than the times predicted.

This was immediately explained, by supposing that the light, which conveyed to the eye, as it were, the intelligence of the eclipse or occultation having taken place at Jupiter, did not arrive instantaneously, but travelled with a certain velocity—namely, a velocity just sufficient to transmit it across the Earth's orbit in sixteen minutes and twenty-six seconds, or in round numbers, a velocity of twelve millions of miles per minute, the diameter of the Earth's orbit being about 190 millions of miles. For on this supposition it is clear, that since the Earth is farther from Jupiter in the position represented in fig. 75 than in fig. 74, by a distance equal to the diameter of the Earth's orbit, the eclipse or occultation would be seen sixteen minutes and twenty-six seconds later in the former position than in the latter, since the light would take that additional time to travel across the Earth's orbit when Jupiter and the Earth were on opposite sides of the Sun.

273 That this is the real cause of the difference between the observed and predicted times of the eclipses and occultations, is in a great measure proved by making observations on the satellites during the whole year. It will be found that when the bodies are situated as in fig. 76, where S and E are at equal distances from J, the eclipses and occultations will occur eight minutes and thirteen seconds later than in the position fig. 74, the light then having to travel an additional distance equal to half the diameter of the Earth's orbit. And in the intermediate positions which the bodies occupy at different times of the year, it will be found that the number of minutes and seconds, which the eclipse or occultation appears to be later than in the position fig. 74, is always proportional to the additional distance the light has to travel over, in consequence of the Earth being farther from Jupiter than he is in the position fig. 74.

Fig 76



274 *Stellar Aberration.*—But the velocity of light shows itself in another curious phenomenon, called *stellar aberration*, which was discovered by the astronomer, Bradley. Respecting this subject we have only time to remark, that Bradley found out that the stars are observed to describe every year little orbits in the heavens; in fact, they always appear to be displaced from their true positions in the direction in which the Earth is moving. For instance, in spring the star γ Draconis when seen near the zenith, as it will be in the south of England, will appear to be nearly 20″ south of its real position, in summer nearly 20″ east, in autumn about the same distance north, and in winter about the same distance west of its true place; at which times the Earth is moving southward, eastward, northward, and westward, respectively. Stars 90° distant from the pole of the ecliptic, which it will be remembered is about half-way between Polaris and γ Draconis, appear to suffer no displacement when the Earth is moving either directly towards them or from them. In fact, this apparent displacement is found to diminish as the distance of the star from the point of the heavens towards which the Earth is moving diminishes.

275 Bradley showed that this phenomenon is completely and satisfactorily explained, by supposing it to arise from a combination of the Earth's motion and the motion of light. He was able to calculate what ought to be the velocity of light to give rise to this apparent displacement of the stars, and he found it to be the same as that determined by Römer from the eclipses and occultations of Jupiter's satellites. That the velocity determined by Bradley should agree with that given by Römer from such totally different observations and reasonings, is of course a most satisfactory proof of the truth of the hypothesis, *that light moves with a velocity of about twelve millions of miles per minute.*

We have dwelt longer on this optical fact than we shall do on others, on account of its great importance in astronomy.

276 *The Rectilineal Transmission of Light.*—That light is transmitted from luminous bodies in straight lines or rays, is so obviously true, that we need not say much on the subject. If we make a small hole in the shutter of a darkened room, so as to allow the sunlight to enter through it, the rectilineal course of the light will be made very evident by shaking out some dust from a puff-bag, which will be illuminated by the light. The fact that we cannot see round a corner, or through a bent tube, is a familiar proof that light travels in straight lines, and so also is the shadow cast by any opaque object, which is always exactly the shape traced out by straight lines drawn from the luminous point from which the light comes, through the different extreme points of the object.

277 Upon this property of light depends entirely its use as a means of ascertaining *direction*. We can tell in what direction an object is by looking towards it, but we cannot judge, by listening to sound, the direction of a sounding body, because sound does not proceed in straight lines or rays. We shall presently explain fully the means by which astronomers ascertain direction, by means of light.

II. *Inflection and Diffraction of Light.*

278 But though it be a fact, that in ordinary cases light proceeds in rays from luminous bodies, there are cases, often of practical importance, in which light spreads like sound. If the sunlight be allowed to enter a darkened room through a very small hole, (or, what is better, through a lens of short focus placed in front of a hole not quite so small,) the shadows cast by it will exhibit very curious appearances. They will be smaller than they would be if the light entered the room through a hole of moderate size, and of a totally different shape if the body casting the shadow be small; and their edges will be surrounded by coloured bands and bars, and, wherever there are sharp corners, by beautiful curved fringes.

279 To see these in great perfection, all that is necessary is a common spy-glass or telescope. Get a round piece of card the size of the object glass, and cut a hole in the middle, say the size of a shilling, over which gum a piece of sound tinfoil. Then, with a sharp pointed knife, cut carefully a small hole in the middle of the tinfoil of any shape, such as a triangle, a square, a cross, a star; or, with a needle, prick one, or two, or three, or a great number of holes in the tinfoil. Cover the object glass with this card, fastening it on with a little bee's wax, or otherwise. Then drop a little globule of mercury on a piece of black velvet, and lay it on a table or on the ground in the Sun's rays: in this manner a bright point of light will be produced. All that is to be done now is to look at this point of light through the telescope, holding it very steadily, or, what is better, fixing it on some stand, or supporting it on some books. When this is done, the most beautiful optical phenomena will be seen, which may be varied by drawing in or out the tube of the telescope, or by viewing the globule of mercury at a greater or less distance.

280 We have space here only barely to notice these phenomena, and to state that they arise from the fact that light spreads like sound when it enters a darkened room through a very small hole. The curious figures and colours are produced by what is called the *interference* of light, respecting which we cannot say anything here. These phenomena constitute what are called the *inflection* and *diffraction* of light.

281 We have thought it necessary to allude to these optical facts here, because they often prove a source of serious imperfection in astronomical and surveying instruments, and they often greatly add to the difficulty of making certain astronomical observations. We have seen levelling telescopes which could scarcely be used, on account of the wires in the focus being so affected by diffraction, as to appear like a number of indistinct bars; and we are convinced that opticians ought to be more familiar with this subject than they are. In microscopes of high power, with very small object glasses, the diffraction completely spoils the image formed by the instrument, especially when the object is illuminated by a small, well defined luminous surface.

III. *Reflection and Refraction of Light.*

282 We have stated that light is transmitted from luminous bodies in straight lines or rays, but this is true only when the light passes through vacuum, or through a perfectly uniform transparent medium,—i. e., either empty space, or space filled with some gaseous, liquid, or solid matter, which is all through of the same consistence and density. The air immediately surrounding the Earth's surface may be regarded as a uniform medium, but

at some distance upwards from the surface, the density of the air diminishes rapidly as we ascend. Near the Earth's surface, therefore, light passes through the air in straight lines, but this is not true except close to the surface.

283 *Refraction.*—Whenever the density or consistence of the medium through which light is passing changes, the direction in which the light moves is altered. In the case of light coming from a heavenly body to the eye, the path which the light pursues is continually bending as the light moves on, in consequence of the continual change of density of the atmosphere. When a ray of light enters a piece of glass, its direction is immediately changed, in consequence of the consistence of the glass being different from that of the air, out of which we suppose the light to pass into the glass. The same is true of water, oil, spirit, and of every transparent substance, in a greater or less degree.

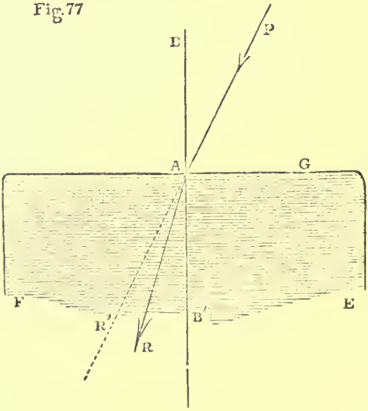
284 The change of direction which a ray of light experiences in passing from one medium into another, as, for instance, from air into glass, is called *refraction*, or the breaking or bending of the ray, as the word signifies. Refraction takes place generally whenever there is any change in the density, consistence, or nature of the transparent medium through which the light is passing.

285 The continual bending which a ray of light from a heavenly body experiences as it is passing through the atmosphere, is called *astronomical refraction.* This *error*, as it is called, affects a large and important class of astronomical observations, and it is therefore necessary to understand it, so as to be able to allow for it, and ascertain the true direction of the heavenly body from which the ray comes.

286 *Reflection.*—The refraction of light is always accompanied by what is called *reflection*, or a casting back of the light. When light is passing from one medium into another, a certain portion of it is always thrown back, or reflected, so that only part of the light enters the second medium. In the case of glass, when light enters it from the air, the portion of light which suffers reflection is small compared with that which enters the glass. In the case of a metallic medium, such as mercury or silver, a considerable portion of the light is reflected, and only a very small part enters the metal. Glass is therefore said to have a weak reflective power, but mercury or silver are said to be highly reflective.

287 *Laws of Reflection and Refraction.*—Let A E F, fig. 77, be any medium, a piece of glass for instance, and let P A be a ray of light which, passing out of air, or any other medium, enters the glass at A. Draw B A B′ at right angles to the surface of the glass at the point A. The ray P A is said to be *incident*,—i. e., to fall upon the glass at A, and therefore this ray is called the *incident ray.* The plane in which the ray P A and the perpendicular B A B′ lie, is called *the plane of incidence.*

Fig. 77



When the ray enters the glass, it is refracted, and proceeds in a different direction to that in which it was going before; let that direction be A R, A R′ being the former direction P A produced. The broken line P A R shows the whole course of the light, which proceeds in a straight line from P to A, is broken or refracted at A, and then goes on in a straight line to R.

Fig. 78

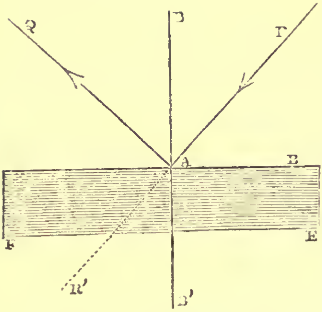


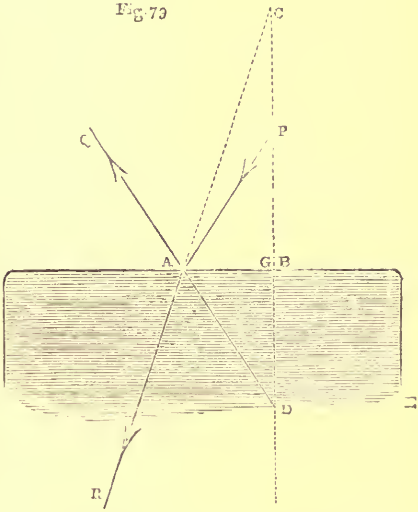
Fig. 78 shows a case of reflection. The incident ray P A, instead of going on in the straight direction A R', is thrown back or reflected at A, and proceeds through the air in the direction A Q.

A R, fig. 77, is called the *refracted ray*, and A Q, fig. 78, the *reflected ray*.

288 The first law of reflection and refraction is this:—The reflected and refracted rays always lie in the plane of incidence; in other words, the three lines, P A, B A B', and A R, fig. 77, and the three lines, P A, B A B', and A Q, fig. 78, always lie in the same plane,—i. e., the incident ray, the perpendicular to the surface, the reflected ray, and the refracted ray, all lie in the same plane.

289 The second law may be stated in the following manner:—Let P A, A R, and A Q, fig. 79, be the three rays as before; A B, the surface of the medium, which we shall suppose to be a plate of glass; draw from any point B of the surface of the glass, a perpendicular, C P B D, meeting the incident ray at P, and the reflected and refracted rays produced backwards at D and C respectively; then the second law is, that A D is always equal to A P, and A C is always about one-half greater than A P,—i. e., three halves of A P.

Fig. 79



290 Whatever the medium may be, whether glass, or water, or oil, or any other substance, A D is always exactly equal to A P, and A C always exceeds (or falls short of) A P by a certain fraction of A P.

291 *Refractive Index.*—The proportion of A C to A P varies with the nature of the substance of which the medium A B E F is composed, and that of the medium out of which the light passes into A B E F. This proportion is called the *refractive index;* thus, if A C is always four-thirds of A P, which is very nearly the case when the medium A B E F is water, and the upper medium air, the refractive index is said to be $\frac{4}{3}$. A C may be always found by multiplying A P by a certain number or decimal, depending on the nature of the two media, and that number is called the refractive index.

292 The following table gives the refractive indices of different substances, supposing the light to enter each substance out of vacuum:—

Substance.	Refractive Index.	
Atmospheric air	1·000·294	about $\frac{10003}{10000}$
Water	1·336	about $\frac{4}{3}$
Alcohol	1·372	
Oil of olives	1·470	
Plate glass	from 1·500 to 1·550	about $\frac{3}{2}$
Flint glass	from 1·576 to 1·642	
Oil of cassia	1·641	
Sapphire	from 1·768 to 1·794	
Diamond	from 2·439 to 2·755	about $\frac{5}{2}$

In this table it will seem that the refractive index is not always exactly the same for the same substance; as, for instance, in the case of sapphire, in some specimens it is as high as 1·794, and in others as low as 1·768. In the case of glass there is a considerable diversity of refractive index, on account of the different ingredients of which glass is made, and the different proportions in which they are mixed together.

293 The angle P A B which the incident ray P A makes with the perpendicular B A B′, figs. 77 and 78, is called the *angle of incidence*. The angle Q A B is, in like manner, called the *angle of reflection*, and R A B′, the *angle of refraction*.

Since A D is always equal to A P, it follows that both these lines are inclined at the same angle to the perpendicular C D; in other words, the reflected ray makes the same angle with the perpendicular to the surface that the incident ray does,—i. e., the angle of reflection is always equal to the angle of incidence.

294 Fig. 79 enables us to determine the course of the refracted ray by construction on paper, as follows:—

Having drawn a line A G, to represent the surface, and a perpendicular, B C, from any point of it; draw P A at the proper inclination to represent the incident ray. Measure A P, and open the compass to once and a half that distance, supposing the medium to be glass of the lowest refractive power; then, putting one point of the compass at A, describe a circular arc with the other, meeting B C at C, from which point draw the line C A R through A. This will give A R, the refracted ray.

295 The refractive index, when the light passes out of glass into air, is the reciprocal of that out of air into glass; that is, if the former be $\frac{3}{2}$, the latter is $\frac{2}{3}$. This is true of all substances; the refractive index, when light passes out of one medium (A) into another (B), is the reciprocal of that out of B into A.

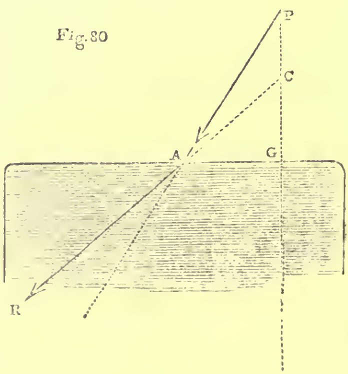


Fig. 80

296 The refractive index is always less than unity, that is, A C is always less than A P, when the light passes out of a denser into a rarer medium. Fig. 80 shows the course of the refracted ray in such a case. We may see, by comparing figs. 79 and 80, that when the light passes out of a rarer into a denser medium, the refraction, or bending of the ray, is *towards* the perpendicular, but out of a denser into a rarer it is *away from* the perpendicular.

297 If the refractive index, when light passes out of a medium A into a medium B, be multiplied by that out of B into another medium C, the result is the refractive index out of A into C. It

follows from this, that the refractive index out of A into C, divided by that out of A into B, gives the refractive index out of B into C. Thus, if the refractive index out of vacuum into glass be $\frac{3}{2}$, and that out of vacuum into water be $\frac{4}{3}$, that out of water into glass will be $\frac{3}{2}$ divided by $\frac{4}{3}$, that is, $\frac{9}{8}$.

IV. *Dispersion of Light.*

298 *Index of Refraction depends upon Colour.*—It is found by experiment that the refractive index depends, not only on the media out of and into which the light passes, but also on the colour of the light. The refractive index is greater when the colour is orange that when it is red; it is still greater when the light is yellow, still greater when green, greater again when blue, and greatest of all when violet.

299 *White Light Compound.*—It is also found that white light, such as the light of the Sun, or of a candle or lamp, is not simple but compound; each ray of white light being a union of several coloured rays, which are usually classed into seven kinds—namely, red, orange, yellow, green, blue, indigo, and violet. Each of these classes includes a variety of different shades; in fact, we may say that in reality a white ray of light is compounded of an infinite number of rays of different colour and shades of colour.

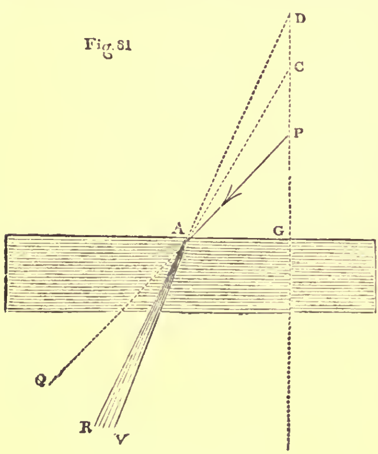
As we have stated, all these colours have different refractive indices. The following table for different substances will show the nature and amount of this diversity of refractive index.

Refractive Index for

Colour	Flint Glass.	Crown Glass.	Water.
Red	1·628	1·526	1·331
Orange	1·630	1·527	1·332
Yellow	1·635	1·530	1·334
Green.	1·642	1·533	1·336
Blue	1·648	1·536	1·338
Indigo	1·660	1·542	1·341
Violet	1·671	1·547	1·344

300 *Dispersion of White Light by Refraction.*—Let P A be a ray of white light incident at A, on the surface of any medium, say crown glass; then, in order to find the course of the light after it has entered the glass, we must proceed to make the construction already explained, remembering that the different colours which compose P A have all different refractive indices, as shown in the table we have just given. Thus for red the index is 1·526; therefore if we suppose A P to be 1, and make A C equal to 1·526, A R, which is A C produced, will show the course of the red ray after refraction. In like manner, since 1·547 is the index for violet, if we make A D equal to 1·547, A V, which is A D produced, will show the course of the violet ray after refraction. In the same way we may find the intermediate refracted rays, the orange, yellow, green, &c.

Fig. 81

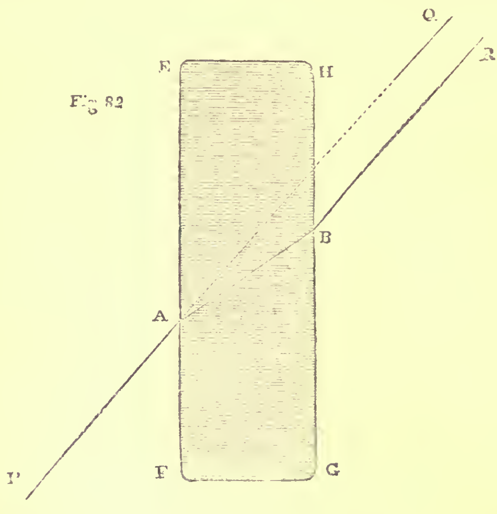


Hence it is manifest that the various coloured rays which were united in the white ray P A, will, after refraction at A, be separated, and pass through the piece of glass in different directions; the red ray A R being least bent out of its original direction P A Q, the violet most, and the intermediate colours in order in an intermediate degree. The white ray P A is therefore, as it were, *dispersed* as soon as it enters the glass into a set of coloured rays diverging from the point A. In this manner the dispersion of white light is produced by refraction.

V. *Passage of Light through Plates, Prisms, and Lenses.*

301 *Passage of Light through a Plate of Glass or other transparent Substance.*—By a plate of glass we mean a piece bounded by plane surfaces which are parallel to each other. Let E F G H, fig. 82, represent a section of such a piece of glass at right angles to the parallel plane surfaces represented by E F and G H. Suppose that a ray of light P A falls upon the surface E F at the point A; then the course of this ray in passing through the glass will be as follows:

Fig. 82



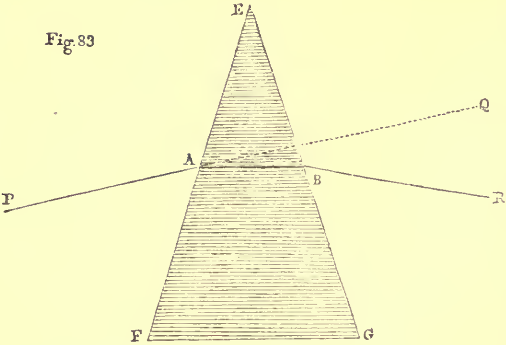
The ray will of course be refracted at A, and instead of going on in the direction A Q, which is P A produced, it will pass through the glass in the direction A B, which, as we have stated, is less inclined to the perpendicular to the refracting surface than A Q is. At B the ray will pass out of the glass into the air, and therefore again suffer refraction; but since it passes from a denser into a rarer medium, it will be bent away from, not towards, the perpendicular. In fact, the refraction or degree of bending at B, will be precisely of the same amount as at A, only it will take place in the opposite direction; this may be easily proved by making the proper construction for the refraction at A and B, according to the method we have explained above, remembering that the index of refraction at B is the reverse or reciprocal of that at A.

The consequence of this will be, that the ray will emerge from the glass at B in a direction B R, parallel to the original direction P A Q; for whatever be the angle through which the ray is bent at A, it will be bent through the same angle in the opposite direction at B, and therefore be restored to its original direction.

302 Hence, when a ray of light passes through a plate of glass, it will emerge parallel to its original direction, but it will suffer a certain degree of lateral displacement—i.e., B R will be parallel to, but not coincident with, P A Q.

303 *Passage of Light through a Prism.*—By a prism we mean a piece of glass or other transparent substance, bounded by plane surfaces which are not parallel, but inclined to each other at a certain angle. Let E F G, fig. 83, represent a section of such a piece, at right angles to the two plane surfaces which are shown by the lines E F and E G. Suppose that a ray of

Fig. 83



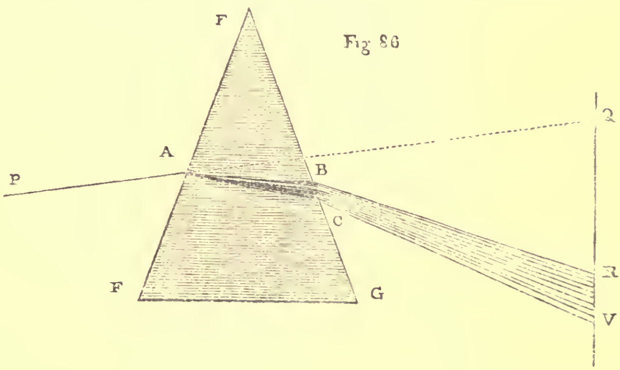
light P A falls upon the surface E F; then the course of this ray in passing through the glass will be as follows:

The ray, being refracted at A, will be turned towards the perpendicular to the surface E F, and pass through the glass in the direction A B. At B it will suffer a second refraction, and will be turned away from the perpendicular to the surface E G. The effect of the second refraction will be, not to turn the ray back to its original direction, but to make it deviate still farther away from it, as is evident from the figure. Thus the ray, instead of going on in the direction A Q, which is P A produced, will emerge out of the glass in the direction B R.

The effect of the prism here is to turn the ray, not towards the angle E, but towards the thicker part of the prism F G; and this is always the case, supposing the prism to be made of glass, or any transparent substance denser than the air; the ray will always be bent away from the angle of the prism towards the thicker part.

304 *Dispersion produced by a Prism.*—The two refractions which take place when a ray of light passes through a prism have the effect of producing a considerable degree of dispersion, and showing the composition of white light, and the different refrangibility of the coloured rays composing it, in a very striking manner. All that is necessary to exhibit the dispersion of light in great perfection by a prism is, to allow a ray from the sun to enter a dark room through a hole or slit in a shutter, and then to intercept it by a prism, and receive the transmitted light on a screen, or on the wall or ceiling. Let E F G, fig. 86, represent the prism, P A, the ray from the Sun falling on the surface

Fig. 86



at A. Suppose the red ray to pass through the prism in the direction A B, and to emerge into the air again in the direction B R; then the violet ray will be more refracted at A than the red, and therefore pass through the prism in a direction A C, more inclined to A Q (A Q being P A produced) than A B is. Again, the violet ray will be more refracted at C than the red is at B, and therefore it will emerge in a direction C V, more inclined to A Q than B R is.

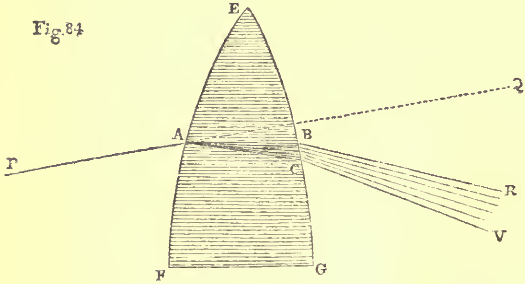
Hence, if the emergent light be received on a screen Q R V, at some little distance from the prism, a red spot will be seen at R, and a violet spot at V. In the space intermediate between R and V will be seen the intermediate colours. The order of the colours will be as follows :—

Red at R.
Orange.
Yellow.
Green.
Blue.
Indigo.
Violet at V.

The coloured space between R and V is commonly called the *Prismatic Spectrum.*

305 If the sides E F E G of the prism be curved instead of plane, the effect it produces on light passing through it will be the same—see figs. 84

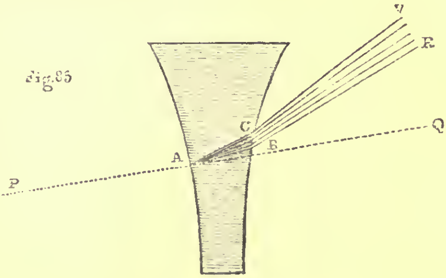
Fig. 84



and 85, which represent prisms with curved sides, and where the course of the light is represented by the same letters as in fig. 86.

It is important to observe the double difference of the effect produced by the two prisms represented in figs. 84 and 85.

Fig. 85

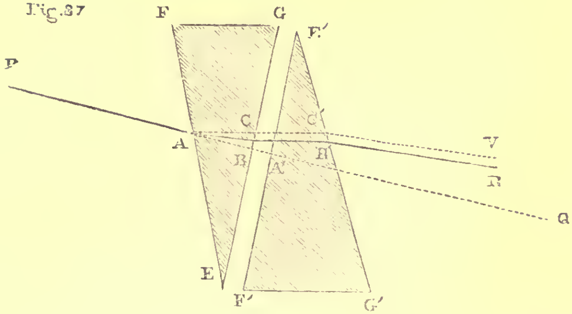


1st. The emergent rays B R C V are *below* A Q (the original direction of the light) in fig. 84, and *above* A Q in fig. 85. In other words, the light in both cases is bent *towards* the thicker side of the prism.

2ndly. The violet is below the red in fig. 84, and above it in fig. 85. In other words, the violet is in both cases on the thicker side of the prism, and the red on the thinner side.

306 *The Compound Achromatic Prism.*—A prism which produces refraction without dispersion—i. e., one which bends all the coloured rays equally, is said to be *achromatic*—i. e., without colour. A single prism, such as one of those we have just spoken of, cannot be achromatic, as is evident from what we have explained. But by putting two prisms together, as in fig. 87, it is possible to make a compound prism which shall be achromatic or nearly so. We shall briefly explain how this is done. The two prisms, E F G and E′ F′ G′, are placed in opposite positions, and therefore produce opposite

Fig. 37



refractions and dispersions; the prism E F G will bend the rays upwards, and throw the violet above the red: while the other prism E′ F′ G′ will have the reverse effect. P A B A′ B′ R represents the course of the red ray through the two prisms, the dotted line A C C′ V, the course of the violet, and A Q is P A produced.

Now, suppose that the refraction produced by the first prism amounts to 10°, and the dispersion to 1°. By saying that the refraction is 10°, we mean that the prism turns the red ray 10° out of its original direction A Q, and by saying that the dispersion is 1°, we mean that the violet ray is turned 1° more than the red out of its original direction—i. e., that the violet ray is turned 11° out of its original direction. Secondly, suppose that the refraction produced by the second prism is 8°, and the dispersion 1°. The effect of the two prisms may be calculated as follows:—

Refraction produced by first prism	10° upwards.
,, ,, by second	8° downwards.
Total refraction produced by both prisms . .	2° upwards.
Dispersion produced by first prism	1° upwards.
,, ,, by second	1° downwards.
Total dispersion produced by both prisms . .	0°

Hence these two prisms will produce a total refraction of 2° without dispersion, and so form a compound achromatic prism.

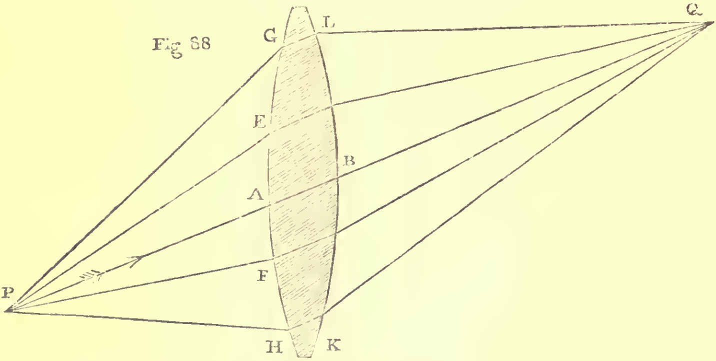
307 Whether it is possible to make prisms which will produce such effects as we have here supposed, is a point to be decided by experiment. Newton concluded from some imperfect experiments that it was not possible to do so; that if the dispersions produced by the two prisms were equal and opposite, as we have supposed, the refractions would also be equal and opposite—that is, that if the total dispersion were nothing, so also would the total refraction; in other words, he concluded that it was a physical impossibility to obtain refraction without dispersion. From this erroneous conclusion, he gave up all hope of making achromatic telescopes, and turned his attention to reflecting telescopes.

308 Mr. Hall, a Worcestershire gentleman, and after him the celebrated optician Dollond, found that Newton's experiments were inaccurate, and proved that, by making one of the prisms of flint glass, and the other of crown glass, a compound achromatic prism might be formed, which would produce a certain amount of refraction without dispersion.

309 *Secondary Spectrum.*—It is possible in this way to destroy the dispersion, as far as the red and violet rays are concerned; but this will not, at the same time, answer for the other colours, as, for instance, the red and green. If, on the other hand, the dispersion is destroyed as far as regards red and green, it will not be quite destroyed as far as regards red and blue. A com-

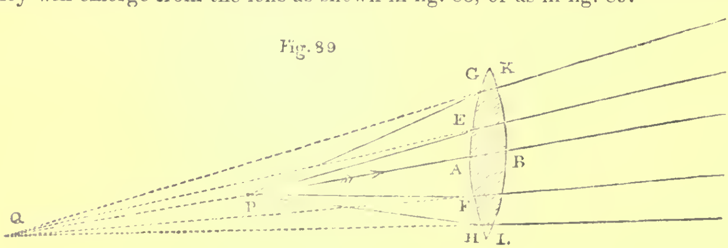
pound prism, such as the above, cannot be made perfectly achromatic for all the colours; but by putting three or more prisms together this may be done, at least to a sufficient degree of accuracy. The light which passes through the compound prism, fig. 87, will therefore exhibit some traces of colour if received on a screen. The slightly coloured spot it makes on the screen is called the *Secondary Spectrum.*

310 *Passage of Light through Lenses.*—A lens (from *lens*, a bean) is a circular piece of glass, bounded by two curved surfaces. Generally these surfaces are spherical, and not very much curved, except in a lens of very high power. When the surfaces are convex or curved outwards, the lens is said to be convex; when inwards, concave. The best way to distinguish between the two kinds of lenses is to say that a convex lens is *thicker* in the middle than at the extreme parts, and a concave thinner.



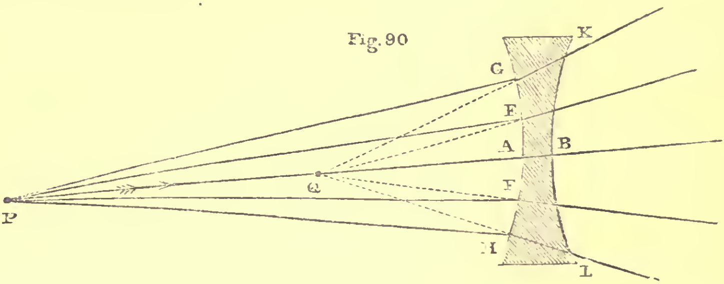
311 *Convex Lens.*—Fig. 88 represents the passage of rays through a convex lens. G H K L represents a section of the lens by a perpendicular plane through the middle, G A H showing one of the bounding surfaces, and L B K the other. A number of rays P G, P E, P A, P F, P H, are supposed to diverge from a point P, and fall on the surface G A H of the lens. The ray P A, which is supposed to pass through the central part of the lens, will not suffer any deviation, but pass straight through the lens in the direction A B Q, which is P A produced. The reason of this is, that the surfaces of the lens at A and B are parallel to each other, and therefore the ray passing through the lens in the direction A B, will be transmitted in the same manner as if the lens were a plate of glass with parallel planes. Now, we have shown in such a case, that the light on coming out of the glass will resume its original direction, and suffer only a slight degree of lateral displacement (*see* fig. 82). The lens is generally so thin, that we may neglect taking any account of this lateral displacement, and therefore we have drawn the ray P A B Q straight through the lens in one unbroken line.

As we have explained in the case of the prism, the other rays, P G, P E, P F, P H, will be bent towards the thicker part of the lens, and therefore they will emerge from the lens as shown in fig. 88, or as in fig. 89.



312 In one case, fig. 88, the lens is supposed to be sufficiently powerful to bend the rays so as to make them converge towards, or nearly towards, some point Q, on the line P A produced. In the other case, the lens not being so powerful, the rays are not bent sufficiently to converge to a point in front of the lens, they are only made less divergent than they were before passing through the lens. In fact, if we produce them backwards they will meet, or nearly meet, in a point Q, behind P on the line P A produced backwards.

Fig. 90



313 *Concave Lens.*—Fig. 90 represents a concave lens and the passage of the light through it, the letters denoting the same things as before. The ray P A which passes through the central part of the lens will go on straight without deviation; the other rays, P E, P F, P G, P H, will be bent towards the extreme parts K and L of the lens, which are now thicker than the central part A B. The effect of this will be to increase the divergence of the rays, so that, on producing them backwards, they will meet, or nearly meet, at a point Q, in front of P on the line P A.

314 We have in all these cases represented the ray P A as passing somewhat obliquely through the lens; of course all that has been said will apply equally when P A passes perpendicularly instead of obliquely.

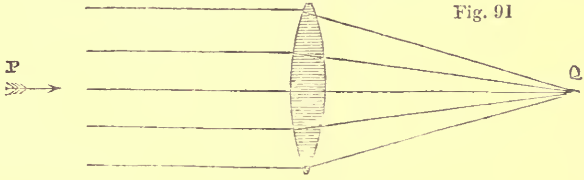
315 *Focus.*—A point in which rays of light meet is called a *focus*, a name derived from the Latin word signifying 'fire-place,' because objects placed in the focus of a burning lens were set fire to. The point P is called the *focus of incident rays*, and the point Q the *focus of emergent rays.*

In fig. 88, the emergent rays actually cross at Q; but in figs. 89 and 90, this is not the case, the emergent rays proceed, however, just as if they diverged from the point Q, and we may regard Q as an imaginary focus. Q, in fig. 88, is called a *real focus*, and in figs. 89 and 90, a *virtual* or *imaginary focus.*

316 *Principal Focus. Focal Length.*—When the incident rays come from the Sun, or any other very distant body, the focus of emergent rays is called the *principal focus* of the lens, and the distance of this focus from the lens is called the *focal length* of the lens. When the point P is very distant, the rays P G, P E, P A, P F, P H, will be inclined to each other at extremely small angles, so small, that we may consider the rays to be parallel to each other. We may therefore define the principal focus to be the focus of emergent rays when the incident rays are parallel.

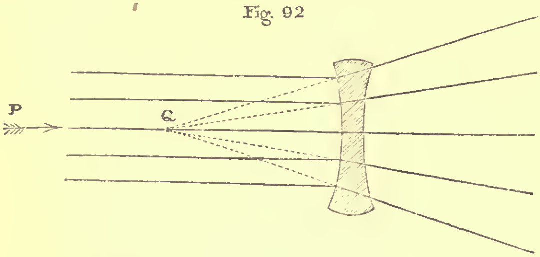
317 If parallel rays fall on a convex lens, as in fig. 91, where the focus P

Fig. 91



of incident rays is supposed to be at a great distance from the lens, it is evident, from what has been said, that the emergent rays will converge towards a point Q in front of the lens. Hence the principal focus of a convex lens is *in front* of it, and is a *real* focus.

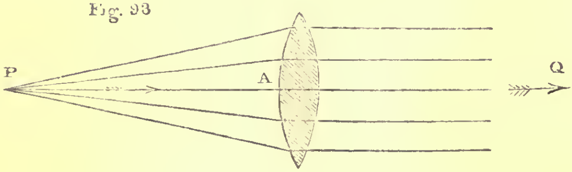
Fig. 92



318 If parallel rays fall on a concave lens, as in fig. 92, the emergent rays will diverge, and therefore the principal focus is *virtual,* and *behind* the lens.

319 If the distance P A be equal to the focal length of the convex lens, the rays will emerge parallel to each other, as is shown in fig. 93, where Q is supposed to be at an infinite distance from the lens. That this will be the case is evident, by supposing the course of the light in fig. 91 to be reversed —i. e., to come from Q instead of P.

Fig. 93



320 If P A be less than the focal length, the rays will emerge diverging, and if P A be greater than the focal length, the rays will emerge converging.

321 Hence we may make the following comparative statement respecting convex and concave lenses.

A convex lens either diminishes the divergence of rays or makes them convergent. We may say that the effect of a convex lens is *always* to produce a certain degree of convergence, for we may consider that diminishing the divergence of the rays is nothing more than producing a certain amount of convergence, which partly destroys the divergence of the rays, and therefore has the effect of making them less divergent than before.

A concave lens always increases the divergence of rays.

A convex lens sometimes brings the emergent rays to a focus *in front* of the lens, but a concave lens never does so.

A convex lens may be used to make diverging rays parallel; a concave to make converging rays parallel. In both cases, the distance from the lens of the point from which the rays diverge, or to which they converge, must be equal to the focal length of the lens.

322 *Achromatic Lens.*—A single lens, such as one of those we have just described, produces its effect by refracting the rays just like a prism, and so bending them towards or from the central ray, according as the lens is convex or concave; but this refraction will be accompanied by dispersion; the violet rays will always be more refracted than the red rays, and therefore, in the case of a convex lens, the violet rays will emerge more inwards—i. e., more towards the central ray, than the red rays do; but in the case of a concave lens, the violet ray will emerge more outwards than the red.

If, however, we put two lenses together, one convex and the other concave, such that the outward dispersion produced by one may be just equal to the inward dispersion produced by the other, the total amount of dispersion produced by the two lenses in combination will be nothing, as in the case of the two prisms above explained. At the same time, by making one lens of crown glass, and the other of flint glass, there will be a certain amount of refraction still produced. In this manner the lenses will bend the rays sufficiently for practical purposes without dispersing them, at least, without any serious amount of dispersion, for there will always be some arising from the secondary spectrum.

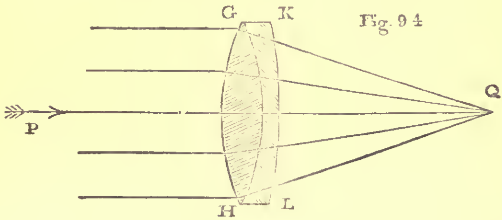


Fig. 94

323 It is usual to put the lenses together as in fig. 94, G H being the convex, and K L the concave lens, the former being made of crown glass, and the latter of flint glass. In the telescope, the convex lens is always that on which the light first falls, and in the microscope the reverse is the case. The manufacture of achromatic lenses is now brought to great perfection. The difficulties of grinding, polishing, and fitting them properly together are considerable, especially when the combination is required to be powerful—i. e., of short focal length.

324 *Spherical Aberration of Lenses.*—We have hitherto, in the figures we have given, represented the emergent rays as meeting in one point Q; but this is only true approximately; the extreme rays P G and P H, after passing through the lens, will meet the central ray P A B at a point Q′, (see fig. 95,)

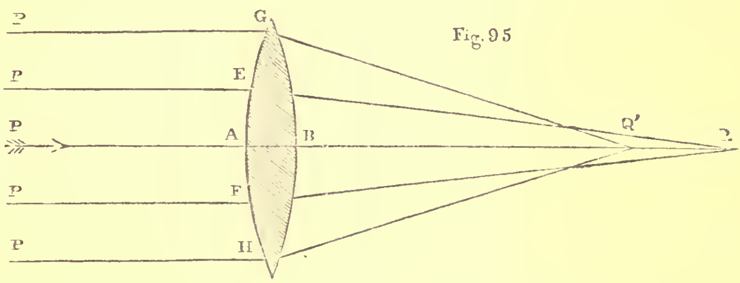


Fig. 95

at some little distance from the point Q, where the intermediate rays P E P F, after emerging from the lens, meet the central ray P A B. In other words, the focus of the extreme emergent rays will be a different point from the focus of the intermediate emergent rays. If we suppose the rays P E and P F to be near the central ray, Q is considered to be the true focus, and Q′ is regarded as an erroneous focus. The error in the position of the focus Q′, which ought to coincide with Q, is called *spherical aberration*, because it arises from the spherical form of the two surfaces of the lens. It is impossible mechanically to grind the surfaces of lenses in any but spherical forms; but such forms are not those which cause the extreme and intermediate rays to be refracted to the same point; this error or aberration is therefore caused by the spherical forms of the lenses.

325 In most cases a convex lens produces a backward aberration of the focus, that is, the point Q′ is behind the point Q, as in fig. 95; but a concave lens generally produces a forward aberration, that is, Q′ is in front of Q. In other words, one lens refracts the extreme rays too much, the other too little.

Now, by putting the two lenses together, as in fig. 94, one convex, the other concave, and by giving a proper spherical shape to their surfaces, we make the two opposite aberrations produced by the lenses almost entirely neutralise each other, and so cause all the emergent rays to converge very nearly to the same point. When the two lenses are properly made, the over refraction of the extreme rays by the first lens will be counterbalanced by their under refraction by the second lens. In this manner a compound lens may be constructed free from any serious amount of spherical aberration. Such a lens is said to be *aplanatic*, from the Greek, signifying 'free from error.'

Lenses which form the object glass of good telescopes and microscopes, are always made both achromatic and aplanatic.

Having now explained briefly those optical principles which are absolutely necessary to be known by persons who wish to understand astronomy practically, and to use astronomical instruments, we shall go on in the next chapter to consider the formation of optical images, by rays passing through a hole or a lens falling on a screen; from which simple, though really instructive case, we shall derive the construction of the telescope and microscope, and explain their uses.

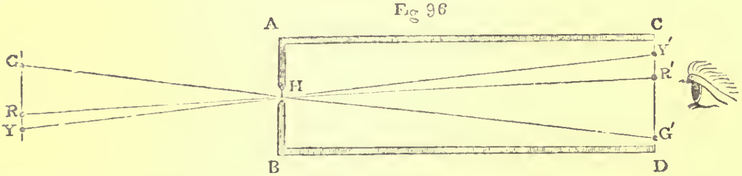
CHAPTER VI.

FORMATION OF IMAGES—VISION—THE TELESCOPE, MICROSCOPE, AND MICROMETER—THE VERNIER.

I. *Formation of Images by a Hole or a Lens.*

FORMATION of Images on a Screen by means of a Hole.—Let A B C D, fig. 96, represent a box or tube, in one end of which A B is a very small hole H, and at the other end a semi-transparent screen C D, made of ground glass, or thin silver paper, or a piece of smooth glass with a film of milk dried

Fig 96



upon it. The eye is supposed to look at this screen, and an object G Y is placed before the hole H: then the following effect will be produced:—

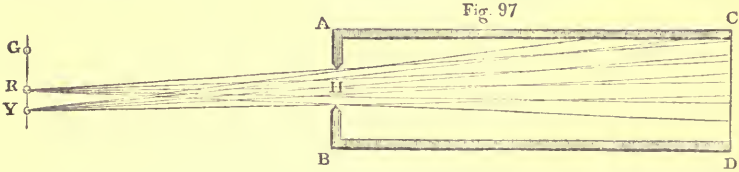
Supposing for an instant that the object G Y consists simply of three luminous points, one green, another red, and the third yellow, which are represented by G R and Y, respectively. Then green rays will issue in all directions from G, some of which, proceeding in the direction G H, will pass through the hole H, and, going straight on, will fall on the screen C D at G′, the points G H and G′ being in the same straight line. The eye will therefore see a small green spot on the screen at G′. In like manner some of the red rays from R, passing through the hole and going straight on to R′, the points R H and R′ being in the same straight line, will form a small red spot at R′, which the eye will see. In like manner, also, a small yellow spot will be seen at Y′, the points Y H and Y′ being in the same straight line.

Hence the eye will see three small spots on the screen, exactly similar to, and at the same relative distances from each other as the points G R and Y of the object, only inverted in position; in fact, an inverted image or likeness of the object will thus be cast on the screen C D.

Precisely the same reasoning would apply to an object consisting of any number of luminous points, and therefore it follows, that whatever object is placed in front of the hole H, a perfectly accurate inverted image of it will be formed on the screen C D.

327 *Defect of the Image thus formed.*—The hole H must necessarily be a very small hole, otherwise a distinct image will not be formed on the screen. This will be evident immediately, from fig. 97, in which H is supposed to be large. It will be seen in this figure that the red and yellow rays, after passing

Fig. 97



through the hole, get mixed together, and fall nearly on the same part of the screen. The consequence of this will be, that instead of two distinct small spots, one red and the other yellow, being seen on the screen, as in fig. 96, there will be but one large spot seen, consisting of a confusion of red and yellow. Hence it is manifest that, by enlarging the hole H, we make the image on the screen indistinct and confused. Indeed, however small the hole may be, there will always be a certain degree of indistinctness, arising from the mixture and confusion of rays coming from points of the object very near each other. In fact, a little consideration will show that the rays from two points of the object, not farther from each other than a distance equal to the diameter of the hole, will always be mixed together before they reach the screen.

Now, this is a serious defect; for, when the hole is extremely small, the light that falls on the screen becomes too faint, and can scarcely be seen. Hence there is an inevitable fault in this instrument; the image on the screen is either too faint or too indistinct, and we cannot diminish one imperfection without increasing the other.

328 *Use of a Lens placed in the Hole.*—Let us now suppose that we enlarge the hole, and put a lens in it, as is represented in fig. 98, of sufficient

Fig. 98

power to produce convergence in rays diverging from any point Y of the object, and bring them to a focus at Y′ on the screen. As we have already explained, the point Y′ will be found by drawing a line through the centre of the lens from Y, to meet the screen in Y′. In like manner, if we draw a line from any other point R of the object, through the centre of the lens, to meet the screen in R′, the rays diverging from R will be brought to a focus at R′; and the same may be said of G, and of every other point of the object.

Hence it is evident that an image will be formed on the screen of exactly the same size and shape, and as distinct and free from confusion as the image in fig. 96, supposing the hole in that figure to be extremely small. But there will be this important difference between the two images: the quantity of light admitted through the lens will be very much greater than that admitted through the hole in fig. 96, and therefore, while the image in fig. 98 is perfectly distinct, it will at the same time be bright and clear.

The use of a lens is, therefore, most important; with a good aplanatic and achromatic lens, a very perfect image may be formed on the screen, as we know by the beautiful photographic pictures which are produced by an instrument of the kind represented in fig. 98.

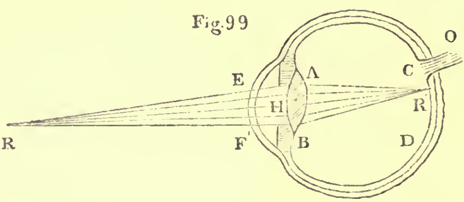
329 This instrument is called a *camera obscura*, or "dark chamber;" we introduce it here with a view to the better explanation of the telescope, and its various uses in astronomy.

330 It is important to observe that the different points of the image are found by drawing straight lines from the corresponding points of the object, through the centre of the lens, to meet the screen; and from this it follows that the image, though inverted, must be accurately similar to the object.

II. *Of Vision.*

331 *The Eye is a sort of Camera Obscura.*—A section of the eye is represented in fig. 99. It is a round ball consisting of certain transparent fluids enclosed in an opaque membrane. In front there is a hole H, called the *pupil*, before which is a transparent fluid, called the *aqueous humour*, enclosed in a delicate membrane, the whole being kept in and protected by a strong horny and transparent substance, E F, called the *cornea*. Behind the hole H is a very clear lens A B, called the *crystalline lens*, between which and the back of the eye is another humour, called the *vitreous humour*. Lastly, C D is a nervous membrane, called the *retina*, spread out to form a screen at the back of the eye: it consists of a network of fine nerves, which, uniting at a point called the *punctum cæcum*, form the *optic nerve* O, by which luminous impressions made on the retina are conveyed to the brain. The interior surface of the eye is darkened, probably to prevent stray light, by a black substance, called the *pigmentum nigrum*.

Fig. 99



332 It will be easily seen from this description that the eye is a sort of camera obscura. The pupil H corresponds to the hole in front of the tube in figs. 96, 97, 98; the retina corresponds to the screen C D; and the crystalline lens, assisted by the cornea, which is a sort of lens, serves, like the lens in fig. 98, to bring the rays to a focus on the retina or screen. The humours in the interior of the eye serve to keep it in its proper globular shape, though they are also intended to assist in the optical performance of the eye to a certain extent.

In fig. 99 the course of rays falling on the eye from a luminous point R is shown; a certain portion of these rays are admitted through the pupil or hole H, and are then caused to converge to a point R′ of the retina or screen. In this way every point of an object placed before the eye has a corresponding image on the retina, and therefore an image of the whole object will be formed on the retina, clearly inverted, as in the case of the camera obscura. The optic nerve conveys this image to the brain in some mysterious way, and an idea of the external object is thus produced in the mind.

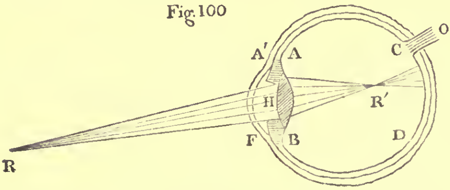
333 It is, of course, necessary that the image* formed on the retina should be perfectly distinct and free from confusion, otherwise no clear idea of the external object could be conveyed to the mind. The lenses in front of the eye—namely, the cornea and crystalline lens, must therefore be just of suffi-

* It is enough that a very small portion of the image should be distinct, (namely, that portion formed at the point of the retina called the foramen centrale.) This appears from the fact that we can see only one point of an object distinctly at a time.

cient power to bring the rays to a focus on the retina. This is represented in fig. 99.

334 In fig. 100 is represented the case when the lenses of the eye are too strong, so that they cause the rays to converge too rapidly, and so bring them to a point R′, in front of the retina The consequence of this will be, that instead of a point on the retina, we shall have a spot of light of some size, and this will destroy the distinctness of the image ; for the different spots which correspond to neighbouring points of the object, will overlap each other, and so be mixed and confused with each other, exactly in the manner we have already explained in speaking of the effect of enlarging the hole in the camera obscura, Art. 327.

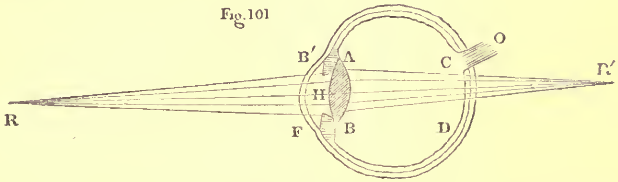
Fig. 100



335 When, however, the point R is much nearer to the eye than is represented in the figure, the rays which fall on the eye from it will be very divergent, and it will require more powerful lenses to make them converge; therefore, though the lenses were too powerful before, they may not be so now; in fact, they may be only just sufficiently strong to overcome the increased divergency of the rays, and make them converge to a point on the retina exactly. Hence it appears that, when the lenses of the eye are too powerful, an object which cannot be seen distinctly at some distance, will become distinctly visible when it is brought sufficiently near the eye.

This is the case with short-sighted persons, and therefore such persons have too powerful eyes, which is generally evident by the more than usual roundness of the cornea.

Fig. 101



336 In fig. 101 is represented the case where the lenses of the eye are too weak, so that they do not cause the rays to converge with sufficient rapidity, the consequence of which is, that the rays are intercepted by the retina before they come to a focus. This will of course produce indistinctness of vision, just as in the former case.

When the lenses are too weak, the object may be made more distinctly visible by removing it to a greater distance from the eye, and so diminishing the divergence of the rays, which will allow the weak lenses to produce a greater degree of convergence. and so bring the point R′, towards which the rays converge, nearer to the retina. Persons with weak lenses are therefore long-sighted.

337 Most eyes are adapted for vision of distant objects, the lenses being only just powerful enough to bring rays from a distant point to a focus on the retina. But the lenses may be made more powerful by the action of certain muscles, which, by compressing the ball of the eye, and so making the cornea rounder, increase the power of the cornea, and possibly that of the crystalline lens also. By the almost involuntary action of these muscles, the eye has a power of adapting itself to near objects ; but generally this power of adaptation is limited to objects not nearer to the eye than six inches, or thereabouts. The eye is perfectly incapable of seeing nearer objects without the assistance of a microscope.

338 It is easy to understand, from what has been stated, how the vision of short-sighted persons is assisted by their looking through a concave lens, for that lens increases the divergence of the rays, and has the same effect as if the object were brought nearer to the eye.

339 In like manner, it is evident how long-sighted persons are benefited by convex lenses, which diminish the divergence of the rays, and therefore have the same effect as removing the object to a greater distance from the eye.

340 It is important to observe here, that it follows from what we have explained respecting the eye, that a near object and a distant object can never be seen distinctly at the same time; for it is plain that if the lenses are of the proper power to bring the more diverging rays, which come from a nearer object, to a focus on the retina, they will not be of the proper power to produce the same effect on the less diverging rays which come from more distant objects. This is a point of some importance in practice.

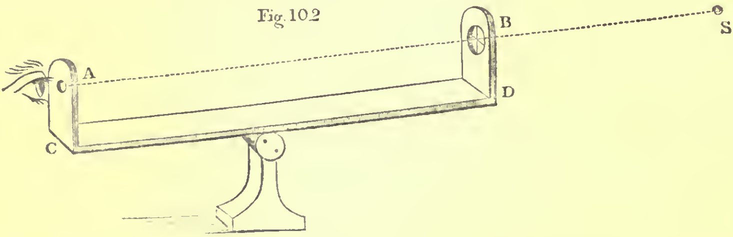
We have now said enough respecting light generally, and the formation of images, to enable us to proceed to the two special subjects we have to consider in the present chapter—namely, the telescope as a means of ascertaining *direction,* and the microscope as a means of measuring *minute distances.*

III. *Of the Telescope as a means of ascertaining Direction.*

341 *Direction how determined by Sights.*—Simple as it may seem at first sight, it is no easy matter to determine and define the direction in which any distant object appears to be. In a rough way, we might point a straight rod at the object, and say that that rod showed the direction of the object; but it is not possible to point a rod in this way with any degree of accuracy.

By putting a pair of sights on the rod, the direction of the object may be much more accurately ascertained. Fig. 102 represents a rod C D, with two

Fig. 102



sights A and B fixed upon it, A being a small hole, and B a larger hole, with two cross wires. By looking in such a manner through the hole A, and putting the rod in such a position that the point of intersection of the wires appears to coincide with a distant object S, and at the same time with the centre of the hole, it is evident that we ascertain the direction in which S is seen, for the line joining the centre of the hole and the point of intersection of the cross wires shows that direction.

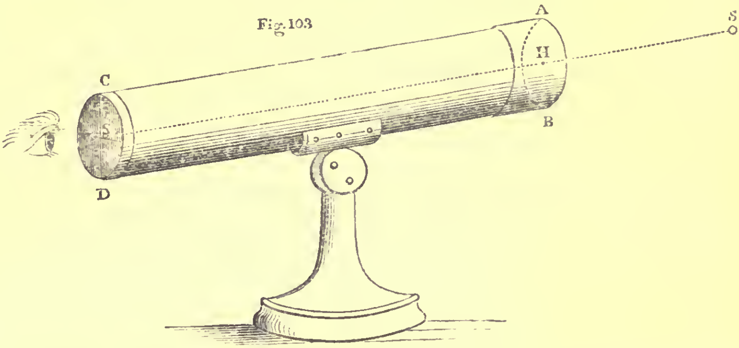
342 This method of ascertaining direction is, however, by no means sufficiently accurate, for several reasons, and among the rest for this—that the eye cannot possibly see the hole at A, the cross wires at B, and the object S, all distinctly at the same time. If the attention be fixed on S, it will be seen distinctly, but the cross wires will not, and the hole will appear quite indistinct. In practice, the hole at A is often very small, and the eye is put quite close to it, in which case the hole is scarcely seen, and only serves to show the place where the eye should be put.

We shall now show that the camera obscura, above described, affords a most simple and accurate method of determining direction, especially with certain additions, which convert it into a telescope.

343 *Direction how determined by a Camera Obscura.*—We shall suppose

the camera obscura to consist of a tube, A B C D, fig. 103, C D being the semi-transparent screen on which the image is formed. At the other end A B, is the lens, which is of the proper power to make the rays which come from a distant luminous point S, converge to a focus on the screen C D; but, as we have shown above, this lens produces precisely the same effect on the screen as an extremely small hole H, only the image formed by the lens is not extremely faint, like that formed by the hole.

Fig. 103



As we are only concerned with the size and shape of the image, and not with its brightness, we shall for simplicity suppose that there is a hole H, instead of a lens, at A B, the hole representing, in fact, the centre of the lens. On the screen C D there are two fine wires or lines, intersecting each other at right angles; the use of these lines is to make, by their intersection, a fixed mark at a particular point of the screen.

344 The imaginary line drawn from the point of intersection of the two cross wires through the point H, is called the *line of collimation* of the instrument, that is, as we have explained before, the line which is pointed or aimed at any distant object, and which is the direction in which that object is seen.

345 Now, we can evidently ascertain, with the greatest precision, whether the line of collimation points to any distant point S, or not; for we have only to look at the image S′ of the point S, found on the semi-transparent screen, and see whether it coincides with the intersection of the cross wires or not. If it does, then the line of collimation must point exactly to the point S, for, as we have explained above, S′ H and S are always in the same straight line, and therefore, if S′ is seen at the point of intersection of the cross wires, it follows that the point of intersection of the cross wires, the point H, and the point S, are in the same right line; or, in other words, the line of collimation points to S.

346 If S′ were a material point, instead of being a mere optical image, as it is, it would not be possible to see whether S′ coincided exactly with the intersection of the cross wires or not; for, in point of fact, it is impossible to see with accuracy whether two material points coincide or not; indeed, two material points cannot coincide with each other. It is altogether different when one point is material and the other only an optical image; in such a case actual coincidence is possible, and it is easy to see whether there is actual coincidence or not, especially if we use a microscope to magnify the cross wires, in which case the coincidence of the image S′ of the distant point S, with the intersection of the cross wires, may be seen with wonderful distinctness.

347 The great advantage of the camera obscura, fig. 103, over the two sights, fig. 102, for the purpose of ascertaining the direction of the distant point S, is now manifest. In one case the eye has to look whether two points,

that are really at some distance from each other, appear to coincide or not, which it is impossible accurately to determine, because the eye cannot see distinctly two objects at different distances from it at the same time. In the other case the eye has only to see whether an optical image formed on a screen actually coincides with a mark on that screen or not, which may be done with the greatest exactness.

In order, then, to determine accurately the direction in which any distant luminous point S is seen, we have only to point the instrument represented in fig. 103 towards S, and move it carefully until the image of S, which will be seen on the semi-transparent screen C D, coincides exactly with the point of intersection of the cross wires. Then the line drawn from that point through the point H—i. e., the line of collimation, must point directly to S. In this manner the direction in which S is seen is ascertained.

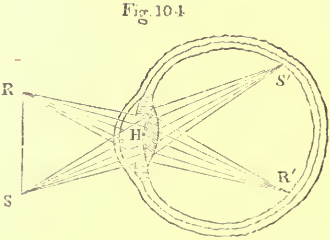
348 By using a microscope to magnify the cross wires, this may be done, as we have stated, with extraordinary accuracy. When a microscope is attached to the instrument for this purpose, the whole compound instrument so formed becomes the regular astronomical telescope. We shall now say a few words respecting the proper kind of microscope, or *eye piece,* as it is generally called, which is thus employed.

IV. *Of the Eye Piece, or Microscope.*

349 *Simple Microscope.*—By looking through a convex lens, placed close to the eye, we may see objects distinctly much nearer to the eye than we could do without such assistance. Now, the nearer an object is, the larger it appears, and therefore a convex lens thus used will enable us to see an object larger than it can possibly appear to the naked eye.

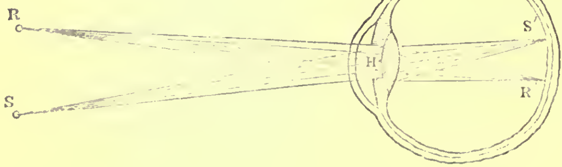
To explain this point the better, let us suppose that the naked eye cannot see an object distinctly nearer than six inches, and that the focal length of the convex lens is one inch; then, if we place the object at an inch from the eye, and look through the lens at it, we shall see it distinctly; for, as we have explained above, rays diverging from a point whose distance from a lens is equal to the focal length, emerge from the lens parallel to each other, and therefore are brought to a focus on the retina by the action of the lenses of the eye, as has been stated above. Hence, the effect of the convex lens is simply to enable us to see an object placed at a distance of one inch from the eye, which could not be seen without the lens nearer than six inches. The result of this will be, that the object will appear, when seen through the lens, six times larger than when seen by the naked eye.

Fig. 104



350 This will be seen by comparing figs. 104 and 105; in the former, R S, the object, is supposed to be one inch from the eye; in the latter, R S is supposed to be six inches from the eye. The image of R S on the retina is found by considering that it is produced by the lenses of the eye, in the same manner as the image on the screen in the camera obscura by the lens in the hole; and therefore if we suppose H to be the centre

Fig 105



of the lenses of the eye, we have only to draw straight lines from S and R through H, to meet the retina at S′ and R′, and then S′ and R′ will be the points where the rays from S and R respectively are brought to a point on the retina. This being the case, it immediately follows, that if R S be six times farther from H in fig. 105 than it is in fig. 104, the size of the image, R′ S′, will be six times greater in fig. 104 than it is in fig. 105.

Now, in fig. 104, the eye, unassisted, cannot see R S distinctly, because the rays diverge too much, and the lenses of the eye will not be powerful enough to make them converge to the points R′ and S′ on the retina. Therefore the convex lens above spoken of will be necessary to make the vision distinct, by helping the lenses of the eye to overcome the great divergency of the rays, and make them converge with sufficient rapidity to form an unconfused image on the retina.

351 A very simple way of showing the truth of this account of the manner in which a lens placed close to the eye magnifies, is to look at the object R S, fig. 104, through a pin hole in a card, instead of through a convex lens. The hole, like the lens, will evidently diminish the divergence of the rays, and therefore assist the lenses of the eye. Of course the hole greatly weakens the brightness of the image, because it cuts off a great portion of the rays, or rather, allows only a small portion of them to enter the eye; but still it makes the object distinctly visible, and, as we have explained, magnifies it by enabling the eye to see it so much nearer than it could do without the hole.

352 To try this experiment, it is only necessary to look at small print through the hole in the card, placed very close to the eye; it will be found that we may, by so doing, bring the print within a few inches of the eye, and still see it distinctly, though it will not appear strongly marked, on account of the small quantity of light allowed to pass by the hole. The card should then be removed, keeping the eye still at the same distance from the print, and it will be perceived immediately how much the hole assisted in making the vision distinct; for the moment the card is removed, the print will become utterly confused and indistinct, so that one letter cannot be distinguished from another.

353 A convex lens used in this manner, that is, put close to the eye, is called a *simple microscope*. It is important to remember that a lens thus used magnifies simply by enabling the eye to get nearer to the object than it could do naturally, and this it does by helping the lenses of the eye to overcome the increased divergence of the rays.

354 *Vision through a Lens not placed close to the Eye.*—There is a very important difference in the action of a lens *not placed close to the eye*, from that we have just explained, as we shall now show.

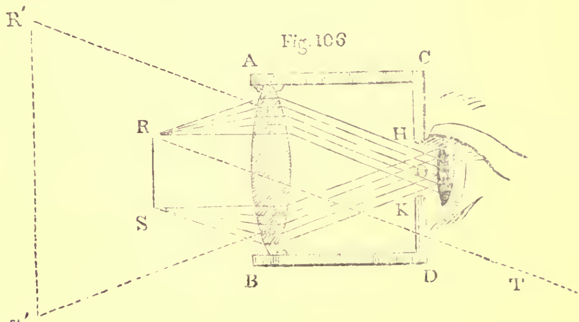


Fig. 106 represents a short tube A B C D, at one end of which is a lens A B, and at the other a hole H K, not much larger than the pupil of the eye:

it is called the *eye hole*, the eye being always placed close behind it, as is represented in the figure. R S is any object placed before the lens at a distance equal to the focal length. The use of the tube A B C D, and the hole H K, is to keep the eye always at a certain distance from the lens.

The course of the rays which enter the eye from the two points R and S is shown in the figure. The rays from R falling on the lens will emerge parallel to each other, or nearly so, because the distance of the object from the lens is equal to the focal length; but the ray R T, through the centre of the lens, will suffer no deviation; therefore the other rays, after emerging from the lens, will be parallel to R T, and those which are allowed to pass through the hole will enter the eye. To find the rays which pass through the hole, we have only to draw lines towards the lens from H and K parallel to T R, and all the rays between these two lines will get through the hole. Hence the rays drawn in the figure, and those only, will get through the hole to the eye; all the rest will be stopped by the tube. The course of the rays from S is exactly similar to that of the rays from R.

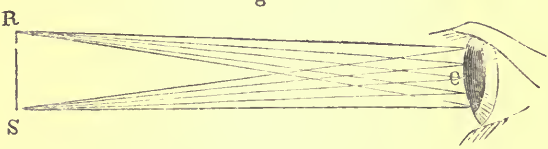
355 Now this being the case, it is evident that the lens A B discharges a two-fold office.

1st. It diminishes the divergence of the rays, and so assists the lenses of the eye to make them converge to points on the retina. It therefore so far acts in the same manner as the simple microscope.

2ndly. It magnifies the object, not merely by enabling the eye to get closer to it, but also by bending all the rays in the manner shown in the figure. This is a point of considerable importance, as will appear more clearly when we come to speak of the telescope; for in the telescope the rays, without the action of a lens thus disposed, would enter the eye almost perpendicularly, and the image would appear very small, or rather, very little of it would be seen.

356 The degree in which this instrument magnifies the object R S will appear better by comparing the vision through it with vision by the naked eye. In fig. 107, R S is supposed to be viewed by the naked eye; the point

Fig. 107



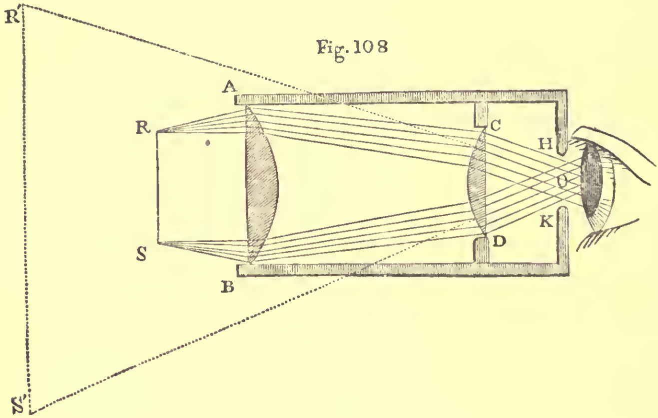
O in this figure, and in fig. 106, representing the centre of the lenses of the eye; the dotted lines R′ O and S′ O are the central rays which enter the eye from R and S produced backwards; the distance of R′ S′ from the eye in fig. 106, is supposed to be about one foot, and R S, in fig. 107, is also supposed to be about one foot from the eye. We say a foot, because at that distance the eye may see an object distinctly without any exertion; in fact, in reading small print, a person with good eyes would naturally hold his book at that distance, or thereabouts, from the eye. The eye could see an object at six inches, but not without fatigue.

Now, in fig. 106, if we supposed the instrument removed, the points R′ and S′ would evidently be seen by the eye in the same directions as the points R and S appear to be when seen through the instrument; in other words, the object R S appears, when seen through the instrument, to be of the same size as the object R′ S′ seen by the naked eye. As far, then, as apparent size is concerned, we may substitute the object R′ S′ seen by the naked eye, in place of the object R S seen through the instrument.

Then, since R′ S′, fig. 106, and R S, fig. 107, are at the same distance from O, and since the images of these two objects on the retina are found by drawing straight lines from them through O to meet the retina, it is manifest that those images will be exactly proportional in size to the objects respectively. If, for instance, R′ S′ be ten times R S, the image on the retina in fig. 106 will be ten times larger than that in fig. 107; if R′ S′ be twenty times R S, the former image will be twenty times the latter, and so on.

357 Hence the degree in which this instrument magnifies is obvious; at the same time we must observe, that the above explanation is to be received merely as a general account of the nature of the magnifying power of the instrument; for the eye in judging of magnitude is greatly influenced by a variety of circumstances which we have not time to speak of here. This instrument is the *astronomical eye-piece* in its simplest form.

Fig. 108



358 *The Compound Eye-Piece.*—This is shown in fig. 108. It consists of two lenses instead of one, but in other respects it is exactly the same as the simple eye-piece just explained. It is, however, a much more perfect instrument, and its optical effect, when well made, is almost faultless. The front lens A B is called the *field-glass*, because it enables us to see a greater extent of the object R S distinctly, than we could possibly do with the single lens, fig. 106. The extent of the object visible through the instrument is commonly called the *field of view*, and hence the name *field*-glass. The lens C D being next the eye, is called the *eye-glass*. The light coming from the object R S is bent by each of the lenses, as shown in the figure, and enters the eye as if it came from a larger object R′ S′. All that we have just said respecting fig. 106 applies, therefore, equally well in this case.

359 *How the Compound Eye-Piece is made Achromatic.* — One great defect of the single lens, fig. 106, is, that it is not achromatic; in consequence of the different refrangibility of the different colours, the image seen by the eye is imperfect and confused, the violet being more magnified than the red, and the intermediate colours in an intermediate degree. In the compound eye-piece this defect is remedied in the following manner:—

In fig. 109, A B and C G are the two lenses, and R D is any ray from the object incident on the field-glass at D. This ray is of course separated into its component colours by the dispersion which inevitably accompanies refraction (except the lens be compound). The violet ray will be more bent than the red, so that the former will fall below the latter, as is shown in the figure, where D E represents the red ray and D E′ the violet.

But the consequence of this will be, that the violet ray will fall on the second lens nearer the central part than the red ray, and therefore so far the second lens will produce a less effect on the violet than on the red ray; for the nearer to the central part a ray is incident on a lens, the less is it bent by the lens. Hence, if the two lenses be at a sufficient distance from each other, the fact that the violet is more refracted than the red by the first lens, and less by the second, may lead to a mutual correction between the two lenses—i. e., the under refraction of the second may just correct the over refraction of the first. This, it may be shown, will take place when the distance between the two lenses is half the sum of their focal lengths. When the lenses are so placed, it is found that the red and violet, and the other colours, emerge from the second lens parallel to each other, and are all caused to converge to the same point of the retina by the action of the lenses of the eye; for the lenses of the eye are so far achromatic that they always cause parallel rays, whether of different colours or not, to converge to the same point on the retina.

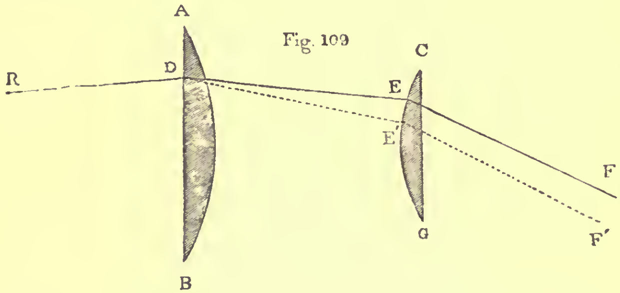


Fig. 109

360 This eye-piece was the invention of Huygens, but the principle upon which it acts was pointed out by Boscovich. In astronomical instruments this eye-piece cannot be used in its perfection on account of its being necessary to have the object R S too close to the field-glass, whereby every spot and flaw in that glass is made visible, and spoils the clearness of the field of view. To remedy this defect, Ramsden placed the lenses a little closer to each other, and so was enabled to keep the object R S at a greater distance from the field-glass. The lenses are each of the same focal length in Ramsden's eye-piece; they are also plano-convex—i. e., convex with one side plane, the convex surfaces being turned towards each other, as is shown in the figure.

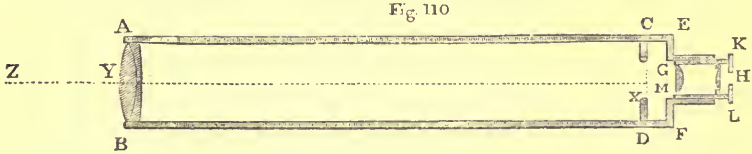
361 The compound eye-piece has many other advantages over the simple one represented in fig. 106, chiefly arising from the refraction in the former being divided, as it were, between two lenses, instead of being entirely effected by one; but we have not space to say more on the subject.

V *Of the Astronomical Telescope.*

362 It will now require but a few words to explain the construction of the astronomical telescope; it is, in fact, nothing more than the camera obscura represented in fig. 103, with the addition of Ramsden's eye-piece, to enable the eye to see more accurately whether the image of a distant luminous point, formed on the semi-transparent screen, coincides with the centre of the cross wires or not. Furthermore, the screen is either removed or made transparent, as its semi-transparency is of no use where an eye-piece is used to view the image and the cross wires, and only has the effect of diminishing the brightness of the image. It would be absolutely necessary to retain the semi-transparent screen, if a simple microscope were used instead of an eye-piece, for without the semi-transparent screen the rays that would get into the eye through a lens placed close to it would be only those which come from the central part of a distant object, so that the field of view would be extremely limited. But with an eye-piece, if the eye-hole is placed in the proper position, the rays from a comparatively great extent of a distant object are brought to the eye.

363 Fig. 110 represents the astronomical telescope. A E F B is the tube, and C D is the screen, which in the camera obscura above described was semi-transparent, but is now supposed to be perfectly transparent; it may be a piece of plate glass with two fine cross lines drawn upon it, or it may be simply a round hole in a piece of brass fixed inside the tube, with two extremely thin wires drawn tight across it. At A B is the lens which produces the image of any distant object at which the telescope is pointed, which image must be formed exactly at the transparent screen or hole C D, where the cross lines or wires are placed. This lens is called the *Object Glass*, and is, of course, achromatic and aplanatic, so as to form a perfectly distinct and well-defined image of the object.

Fig. 110



X is the point of intersection of the cross lines or cross wires, which are supposed to be so fine and delicate that the point X is defined by them in the most perfect manner possible.

Two intersecting lines are found to form the best kind of mark for defining a particular point in the interior of an instrument· these lines are generally at right angles to each other but they are sometimes made to intersect obliquely.

Y is the centre of the object glass corresponding to the hole H in fig. 103, and the imaginary straight line X Y Z, drawn from X through Y, is the *line of collimation*, which we have spoken of before. This line is the great and principal thing to be attended to in the instrument. The instrument itself is nothing but a contrivance for pointing this line very accurately towards any particular star or distant luminous point. When the line of collimation points towards any star, an image of that star is seen to coincide exactly with X, the centre, or point of intersection, of the cross wires, and this is the test whereby we know whether the line of collimation points in the proper direction or not.

G M K L is the eye-piece (Ramsden's) already described, the use of which is simply to magnify the image of the star and the cross wires, and so enable the eye to judge the better whether that image is exactly at the point X or not. This eye-piece is capable of sliding in a tube attached to the large tube, as shown in the figure, for the purpose of accurate adjustment, and for adapting the vision to eyes of different powers.

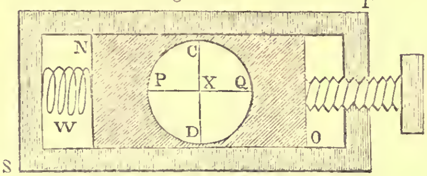
364 It is important to observe that there is no connexion whatever between the line of collimation and the eye-piece; the eye-piece may not be placed quite straight, or it may distort the image and the wires, which it always does to a certain extent; but if it shows the image of the star distinctly coincident with the centre of the cross wires, we may be sure that the line of collimation points exactly to the star.

365 It is also necessary to remark that the cross wires need not be placed exactly in the middle of the tube, they may be moved a little to one side or the other if necessary; though it is better that their intersection X should be as nearly as possible opposite to the centre of the object glass Y, in order that the line of collimation may be perpendicular to the object-glass, or very nearly so.

366 *Adjustment and Movement of the Cross Wires.*—The piece of plate glass on which the cross lines are drawn (or, what is the same thing, the piece of brass with a circular hole, across which the cross wires are fixed) is generally made capable of movement backwards and forwards across the instrument, in the following manner:—

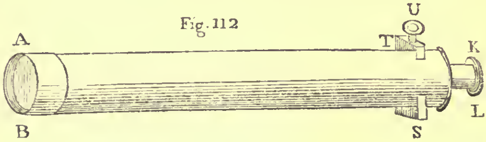
C Q D P, fig. 111, represents the piece of plate glass, having the cross lines C D P Q traced upon it. It is fixed in a flat piece of brass N O, with a circular hole C Q D P. If there is no piece of glass, the lines C D and P Q are simply wires fixed tightly across this hole. The piece N O slides in a frame of brass S T. A screw U, and a spring W, act upon the piece N O, in the manner shown in the figure, so that by turning the head of the screw U, the piece N O is caused to slide in the frame S T towards S, and by the opposite motion of the screw the spring W acts upon N O, and makes it slide the opposite way. Sometimes, however, instead of the spring W there is another screw, the counterpart of U, and by means of the two screws the piece N O is moved at pleasure, and kept fixed if necessary. The two screws are used instead of the screw and spring, where it is not necessary to move the piece N O, except occasionally by way of adjustment.

Fig. 111



The frame S T pierces the tube of the telescope, and is fixed across it near the eye end, in the manner shown in fig. 112, where A B K L is the telescope, A B the object glass, K L the eye-piece, S T the frame shown in fig. 111, and U the screw, by which the piece N O (fig. 111) is moved.

Fig. 112

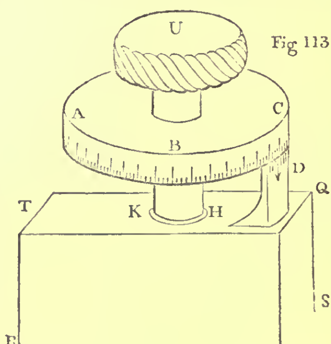


In this manner we may, by turning the screw U one way or the other, move the cross wires backwards or forwards across the tube of the telescope, and so adjust the point of intersection of the wires in its proper position, as will be explained presently.

VI. *The Micrometer.*

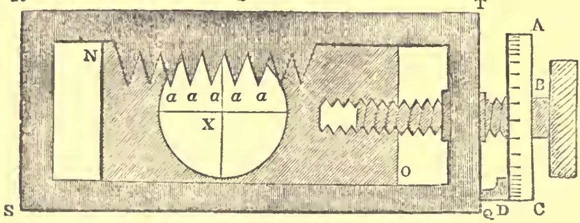
367. Where it is required to measure the image formed by the object glass, the thread of the screw U is formed with great accuracy, and the motion of N O is made as steady and even as possible. The head of the screw is also graduated, as shown in fig. 113, where T Q R S is a portion of the frame, H K the screw, working through the end T Q of the frame; U A B C is the head of the screw, consisting of two parts—namely, a milled or grooved circle U, which the fingers lay hold of in order to turn the screw, and a graduated circle A B C, the graduations being shown in the figure on the rim of this circle. D is the index, which is fixed to the end of the frame T Q, and which just touches the graduated circle, without, however, impeding its motion. The screw in this case does not work exactly in the same manner as that shown in fig. 111; for it is necessary, evidently, that it should move the piece N O after the manner of an endless screw—that is, the female screw is not in the frame as in fig. 111, but in the piece N O. In this way the screw itself does not move in and out when it is turned round.

Fig 113



This is shown in fig. 114, which represents a section of the micrometer; where A B C U is the head of the screw, R S Q T the frame in which the piece N O moves; the end of the screw piercing the piece N O. D is the index, which is attached to the end of the frame T Q.

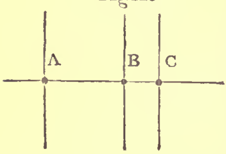
Fig. 114



368 *a, a, a, a,* &c. represent a set of brass points equidistant from each other, projecting from the upper side R T of the frame. These points are seen in the field of view, along with the cross-wires: the use of them is to help in counting the number of turns we give to the screw in any case. When the screw is turned round, the vertical cross-wire passes each of these points in succession, and they are placed at such distances, that one turn of the screw makes the vertical cross-wire move from one point to the next. It is not necessary that these points should be placed with great exactness, as they only serve to count the number of turns given to the screw.

369 An example will best show the use of this micrometer. We shall suppose that A B and C (fig. 115) are three stars, or rather, images of stars, seen on the horizontal cross-wire, and that we wish to measure their relative distances from each other. We shall also suppose that there are 100 graduations on the head of the screw, which are numbered 0, 1, 2, 3, 4, &c. in order. By means of these graduations, we can tell how much we turn the head of the screw; for every graduation that passes the index D, as we turn the screw, corresponds to the hundredth part of a complete revolution.

Fig. 115



Suppose now, that we turn the screw until the vertical wire is brought to meet the star A, and that the graduation seen at the index D is ten. Let us then turn the screw until the vertical wire comes to the star B, and suppose that as we do this the vertical wire passes across four of the points *a, a, a, a,* and that the graduation seen at D, when the wire comes to B, is thirty-five. Then it follows, the motion of the wire from A to B corresponds to four complete turns of the screw, and twenty-five graduations, or twenty-five hundredth parts of a complete turn.

In like manner, let us move the wire from B to C, watching the points and looking at the graduations at D, when the wire comes to C; and suppose that the number of points the wire passes across is two, and the graduations forty. Then the motion of the wire from B to C corresponds to two complete turns of the screw, and five graduations.

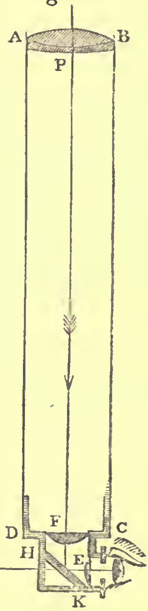
Hence it follows, that the distance A B is to the distance B C as four units and twenty-five hundredth parts of unity to two units and five hundredth parts—that is, A B is to B C as 4·25 to 2·05.

370 From this example the use of the micrometer is manifest. The above is but a rude representation of the simplest kind of micrometer; there are many details and niceties in the construction, which we could not give without entering into the subject more at length. There are several other kinds of micrometers, nearly all, however, depending on the principles above explained, and consisting of various contrivances for measuring the image seen in the focus of a telescope, by means of the motion of a graduated screw.

VII. *The Diagonal Eye-piece.*

371 Before we leave the telescope, we must mention the *diagonal eye-piece*, which is indispensable in small instruments. It is often necessary to look through a telescope at stars near the zenith, and this requires the head of the observer to be placed in a very inconvenient position, except the instrument be so large that a reclining chair may be placed under it, upon the back of which the observer may lay his head, and look directly upwards without fatigue. In a small instrument it is impossible to do this, and therefore the following kind of eye-piece, called diagonal from its shape, is used.

Fig. 116



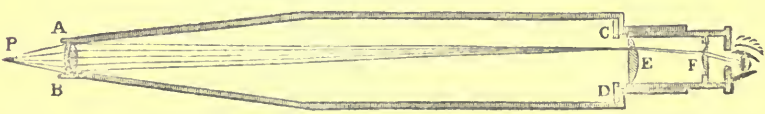
A B C D, fig. 116, represents the tube of the telescope pointed upwards, and F the field-glass; between the field-glass and eye-glass is placed a plane mirror H K, diagonally, so as to reflect the light which comes down the tube in a horizontal direction towards the eye; then the eye-glass E receives this light, and transmits it through the eye-hole to the eye. The only difference between this and the common eye-piece is, that the mirror is interposed between the field-glass and eye-glass, so as to make the light emerge at right angles to the tube, which arrangement requires the eye-glass to be placed, not at the end, but at the side of the tube, as is shown in the figure. The ray of light P F which comes down the centre of the tube, is reflected by the mirror in a horizontal direction, and enters the eye as if it came from the point Q. It is evident that, since the eye-piece is only a contrivance for better ascertaining whether the image of a star coincides with the centre of the cross-wires or not, this change in the form of the eye-piece does not, in any way, alter the nature of the instrument, but simply enables the eye to look at the wires and image horizontally intead of vertically.

372 The diagonal eye-piece is made capable of sliding on or off the instrument at pleasure, so that it may be used whenever occasion requires it. Good telescopes have generally several eye-pieces, or *powers*, as they are called by opticians, of different magnifying power, which may be employed according to the nature of the observations, and the state of the atmosphere.

VIII. *Of the Astronomical or Reading Microscope.*

373 We need say but little here respecting the miscroscope, as we have already stated what the simple microscope is, and the compound miscroscope is precisely the same instrument as the telescope; being, in fact, a telescope, if we may so use the word, employed to view near instead of distant objects. Dr. Goring has proposed to call the compound microscope by the

Fig. 117



name *engiscope*, which well expresses its nature, as compared with the *telescope;* the former word signifying that which views *near*, and the latter distant, objects.

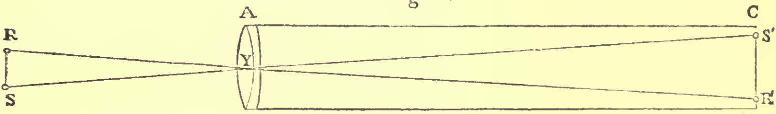
374 The compound microscope is shown in fig. 117, with the course of the

rays, which come from a near luminous point P, through the instrument. The tube A B C D, tapers towards the object end A B, because the object glass, being of high power, is necessarily small. The object glass is of high power, in order that it may be able to overcome the great divergency of the rays coming from an object so near as P, and make them converge to a focus at C D, which, as in the case of the telescope, is supposed to be a piece of plate glass with cross lines drawn upon it, or simply a hole in a brass plate with cross wires stretched across it. The eye-piece consists of a field-glass, eye-glass, and eye-hole, and is, in fact, precisely the same that has been described in the case of the telescope. In microscopes which are used simply for magnifying, but not measuring, a different eye-piece is used—namely, Huygen's eye-piece, above alluded to.

375 This instrument, though precisely the same in principle as the telescope, differs from it in one important particular—namely, that in the miscroscope, the image formed at C D is always much larger than the object, whereas, in the telescope, it is much smaller. We may show this very easily as follows:—

Let A B C D, fig. 118, represent the telescope, at least the telescope without

Fig. 118

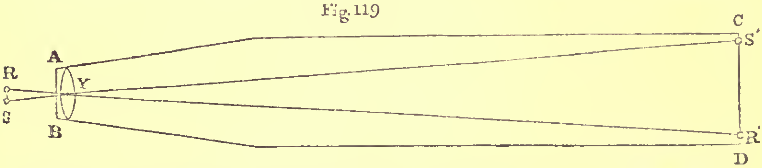


the eye-piece, which we do not now require to consider; C D the screen, Y the centre of the object glass, and R S a distant object, but which, for want of room on the paper, must necessarily be drawn near. Then R′ S′, the image of R S, formed at C D, is found by drawing straight lines from R and S through Y, to meet C D at the points R′ and S′; from which it is evident that R′ S′ bears the same ratio to R S that the length of the tube does to the distance of R S from Y; for instance, if the length of the tube be three feet, and R S be 3000 feet from Y, it is evident that R′ S′ will be 1000 times smaller than R S.

Now, in the telescope R S is always a distant object, and therefore the image R′ S′ formed by the object glass is always considerably smaller than the object R S.

In the microscope this is reversed, as is evident immediately from fig. 119;

Fig. 119



where the image R′ S′ is found as before, by drawing straight lines from R and S through Y, the centre of the object glass A B, to meet C D at R′ and S′. Now, here R S is very close to Y—in some of the good instruments lately made, the distance may not be more that $\frac{1}{12}$th of an inch*—but suppose we call it an inch, and assume the length of the tube to be six inches; then it is clear that R′ S′ will be six times greater than R S.

376 In both the telescope and microscope, the eye-piece magnifies in the manner we have explained; hence, in the telescope, the eye-piece alone

* In this case the object glass is a *triple achromatic*, consisting of six lens altogether, united in pairs.

magnifies, but in the microscope both the object glass and the eye-piece magnify.

377 From what has been just explained, it is clear that, *cæteris paribus*, the magnitude of the image R′ S′ in both instruments is proportional to the length of the tube; the longer the tube, therefore, the greater the magnifying power of the instrument.

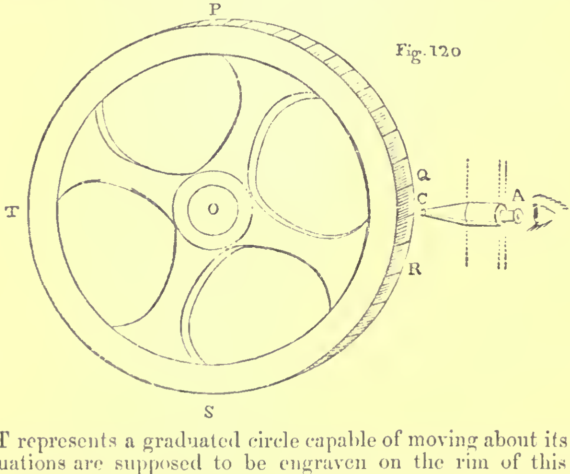
378 In the microscope, the size of the image is evidently increased by bringing the object R S nearer to the object glass: to do this, the power of the object glass must be increased, for it must be sufficient to overcome the divergence of the rays, and make them converge to a focus at C D. Now, when the object is placed at a distance from the object glass equal to its focal length, the power of the glass is then just sufficient to overcome the divergence of the rays, and cause them to emerge from the lens parallel to each other: hence, to make the rays converge to a focus at C D, either the object glass must be made a little more powerful, or the object must be moved a little farther from the lens, in order to diminish the divergence of the rays a little.

It appears, then, that the distance at which the object must be placed from the object glass of a microscope is a little greater than the focal length of that glass.

379 Great improvements have of late been made in the manufacture of object glasses for microscopes, which are now ground, polished, and centred in their proper positions, with perfectly wonderful accuracy. Object glasses are now made of a focal length of $\frac{1}{12}$th of an inch, which are capable of overcoming a divergence of 120° in the incident rays, and bringing them to an accurate focus at C D.

380 *The Reading Microscope.*—The *astronomical* or *reading* microscope, which is used for reading and subdividing the graduations in large instruments, is a compound microscope, with a micrometer such as that we have above described. Each graduation of the instrument is generally about 5′; five complete turns of the screw move the wire of the micrometer from one graduation to the next, and the graduated head of the screw is divided into —suppose sixty graduations. In this manner each graduation of the screw corresponds to 1″.

381 As the reading microscope is a very important part of several useful instruments, we must explain the manner in which it is used. In fig. 120,



P Q R S T represents a graduated circle capable of moving about its centre O. The graduations are supposed to be engraven on the rim of this circle, as shown in the figure, and they are viewed by a fixed microscope A C. The whole rim P Q R S T is divided into 360 equal parts, and each part subdivided into twelve equal parts, so that each of these subdivisions is the twelfth part of a degree, or 5′. The microscope is furnished with a micrometer and graduated screw, as above described, the graduated head of the screw being divided into 60, or 120, or 240, or 300 equal parts—say 60, for simplicity.

Fig 121

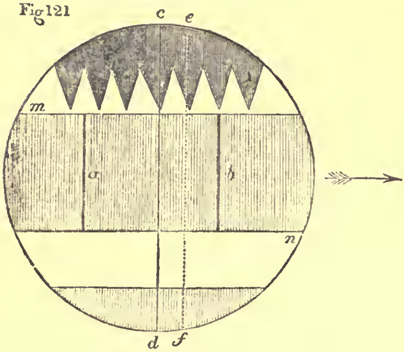


Fig. 121 shows the field of view of the microscope—i. e., what the eye sees on looking through it. *m n* is a portion of the rim P Q R S T of the instrument seen in the microscope, and, of course, greatly magnified; *a* and *b* are two consecutive graduations of the rim, so that the space *a b* is the image of 5′ of the rim formed in the focus of the microscope, C D is a fixed wire, parallel to the graduations *a* and *b*, and firmly fixed in the focus; *e f* is another parallel wire—viz., that which is moved by turning the screw of the micrometer, as above explained. Points are seen on the field of view, to help in counting the number of complete turns of the screw, as we have described before.

The fixed wire *c d* serves as a mark, and the moveable wire *e f* serves to measure the space between this mark and the next graduation *a* or *b*. Five complete turns of the screw move *e f* from *a* to *b*, that is, over a space of 5′; therefore, one turn moves *e f* over a space of 1′, and the sixtieth part of a turn moves it over a space of 1″.

Suppose now that the circle P Q R S T is turned round, and we wish to find out through how many degrees, minutes, and seconds we have turned it. Let the hinder graduation *a*, seen in the microscope before moving the rim, be 20° 10′, and therefore the graduation *b*, 20° 15′, and suppose that it requires two turns and four sixtieth parts of a turn of the micrometer screw to make the wire *e f* move from *a* to *c d;* then it is evident that if the rim were divided so minutely as to show seconds, the graduation opposite the mark *c d* would be 20° 12′ 4″; for *a* is 20° 10′ and it is 2′ 4″ farther to *c d*, as shown by the micrometer screw. After the rim has been moved, suppose that the hinder graduation *a* seen in the microscope is 43° 35′, and that it takes three turns and twenty-four sixtieth parts of a turn of the screw to move *e f* from *a* to *c d;* then the graduation of the rim opposite the mark *c d* is 43° 38′ 24″, *a* being 43° 35′, and *c d* being 3′ 24″ farther on.

Since, then, the graduation opposite the mark is 20° 12′ 4″ before, and 43° 38′ 24″ after turning the rim, it follows that the difference—namely, 23° 26′ 20″—is the number of degrees, minutes, and seconds through which we have turned the rim.

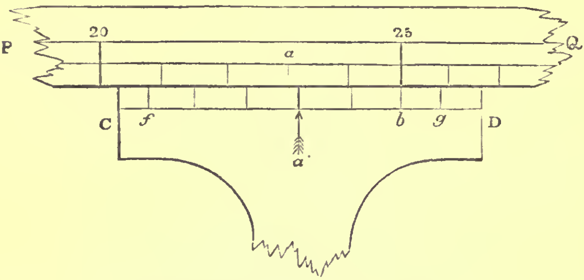
382 Thus the use of the reading microscope is obvious; for though the rim is only divided to 5′, we can read off and observe as accurately as if it were divided to seconds. Now, to divide the rim of a large instrument accurately to 5′—that is, into twelve times 360 exactly equal parts—is no easy matter, and costs a large sum of money; it is easy, then, to conceive what it would be to divide it to seconds—that is, into 60 × 60 × 360 equal parts—if the engraving of such a number of lines so close together were possible. Hence the importance of the reading microscope is obvious.

IX. *Of the Vernier.*

383 We must here briefly describe a very useful contrivance called the Vernier, from the name of the inventor, which takes the place of the reading microscope in smaller instruments, being much less expensive.

Let P Q, fig. 122, be a portion of the rim of a graduated circle, similar to

Fig. 122



that we have just described, which we shall suppose to be divided into 360 equal parts, each part being therefore 1°. In the figure these graduations are shown from 20° to 27°. C D represents the Vernier, which, in this case, is supposed to be fixed: it consists of a short graduated piece of brass or other substance, the graduation extending from *f* to *g*, and in the present instance we shall suppose them to be six in number; the graduated edge of the Vernier lies as close as possible to that of the rim, without preventing the motion of the rim round its centre.

a′ is the mark corresponding to the fixed wire *c d* in the reading microscope, (fig. 121.) Our object is to find what graduation of the rim is exactly opposite this mark.

Now, if the graduation *a* of the rim were exactly opposite *a′*, we should have no difficulty in doing this, for it is manifest that the arrow would then point at 23°; but this is not the case; *a* is a little behind *a′*, and before we can tell at what graduation *a′* points, we must find what fraction of a degree it is from *a* to *a′*.

To do this, suppose that the six graduations of the Vernier, from *f* to *g*, are exactly equal to five graduations of the rim, so that, if *f* were opposite 20°, *g* would be opposite 25°. Furthermore, suppose that the graduation *b* of the Vernier is just opposite 25, then six graduations of the Vernier are equal to 5°, and therefore one graduation is the sixth part of 5°—i. e., 50′—consequently from *a′* to *b* is twice 50′ or 100′; but from *a* to *b* is twice 60′ or 120′; therefore, from *a* to *a′* is the difference between 120′ and 100′—that is, 20′. It appears, therefore, that the mark *a′* points to 23° 20′.

Hence the principle of the Vernier is obvious; it enables us to find at what graduation of the rim the mark *a′* points, though none of those engraven on the rim may be exactly opposite *a′*.

384 Generally, to find how far it is from *a* to *a′* we have the following rule:—Look for that graduation of the Vernier which is exactly opposite a graduation of the rim; count on the Vernier what number of graduations it is from that graduation to *a′*; multiply 10′ by that number, and then the result is the number of minutes from *a* to *a′*. 10′ in this case is the difference between a graduation of the Vernier and a graduation of the rim, one being 50′, the other 60′. In every case the distance from *a* to *a′* is found by multiplying this difference, whatever it may be, by the number of graduations from *a′* to *b*.

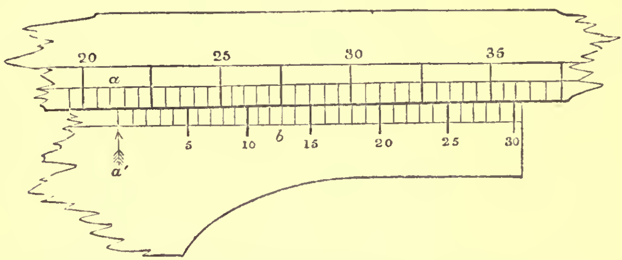
385 If the Vernier consist of thirty graduations, and these thirty graduations are equal to twenty-nine graduations of the rim; and further, if the whole rim be divided into twice 360 equal parts, so that each division is half

a degree or 30′, then each division of the Vernier will be the thirtieth part of twenty-nine half degrees, or, what is the same thing, each division of the Vernier will be 29′. In this case, suppose that the graduation b of the Vernier, which is exactly opposite a graduation of the rim, is ten graduations from the mark a'; then from a to b will be 10 times 30′, or 300′, and from a' to b will be 10 times 29′, or 290′; and therefore from a to a' will be the difference—that is, 10′. In like manner, if the graduation b of the Vernier be twenty graduations from a', the distances from a to b and from a' to b will be respectively 20 times 30′, and 20 times 29′; and therefore the distance from a to a' will be clearly 20′. And, in general, the distance from a to a' will always be as many minutes as there are graduations from a' to that graduation of the Vernier which is opposite one of the rim.

386 If there be no graduation of the Vernier exactly opposite one of the rim, we must in place of it look for that graduation which is *most nearly* opposite one of the rim. In this case we shall be subject to a small error, not, however, exceeding 30″ in the case just described.

387 The graduations of the Vernier are always numbered, beginning from a', as is shown in fig. 123. There should always be a lens or simple

Fig 123



microscope attached in some convenient way to the Vernier, in order to magnify the graduations, and make it more easy to see what graduation of the Vernier is exactly opposite one of the rim, or most nearly so.

388 The Vernier shown in fig. 123 is one very frequently used; the rim being divided into half degrees, and the Vernier into thirty equal parts, which are together equal to twenty-nine half degrees; and the graduations of the Vernier are numbered, beginning from a'. In this case we have the following simple rule for reading off:—

Look for the graduation of the rim (a) which is just behind the mark a' of the Vernier; look also for the graduation (b) of the Vernier which is exactly, or most nearly, opposite one of the rim; then the number of minutes from a to a' is the number on the Vernier opposite b, and the mark a' therefore points to that graduation of the rim which is the number of degrees, or degrees and a half, shown on the rim at a, together with the number of minutes shown on the Vernier at b. In this manner, therefore, we read off very quickly the graduation the mark a' points at.

In fig. 123, a is supposed to be at 21° on the rim, and b is at 12 on the Vernier; therefore a' points at 21° 12′. If a were at $26\frac{1}{2}°$ on the rim, and b at 16 on the Vernier, the reading would be $26\frac{1}{2}° + 16'$, or 26° 46′.*

389 We have now sufficiently explained, for our present purpose, those optical principles which are most essential to be known in astronomy; we have also described the two great instruments, the telescope and microscope, by which the eye is enabled to judge so accurately of direction and measure such small subdivisions of space. We shall now proceed to the Transit Telescope or Instrument.

* The graduations in figs. 122 and 123 have not been made exactly equal to each other by the engraver, but the error does not affect the explanation.

CHAPTER VII.

THE TRANSIT INSTRUMENT.

I. *Description of the Transit Instrument.*

THE Transit Instrument consists of a telescope such as we have just described, mounted in such a way that the line of collimation may move freely in a vertical plane, which plane is generally the plane of the meridian, but sometimes the prime vertical plane, or some other vertical plane suitable to the observer's purpose.

The transit instrument may be said to be the most perfect, simple, and useful of all astronomical instruments: it is capable of the following important applications:—

1st. To determine the position of the meridian plane, and therefore the true points of the compass, at any place.

2nd. To determine the correct time at any place, and so to serve as a regulator of clocks and chronometers.

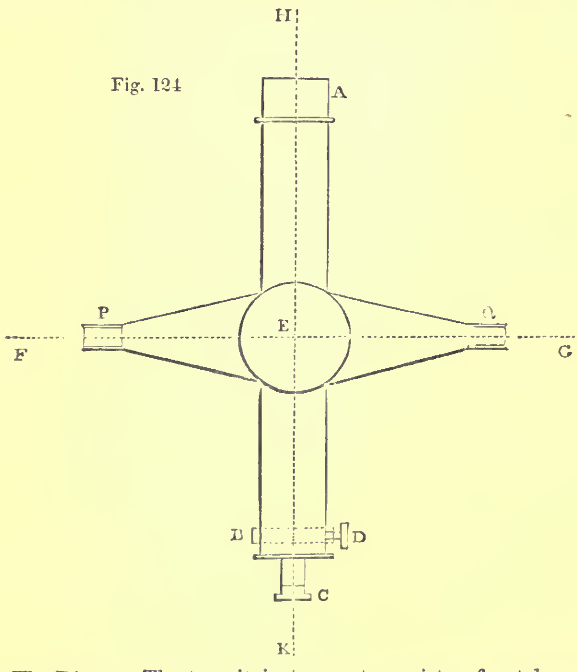
3rd. To determine the right ascension of any heavenly body.

4th. To determine the longitude of any place.

5th. To determine the latitude of any place.

When applied to any of the four former uses, the instrument is set in the meridian plane; but for the latter use it is set in the prime vertical generally.

Fig. 124



391 *The Pivots.*—The transit instrument consists of a telescope A B C, fig. 124, attached firmly to a perpendicular axis P Q, which is made of a conical shape on each side, in order to combine strength and lightness. The extremities P and Q of this axis are cylindrical, of the same size, and having

the same imaginary axis F G—that is, the imaginary line F G runs exactly through the middle of each cylinder P and Q, and the cylindrical surface of each runs exactly parallel to F G.

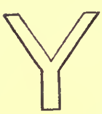
P and Q are called the *Pivots* of the transit instrument, and the imaginary line F G is called the *Axis of the Pivots*, or, what is the same thing, the *Axis of the Transit*. It is of the utmost importance that these pivots should be correctly made, as the goodness of the instrument depends mainly upon them. Three things are necessary to the perfection of the pivots—viz.,

1. They must be truly cylindrical.
2. They must have the same imaginary axis.
3. They must be equal in diameter.

Hence it is obvious, that not only must great pains be taken by the workmen in turning these pivots so as to secure the above requisites, but the observer must take care when he uses the instrument to keep the pivots clean, and to preserve them from being indented in the least degree by any blow or rough handling. This caution is given, because it is necessary frequently to lift the pivots off their bearings, and put them down again.

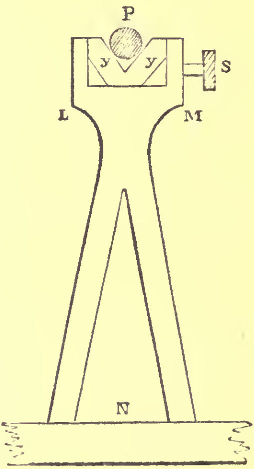
392 *Bearings of the Pivots.*—The pivots do not turn in circular holes, as might at first be supposed, because circular bearings are not sufficiently steady, inasmuch as the circular hole in which a pivot turns must always be a little larger than the pivot, to allow of free motion. Instead, therefore, of circular bearings, the pivots are supported on forks, or Y's, as they are called, being of the shape of the letter Y, (see fig. 125,) or something approaching thereto.

Fig. 125



In fig. 126 is shown the manner in which the pivot P rests on its forked bearing y y, L M N being the pillar or stand to which the Y or bearing is attached. S is a fine screw, which, being turned, gives a horizontal motion to the Y, for the purpose we shall explain presently.* The other pivot Q is supported on a similar Y and pillar, only instead of having a fine screw such as S to move it horizontally, it has one to move it vertically up or down. P is called the *horizontal* Y, and Q the *vertical* Y.

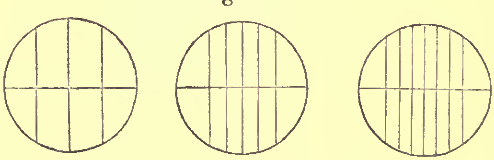
Fig. 126



393 *The Telescope.*—The telescope has cross wires in the focus such as we have described in the former chapter, which are moved horizontally by a screw D, in the manner we have explained. Generally, in small instruments, there are one horizontal wire and three vertical wires equidistant from each other, as is represented in fig. 127, but in large instruments there are five, and often seven, vertical wires.

There are three or four eye-pieces of different powers which slide in at C, one of which is

Fig. 127

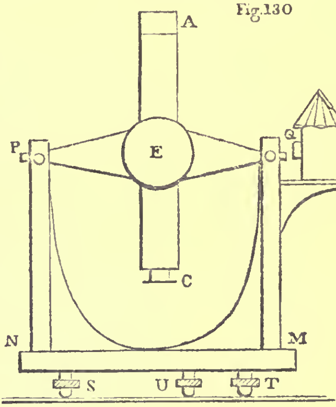


* We have represented S as an ordinary screw with a milled head; generally, instead of such a screw, there are two opposing screws, for the sake of greater steadiness, which are worked by a lever.

always a diagonal eye-piece—see former chapter. When we wish to use the telescope, we must slide in a suitable eye-piece, and move it in or out until the wires are seen distinctly, and sharply defined. We must then direct the telescope to a star, and if the star is also seen distinctly and well defined, the telescope is properly adjusted as far as the focus is concerned; if not, the wires in the focus must be moved in or out till the image of the star becomes well defined. If, on moving the eye a little to one side or the other of the eye-hole, the star appears to keep steadily on one of the wires, this shows that the focus is correctly adjusted.

394 *The Stand and Pillars.*—These are shown in fig. 130, where P N and Q M are the two pillars which support the Y's and pivots P and Q. A C is the telescope, N M is the base of the stand, which is generally circular, and, for greater steadiness, supported on three short legs S U and T, which have screws for shortening or lengthening them, in order to make the stand as nearly as possible horizontal, and therefore the pillars vertical. The pillars in large fixed instruments are made of stone, firmly imbedded in a hard foundation, but in small portable instruments they are of metal, firmly braced to the stand N M, so that they may not be capable of shaking or trembling.

Fig. 130

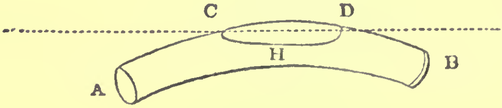


395 *Illumination of the Wires in the Focus.*—At night it is necessary to illuminate the wires, in order to make them visible. This is done by means of a lamp L, placed on a stand close to one of the pivots. The pivot is pierced, and the conical axis is hollow, so that the light from the lamp, passing through the hole in the pivot, enters the middle of the tube of the telescope at E. There is a plane reflector placed diagonally across the telescope tube at E, by which the light from the lamp is reflected down the tube to the focus, and in this manner the wires are illuminated. The reflector has a good-sized hole cut in the middle of it, so that it may not intercept any of the light which comes through the object-glass down the tube to the eye. The lamp has a moveable shade, by which the degree of illumination may be diminished, which is necessary when observing faint stars.

396 *Object of Mounting the Telescope in this manner.*—The object is, in the first place, to make the telescope move with great steadiness in a plane; this is effected by the long axis P Q; for it is evident that the longer the axis is, the less effect will imperfections in the pivots have in making the telescope move unevenly. In the second place, the bearings of the pivots are made moveable horizontally and vertically, by means of fine screws, as above described, in order to place the axis more accurately in any required position—as, for instance, in or perpendicular to the plane of the meridian; the stand is placed in the proper position at first, as nearly as can be judged, and then the further and complete adjustment of the axis is effected by the delicate motion of the screws.

397 *The Level.*—The transit instrument is always accompanied by a spirit level, for the purpose of making the axis perfectly horizontal. The construction and use of the level is as follows:—

Fig. 129



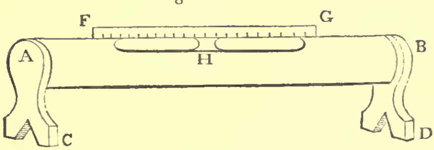
A B, fig. 129, is a glass tube, slightly curved, and almost, but not quite, filled with alcohol, so that a bubble C D is left in the tube. This bubble will, of course, always ascend to the highest part of the tube, in whatever position it may be held, and so will serve as a mark of the inclination of the tube; for if the inclination be altered, the highest part is not where it was before, and therefore the bubble will change its position, since it must always ascend to the highest part of the tube.

The curvature of the tube, as shown in the figure, is considerably exaggerated, for the purpose of showing the nature of the level; in practice, the curvature is so small that the tube appears quite straight to the eye. The smallness of the curvature makes the least change of inclination of the tube evident; for the more nearly straight the tube is, the more does the bubble move when the inclination of the tube is altered. The tube is not made quite straight, because, if it were so, the moment one extremity was elevated in the least degree above the other, the bubble would immediately move to the former extremity—in fact, the instrument would then be too sensitive, and would require the tube to be placed always in a horizontal position with a degree of exactness not attainable in practice. This is the reason why a slight curvature is given to the tube.

398 The line C D joining the extremities of the bubble will be always horizontal if the tube be of uniform bore and curvature, otherwise, in consequence of capillary attraction, this will not be the case. However, the horizontality of this line is not by any means essential, for the principle of the instrument consists in this, that any change in the inclination of the tube to the horizon will be immediately shown by the motion of the bubble.

399 Hence we have the following conclusion upon which it will be seen the use of the level depends—viz., that if the bubble does not move when we change the position of the tube, it follows that the inclination of the tube to the horizon has not been altered by the change of position.

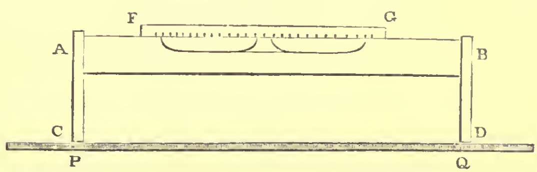
Fig. 128



400 The tube is fixed in a frame of brass A B, shown in fig. 128; the upper part of the frame is open so as to show the upper surface of the tube; on the top is a straight scale F G, marked with a number of equidistant vertical lines, the use of which is to enable the observer to note the position of the bubble with accuracy. The frame A B has two legs A C and B D of equal length, and cut at the bottom in the shape of inverted Y's, for the purpose of being placed upon the pivots of the transit instrument, the distance from C to D being the same as the distance between the two pivots, so that C may rest on one pivot, and D on the other.

401 From what has been above stated, it follows, that if we place the level with the legs C and D upon a rod or axis P Q, in the manner shown in fig. 133, and note the place of the bubble by looking at the scale F G; and

Fig. 133



this being done, if we change the position of the level by placing the leg C at the end Q, and D at P, and again note the place of the bubble; then, if the bubble is not in the same place as before, one of the extremities of the rod P Q must be higher than the other; but, if the place of the bubble is unchanged, the extremities must be exactly on the same level, and therefore the rod is horizontal. This is manifest: for, if one of the extremities, P or Q, be higher than the other, the above change in the position of the level evidently changes its inclination to the horizon, and therefore the bubble must move; but if one extremity of the rod is not higher than the other, then the change of position does not alter the inclination of the tube to the horizon, and therefore the bubble does not move.

II. *Examination and Adjustment of the Transit Instrument.*

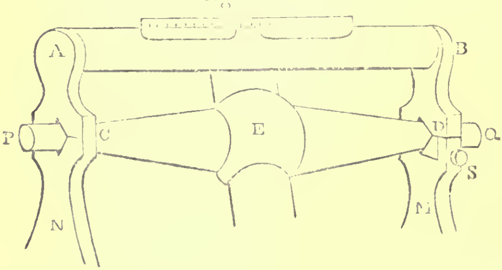
402 *Examination of the Transit.*—It is very important that an observer should be able to examine a new instrument he is about to purchase, to determine whether it is accurately constructed or not, and an instrument which has been for some time in use, to discover whether it has suffered any injury. The first thing to be looked to is the steadiness of the stand and pillars on which the instrument rests: they should be well braced together, and the three screws, or short legs on which the whole stands, should turn tightly, and be perfectly free from any tendency to shake. The Y's should be made with great care, and of hard material, and their motion should be smooth and steady.

The telescope should be strongly supported and well balanced, so as to rest at any inclination, and to be easily turned about the pivots. The wires in the focus should be seen sharply and distinctly defined when the telescope is pointed towards the edge of a tolerably bright distant object by daylight. Sometimes, owing to bad workmanship in the object-glass or eye-piece, and to the eye-hole being too large and too near the eye-glass, the wires appear to be doubled or trebled, and very indistinct, and no adjustment of the focus will make them appear sharp and single. This defect arises from Interference or Diffraction, and may sometimes be remedied by diminishing the eye-hole, which need not be larger than the pupil of the eye, and ought to be exactly in its proper place.

The wires should move perpendicula ly across the tube of the telescope when the screw which moves them is turned. If they continue to appear well defined when the screw is turned, their motion is correct.

403 *Examination of the Pivots.*—If the pivots are imperfect in any way, the instrument is good for very little. To test the pivots, place the level on them in the manner represented in fig. 127 (*bis*), and turn the telescope

Fig. 127



slowly and carefully round, watching the bubble all the time; then, if the bubble keeps steadily in the same position, we may be sure that the pivots are truly cylindrical, and have the same imaginary axis; at least, if there be any inequality in the shape of one pivot, there must be precisely the same in the other, and the two errors destroy each other. Of course the pivots ought to be cylindrical, and they may always be so made; but corresponding and exactly equal deviations from the cylindrical form in each pivot would not affect the performance of the transit instrument. That such equal imperfections should exist is, of course, a scarcely possible accident, and therefore we may conclude that, if the bubble does not move as the telescope is turned slowly round, the pivots must be cylindrical and *conaxial*, if we may use the word in imitation of 'concentric.'

404 But it is necessary also that the pivots should be of exactly the same size; the reason why will appear when we come to speak of the adjustments of the instrument. To examine this point, place the level as before, the leg C on the pivot P, and D upon Q, (see fig. 127, *bis*,) and note the position of the bubble; then raise the level off the pivots, and, taking up the telescope, carefully reverse the pivots, that is, place the pivot P on the Y upon which the pivot Q rested before, and Q on the Y upon which P rested before; P will then be on the side M, and Q on the side N. Having done this, put the level again on the pivots in the same position as before; that is, the leg C on the side N, and D on the side M, so that now the leg C will rest on the pivot Q, and D on P. Then note the position of the bubble, and if it remains exactly where it was before, and continues in that position when the telescope is turned slowly round, we may be sure that the pivots are of exactly equal size.

405 It might be easier to test the equality of the pivots otherwise, but the method just described is that most suitable with reference to the use of the equality of the pivots. In fact, it is necessary often to reverse the pivots, and it is on this account that their equality is a matter of importance; otherwise they might differ in size without causing any error in the performance of the instrument.

406 Hence the goodness of the pivots is completely tested by the following methods of examination, viz.:—

1. Place the level on the pivots, turn the telescope slowly round, and watch the bubble.

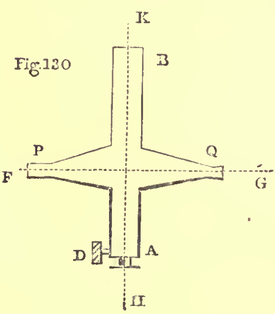
2. Reverse the pivots (but not the level) and note the bubble again as the telescope is turned slowly round.

If in both cases the bubble remains unmoved, and in exactly the same place after the reversion of the pivots as before, then we may place perfect reliance on the accuracy and equality of the pivots.

III. *Adjustments of the Transit Instrument.*

407 We have not space to say more respecting the examination of the transit instrument than what has been just stated. It is highly important for an observer to be able to examine an instrument, and determine whether it has any imperfections or errors which ought not to exist, and which he has neither the skill nor the means to correct. Such errors are those just alluded to, which it is the part of opticians and not the observer to correct, and which completely spoil the performance of the instrument. But there are other errors, which the observer and not the optician must get rid of, and which require repeated correction. These are usually called the *Adjustments* of the transit instrument.

Fig. 130



408 *Adjustment of the Line of Collimation.*—In fig. 130 (*bis*), A B is the telescope, P and Q the pivots, and F G the imaginary axis of the pivots; then, the pivots being supposed to be perfectly cylindrical and conaxial, it is manifest that the line F G remains unmoved when the telescope is turned about the pivots. Now H K, the line of collimation, ought to be

perpendicular to this line, in order that it may move accurately in the same plane; for, if it be not at right angles to H K, it will describe a conical and not a plane surface. It is necessary, therefore, to adjust the line of collimation so that it may be perpendicular to the imaginary axis F G about which it turns.

To do this we must remember that by turning the screw D, we move one extremity of the line of collimation; for the line of collimation is that line which is drawn from the point of intersection of the cross wires through the centre of the object-glass, and by turning the screw D we may move the cross wires either to the right or to the left at pleasure, and so place them in any required position. Hence we only require a method or test for determining whether H K is perpendicular to F G or not. The following simple method is the most accurate that can be employed:—

409 *Reversion a test of Perpendicularity.* — Suppose P Q and A C, fig. 131, to be two rods fixed together, not quite at right angles to each other, the extremity A of the rod A C being a little on the right of the true perpendicular R S. Let us now reverse the extremities P and Q—that is, let us take up the rods and turn them over, so as to place P where Q was before, and Q where P was before; which, being done, it is clear that the rod A C will now lie in the position A′ C′, the extremity A′ being as much to the left of the true perpendicular R S as A was to the right of it. Thus P Q A C represent the rods in one position, and P′ Q′ A′ C′ in the reversed position, the line R S, which is perpendicular to P Q, being exactly half-way between A C and A′ C′.

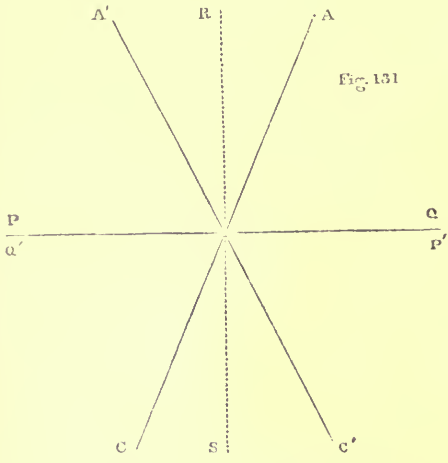


Fig. 131

Hence this reversion is a test by which we can determine practically whether A C is perpendicular to P Q or not. If A C is not perpendicular to P Q, as above supposed, the reversion of P and Q will cause the rod A C to lie in a different position to that in which it lay before; that is, after the reversion the extremity A of A C will fall as much to the left of the true perpendicular as it was to the right before, or *vice versa.* But if A C is perpendicular to P Q, then the reversion will produce no change in the position of A C.

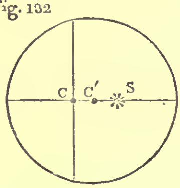
410 To apply this to the transit instrument, we have only to suppose P Q to be the imaginary axis of the pivots, and A C the line of collimation; then, if we take up the telescope and put it down again, reversing the pivots, we shall not alter the position of the line P Q, because the pivots are of exactly equal size, (and here the importance of the equality of the pivots is manifest;) in other words, after the reversion the imaginary axis of the pivots will lie exactly in the same line as before. Hence, if the line of collimation points in exactly the same direction after the reversion as before, it must be at right angles to the imaginary axis; but if this is not the case, the two lines are not perpendicular to each other.

411 Hence we derive the following method of adjusting the line of collimation so as to make it perpendicular to the imaginary axis about which it turns.

Point the telescope to some distant object, say a star, and suppose that the star is seen at the centre of the cross wires: take up the instrument off the

Y's, and put it down again carefully, with the pivots reversed, and point it at the star again; then, if the star appears again at the centre of the cross wires, the line of collimation is perpendicular to the axis; but if the star is seen either on the right or left of the centre of the wires, the line of collimation is not perpendicular to the axis.

Fig. 132



To adjust the line of collimation, let C, fig. 132, be the centre of the wires, and S the star, seen, after the reversion, to the right of C; then, by turning the screw D, (fig. 130, *bis,*) move the centre of the cross wires to the right until it comes to the point C′, which is half-way between C and S. This being done, the line of collimation becomes perpendicular to the axis. The reason why we move the centre of the cross wires half-way towards the star, is because the point S, which marks where C was before the reversion, falls as much to the right of the true perpendicular as C, after the reversion, does to the left.

412 If the screw D has a graduated head, we may move C half-way towards S with accuracy; but if not, the eye must judge as well as it can the half-way point C′. To test whether the centre of the cross wires has been moved into the proper position exactly, reverse the pivots again, and if no change takes place in the position of the star, the position of the wires is correct. Otherwise the adjustment must be made again. A few trials will answer to make the adjustment of the line of collimation complete.

In each case, before the reversion, the star should be brought to the centre of the wires; this is easily done by turning the telescope till the star comes on the horizontal wire, and then turning the screw of the horizontal Y, until the star (which will appear to move along the horizontal wire as the screw of the Y is turned) comes to the centre of the wires.

The star made use of for this adjustment should be the pole star; the apparent diurnal motion of any other star, while the pivots are being reversed, would give rise to some error, but the motion of the pole star is too slow to be perceptible in so short a time. A distant mark on some building is what is generally employed for this adjustment in large fixed instruments; but it may not be easy for a traveller to find such a mark when required, inasmuch as it must be a well-defined point at a considerable distance from the observer.

413 *Adjustment of the Axis of the Transit Instrument by the Level.*— The next thing to be done is to make the imaginary axis of the pivots perfectly horizontal by means of the level, so that the plane in which the line of collimation moves may be a vertical plane.

Before making this adjustment, the instrument should be placed, as nearly as it is possible to judge, in its proper position, either in the meridian or in the prime vertical, as the occasion may require. To place the instrument nearly in the meridian, point the telescope towards the Pole star, or rather about a degree and a half on one side of the Pole star, towards the middle of the Septemtriones, at the same time keeping the bubble as near the middle of the level as possible. If this be done, the instrument will not be much out of the meridian; at least it will be sufficiently near the meridian plane to enable the observer to place it accurately in that plane by a further adjustment, which we shall soon explain.

414 Another point to be attended to before making the adjustment of the axis with the level, is to examine the motion of the horizontal Y when its screw is turned, in order to secure the perfect horizontality of that motion. If this be not done before adjusting the axis, then any motion of the horizontal Y which may be afterwards necessary, will derange the adjustment of the axis. To make the motion of the horizontal Y perfectly horizontal, we must give its screw a few turns, and note the effect produced on the bubble of the level. If the bubble remains stationary, we may be sure the horizontal Y

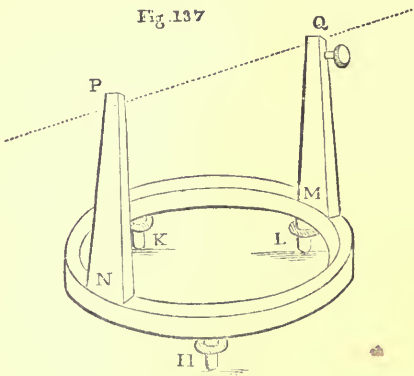
moves truly horizontally; but if the bubble moves, this is not the case. If the motion of the Y is not found correct in this way, we have only to turn one of the foot screws or short legs on which the stand is supported, until the bubble ceases to move, when the screw of the horizontal Y is turned.

415 These points being attended to, we may proceed to adjust the axis by the level as follows:—

Place the level with its legs C and D resting upon the pivots P and Q, and note the place of the bubble; afterwards take up the level, reverse it, and put it down again, so that C may rest on Q, and P on D, and note the place of the bubble again. Then, if the bubble has not altered its position, we may be sure that the imaginary axis of the pivots is perfectly horizontal; but if the bubble has moved, turn the screw of the vertical Y till the bubble moves half way towards its original position. It will then be found, on reversing the level again, that the bubble does not move, and therefore that the axis is horizontal. If, however, the bubble should move a little after the second reversion, (which may happen if the adjustment is not carefully made,) it will be necessary to move the bubble, by turning the screw of the vertical Y half way towards its position after the first reversion. A few trials will soon make the axis quite horizontal, which will be made manifest by the position of the bubble not being affected by the reversion of the level.

416 We have here described the adjustment of level, as being made by moving the vertical Y. In most portable instruments, however, the vertical Y is immovable, and the adjustment of the axis is made by turning the foot screw or short leg which is under the horizontal Y. The stand on which the two pillars are supported is often circular, as is shown in fig. 137, where N P M Q are the two pillars; P Q the axis of the pivots, the horizontal Y being at Q; H, K, L the three foot screws, one of which, L, is immediately under Q, and the other two, K and H, equidistant from L. By turning L, it is evident we raise or depress Q, and so we may make the line P Q horizontal. The previous adjustment, above described, by which the motion of the horizontal Y is made truly horizontal, is effected by turning either of the screws H or K. The subsequent turning of L will not derange this adjustment, if H and K be equidistant from L, and N exactly opposite M.

Fig. 137



417 *Adjustment of the Vertical Wire.*—It is important that the vertical wire in the focus of the telescope should be truly vertical, for then it will show, through its whole length, the vertical plane in which the centre of the wires moves when the telescope is turned about its pivots, or rather, the vertical plane described by the line of collimation: so that, if a star be seen on any part of the vertical wire, we may be sure that it is in the plane described by the line of collimation, without having to turn the telescope, so as to bring the star exactly to the centre of the cross wires. This will often save trouble; and indeed it is essential in nice observations not to be obliged always to bring the centre of the cross wires to bear upon any star we may be observing, but simply to allow the star to move across the field of view, and meet the vertical wire wherever it may happen to do so, whether at the centre, or above it, or below it. It is, however, better to point the telescope so that

the star may move across the central part of the field of view; for the vision is not always distinct near the extreme parts of the field of view.

To determine whether the vertical wire is truly vertical or not, we have only to bring a star upon it, and gently turn the telescope, the axis having been made truly horizontal by the previous adjustment; then if the star appears to run along the wire, the wire is truly vertical; but if the turning of the telescope makes the star appear to move off the wire, then the wire is not truly vertical.

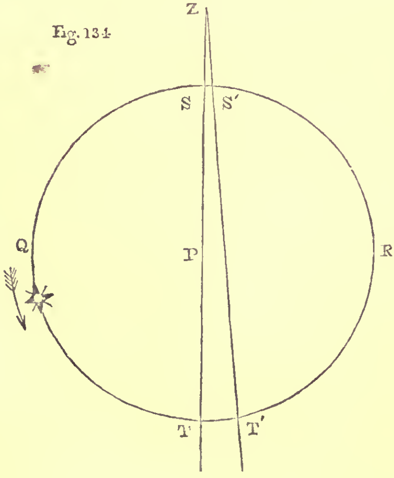
If the wire be found, on examination after this manner, to be out of the vertical, the wires must be turned round a little by means of a screw, which is generally accessible to the observer; but sometimes it is not, or there is no screw, and then this adjustment must be left to the instrument maker.

418 *Meridian Adjustment of the Transit Instrument.*—Having placed the instrument with its axis perfectly horizontal, and the telescope moving nearly in the plane of the meridian, and having made the motion of the horizontal Y truly horizontal, one more adjustment is required, in order to place the instrument exactly in the meridian—that is, so to place it, that the line of collimation may move truly in the meridian plane. This may be effected, without deranging the previous adjustment of the axis, by simply turning the screw of the horizontal Y. It remains, therefore, to explain the test by which it may be known whether the line of collimation moves in the vertical plane or not.

419 *Superior and Inferior Transits of a Circumpolar Star test the Meridian Adjustment.*—Let us consider the circumpolar motion of any particular star not far from the pole, as, for instance, *α* Ursæ Majoris. This star describes a circle about the pole in twenty-four hours, and never sets; it will therefore cross the meridian twice every twenty-four hours, once below the pole, and once above the pole. The star's transit across the meridian below the pole is called its *inferior* transit, and that above the pole its *superior* transit. The interval of time between the superior and inferior transits of every star is exactly twelve hours, sidereal time.

Hence we have an accurate test by which to determine whether the line of collimation moves in the meridian plane or not; for if it does, the interval between the two appearances of the star on the vertical wire will be exactly twelve hours sidereal time; but if it does not, the interval will be either greater or less than twelve hours. All that we have to do, therefore, is to watch *α* Ursæ Majoris, or any other circumpolar star, when it is below the pole, and note the exact time when it crosses the vertical wire; and in about twelve hours, when it will be above the pole, watch it again, and note the exact time of its coming on the vertical wire: then if the interval between the two times is exactly twelve sidereal hours, the line of collimation moves in the meridian plane; otherwise it does not.

Fig. 134.



420 To explain this important point more completely, let P (fig. 134) be the pole, Z the zenith, Q S S′ R T′ T the circle which the star describes about the pole, S being the place of the superior transit, and T that of the inferior. Also suppose that the line of collimation does not move exactly in the meridian plane, and that Z S′ T′ is the portion of the great circle

it describes on the celestial sphere, which circle of course passes through the zenith Z, since the plane in which the line of collimation moves is made truly vertic.l by the adjustment of the axis of the transit instrument.

Now, when the star is at S′ it will be seen on the vertical wire, if the telescope be pointed towards it; and again, when it comes to T′, it will also appear on the vertical wire, the telescope, of course, being sufficiently lowered, that the star may be seen again in the field of view. The interval of time between these two appearances on the wire will be the time the star takes to move over the space S′ S Q T T′. Now the time the star takes to describe the space S Q T is twelve hours exactly; therefore the interval between the two appearances of the star on the vertical wire will be a little greater than twelve hours, the excess being the time the star takes to move from S′ to S, together with that from T to T′.

Hence it is manifest that if the line of collimation move eastward of the pole, as is represented in the figure, the time reckoned from the superior to the inferior transit across the vertical wire will exceed twelve hours; and *vice versa*, if the line of collimation move westward of the meridian, the same interval of time will fall short of twelve hours.

421 To find out the angle of deviation S Z S′ of the plane in which the line of collimation moves, mathematicians give a formula by which it can be computed from the observed interval between the two transits across the vertical wire; but this formula requires both the latitude of the place and the declination of the star to be known. We shall give here a different method, which has the advantage of being easily understood, and requires neither the latitude nor the declination of the star to be known.

To apply this method it is necessary that the screw of the horizontal Y should be very accurately made, in fact, that it should be a fine micrometer screw, and have a graduated head, such as we have already described. There would be practical difficulties in making a screw of this kind work correctly; but a micrometer screw, to move the wires of the focus, which is often added to 'transit instruments, would answer the same purpose. It is easier, in explanation, to consider that the Y is moved.

IV. *Method of finding the True Time of Transit of a Star across the Meridian with a Transit Instrument not exactly in the Meridian Plane.*

422 *Of the Clock, or Chronometer.*—We must say a word respecting the instrument for measuring time, which must always accompany the transit instrument. When the observer never has to move from place to place, the clock will be the proper instrument to use for measuring time; otherwise, as a clock is not portable, he must employ a chronometer, which is a large watch of peculiar and very accurate construction. The chief thing to be noticed respecting the chronometer is, that it has a peculiar scapement, which gives a distinctly audible and sharp tick. It is by listening to this tick that the observer counts time; for he cannot look at the hand of the chronometer at the same time that he is looking through the telescope, and therefore he must use his ear for observing time. The seconds hand of the chronometer is the large hand, and not the minute hand. as in a common watch. The seconds hand does not move like that of a watch, but drops from one second mark to another on the dial plate in a remarkably steady and regular manner, making a sharp tick each time. The chronometer, we shall suppose, is regulated exactly to sidereal time.

423 *To determine the effect of turning the Screw of the Horizontal Y.*—Suppose the telescope to be pointed at any particular star, S, fig. 134 (*bis*), and that by turning the screw of the horizontal Y the vertical wire A B is made to *bisect* the star, that is, to pass exactly through the centre of the image of the star, so that half that image may appear on one side of the wire, and

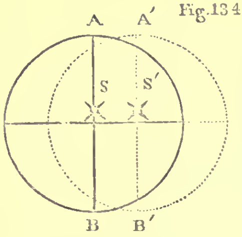


Fig. 134

half on the other. Then, in consequence of the diurnal motion of the heavens, the star will move, but by turning the screw of the horizontal Y, we may make the vertical wire always to follow the star, so that, when the star has moved to S′, the vertical wire shall move to the position A′ B′, and still bisect the star. It will require some practice to be able to turn the screws so as to keep the wire always bisecting the star; also the screw must be accurately made, and the motion easy and smooth: but very soon an observer will acquire the power of doing this with the greatest ease, in fact quite mechanically and habitually.

Now this being the case, listen attentively to the ticking of the chronometer, keeping the vertical wire upon the star by turning the screw of the Y, and just at a tick cease turning the screw and let the star move off the wire; then look at the graduated head of the screw, and note the graduation shown by its index. Having done this, look again at the star, which of course will now have moved some way from the wire, and turn the screw till the wire comes up to the star; then, just at a tick, cease turning the screw, look at the graduated head, and note the graduation shown by the index.

During these operations the ticks of the chronometer must be carefully counted, so as to observe by the ear the number of seconds that elapse between the two ticks at which the motion of the screw was stopped.

424 Now suppose that A B, fig. 134 (*bis*), is the place of the vertical wire at the instant (or tick) when the motion of the screw ceases the first time, and A′ B′ its place the second time; and suppose also that the number of seconds counted while the star was moving from S to S′ is ten, and that the number of turns of the screw of the Y which produced that motion is two, then it is evident that since two turns of the screw correspond to ten seconds of time, one turn corresponds to five seconds; that is, one turn of the screw moves the wire over a space which the star takes five seconds to describe, so that if the star be on the wire at any instant, and one forward turn be given to the screw of the Y, it will be five seconds before the star comes on the wire again.

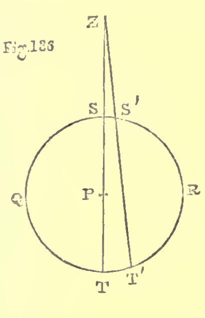
In general, divide the number of seconds counted by the corresponding number of turns of the screw, and that will give the number of seconds corresponding to one turn of the screw, and so determine the effect of turning the screw.

425 It will be found that the number of seconds corresponding to one turn of the screw of the Y will be greater at the inferior than at the superior transit. The reason of this is manifest from fig. 136; for, supposing that one turn of the screw moves the circle of collimation* from Z T to Z T′, T T′ is greater than S S′, and therefore it will take a longer time for the star to perform the former distance.

426 *To find the exact Time of Transit across the Vertical Wire in any position.*—Let Z S P T, fig. 136, be the meridian, Z the zenith, P the pole, S′ S Q T T′ R the circumpolar course of the star, Z S′ T′ the vertical circle described by the line of collimation, which is not supposed to move exactly in the meridian.

A little before the star comes to S′, that is, a little

Fig. 135



* That is, the circle which the line of collimation describes on the celestial sphere as the telescope is turned about its axis.

before it comes on the vertical wire at its superior transit, look at the chronometer, and note the hour, minute, and second; note also the graduation of the screw of the Y, shewn by its index. Then, counting the seconds or ticks carefully, watch the star, and by turning the screw, bring the wire upon the star just at a tick of the chronometer; note the graduation of the screw, (as described in Art. 424,) bring the wire again on the star, and again note the graduation of the screw, counting the ticks all the time. Suppose the results of these observations to be as follows:—

(1)	Graduation of screw before it is moved		0
(2)	When the wire is brought upon the star the first time . . .	Time noted	$1^h\ 2^m\ 3^s$
		Graduation of screw shows	$1\frac{1}{4}$ turns.
(3)	Ditto, ditto, the second time .	Time noted	$1^h\ 2^m\ 7^s$
		Graduation of screw shows	$3\frac{1}{4}$ turns.

Then from (2) and (3) it follows, as we have explained in Article 424, that one turn of the screw corresponds to 2^s: therefore, if we suppose $3\frac{1}{4}$ turns to be given to the screw backwards, which will put the line of collimation where it was orignally (that is, at S′), this will correspond to $6\frac{1}{2}^s$; in other words, the star was at S′ $6\frac{1}{2}^s$ before the time (3), and therefore the exact time of the star's crossing the vertical wire in its original position was $1^h\ 2^m\ \frac{1}{2}^s$.

In this manner the exact time of a star's crossing the vertical wire, in whatever position it is placed, may be easily found. The rule in general is as follows:—

Supposing the graduation of the screw originally to be 0 (any other number will do as well), subtract the time (3) from the time (2), and the number of turns (3) from the number of turns (2), divide the former difference by the latter, multiply the quotient by the number of turns (3), and subtract the result from the time (3): then the time so obtained will be the exact time when the star crossed the vertical wire in its original position (1).

427 The above method, or something equivalent, is absolutely necessary for accuracy, because it may happen, and generally happens, that the star crosses the wire between two ticks. Astronomers always guess the instant, or fraction of a second, between the two ticks, when the star is on the wire, and to attain greater accuracy they have three, five, or seven wires in the focus, equidistant from each other (see fig. 127). They judge, as well as they can, how far the star is from each wire at the tick just before it crosses it, so determine the time of transit across each wire, and, by taking an average, the time of transit across the middle wire.

428 *To find the exact Time of a Star's Transit across the Meridian.*—Referring to the same figure and letters as in Art. 426, and supposing everything the same as in that article, find the exact time of the star's being at S′, by the method just explained: find also, in the same way, the exact time of the star's being at T′, by making the observations at the inferior transit, and suppose that one turn of the screw corresponds to 2^s at S′, and to 3^s at T′. Furthermore, let the time of the star being at S′ be $1^h\ 2^m\ \frac{1}{2}^s$, and the time of its being at T′, $13^h\ 2^m\ 10\frac{1}{2}^s$. Then it follows, that the time the star takes to move from S′ to T′ is $12^h\ 0^m\ 10^s$, and therefore, since the time from S to T is 12^h exactly, the two times, from S′ to S and from T to T′, must together be 10^s. But since one turn of the screw of the horizontal Y at S′ corresponds to 2^s, and at T′ to 3^s, the spaces S S′ and T T′ must be in the proportion of two to three, and therefore the whole time of describing these spaces being 10^s, it follows, that S S′ is described in 4^s, and T T′ is 6^s. Now the time of the star's being at S′ is $1^h\ 2^m\ \frac{1}{2}^s$; therefore the star will be at S in 6^s more, that is, at the time $1^h\ 2^m\ 6\frac{1}{2}^s$. It appears therefore that the exact time of the star's crossing the meridian at S is $1^h\ 2^m\ 6\frac{1}{2}^s$.

429 In general, to find the time of the star's being at S, we must find the times of its being at S′ and T′, by the method above explained, and thence the time it takes to move from S′ to T′. The excess of this time over 12^h

is the time the star takes to describe the two spaces S′ S and T T′, and these two spaces are described in times proportional respectively to the times corresponding to one turn of the screw at S′ and T′. Hence, if we assume t to represent the excess over 12^h of the time of moving from S′ to T′, and a and b to represent respectively the times corresponding to one turn of the screw at S′ and T′, we have the following proportion—

$a+b : t :: a :$ the time of moving from S′ to S.

From this proportion the time of moving from S′ to S being found, and being added to the time of the star's being at S′, the result will give the exact time of the star's crossing the meridian at S.

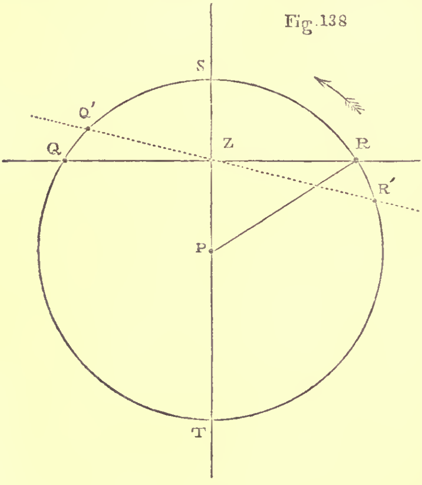
V. *Method of observing Transits across the Prime Vertical.*

430 One of the best methods of finding the latitude of a place consists in observing the transit of a known star across the Prime Vertical; we shall therefore explain how such a transit may be observed.

431 *Method of placing the Transit Instrument nearly in the Prime Vertical Plane.*—First place the instrument as nearly as can be judged in the meridian plane, in the manner already explained, and fix a common magnetic needle or mariner's compass on some convenient part of the stand, so that the needle may move freely in a horizontal plane.* Furthermore suppose, for the sake of simpler explanation, that the needle is made to point to the North point of the compass. Having done this, lift up the whole instrument and turn it round till the needle points to the East or West point of the compass, and put it down again carefully, so that the needle may continue to point in either of these directions. The instrument will then be placed nearly in the prime vertical plane.

For it is obvious that the plane of collimation is now at right angles to its original position, in which it was nearly coincident with the meridian plane, and therefore, since the prime vertical is perpendicular to the meridian, the plane of collimation is now nearly coincident with the prime vertical plane.

Fig. 138



432 When the instrument has been thus placed, the level should be applied, in the manner already explained, in order to make the axis perfectly horizontal. When this is done, the line of collimation will describe a vertical plane nearly coincident with the prime vertical.

433 *To determine, by means of the instrument thus placed, the exact time of Transit of a Star across the Prime Vertical.*—Let P, fig. 138, be the Pole, Z the Zenith, S Z P T the Meridian, Q Z R the Prime Vertical, which is at right angles to the Meridian, and Q′ Z R′ the circle of collimation—that is, the circle which the line of collimation describes on the celestial sphere. Observe the lines S T Q R and Q′ R′ represent circles of the sphere which appear to be projected as straight lines on a horizontal plane to an eye looking vertically upwards on the sphere.

* It will be advisable, in purchasing a transit instrument, to order a magnetic compass to be fitted to it on some convenient part of the stand.

The circle of collimation Q′ Z R′ is supposed to deviate a little from the prime vertical Q Z R, but the amount of deviation is unknown. We can observe, in the manner already explained, the exact time when the star crosses the circle of collimation, that is, supposing S Q T R to represent the circular course of the star round the Pole, we can observe the exact times of the star's being at R′ and Q′. We suppose the star to cross the prime vertical twice, (which it will do, if it crosses the meridian beyond the zenith at its superior transit S,) once on the east of the meridian, and once on the west.

434 We must observe, before proceeding, that the time of the star's transit across the meridian at Q′, is supposed to be known, either by actual observation (as above explained), or from the star's known right ascension. If it be the same star as that by which we have determined the meridian (as above explained), of course its time of transit at S is known by observation; if not, the right ascensions of both stars must be found from the Ephemeris, or Nautical Almanack, and the difference taken, and this will determine the time that elapses between the transits of the two stars, and therefore the time of transit now required.

For example, suppose that the superior transit of the star (call it a) by which the meridian was determined was observed to take place at $1^h\ 4^m\ 10^s$, and that the right ascension of another star (call it β) exceeds that of a by $4^h\ 2^m\ 3^s$; then β will cross the meridian $4^h\ 2^m\ 3^s$ after a, and therefore the time of transit of β will be the sum of—

	$1^h\ 4^m\ 10^s$
and	$4^h\ 2^m\ \ 3^s$
that is,	$5^h\ 6^m\ 13^s$

CHAPTER VIII.

THE GEOGRAPHICAL USES OF THE TRANSIT INSTRUMENT.

HAVING explained fully the construction of, and method of observing with the Transit Instrument, it will not require many pages to show how it may be used for geographical purposes.

The chief things which a traveller has to determine at any place, by means of astronomical observations, are as follows:—

The Position of the Meridian.
The Latitude.
The Longitude.

We shall now explain, in order, how these three things are to be determined.

I. *Determination of the Position of the Meridian.*

438 To determine the meridian, we have only to determine, by the method explained in the preceding chapter, the exact time when any particular star crosses the meridian; and, knowing this, we may, by turning the screw of the horizontal Y, bring the line of collimation into the meridian plane, with great accuracy, as an example will best show:—

Suppose that any particular star is observed to cross the wire at the time $6^h\ 12^m\ 17^s$, and that it is calculated, by the method explained in the previous chapter, that the star crosses the meridian exactly at the time $6^h\ 12^m\ 23^s$; also, suppose that one turn of the screw corresponds to 3^s. Then it follows, that the star takes 6^s to move from the wire to the meridian, and, consequently, that two turns of the screw will bring the wire up to the meridian. We have only, therefore, to give the screw two turns, and we shall so bring the line of collimation exactly into the meridian plane. Since the star crosses the meridian after the wire, the screw must be turned so as to make the wire move the same way that the star does—that is, westward at a superior transit, and eastward at an inferior.

In general, to bring the line of collimation exactly into the meridian plane, we must divide the time the star takes to move from the wire to the meridian, by the time corresponding to one turn of the screw, and the result will show how much we must turn the screw in order to bring the wire into the meridian.

439 Having thus ascertained the precise position of the meridian, some mark, as distant as possible, is generally chosen to indicate either the north or the south point of the horizon. This mark is called the *Meridian Mark.* Its use is—to enable the observer to place his transit instrument in the meridian plane on any future occasion, without having to make fresh astronomical observations; it also serves to determine whether the instrument has been in any way displaced or disturbed, by accident or otherwise.

This mark should be, if possible, some small, well-defined object, such, for instance, as the point of a church spire, or the top of a pole fixed in the ground; or it may be the vertical edge or extremity of some object, such as a chimney or house. It is not possible, of course, to get a mark of this kind exactly in the meridian, nor is it necessary to do so; it will be sufficient if the mark is near the meridian,—that is, within a few turns of the screw, or, to speak more definitely, so near, that a few turns of the horizontal screw may be sufficient to make the vertical wire move from the mark to the meridian. Of course the exact number of turns of the screw, by which the wire is moved from the mark to the meridian, must be noted, in order that we may be able to place the instrument in the meridian, which is done by first making the wire coincide with the mark, and then giving the screw the proper number of turns to bring the wire into the meridian. If the mark be a small round or narrow vertical object, the wire may be considered to coincide with it when it appears to be bisected by the wire.

440 It is important for several reasons not to trust entirely to a meridian mark, and therefore observations should always be made to determine whether the instrument is exactly in the plane of the meridian or not. The use of a meridian mark, geographically, is to define the north or south points of the compass in any particular locality.

II. *Determination of the Latitude.*

441 A very exact and simple method of finding the latitude of any place by observation is by means of transits across the prime vertical, as proposed by Bessel, and adopted with great success in the Russian surveys. We have already shown how the transit instrument is to be placed in the prime vertical, and it is only necessary to explain the method of finding the latitude by the use of the transit instrument thus placed. The great advantage of this method is, that it requires no corrections for refraction and parallax, which are sources of error in other methods of finding the latitude.

442 *Method of finding the Latitude of a place by observing Transits across the Prime Vertical.*—Let P, fig. 138, represent the Pole; S Q′ Q T R′ R the circumpolar circle, which any star describes in twenty-four hours; Z the zenith; S Z P T a portion of the meridian; Q Z R a portion of the prime vertical, which is, it will be remembered, at right angles to the meridian.

Let the transit instrument be placed as nearly as possible in the prime vertical, that is, let it be placed in such a manner that the line of collimation of the telescope may describe a plane very nearly coincident with the prime vertical plane. This may be done by means of a magnetic compass fixed on the stand of the instrument. The instrument is first to be placed as nearly as possible in the meridian, as above explained, and then the whole is to be lifted up, turned round till the magnetic needle moves through 90°, and then set down again.

443 Sometimes the instrument has an azimuthal motion, that is, it is capable of being turned round a vertical pillar or axis; and it has a graduated horizontal circle. In this case, after having placed the instrument as nearly as possible in the meridian, we have only to turn it round the vertical axis through 90°, by means of the graduated horizontal circle; and, this being done, the instrument is placed nearly in the prime vertical.

444 When the instrument is thus placed, the axis of the telescope must be carefully levelled, as above explained, otherwise the observations made will be erroneous. It is very important, in all observations with the transit instrument, to attend particularly to the horizontal adjustment of the axis of the telescope.

445 Supposing, then, that the instrument is placed as nearly as possible in the prime vertical, let R′ Z Q′ represent a portion of the vertical circle, which the line of collimation describes on the celestial sphere when the telescope is turned round its axis. This circle passes through the zenith Z, because, the axis being properly levelled, the line of collimation describes a vertical plane; also, this circle, as we have supposed, is nearly coincident with the prime vertical Q Z R.

Now, the star which is supposed to describe the circle S Q T R will be seen crossing the vertical wire when it arrives at R′, and afterwards at Q′. In the former case the telescope is pointing eastward, in the latter westward. Let the exact time of the star's being at R′ be observed, according to the method already explained with reference to transits across the meridian;

also, let the exact time of the star's arriving at Q′ be observed in the same manner. Furthermore, the exact times when the star crosses the meridian, at its superior and inferior transits at S and T, must be determined by observation, or by calculation, as we have explained. Then the exact time of the star's crossing the prime vertical at R or Q may be immediately determined, as an example will best show.

446 *Example.*—Let the observed times when the star arrives at T R′ S and Q′ be as follows:—

At T	1^h	10^m	3^s
At R′	10^h	3^m	2^s
At S	13^h	10^m	3^s
At Q′	16^h	17^m	0^s

Then the interval of time from the star's being at R′ to its being at S is—

$$3^h \quad 7^m \quad 1^s$$

and the interval from S to Q′, is—

$$3^h \quad 6^m \quad 57^s$$

Now, the time the star takes to move from R′ to R may be considered as equal to that from Q′ to Q; for, inasmuch as the circles R Q and R′ Q′ are very nearly coincident, the spaces R′ R and Q′ Q differ only insensibly from each other. Therefore, since the interval from R to S is the same as the interval from S to Q, S being evidently mid-way between R and Q, it follows that the interval from R′ to R, and that from Q′ to Q, must be each 2^s, and the interval from R to S, and that from S to Q, must be each—

$$3^h \quad 6^m \quad 59^s$$

for then the intervals from R′ to S and from S to Q′ will be respectively—

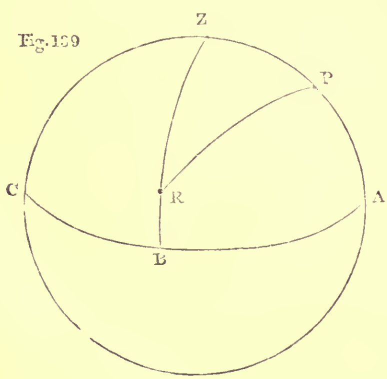
$$3^h \quad 7^m \quad 1^s \quad \text{and} \quad 3^h \quad 6^m \quad 57^s$$

as they ought to be.

447 In general, the interval of time the star occupies in moving from R to S will be half the sum of the two intervals from R′ to S and from S to Q′; for it is manifest that the interval from R′ to S exceeds, and that from S to Q′ falls short of, the interval from R to S, by the same quantity, so that twice the latter interval will be equal to the sum of the two former intervals.

448 Thus the time the star takes to move from R to S may be easily determined by observation; and this also determines the angle Z P R (P R representing a portion of the polar circle, or circle of declination, drawn from the pole to the star), for, as the time of the star's moving from R to S is to 24^h, so is the angle Z P R to 360°.

Fig. 139



Thus, in the case of the example just given—

$$24^h : 3^h\, 6^m\, 59^s :: 360° : \text{angle } ZPR,$$

when the angle Z P R may be determined by the Rule of Three.

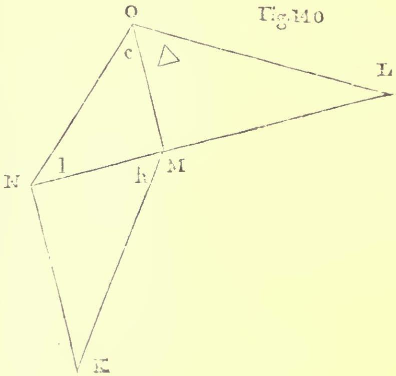
449 We are now prepared to show how the latitude may be found. Let A P Z C (fig. 139) represent the meridian; Z R B a portion of the prime vertical; Z the zenith; R the star crossing the prime vertical in the triangle Z P R in the present figure, the same as the triangle Z P R in fig. 138, only

represented in a different projection or view. Then Z P R is a spherical triangle in which we know three things; namely, the side P R, the angle Z P R, and the angle P Z R. The side P R is known, because the star R is supposed some known star, whose distance from the pole P is given in the Ephemeris, or Nautical Almanack. The angle Z P R is determined, as above explained, and the angle P Z R is a right angle, because the prime vertical Z R is perpendicular to the meridian Z P.

Hence, three things being known in the spherical triangle Z P R, we may find the remaining parts of the triangle; namely, the angle Z R P, the side Z R, and the side Z P, either by mathematical calculation, or by the method of construction we have given in a former chapter. Now Z P is the complement of the latitude, being the distance of the zenith from the pole; for the latitude is the distance of the place of observation—in degrees, minutes, and seconds—from the terrestrial equator, or, what is the same thing, the distance of the zenith from the celestial equator.

It appears, therefore, that the latitude may be found from the spherical triangle Z P R, by determining by observation the angle Z P R, as above explained.

450 The following is the construction for finding Z P. Let us take the letters *l*, *c*, Δ, *h*, to represent respectively the latitude, the colatitude Z P, the polar distance P R of the star, and the hour angle Z P R. Then the relation between these quantities is represented by construction in fig. 140, where the line O M is perpendicular to the line N L; N K also perpendicular to N L; and M K equal to M L. The angle N M K is *h*; N O M, *c*; L O M, Δ; and O N M, being the complement of N O M, is *l*. That this is the proper construction for representing the relation between *c*, Δ, and *h*, will be seen immediately by referring to the article where the construction for exhibiting the parts of a right angled spherical triangle is given.



Hence, to find the latitude *l*, Δ, and *h*, the polar distance and hour angle being known, as we have stated, we proceed as follows:—

Draw two lines, O L. O M, fig. 140, making the angle M O L equal to the known polar distance Δ of the star; and, taking O L of any convenient length, draw L M perpendicular to O M; draw M K equal to M L, making the angle N M K (M N being the production of the line M L) equal to the hour angle *h*, which has been determined from observation; then draw K N perpendicular to M N, and join N O, and measure the angle O N M, and the angle thus measured will be the latitude required.

451 We may here observe that the time of the star's transit across the meridian need not be observed, provided we know the time of transit of any other star, (as, for example, the star made use of in determining the position of the meridian,) and the right ascensions of both stars. For the difference between the two right ascensions will be the interval between the transits of the two stars across the meridian; and therefore, if the time of transit of one star is known, that of the other may be immediately determined.

III. *Determination of the Longitude.*

452 *Connexion between the Longitude of a Place and the Time.*—When it is 12 o'clock at London, it is 1 at a place 15° of longitude east of London; for, since the Sun describes the whole 360° of longitude in 24 hours, that is, at the rate of 15° per hour, he comes on the meridian of London an hour later than on the meridian of a place 15° east of London, and therefore the time at that place will be an hour in advance of that at London. In like manner, the time at a place whose longitude is 15° west of London, is one hour behind the time in London. And in general, if we consider the meridian of London to be the First Meridian, reckoning longitudes from it, the difference between the time at any place and that at London will be found by converting the longitude of the place into time at the rate of 15° per hour, the time at the place being in advance or behind that at London, according as the longitude is east or west.

453 *Method of finding the Longitude of any Place.*—Hence, in order to find the longitude of any place, we have only to determine how much the time at that place is in advance or behind the time at London, and convert the difference into degrees at the rate of 15° per hour. For example, if the time at a place be $3^h\ 6^m$ behind London time, what is the longitude of the place? To determine this, we have the proportion:

$$1^h : 3^h\ 6^m :: 15° : \text{longitude required},$$

which, by the Rule of Three, gives for the required longitude,

$$46°\ 30'\ \text{west}.$$

Now, in order to determine how much the time at a place is in advance or behind the London time, we must determine two things—namely, the London time and the time at the place. How this is to be done we shall now briefly explain.

454 *Method of determining the Time at any Place.*—We have explained how time is measured by the Sun's apparent diurnal motion, corrected by the equation of time, in order to make the proper allowance for the inequalities in the Sun's motion. To determine the time at any place, that is, the mean solar time, we must determine the exact instant when the Sun crosses the meridian of that place, and make the proper correction for the equation of time, and then the time at the place will be determined.

For example, suppose that the observer has a chronometer and transit instrument, and that he obtains the following result by observation with them, and the equation of time from the Ephemeris:—

Time of the Sun's transit as shown by chronometer .	$2^h\ \ 4^m\ 18^s$
Equation of time, (Sun too slow)	$0^h\ \ 7^m\ 42^s$
Sum . . .	$2^h\ 12^m\ \ 0^s$

Hence the chronometer is $2^h\ 4^m\ 18^s$ faster than the time actually shown by the Sun; for it is 0 o'clock by the Sun when he is on the meridian; and the equation of time shows that the Sun is $7^m\ 42^s$ slow; therefore the chronometer is 2 hours and 12 minutes faster than the mean solar time at the place of observation, and thus that time is determined.

455 But putting back the hand of the chronometer 2 hours and 12 minutes, we may make it show the exact time of the place of observation; but this is never done, because it would spoil the chronometer to move the hand backwards or forwards as in a common watch. The error of the chronometer is noted, and this is quite sufficient; for instance, in the example just given it will be sufficient, instead of putting back the hand, to make a note that the chronometer is 2 hours 12 minutes fast at the place of observation.

456 Thus the time at any place may be determined by observing, with a

transit instrument and chronometer, the instant at which the Sun crosses the meridian. The same may be done by observing the instant when any known star crosses the meridian, and making the proper allowance for the difference of the Sun's right ascension and that of the star.

For example, suppose the star's transit to be observed, and the right ascensions of the Sun and star taken from the Ephemeris, or Nautical Almanack, as follows—

Sun's right ascension . . .	$4^h\ 12^m$	mean time.
Star's right ascension . . .	$6^h\ 16^m$	
Difference	$2^h\ 4^m$	

Therefore, when the star is on the meridian, the Sun is $2^h\ 4^m$ past the meridian; or, in other words, it is 4 minutes past 2 by the Sun.

Time of star's transit by chronometer .	$10^h\ 13^m$
Ditto by Sun	$2^h\ 4^m$
Difference	$8^h\ 11^m$
Equation of time (Sun too fast)	$0^h\ 10^m$
Sum . . .	$8^h\ 21^m$

The chronometer is $8^h\ 11^m$ faster than the time actually shown by the Sun; but the Sun is 10^m too fast; therefore the chronometer is in advance of the mean time at the place of observation by the quantity—

$$8^h\ 21^m$$

which, being noted, determines the mean time at the place of observation.

457 *Determination of the London Time.*—The simplest method of doing this is by means of good chronometers, set to London time, and transported with great care to the place of observation. Now, chronometers, however good, are always subject to some error in their rate of going; this error is determined as well as it can be, and is noted. Also, as we have already stated, the chronometer is not actually set to London time by moving the hand, but the error is simply noted. Thus, two kinds of error are noted, the error in London on a certain day and hour, and the gaining or losing rate of the chronometer; and, by making the proper allowance for these errors, the London time may be found from the chronometer at any place to which it has been transported.

For example, suppose the following case—

Error of chronometer in London at 12 o'clock, June 1 .	$0^h\ 2^m\ 3^s$ fast.
Gaining rate 1^s per day.	
Error from gaining rate at 12 o'clock, June 23 . . .	$0^h\ 0^m\ 23^s$,,
Whole error at 12 o'clock, June 23	$0^h\ 2^m\ 26^s$ fast.

So that, according to London time, the chronometer is $2^m\ 26^s$ too fast on the 23rd of June.

458 This presumes of course on the invariability of the gaining rate of the chronometer, for this calculation supposes that the chronometer gains regularly one second per day. When chronometers of first-rate construction are transported by sea, with proper precautions against the motion of the ship, it is wonderful how little the gaining or losing rate changes. Good chronometers are therefore invaluable in navigation, for they give the London time with great facility, and therefore, as we have explained, serve to determine the longitude. The means of transport by land are by no means so favourable to the correct going of the chronometer.

459 *Method of determining London Time, by observing the Moon's motion among the fixed stars.*—The apparent diurnal motion of the heavenly bodies serves to determine the time at any particular place where the observer

actually is, but not the time at a different place, except the difference of the longitudes of the two places be known. An observer at New York may determine the time at New York by observing the daily motion of the Sun or other heavenly body; but there is nothing in the diurnal motion of the heavenly bodies which will enable him to find the time at London, except he knows how many degrees New York is west of London. It is different, however, with regard to the proper motions of the heavenly bodies among the fixed stars, for these motions are capable of showing the time at a place different from that in which the observer is stationed, without his knowing anything about difference of longitude of the two places. With the exception of the Moon, however, the proper motions of the heavenly bodies are too slow to be made use of for the purpose of determining time with any degree of accuracy: the Moon alone moves with sufficient quickness among the stars to enable us to make use of her motion with this view; and even in the case of the Moon, it requires considerable nicety on the part of the observer to attain sufficient accuracy in the results of his observations.

460 The Moon performs the circuit of the heavens among the fixed stars in less than a calendar month, and therefore describes more than 12° per day, or 30′ per hour. Suppose for a moment that she moves over 30′ per hour, and therefore 30″ per minute. Suppose also that the Moon is seen to coincide with a certain star at 0 o'clock in London, and that an observer in some other place is aware of this, but is ignorant of his longitude. Suppose that he determines the time at the place he is in, according to the method above explained, and that at 2 o'clock he observes that the Moon is 6° 10′ from the star. Now at 0 o'clock, London time, the Moon coincided with the star, but now she is 6° 10′ from the star; therefore, since she describes 12° per day, or 30′ per hour, it follows that at the time of observation it is $12^h\ 20^m$ London time—for

6° corresponds to	$12^h\ 0^m\ 0^s$
10′ ,, ...	$0^h\ 20^m\ 0^s$
Total	$12^h\ 20^m\ 0^s$

Hence the London time is determined.

We have then the following calculation for finding the longitude of the place of observation:—

Time at place of observation	$2^h\ 0^m\ 0^s$
Corresponding London time	$12^h\ 20^m\ 0^s$
Difference	$10^h\ 20^m\ 0^s$

Hence the time at the place of observation is $10^h\ 20^m$ behind the London time, and therefore

$$1^h : 10^h\ 20^m :: 15^\circ : \text{longitude of place.}$$

Whence the longitude of the place is

155° west.

461 In the foregoing example we have assumed that the motion of the Moon is perfectly uniform, in order to explain more simply the principle upon which the method of finding the London time, and thence the longitude of any place, by means of the Moon's proper motion, depends. The Moon's motion is, however, very variable, but astronomers have determined the nature and law of that variation with great exactness. They can therefore make due allowance for every inequality in the Moon's motion, and employ it to determine the longitude with the same exactness as if it was perfectly invariable.

462 *Method of finding the Longitude by Transits of the Moon.*—This method is founded upon the principle just explained, and is in fact the simplest way of applying it in practice. It consists in observing with a transit instrument and chronometer the times at which the Moon and a fixed star cross the

meridian at the place of observation, and so determining the interval of time between the two transits. The interval thus found is compared with the interval between the two transits as seen at London, which can be easily calculated from tables given in the Nautical Almanack; and the comparison immediately shows the London time at which the two transits took place when seen by the observer. The London time being thus found, of course the longitude follows, as we have explained.

For example, suppose the following case:—

Observed interval between the two transits . . .	$12^m\ 6^s$
Interval at 0 o'clock, London time, given by the Nautical Almanack	$18^m\ 6^s$
Difference	$6^m\ 0^s$

Now, suppose that we find from the Nautical Almanack that a change in the Moon's right ascension, amounting to 6^m in time, takes place in $3^h\ 4^m\ 2^s$; then it follows, that when the observer sees the Moon's transit, the London time is

$$3^h\ 4^m\ 2^s$$

Whence the longitude may be found.

463 *Lunar Method.*—The method of finding the longitude which we have just explained, is called the method of *Moon Culminating Stars,* because it consists in observing when the Moon and certain convenient stars come on the meridian, or culminate. There is another method of finding the longitude, which is usually called the *Lunar Method.* It consists in observing the distance of the Moon from some convenient fixed star, and it depends upon the principle just explained. The instrument employed in this method is one specially adapted for observing on board ship, called Hadley's sextant. A mathematical calculation is required to obtain the longitude, and the observations must be corrected for refraction and parallax. On the whole, it is much more complicated than the method of Moon culminating stars: but, since a transit instrument could not be employed on board ship, the latter method cannot be employed at sea.

CHAPTER IX.

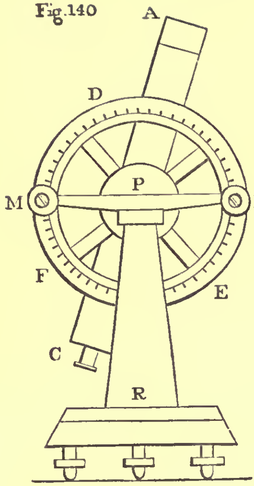
THE ALTITUDE AND AZIMUTH INSTRUMENT—HADLEY'S SEXTANT—REFRACTION AND PARALLAX.

WE have dwelt at some length on the transit instrument, because of its great practical utility, and the simplicity of its details and adjustments; besides, a knowledge of the method of using it is valuable, because other instruments are adjusted on exactly the same principles, and by similar contrivances; so that one who understands the transit instrument well, may be said to understand a good deal about astronomical instruments in general. We have now only space to say a very few words respecting two other very important astronomical instruments — namely, the *Altitude and Azimuth Instrument* and *Hadley's Sextant.*

I. *The Altitude and Azimuth Instrument.*

465 This instrument consists of a telescope C A, fig. 140, of exactly the same description as that in the transit instrument, capable of turning round a horizontal axis, the pivots of which rest on two Y's, which are fixed on two vertical pillars, one of which, P R, is represented in the figure. In fact, the

Fig. 140



telescope, axis, pivots, and pillars, are precisely the same as in the transit instrument, only the axis is generally shorter, and the pillars are closer together.

The stand to which the two pillars are fixed is a circular horizontal piece of metal, capable of moving round its centre about a vertical axis. This vertical axis is supported by another circular piece of metal, which rests on three foot screws, like the base of the transit, as we have above described it.

So far, then, the altitude and azimuth instrument is nothing more than a transit instrument, whose pillars, instead of being immoveable, are capable of moving round a vertical axis; thus the telescope has a motion about a horizontal axis, and that axis has another motion about a vertical axis. The telescope, or rather the line of collimation, moves in a vertical plane, and the axis of the telescope moves in a horizontal plane. The former is called a motion *in altitude*, because it measures the altitudes of heavenly bodies; the latter is called a motion *in azimuth*, because it measures their azimuths; and hence the name Altitude and Azimuth Instrument.

The telescope has a graduated *vertical circle*, D E F, fig. 140, attached to it, which is called the *altitude circle;* and the vertical axis, about which the pillars turn, has a graduated horizontal circle attached to it, which is called the *azimuth circle.* Both these circles are correctly centred, at least as correctly as possible, that is, the centre of the graduated circle is also the centre of motion about which the circle turns. We shall not have time to say anything here respecting the azimuth circle, but we shall confine our attention altogether to the altitude circle; in fact, we shall consider the instrument merely with reference to its use in measuring the altitudes of heavenly bodies.

466 The graduations are read off by means of two reading microscopes, M and N, fixed at opposite extremities of a piece of metal, M P N, which is attached to one of the pillars at P. We need not say much respecting microscopes, as we have already fully explained the nature and use of the microscope employed to read off the graduations of a circle. (See Articles 373—382, &c.)

In small instruments these microscopes are simply employed to magnify the graduations, which are read off by verniers, (see Articles 383, &c.,) at M and N. They are always placed exactly opposite each other; in other words, the line joining the zero point or index point of each vernier or microscope passes through the centre of the graduated circle. The object of this is to correct any error of centering that may exist in the circle; for it is easy to see that, if the centre of the graduated circle does not exactly coincide with the centre of motion, the graduations will not correctly indicate the motion of the telescope in altitude. But whatever error may be made on one side, at M, for instance, it is clear that exactly the opposite error will be made at the opposite point N: so that, if the reading at M gives the altitude, say 10″ too great, the reading at N will give the altitude 10″ too small. Suppose, then, the following case:—

True altitude	35° 20′ 17″
Altitude by reading at M	35° 20′ 7″
Ditto " N	35° 20′ 27′
Half sum of two readings	35° 20′ 17″

Whence it appears that half the sum of the two erroneous readings at M and N is the true altitude; and this, it is easy to see, will always be the case. The use of a pair of microscopes to read off at opposite points of the graduated circle is therefore obvious, inasmuch as it is extremely difficult, in making an instrument, to avoid all error of centering.

467 In larger instruments there are often as many as three pairs of reading microscopes, in order to attain greater accuracy. All these microscopes are read off at each observation, and the mean, or average, of the whole set of readings is taken: in this way considerable accuracy is secured, for not only are the consequences of erroneous centering thus obviated, but also errors of graduation, that is, errors committed by the instrument-maker in engraving the graduations are made in a great measure to balance and destroy each other.

468 The graduations of the azimuth circle are read off in a similar manner, either by verniers or reading microscopes. Both circles may be either turned by the hand or by means of certain fine screws called *tangent screws.* A tangent screw is a screw which gives to a graduated circle a very delicate motion, and so enables the observer to make his observations with greater ease and certainty than he could otherwise do. The tangent screw may be made to act upon the graduated circle at pleasure, by means of what is called a *clamping screw.* When the clamping screw is tightened, the tangent screw acts upon the circle; but when the clamping screw is relaxed, the tangent screw produces no effect, and the circle may be turned round freely by the hand.

469 There are horizontal and vertical wires in the focus of the telescope, which, as in the transit instrument, determine the line of collimation by their intersection. These wires are moveable by means of screws, and are adjusted in their proper positions in a similar manner to that described in Chapter VII.

II. *Adjustments, and Method of Observing with the Altitude and Azimuth Instrument.*

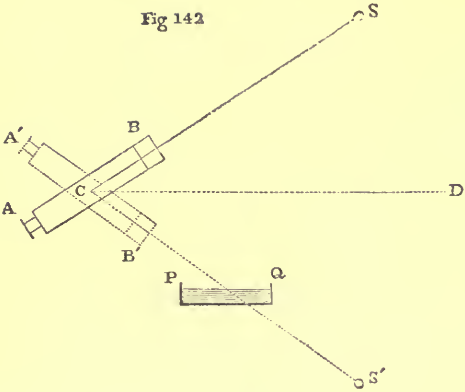
470 *Adjustments.*—Having so fully described the adjustments of the transit instrument, which are the same in kind and principle as those of the instrument we are at present considering, we must not dwell upon this subject here. The axis of the telescope must be levelled, by means of a level and the principle of inversion, as in the transit; the vertical axis about which the azimuth circle turns must be truly vertical, and both axes must be at right angles to each other. All these conditions of good adjustment are satisfied if, when a level is placed upon the pivots, and the instrument turned about its vertical axis, the bubble keeps steadily in the same position, even when the level is reversed. If no alteration is made in the position of the bubble, either by reversing the level, or turning the instrument round its vertical axis, we may be sure that the vertical axis is truly vertical, and the axis of the telescope truly horizontal.

471 *Index Error.*—This is an error affecting the verniers or reading microscopes, or the position of the telescope with reference to the graduated circle, but as it is entirely destroyed by a method of observing which we shall now explain, it will not be necessary to say anything about it.

472 *Method of observing Altitudes by Reflection.*—This method consists in observing the altitude of a star or heavenly body directly and by reflection in a trough of mercury, in the following manner:—

Let A C B, fig. 142, represent the telescope of the altitude and azimuth instrument pointing towards a star in the direction C S; let P Q be the still surface of some mercury in a trough, placed somewhat below, and in front of, the instrument; let A′ C B′ represent the position of the telescope when it is made to point towards the reflection of the star seen in the mercury, in the direction C S′; and let C D be a horizontal line.

Fig 142



Then, by the laws of reflection, the line C S′ will be as much inclined below the line C D (which is parallel to P Q, both being horizontal) as C S is inclined above C D; and therefore the angle S C S′ will be double the angle S C D. Now the angle S C D is the angle of altitude of the star above the horizon, since C D is a horizontal line. Hence, the correct altitude of the star is half the angle made by the lines C S and C S′, which are drawn respectively to the star, and to its image or reflection in the mercury.

Let us now suppose the following case, with reference to the two positions, A C B and A′ C B′ of the telescope.

Reading given by vernier in first position	29°
Ditto „ „ second ditto	99°
Difference	70°

This difference is evidently the angle S C S′, and therefore half this difference, 35°, is the altitude of the star.

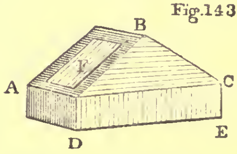
But suppose there is some error in the position of the vernier or telescope, which makes the first reading 33° instead of 29°, and of course equally affects the second reading, making it 103° instead of 99°; then the case will stand as follows:—

Reading in first position	33°
Ditto second ditto	103°
Difference	70°

And therefore altitude—35°

Hence it appears that an index error, that is, an error in the position of the vernier, or in that of the telescope on the graduated circle, does not affect the result of an observation according to this method. It is generally in this manner that altitudes are taken by means of the altitude and azimuth instrument.

Fig. 143



473 *Artificial Horizon.*—The artificial horizon is a small vessel or trough of wood, roofed in, as it were, with glass, in order to prevent the wind from disturbing the surface of the mercury. A D E C, fig. 143, is the trough for containing the mercury. A B C is the roof; F, and the opposite slanting side, which does not appear in the figure, being glass. This is a necessary instrument, when either an altitude and azimuth instrument, or a Hadley's sextant, which we shall soon describe, is used. It is made to be portable, and is rather more expensive than a purchaser generally expects, on account of the importance of having the glass roof made of accurately polished plates of glass. The mercury ought to be allowed to run into the trough through a very small hole, in order to clear the surface of the scum which will otherwise obscure it.

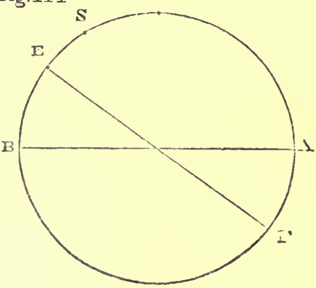
III. *Uses of the Altitude and Azimuth Instrument.*

474 We can only very briefly touch upon this part of the subject. We shall suppose the instrument to be placed in the plane of the meridian, that is, so that the line of collimation of the telescope may move in that plane; and this may be done exactly in the same manner as in the case of the transit instrument, as above explained; only the axis of the telescope is moved horizontally by means of the tangent screw of the azimuth circle instead of by moving the horizontal Y by a screw, as in the transit instrument. The instrument thus placed is equivalent to what is called the *Mural* or *Meridian Circle* in large observatories.

Altitudes of heavenly bodies observed by means of the instrument thus placed are called *Meridian Altitudes.*

475 *To determine the Latitude by observing the Meridian Altitude of a heavenly body whose declination is known.*—Let A Z E B F (fig. 144) be the Meridian, A B the Horizon, E F the Equator, S the heavenly body on the Meridian, and Z the Zenith. Then B S is the meridian altitude of the heavenly body, and this is supposed to be observed by means of the altitude and azimuth instrument. Therefore Z S, which is the complement of B S, is known. But E S is the declination of S, which is also known, and E Z is the latitude of the place. Hence, by adding Z S and E S, both of which are known, we find the latitude.

Fig. 144



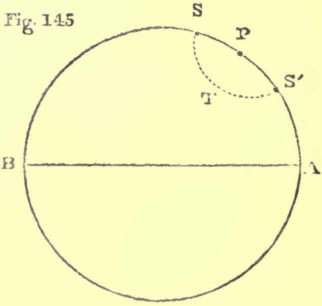
Thus, if the observed altitude be 60° 10′, and the known declination 20° 15′, we have—

B Z . . .	90° 0′
Subtract B S . . .	60° 10′
	29° 50′ which gives Z S.
Add E S	20° 15′
	50° 5′

which gives E Z, or the latitude required.

476 *To determine the Latitude by observing an unknown circumpolar Star.*—Let A P B (fig. 145) be the Meridian, P the Pole, S′ T S the circumpolar circle described by the unknown star crossing the Meridian at S and S′, and A B the Horizon. Then let the meridian altitudes S A and S′ A be observed, and added together, and the sum found will give P A, the altitude of the Pole; whence the latitude, which is equal to the altitude of the Pole, is known.

Fig. 145



For example, let the observed meridian altitudes be 79° 14′ and 49° 30′; then we have—

S A	79° 14′
S′ A	49° 30′
Adding	128° 44′

Half of which is 64° 22′, which is the required latitude.

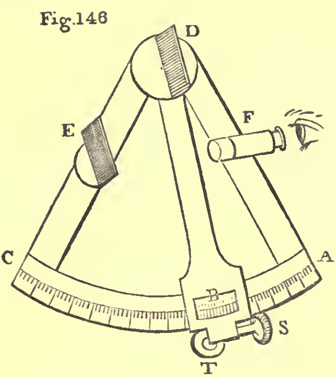
The reason why P A is half the sum of S A and S′ A is, because P is half way between S and S′, therefore S A exceeds P A by the same quantity that S′ A falls short of P A, and therefore S A and S′ A added together must just make double of P A.

477 These results must be corrected for refraction, and sometimes for other errors, as we shall briefly explain, and hence it is that these methods of finding the latitude are not by any means so simple as they appear to be.

IV. *Hadley's Sextant.*

478 This instrument is invaluable where the observer is not able to use fixed instruments, as, for instance, at sea. It consists of a stout frame D A C, fig. 146, of a triangular (or rather, sectorial) shape, of which A B C is a flat graduated circular arc, generally a sixth part of the whole circumference, (whence the name sextant,) but often it is a fourth part or quadrant. D B is an arm which moves about a centre—namely, the centre of the graduated arc A B C. The end B of this arc moves in close contact with the graduated arc, and carries an index and Vernier by which the graduations are read off. (See Article 383, &c.) S is a tangent screw, which, being turned, causes the arm D B to move very slowly; and T is a clamping screw, which, being tightened, causes the screw S to act on the arm, but, when relaxed, the arm may be moved freely by the hand.

Fig. 146



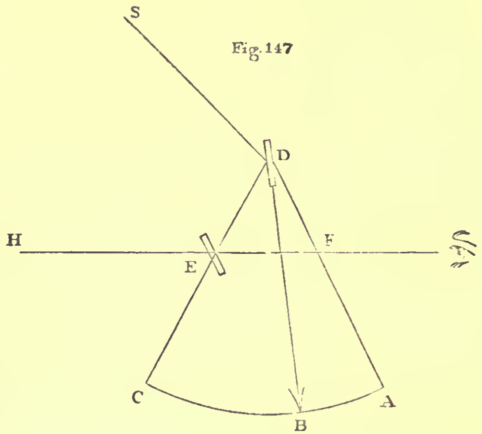
Perpendicular to the plane of the graduated arc A B C, in which plane the arm D B moves, are two mirrors E and D, one fixed at E on the side D C of the frame, and the other attached to the arm at D, immediately over the centre round which the arm turns. The mirror E is immovable, but the mirror D moves with the arm D B. Both are plane mirrors of silvered glass, but E has this peculiarity, that the upper half of the silvering is rubbed off, so that E is partly a reflector and partly transparent.

F is a telescope fixed on the side D A of the frame, and pointing directly towards the half-silvered mirror E. Behind the instrument is a handle (not shown in the figure). By this handle the instrument is held in the right hand, the left being used to move the index arm D B, or turn the screws S or T.

479 When the instrument is in proper adjustment, and the arm D B is moved till its index B is at the zero of the graduated arc A B C, which zero is near the point A, then the two mirrors D and E are so placed as to be exactly parallel to each other.

480 *Principle of Hadley's Sextant.*—Let A D C, fig. 147, represent the principal lines in fig. 146; A B C being the graduated arc, E the half-silvered mirror, D the moveable mirror on the index arm, B the index, A the zero point of the graduated arc, F the place of the telescope. Suppose S D E F to be the course of a ray of light, which, falling on the mirror D, is reflected to E, and thence again reflected towards the telescope at F, through which it passes to the eye. We may observe here, that the telescope is always so placed that the lines F E and D E make equal angles with the mirror E; and then, by the law of reflection, a ray falling on the mirror E, in the direction D E, is always reflected in the direction E F.

Furthermore, let H E be another ray of light, which, falling on the unsilvered part of the mirror E, passes straight through the telescope at F to the eye.



Then it may be proved geometrically, from the law of reflection, that the angle A D B is always half of the angle at which the two rays S D and H E are inclined to each other; so that double the number of degrees in the graduated arc A B is the angle which the ray S D makes with the ray H E. Now, the arc A B C is not graduated in the usual way, but every half degree of it is represented as a whole degree, so that there would be twice 360 degrees in the whole circumference if completed. This being the case, it is evident from what has been stated, that the number of degrees from A to B shows the angle at which S D and H E are inclined to each other. For example, if the index B points to 20°, the rays S D and H E make angles of 20° with each other.

Now, if S and H be two distant objects, two stars for instance, from which these rays come, it is clear that to the eye S will appear to be in the same place as H, for the rays of light which come from S will, by the two reflections at D and E, enter the telescope in the direction E F, in which direction the rays from H also enter the telescope. Whence it is evident, from the explanation we have given of the nature and action of the telescope, that both sets of rays will be mixed by the telescope, and enter the eye just as if they came from one object. To the eye, therefore, looking through the telescope, S will appear to coincide with H.

Hence we may state the principle of Hadley's sextant as follows :—When the telescope is directed towards a star H, and the index arm is moved till another star S is seen to coincide apparently with H ; then, the number of degrees, minutes, and seconds shown by the index B on the graduated arc A C, gives the angular distance of the star S from the star H, that is, the number of degrees, minutes, and seconds between S and H on the celestial sphere.

481 *Method of observing with Hadley's Sextant.*—Suppose we wish to observe the angular distance between two stars S and H. Holding the instrument by the handle in the right hand, and the plane of the instrument (that is, the plane D A C, fig. 147,) as nearly as possible in the plane in which the two stars are situated, direct the telescope towards the lower star H, and, holding the instrument as steadily as possible, move the index arm backwards and forwards with the left hand till the other star S appears in the field of view. The moment the two stars are, as it were, thus caught in the field of view, tighten the clamping screw T, and then turn the tangent screw until the star S appears to come exactly unto the same place as H, so that both seem to be coincident with each other. When this is done, the observation is made, and the observer has only to look at the index B, which, with the help of the vernier, will show in degrees, minutes, and seconds, the angular distance between the two stars.

482 *Adjustments of Hadley's Sextant.*—We shall only mention here the adjustments which it is always necessary for the observer to attend to, which are effected by means of two screws at the back of the instrument, close under the half-silvered mirror E, and by a screw at the back of the index mirror D.

Of the two former screws, one alters the inclination of the half-silvered mirror to the plane of the instrument, that is, the plane A B C D, fig. 147; and the other alters the inclination of the half-silvered mirror to the index mirror. These two screws have milled heads generally, and may be turned by the hand. The screw at the back of the index mirror D alters the inclination of that mirror to the plane of the instrument. This screw has not a milled head, and must be turned by a screw driver, for this reason, that it ought to be meddled with as little as possible.

When the instrument is properly adjusted, both mirrors should be perpendicular to the plane of the instrument, and they should be exactly parallel to each other when the index B is at the zero of the graduated arc A C.

483 *Adjustment of the Half-Silvered Mirror.*—Bring the index B to the zero of the graduated arc, making it exactly coincident with the zero by tightening the clamping screw T, and then using the tangent screw S. Then, holding the instrument by the handle, direct the telescope towards a distant, well-defined, small object, (it must be a distant object,) say, for instance, a bright star. On looking through the telescope, the observer will see the star double if the adjustments be not perfect, one image being formed by the rays which come through the unsilvered half of the mirror E, and the other by the rays which fall on the mirror D, and are reflected by the silvered half of E to the telescope.

Let the observer now turn in succession the two screws which adjust the mirror E, and he will perceive that one of these screws makes one of the images appear to move at right angles to the plane of the instrument, and the other in that plane. All that he has to do in order to adjust the mirror is, to make the two images of the star exactly coincident with each other, by turning one or both the adjusting screws, as the case may require. When he sees the star single, then the adjustment is complete.

484 *Adjustment of the Index Mirror.*—This adjustment should be done by the instrument maker, and the observer ought to be careful not to disturb it by rough handling, or meddling with the screw.

But, should necessity require it, the adjustment of the index mirror is effected by turning the screw (or screws) at the back of it, till the following condition is satisfied.

Let the observer hold the instrument before him in a horizontal position, and in a level with his eye, having the index mirror D next his eye, and the graduated arc A B C away from him. On looking in the index mirror, as he thus holds the instrument, he will see the portion B C of the graduated arc reflected; he will at the same time see the arc B C itself. In fact, the arc B C, and its reflection in the mirror D, will appear to unite at B, and form one continuous arc. Now, the condition of perfect adjustment is this.—The arc B C and its reflection must not appear bent or broken at the place where they seem to unite, but they must appear to form one unbroken graduated surface, so that the reflection of the arc B C may look as if it was really the continuation of the arc B C itself.

This condition being satisfied, the observer may be sure that the index mirror is truly perpendicular to the plane of the instrument.

485 If this condition appears to be satisfied into whatever position we move the index arm D B, the axis, round which the arm turns at D, must be truly perpendicular to the plane of the instrument, and so far the instrument must be a good one. It requires a little practice, however, to see whether this condition is accurately satisfied or not. But extreme accuracy is not necessary in this adjustment.

486 *Dark Glasses.*—There are always a set of dark coloured glasses near the two mirrors D and E, which may be placed before them or not at pleasure. The use of these glasses is to destroy the excessive glare of the Sun, when it is necessary to make an observation upon him.

V. *Uses of Hadley's Sextant.*

487 Hadley's sextant may be used to observe the angular distance between two heavenly bodies in the manner we have explained. Thus, the Moon's distance from a fixed star may be observed, and the longitude thence determined, according to the method we have explained.

This is a peculiarly valuable method at sea, as Hadley's sextant is the only instrument that can be used for measuring angular distances on the unsteady deck of a ship. The observer at sea often lies on his back, in order to manage the instrument with greater ease and steadiness.

488 *Observation of Altitudes by means of Hadley's Sextant.*—If it be necessary, as it continually is, to observe the Sun's altitude at sea, the observer directs the telescope of the sextant towards the visible horizon (that is, the extreme boundary of the sea, where it appears to touch the sky,) holding the instrument in the same vertical plane with the Sun, as nearly as he can judge. He then makes the Sun appear in the field of view, and, by the tangent screw, in the manner already described, causes the image of the Sun just to touch that of the sea. In this manner he finds the angular distance of the Sun from the visible horizon—that is, the Sun's altitude above the visible horizon.

489 But since the visible horizon at sea is a little below the real horizon, in consequence of the observer being at some elevation above the surface of the sea, there must be an allowance or correction to obtain the true altitude of the Sun above the horizon. This correction is called the correction for the *dip of the horizon.* The manner of making it is explained in treatises on *Nautical Astronomy.*

490 Altitudes on land are observed by the aid of an artificial horizon. (See Article 473.) The telescope is pointed at the image of a heavenly body seen by reflection in the trough of mercury, and the heavenly body itself is brought into the field of view by moving the index arm, and made to coincide exactly with the image seen in the trough of mercury by means of the tangent screw. In this manner, the angular distance of the heavenly body from its image reflected in the trough of mercury is determined, and half that angular distance is the altitude of the heavenly body above the horizon, as we have explained in Article 472.

491 *Determination of the Latitude of a Place by Hadley's Sextant.*—We have already explained how the latitude of a place is found by observing meridian altitudes. For this purpose, the graduated circle with which we observe must be placed exactly in the plane of the meridian. Now, this we cannot do with Hadley's sextant, inasmuch as we hold it in the hand, and therefore cannot be sure whether it is exactly in the meridian plane or not. To obviate this difficulty, meridian altitudes are observed by means of Hadley's sextant in the following manner:—

The observer makes as good a guess as he can at the position of the meridian, either by means of a magnetic compass, or the pole star, or otherwise; and he commences his observations on the heavenly body whose meridian altitude he wishes to determine, a short time before it comes on the meridian. He observes several altitudes of the heavenly body in succession at short intervals, which he finds to increase for a certain time, and then to diminish; for the heavenly body culminates, or attains its greatest altitude, when it comes on the meridian. Hence, the observer has only to select the greatest of the altitudes he has observed, and that cannot differ materially from the meridian altitude, if the observations have been made quickly one after the other at the time when the observer perceives the altitudes to increase very slowly and then begin to diminish.

There is, however, a simple mathematical rule, called the Rule of Interpolation, by which the observer may determine the exact meridian altitude, and the time of transit across the meridian, from a few altitudes observed every five minutes or so about the time when the heavenly body comes on the meridian. In this manner, Hadley's sextant may be used with considerable accuracy to determine the meridian altitude and time of transit of a heavenly body.

492 The greatest altitude of a heavenly body is easily determined by gradually turning the tangent screw, so as to keep the body and its reflected image in contact as long as the body is ascending, and ceasing to turn the screw as soon as the body appears no longer to ascend. The reading given by the index will then be the greatest altitude of the body. It is important to observe, that though the greatest altitude may be thus found with tolerable accuracy, the time of the body's transit over the meridian cannot be found with any degree of exactness in this way, as a little consideration will show.

493 Hence the time at any place may be determined by means of Hadley's sextant, by observing the time of transit of the Sun, or any other heavenly body whose right ascension is known. (See Article 454, &c.) Thus Hadley's sextant may supply the place of a transit instrument; it is not, however, to be compared with a transit instrument as regards accuracy in determining the time of transit.

494 We may observe here, that when we speak of the altitude of the Sun, we mean the altitude of his centre, and therefore when we make the Sun's lower limb appear just to touch the sea. we take the altitude of the Sun's lower limb, and not of his centre. It is necessary to correct this error, which is often done by means of a table in the Ephemeris, or Nautical Almanack, which gives the number of degrees, minutes, and seconds, in the Sun's apparent semi-diameter, which must be added to the altitude of the lower limb, in order to give the altitude of the centre.

Sometimes the altitudes of the upper and lower limbs are observed, half the sum of which will be the altitude of the centre.

495 The same remarks apply to the Moon, but, one side of the Moon being generally dark and indistinct, the second method does not always apply, and therefore the altitude of the Moon's centre must be found by observing the altitude of the enlightened limb, and adding or subtracting the semi-diameter, according as the enlightened limb is lower or upper.

The apparent semi-diameter must be given in the Almanack, because it is a variable quantity, being greater or less according as the Moon or Sun is nearer or farther off.

Refraction.

496 We have alluded to the astronomical corrections in two or three places already, and explained in a former chapter the causes of some of them. Two of them are optical, arising respectively from a real and an apparent deviation of the light, which comes from a heavenly body to the eye, from its rectilineal course. Another correction arises from the observer's change of position, which produces a corresponding apparent change in the positions of the Sun, Moon, and planets, the stars being too far off to be affected by it. Lastly, the correction for *Precession and Nutation* is due to the actual motion of the Pole caused by the attractions of the Sun and Moon on the Earth, whose deviation from a perfectly spherical shape, combined with its rotation, caused the Pole by these attractions. We have only space to allude briefly to one of these corrections—indeed, the full explanation of them would require too much mathematical information on the part of the reader to admit of saying much about them here.

497 We have already explained the manner in which the refraction of light takes place when it comes from a heavenly body to the eye, by the refractive power of the atmosphere. This refraction always makes a heavenly body appear higher up than it really is, and that in a greater degree according as the body is nearer to the horizon. A body in the zenith is not affected by refraction; at 45° from the zenith it is elevated about 1′ by refraction, and at

the horizon as much as 33′; so that the amount of refraction increases rapidly towards the horizon.

498 The density of the atmosphere, as is well known, is continually changing, in consequence of the continual variations of pressure and temperature which, from various causes, are always taking place at the earth's surface. The barometer is an instrument which measures the pressure of the air, and therefore its density, provided we take proper account of its temperature. Now, the refractive power of a transparent substance increases with its density, and the atmosphere is no exception to this rule. Hence, the indications of the barometer must always be observed before we can make a correct allowance for the atmospheric refraction.

It appears that the refraction of the atmosphere mainly depends upon its density, and that it varies very little in consequence of changes of temperature or humidity.

499 Since refraction always makes heavenly bodies appear to be higher up than they really are, the correction for refraction must always be subtracted from the observed altitude of a body in order to find its true altitude.

The following formula gives the amount of the correction for refraction of a heavenly body not far from the zenith:—

Let z be the observed or apparent zenith distance of the body, and r the correction; then

$$r = 57'' \times \tan. z,$$

and the true zenith distance is $z + r$:

that is, in order to find the true zenith distance, as far as refraction is concerned, multiply the tangent of the observed zenith distance by 57″, and the result added to the observed zenith distance will give the true.

This supposes the barometer to stand at its mean elevation, about 29½ inches, and the thermometer at the mean temperature, about 50 Fahr. If this be not the case, we must multiply the above formula by the quantity $\frac{b}{29{\cdot}6}$ to correct for the barometer, and moreover by the quantity $\frac{500}{450 + t}$ to correct for the thermometer: b being the height of the barometer in inches, and t the degree of the thermometer, (Fahr.) The formula for r will therefore be—

$$r = 57'' \times \frac{b}{29{\cdot}6} \times \frac{500}{450 + t} \times \tan. z.$$

Furthermore, if the body be not near the zenith, instead of tan. z, we must put tan. $(z - 230'' \tan. z)$; that is, the formula for r will be—

$$r = 57'' \times \frac{b}{29{\cdot}6} \times \frac{500}{450 + t} \times \tan. (z - 230'' \tan. z.)$$

This formula is nearly coincident with one given by Bradley, only it has 230″ tan. z, instead of $3 \times 57'' \times \tan. z$, as in Bradley's formula.

The rule, then, for finding r is as follows:—Multiply the tangent of the observed zenith distance (z) by 230″, subtract the result from z, and find the tangent of the remainder, which multiply by 57″. The quantity thus obtained must be multiplied by the height of the barometer (b), and divided by 29·6; also, it must be multiplied by 500, and divided by the temperature (t), increased by 450. The final result thus obtained is the value of r, which must be added to z, and the true zenith distance is thus obtained.

This is the only correction necessary if the heavenly body be a star; but if it be the Moon, another correction, called *parallax*, must be applied: of this, however, we cannot speak here.

For the sake of the reader who does not understand what a tangent is, we give the following short table, in which the tangent for every degree is given. By this table he may calculate the value of the refraction. Practical men generally find the refraction, not by a formula, but by a table of refractions, in which the value of the quantity 57″ tan. $(z - 230'' \tan. z)$ is given for all the values of z between 0° and 60°. The angles are given in degrees, and the tangents to three decimal places, which is sufficient for the present purpose.

Angle.	Tangent.	Angle.	Tangent.	Angle.	Tangent.
1	·017	21	·384	41	·869
2	·035	22	·404	42	·900
3	·052	23	·424	43	·933
4	·070	24	·445	44	·966
5	·087	25	·466	45	1·000
6	·105	26	·488	46	1·036
7	·123	27	·510	47	1·072
8	·141	28	·532	48	1·111
9	·158	29	·554	49	1·150
10	·176	30	·577	50	1·192
11	·194	31	·601	51	1·235
12	·213	32	·625	52	1·280
13	·231	33	·649	53	1·327
14	·249	34	·675	54	1·376
15	·270	35	·700	55	1·428
16	·287	36	·727	56	1·483
17	·306	37	·754	57	1·540
18	·325	38	·781	58	1·600
19	·344	39	·810	59	1·664
20	·364	40	·839	60	1·732

CHARTOGRAPHY.

NEITHER the nature of the present work, nor the space to which we must limit ourselves, permits our treating *in extenso* of Chartography; a subject which, if fully developed, would of itself fill a large volume and require a great many plates. We must accordingly confine ourselves to a brief notice, in which, however, we will endeavour to give all the information we can, consistently with a popular work like the present.

By Chartography, in its widest sense, is understood the construction and delineation of maps, charts, and plans, no matter for what special purpose, upon what projection, or on what scale. The direct object of maps is to represent the whole or some portion of the Earth's surface; but as this surface is spherical, it is evidently impossible to reduce it, or any part of it, to a flat surface, without a greater or less distortion of its details: whence it follows, that the only way in which the Earth can be accurately figured is by a globe; and even then the elevations of the surface cannot be shown in their proper relief, as the highest mountains would be less than the thickness of the paper on an eighteen-inch globe.

Terrestrial Globe.—An artificial globe is a miniature representation of our planet, with its grand divisions of land and water, and on which all the regions of the Earth may be correctly laid down as regards position, form, area, and distances. We do not mean to say, that even on the best globes everything is mathematically correct, for we are far from possessing the exact latitudes and longitudes of all places on the surface of the Earth, and until we have these, the position of many places, even on the most perfect globes, must be regarded only as approximations to truth. But as far as positions are determined, they may be more exactly represented on a globe than on any map. The ordinary size of globes, however, does not admit of much detail, and although very large globes have been constructed, they are rather objects of curiosity than of practical utility. Even a four-foot globe takes up a great deal of room, and is only fit for large libraries or public teaching. In very large globes, again, any small portion of the surface has so little convexity, that if the country contained in such portion were projected on the plane surface of a map, the forms would hardly be distorted, and the relative distances of places so near the truth, that the globe, in such case, would, as far as such country was concerned, offer no great practical advantage. Globes are, nevertheless, very desirable, both as conveying, upon simple inspection, a much more correct notion of the true forms of regions, and the relative positions of places, than can be done by maps, and as enabling us to solve a great many interesting problems: the best adapted for general use are of eighteen inches diameter.

The most accurate globes are those on which the details of the surface are drawn upon the globe itself directly, and this is always done in very large globes; but such are, of course, very expensive. The usual mode is to cover the globe with a map constructed and engraved expressly for the purpose, in a number of separate pieces or slips, called *gores* (in French, *fuseaux*), generally twelve, fifteen, or twenty-four, bounded each by meridian lines, and terminating at the North and South Poles, or at the Arctic and Antarctic circles, in which latter case, two circular pieces are required for the two frigid zones. As each gore is a flat surface, it can be made to coincide with the convex surface of the globe only by the paper itself yielding or stretching, and it will be easily conceived, that the pasting on of the paper, so that each separate gore shall exactly meet without tearing, presenting folds, or overlapping, is a very difficult and delicate operation. When the pasting is dry, the globe is coloured and varnished, and then mounted. There are various ways of setting up a globe; the most usual is to fix it within a brazen meridian, set in a horizontal frame, called the *wooden horizon*, and as the mounting requires as much care as is necessary for pasting the map, we are not to be surprised if many globes are very imperfect, a fact of so much the more importance as a globe is useless unless it be perfect in all respects. We therefore recommend to every one who would possess a really good globe, to examine it well before purchasing. The characteristics of a perfect globe are as follow:—

1. All the meridional edges of the slips or gores must join so perfectly as to form continuous fine circles, neither overlapping nor failing to meet.

2. All these circles must be true, which is seen by bringing them successively under the *Brazen Meridian*, with which they should correspond all the way round: if they do not, the fault may be either in them or in the brazen meridian itself, which is not perhaps in a true plane.

3. When the poles are brought to the wooden horizon, in what is termed the *right position* of the sphere, each meridian brought successively to the wooden horizon, should correspond with it all the way round.

4. The brazen meridian must be in a plane exactly perpendicular to that of the wooden horizon, which it is, if, while any one meridian on the globe corresponds with it all the way round, the equator corresponds at the same time with the wooden horizon all the way round.

5. Every one of the parallels of latitude must form continuous and perfect circles all the way round, and, on turning the globe, must each of them correspond in all its parts with the same precise point on the brazen meridian.

6. When the equator is made to correspond with the wooden horizon, the two zero points of the brazen meridian must correspond exactly with the upper surface of the wooden horizon, in which case, they will, of course, also correspond exactly with the equator on the globe.

7. All the degrees on the equator, on the ecliptic, on the first meridian, drawn on the globe, and those on the quadrant of altitude, when there is one, must be exactly similar. In order to ascertain whether they are so, take with the compasses any number of degrees from any one of these circles, and apply the measure to all the other circles, and see if it intercepts on them all and everywhere the same number of degrees. In like manner, the degrees on the brazen meridian and on the wooden horizon must exactly correspond to each other.

8. The brazen meridian must slide with ease through the notches cut to receive it in the wooden horizon, but must not be so loose as to shake in it.

9. As the globe is turned round, every part of its surface must be equidistant from the brazen meridian and from the wooden horizon, and the nearer the better, provided all be so true that there is no danger of rubbing. This is the true criterion of a well set globe.

10. The globe must be so truly balanced upon its poles, as to remain quite motionless the moment you cease turning it, the poles being placed horizontally.

11. In the right and in every other position of the globe, except the parallel, the equator, on turning the globe round on its axis, must correspond to the same points on the wooden horizon, which points are at 90° from the intersection of the brazen meridian with the horizon.

12. Every part of the polar and tropical circles must correspond with their known latitudes on the brazen meridian.

With respect to the geography of the globe itself, it is necessary to see that it contains all the latest corrections of positions and discoveries of importance, that no place of real note is omitted, that the names be well and distinctly engraved, and that they be not too crowded. Lastly, the wooden horizon must be examined with reference to the several circles marked upon it, each of which must be properly graduated, and their several portions in their true places, as regards the other circles and the globe itself.

We have spoken only of the terrestrial globe, and of the more usual way of setting or mounting it. There are various other modes,* but which our limits will not admit of our detailing. As for the *Celestial Globe*, it is destined for astronomical purposes, and is therefore foreign to our subject.

It is only by means of a globe, we have said, that the Earth's surface can be correctly represented; but as a globe is neither portable, nor capable, from its small size, of exhibiting the details which are often required, we must have recourse to maps, the great and indeed only disadvantage of which consists in the impossibility of truly representing a spherical on a flat surface.

PROJECTION OF MAPS.—Different methods have been devised for the construction of maps, so that the real figure of the several regions of the Earth shall be as little distorted as possible. These constructions are called *Projections*. We cannot here enter into the elaborate researches, the complicated analyses to which some of the greatest mathematicians have subjected the different projections and their modifications; we will merely explain the geometric construction of such as are most commonly employed.

There are five principal projections—namely,

1. The Orthographic,
2. The Stereographic,
3. The Globular, or Equidistant,
4. The Conical, and
5. The Cylindrical, or Mercator's.

In the orthographic, the stereographic, and the globular projections, the *plane of projection*, or the flat surface on which the map is drawn, is supposed to pass through the centre of the globe; but in the first, the orthographic, the eye of the observer is supposed to be at an unmeasurable distance; in the second, or stereographic, it is presumed to be at the surface of the globe; and in the third, or globular, it is supposed situated at a point whose distance from the surface of the globe is equal to the sine of the angle of forty-five degrees.

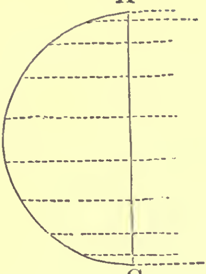
In order the better to understand how, in the several cases, the picture is formed upon the plane of projection, it is customary to imagine both that plane and the globe to be transparent. Now, it is clear, that as we see everything we look at through a pane of glass, as if it were drawn upon such plane of glass, so in the above supposition, all the details of the hemisphere on the opposite side from the spectator would appear to him as though they were drawn upon the transparent diaphragm or plane of projection. But unless this supposition be limited, it is more likely to create a confusion of ideas than assist the student in forming a right conception of the subject; for while, in considering the geographical position of any place on the Earth's surface, we always refer to our own position as external, and thus say the east is to the right when we face the north, it is evident that in a picture traced according to the above supposition, we see the objects reversed, so that what is really to the east appears to be to the west. The fact is, nothing of the surface of the sphere is projected but its great and small circles, and so far only as these are concerned, is it safe to admit the imaginary transparency alluded to. When once the parallels of latitude and the meridians are projected, the several regions of the Earth are laid down upon the map in conformity with the latitudes and longitudes of their several parts.

THE ORTHOGRAPHIC PROJECTION.—In this projection, the eye of the spectator is conceived to be at such a distance from the plane of projection, that the visual rays which traverse it in their passage from different points of the hemisphere beyond, are all parallel and fall perpendicularly upon it, whence it follows that equal spaces on the hemispherical surface are represented by unequal spaces on the plane of projection.

---

* A mode of mounting globes, far superior to that usually adopted, was proposed by Adams, and executed with improvements by C. Covens: a description and plate of it will be found in Malte Brun's *Précis de Géographie Universelle*.

Fig. 1

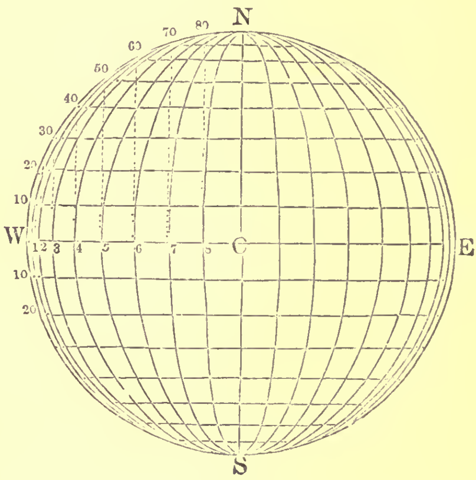


Thus, let A B C (fig. 1) represent a section of the hemisphere divided into nine equal arcs, and A C a section of its plane of projection. Now, if from the several points on A B C, parallel visual rays be drawn perpendicularly through A C, it is evident the spaces intercepted between these rays will be unequal, while the points whence they proceed are equidistant from each other. It will further be observed that those nearest the centre approach nearest to equality, while those further removed from it diminish in proportion to their distance.

As all the parallels of latitude are in planes perpendicular to the plane of projection, they will be projected in straight lines, while all the meridians, except the central one, will be projected in elliptical curves.

The mode in which the orthographic projection is graphically constructed is represented (fig. 2). A circle N E S W is drawn, representing the meridian bounding the plane of projection. Two diameters, W C E and N C S, are next drawn at right angles to each other: the former being the projection of the equator, and the latter that of the central meridian. The quadrants of the circle are then respectively divided into spaces of ten degrees each, marked 10, 20, 30, &c., from the extremities of the equator towards the poles N and S. From these points draw lines parallel to the equator, and these will represent the parallels of latitude for every ten degrees. Now, from their extremities, let fall perpendiculars upon the equator, and through their points of contact with it, draw ellipses with N C S for a common transverse axis, and with C 1, C 2, &c. respectively for half their conjugate axes. These curves will be the projections of the several meridians.

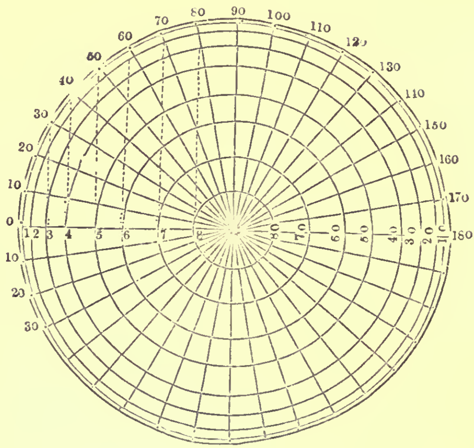
Fig. 2



The same projection may be effected on the plane of the equator. Thus, (fig. 3,) describe a circle to represent the equator, the centre of which circle will represent the pole. Then draw two diameters at right angles to each other, and divide each quadrant, as before, into nine equal parts. From these points draw diameters to the corresponding divisions of the opposite quadrant, and these lines will represent the meridians, any one of which being taken for the first, the others must be numbered 10, 20, 30, &c., half way round on either side, to 180. Next let fall perpendiculars from the divisions of one of the quadrants on one of the radii, and through the points of intersection 1, 2, 3, &c., describe circles to represent the parallels, marking them from the outer to the inner with the numbers 10, 20, 30, &c. for the degrees of latitude.

As all the quadrilateral spaces in figs. 2 and 3 represent ten degrees of longitude and as many of latitude, their simple inspection shows that, with the exception of such places as occupy the centres of the projections, the several regions, particularly those nearest the circumference, must be most dreadfully distorted in form, and diminished in magnitude.

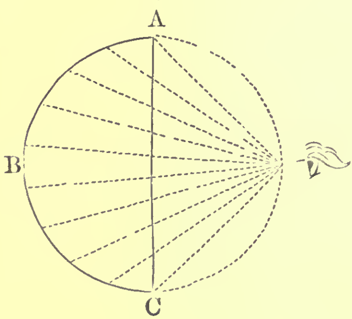
Fig. 3



THE STEREOGRAPHIC PROJECTION.—This projection differs from the former, in presuming the eye of the spectator placed at the surface of the globe and exactly opposite the central point of the plane of projection, which, as in the former case, is supposed to divide the globe into two halves, the farthest of which from the observer being that whose lines are to be projected.

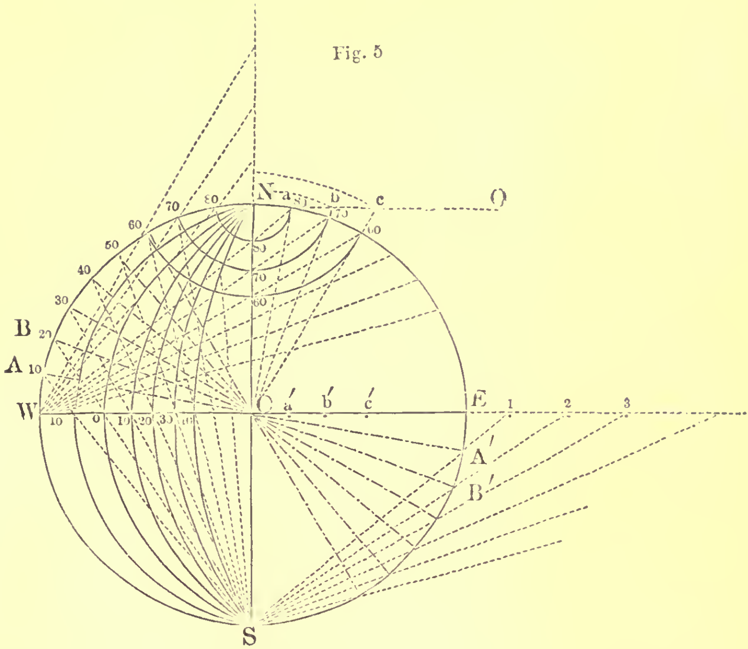
From the proximity of the eye, the visual rays, instead of being parallel, as in the former case, all converge from the hemisphere to the point of projection, so that while equal spaces on the hemisphere are still represented by unequal spaces on the projection, the inequality is not near so great as in the former case, and the spaces, instead of diminishing from the centre towards the circumference, diminish in the contrary direction—namely, from the circumference towards the centre. This is rendered evident by fig. 4, in which the visual rays, passing from the equal spaces, into which the hemisphere, represented in section by the arc A B C, is divided, intercept spaces in the plane of projection (of which A C is the section) so much the larger as they recede from the centre. This inconvenience, however, is in part compensated by the property enjoyed by this projection of representing all the figures on the sphere by *similar* figures, and consequently all the right-angled quadrilateral spaces formed on the sphere by the intersections of the meridians and parallels are projected into similar figures, so that the countries are not distorted in form, as is the case in the orthographic projection.

Fig. 4



The stereographic projection of a hemisphere on the plane of a meridian is thus effected. Describe a circle N E S W (fig. 5) representing the meridian that circumscribes the plane of projection, and draw two diameters, N C S and W C E, the former to represent the projection of the central meridian, and the latter that of the equator. Then divide the quadrants from the equator to the poles into 6 or 9 equal parts, according as it is required to have the parallels at 15 or at 10 degrees apart, (in the figure they are at 10 degrees),

Fig. 5



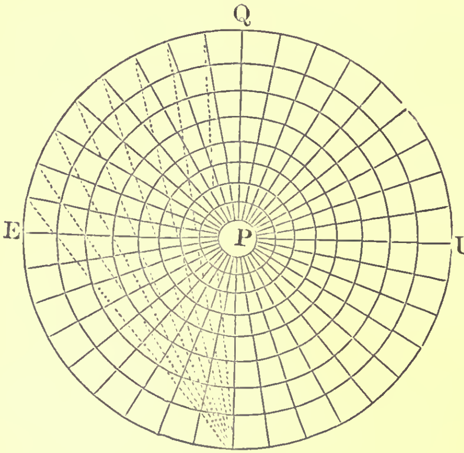
and number them successively 15, 30, 45, &c., or, as in the fig., 10. 20, 30, &c. From S draw lines to the several divisions, as S 10, S 20, &c.. and their intersection with the line W C E will be the points through which the circular arcs representing the meridians must be described. For the parallels, draw lines, in like manner, from either extremity of the line W C E to the divisions of the opposite quadrant, and their intersection with the central meridian will be the points through which the arcs of the parallels are to be struck.

The places of the centres from which the parallels are described, depend on the principles which determine this projection; one of which is, that the distances of the centres of the parallels from the centre C of the projection, are equal to the secants of their distance from the pole, and accordingly, if the length of these secants respectively be marked off from C on the prolongation of S C N, they will give the centres from which to describe the parallels.

Thus, if a tangent N O be drawn parallel to W C E, and lines drawn to it from the centre C through the divisions 80, 70, 60, &c., these latter will be the secants respectively of the angular distances of these parallels from the pole: C a the secant of 10 degrees, or the distance of the 80th parallel from the pole; C b the secant of 20 degrees, or the distance of the 70th parallel, and so on. Transport these distances successively from C on C N prolonged, and they will give the centres sought; or, what is the same thing in theory, though impossible in practice, draw lines from W through the divisions of the quadrant on the same side of the central meridian, until they meet the prolongation of C N, and half the distance between these intersections and the corresponding ones on N C will be the places of the centres.

Another principle of this projection is, that the distance of the centre of projection of any great circle oblique to the plane of projection, is equal to the tangent of the angle at which the circle is inclined, and its radius is equal to the secant of that angle. Hence the centres for describing the meridians may be found by transporting the tangents of 10, 20, 30, &c. degrees already found—viz., N a N b &c. to the line C E and its prolongation, as shown at C a′, C b′, C c′, &c., and from these points, with the secants, likewise found as C a, C b, &c. for radii, describe the meridianal arcs. Or the centres for the meridians may be found thus: from the divisions of the quadrant W N draw diameters to the opposite quadrant, as A A′, B B′, &c. Through A′, B′, &c. draw lines from S, and produce them till they meet the prolongation of W C E in 1, 2, 3, &c.; then half the distances respectively between these points, and the intersections previously found of the line W C, will be the centres sought: that is, the middle a′ of the line 1, 10 will be the centre for striking the meridian S 10 N, the middle b′ of the line 2, 0, the centre for S 0 N and so on. It will be observed that these points a′ b′ &c. are precisely those that were found by transporting the tangents N a, N b, &c. to C E.

Fig. 6



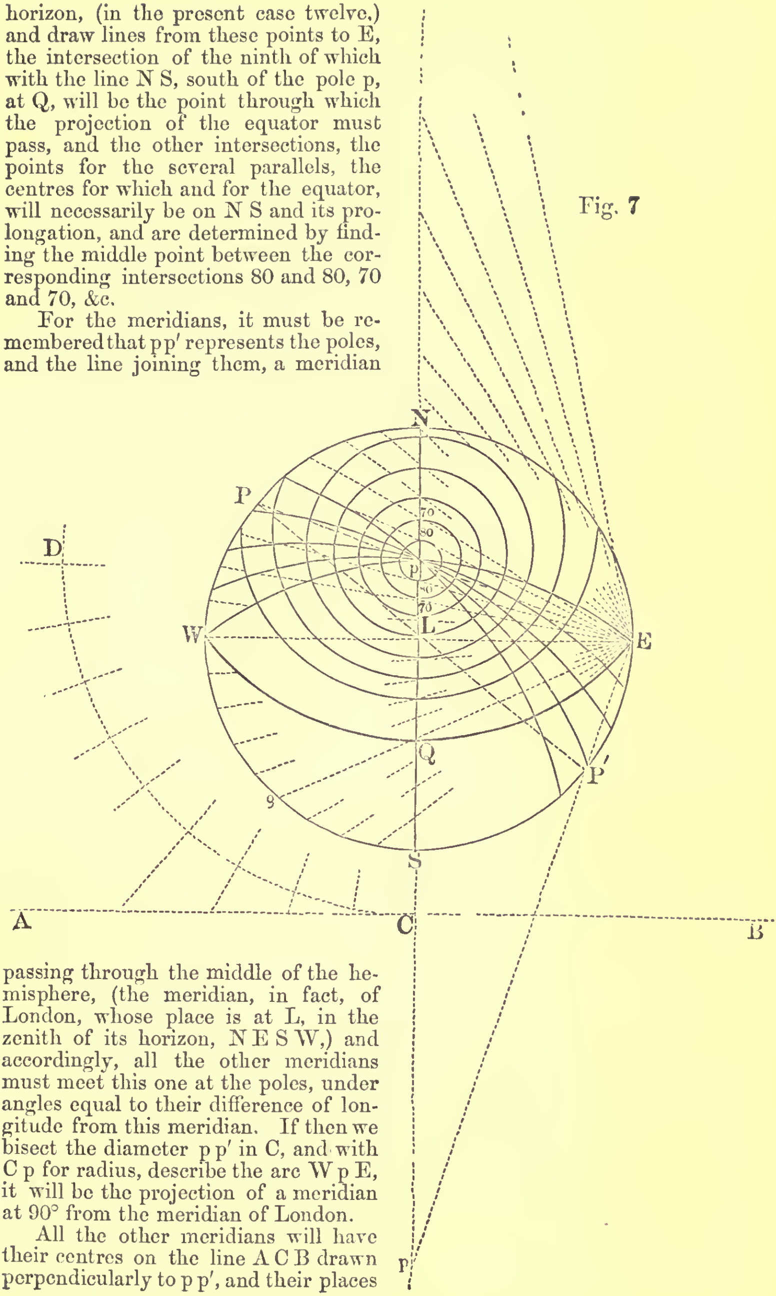
The application of this projection to the plane of the equator is exceedingly simple. Thus, (fig. 6) describes a circle E Q U A to represent the equator; draw two diameters at right angles to each other; divide each of the quadrants thus formed into nine equal parts, and from the divisions on E Q draw lines to A; their intersections with E P will be the points through which circles must be described from P, the pole, to represent the parallels; while radii drawn from P to all the divisions on the equator will be the projections of the meridians.

As the globe may be divided into two hemispheres in an infinity of ways, so many different planes of projection may be chosen, besides those on a meridian or on the equator, and accordingly hemispheres are sometimes projected on the plane of the rational horizon of some particular place, as on the horizon of Paris, as has been done by Lapie; on the horizon of London, as has been done by Mr. W. Hughes, &c. These projections, called *horizontal*, (as those on the plane of a meridian are called *equatorial*, and those on the plane of the equator are called *polar*,) are extremely interesting, but the construction is somewhat complicated: we shall explain it as applied to the horizon of London.

Describe a circle N E S W, (fig. 7,) and draw two diameters, N S and W E, at right angles to each other. From N, mark off on the quadrant, N W, a number of degrees equal to the latitude of the place, or height of the pole above the horizon, (in the present case,) 51° 30′, and P will be the place of the superior pole. From it, draw the diameter P P′, and P′ will be the place of the inferior pole. The eye being at E, draw E P, and its intersection with N S in p will be the projection of the upper pole. Draw also the line, E P′, and produce it till it meet the prolongation of N S in p′, then p p′ will be the projection of the meridian P P′. Now set off on either side of P as many times ten degrees, or the ninth part of a quadrant, as there are parallels that distance apart, between the pole and southern part of the horizon, (in the present case twelve,) and draw lines from these points to E, the intersection of the ninth of which with the line N S, south of the pole p, at Q, will be the point through which the projection of the equator must pass, and the other intersections, the points for the several parallels, the centres for which and for the equator, will necessarily be on N S and its prolongation, and are determined by finding the middle point between the corresponding intersections 80 and 80, 70 and 70, &c.

For the meridians, it must be remembered that p p′ represents the poles, and the line joining them, a meridian

Fig. 7



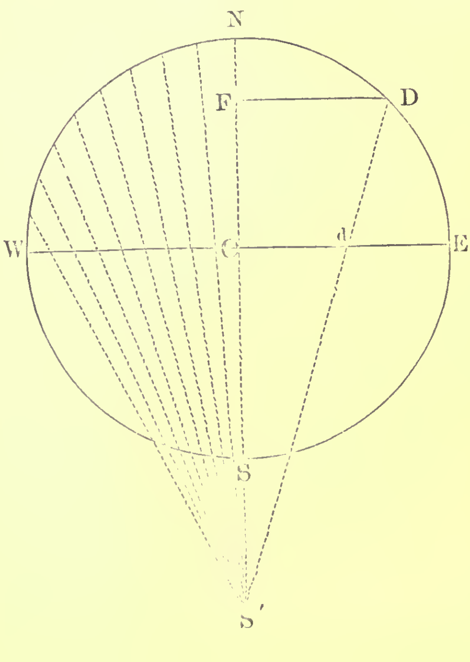
passing through the middle of the hemisphere, (the meridian, in fact, of London, whose place is at L, in the zenith of its horizon, N E S W,) and accordingly, all the other meridians must meet this one at the poles, under angles equal to their difference of longitude from this meridian. If then we bisect the diameter p p′ in C, and with C p for radius, describe the arc W p E, it will be the projection of a meridian at 90° from the meridian of London.

All the other meridians will have their centres on the line A C B drawn perpendicularly to p p′, and their places are found thus:—From p, as a centre, describe a circle with any radius, say p C, and divide it into thirty-six equal parts, beginning at C. Then from p, through these divisions, draw lines till they meet the line A C B, and their intersections with it will be the centres for describing the meridians.

In the two figures, 5 and 7, we have drawn only a few of the meridians and parallels, in order not to create confusion by the great multiplicity of lines: it will be self-evident to the reader, that whatever constructive operations are described for one side of the central meridian, must also be performed on the other in the opposite direction, in order to complete the projection of all the circles. It is also with a view of avoiding too many lines that we have not traced the *polar* nor the *tropical circles*, but as their distance respectively from the poles and from the equator is known to be twenty-three and a half degrees, nothing more is necessary for tracing them than to set off those distances on the quadrant from the N and S points of the central meridian, and from the E and W points of the equator, and then describe these circles by the same processes as have been explained for the parallels.

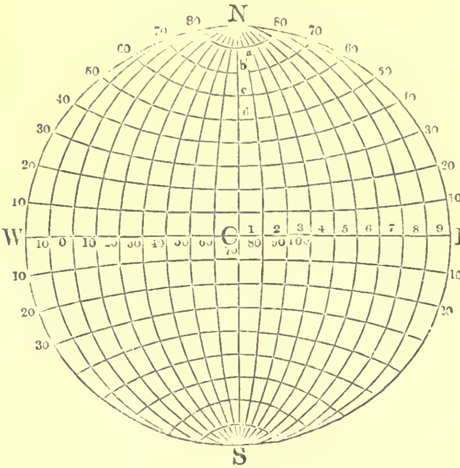
The Globular Projection.—We have seen that, whereas in the orthographic projection, equal spaces on the globe become very much contracted towards the extremities of the projections, they are, on the contrary, greatly enlarged at those parts in the stereographic. In order to rectify these opposite defects, La Hire conceived that between the indefinite distance at which the eye is supposed to be in the case of the orthographic projection, and its position at the surface of the sphere in the stereographic projection, there must be a point from which they would be, if not wholly compensated, at least greatly reduced, and this point he determined to be at a distance from the surface of the sphere equal to the sine of the angle of 45°, or what is the same thing, if the meridian N S (fig. 8) be 200 parts, it must be prolonged 70 of these parts to S′. If, then, visual rays be drawn from S′ to the divisions of the quadrant, their intersection with C W will determine spaces much more equal than in the former projections. Indeed, if F D be the sine of 45°, it is evident that a line drawn from S′ to D will exactly bisect the radius C E in d, so that the equal arcs E D and D N are represented by equal spaces E d and d C. All other arcs, however, will not be so exactly represented by equal spaces. The geometrician, Parent, found that by placing the point S′ at only $59\frac{1}{2}$ parts from S, all the inequalities of the spaces on C E or C W would be the least possible; but in order to have the zones of the hemisphere respectively proportionate to those of the sphere,

Fig. 8



the point S′ must be placed at 110½ parts from S. Still this projection, however modified, is very defective, inasmuch as the parallels and the meridians do not intersect each other in it at right angles. It is, moreover, difficult to construct, as all the parallels and meridians are represented by ellipses.

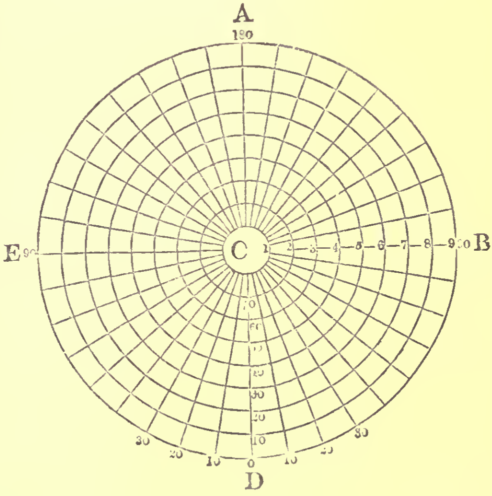
Fig. 9



THE EQUIDISTANT PROJECTION.—We have said that in the globular projection, the spaces representing equal arcs of the sphere are *nearly* equal; whenever, therefore, this projection is used, there is very little disadvantage resulting from rendering them exactly equal, and when this is done, the projection is called the *Equidistant.* Its mechanical construction is as follows:

Describe a circle N E S W, (fig. 9,) and draw two diameters, N C S for a central meridian, and W C E for the equator. Divide each of the quadrants into nine equal parts, and each of the semi-diameters, C N, C E, &c. also into nine equal parts. Then find on the prolongation of N S both ways, the centres of circles whose arcs must pass through 80 a 80, 70 b 70, 60 c 60, &c., and these arcs, described both on the North and on the South of the equator, will be the parallels. In like manner, find on the prolongation of W E both ways, the centres from which to strike the meridians, all of which must join at the poles, and pass through the points 1, 2. 3, 4, &c. Having selected that meridian which is intended for the first, number the others successively 10, 20, &c. to the right and left of it.

Fig. 10



For a polar projection, (fig. 10,) describe the circle A B D E; this will represent the equator. Draw two diameters at right angles to each other, A D and E B, for two meridians at ninety degrees apart. Divide each quadrant into nine equal parts, and also each of the four radii C A, C E, &c. into the same number. From the centre C describe circles passing successively through the points 1, 2, 3, &c.; these will be the projections of the parallels. Now draw lines from the several divisions of the quadrants through the centre to the divisions on the opposite quadrants, and these diameters will be the projections of the meridians. Place the numbers denoting the degrees of latitude 10, 20, 30, &c., upon the central meridian from the equator towards the pole, and from the same meridian place the degrees of longitude on either side half round to 180°.

Having thus described the three principal projections employed for representing the hemispheres, whether North and South, East and West, or those bounded by the rational horizon of any place and of its antipodes, we will now pause a moment to recapitulate their several defects and relative advantages; as to the defects, in some shape or other, they are unfortunately irremediable.

In the Orthographic projection—1st. The parallels are projected in straight lines, and the meridians in ellipses. 2nd. Equal spaces and distances on the sphere are represented by unequal spaces. 3rd. The spaces *lessen* successively from the centre towards the circumference of the hemispheres. The consequence is, that while the central parts are nearly in their correct proportions, those at a distance from the centre are terribly distorted in form and diminished in magnitude.

In the Stereographic projection—1st. The parallels and meridians are all projected in arcs of circles. 2nd. In this, as in the Orthographic projection, equal spaces and distances on the sphere are represented by unequal spaces. 3rd. These spaces *increase* successively from the centre towards the circumference, so that the parts near the circumference are much too large in relation to those near the centre; but as the parallels and meridians intersect each other at right angles, the *forms* of the several regions are better preserved than in the Orthographic projection.

In the Globular and Equidistant projections (which differ chiefly in this, that in the former all the circles of the sphere are projected in ellipses with small eccentricity, whereas in the latter they are projected in perfect arcs of circles)—1st. Equal spaces on the sphere are represented by equal or nearly equal spaces on the projection, and accordingly the *relative dimensions* of the several countries are more correctly obtained; but as the rectangular spaces on the sphere are not represented by similar spaces on the projection, the *forms* of the countries are greatly distorted, and the more so the further from the centre; because the nearer to the circumference, the more do the intersections of the meridians and parallels differ from right angles. Nevertheless, from the great ease with which the equidistant projection is executed, it is very frequently adopted. As for the Globular, some geographers, La Croix amongst others, give it the preference over the two other projections. We, for our own part, prefer the Stereographic.

It is almost needless to observe, that the defects of these several projections are equally sensible, whether they be equatorial, i. e. on the plane of a meridian, or polar, i. e. on the plane of the equator. This will be evident from simple inspection of the figures; though in the case of the Stereographic projection, the enlargements affect the opposite regions in the equatorial to what they do in the polar projection, so that, in some degree, the judgment may be rectified by using both. In the case of the Equidistant projection on the plane of the equator, it will be seen that the degrees on the equator and on the parallels immediately adjacent, are much larger than the degrees on the meridians, and accordingly, countries situated in the equatorial regions must have their dimensions in longitude greatly exaggerated.

Upon the whole, as these several projections are never used but for planispheres, the defects we have endeavoured to point out are not perhaps of any great practical consequence, particularly as this kind of map is only consulted with a view to having a general idea of the relative bearings and positions of the great divisions of the terraqueous globe; and certainly, of these projections the most interesting and instructive are those on the plane of the horizon of the capital of the country for which the map is designed. It is indeed matter of surprise that we see none such constructed on a large scale. Unfortunately, but few map-makers will take the trouble to construct them.*

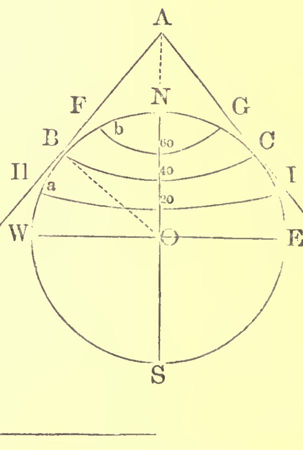
A very useless custom still prevails with some map-makers of representing on their planispheres and globes the tracks of the 'Endeavour' and 'Resolution.' Far be it from us to detract in the least from the merits of the immortal Cook; his glorious achievements are too indelibly impressed on the national mind, and have had too great an influence on the commerce of our country; have too largely contributed to its fame ever to be forgotten; but we think that what was not only justifiable but highly proper at the time, from the novelty of Cook's explorations and the wonders brought to light by his circumnavigation, is no longer so, now that vessels of all the great maritime nations have followed in his track and made the tour of the globe, and we hold that no map should contain a single feature that is unnecessary.

We come now to the other projections we have named. As the former were, so to say, perspective representations, those that remain to be spoken of are more properly developments.

The utter impossibility of fulfilling all the conditions of a perfect representation of a spherical on a flat surface by any of the means we have detailed, led to the search for others less defective. It was considered that as cones and cylinders are simple curves, susceptible of being developed or opened out, without that operation effecting the slightest alteration of these surfaces, or the distortion of anything represented upon them, and that as these figures correspond pretty nearly with portions of a sphere, the latter might be transferred to the former, whose development would then give nearly correct representations.

The Conic Projection.—Let N E S W (fig. 11) represent a sphere, and A B C a cone circumscribed about it, so as to touch it at the latitude of forty degrees. It is evident, that at the parallel of contact, the spherical and the conical surfaces correspond exactly, and this parallel will be represented on the development of the cone by a circle, drawn from its apex A, with the radius A B. Consequently, any portion of this parallel on the sphere will be identical with its corresponding portion on the cone. Not so, however, with the parallels above and below it, as those of 20° and 60°. Here the sides of the cone recede from the sphere, and accordingly the circles representing these parallels, and drawn upon the cone from A, with A H and A F as radii, will be somewhat too large. The difference nevertheless is but trifling, as the surface of the spherical zone comprised between the given lati-

Fig. 11



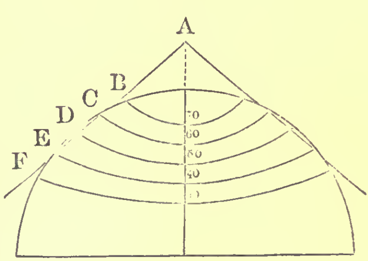
* Mr. W. Hughes has published a very beautiful map of the world, in two hemispheres, projected on the rational horizon of London and its antipodes; London being in the centre of one hemisphere, and a point a little to the S. E. of New Zealand in the middle of the other. Concentric circles are drawn round these centres at the distance of 1000 miles apart, and the points of the compass being marked round the borders, the bearing and distance of any place from London are at once ascertained. It will further be seen by this map, that London is in the exact centre of all the land portion of the earth; the opposite hemisphere being all water, with the exception of the tail-piece of South America, and of Australia and its surrounding islands. This little map is exquisitely engraved, and is highly interesting on every account.

tudes is nearly the same as that of the conic frustrum H F G I; the line H F differing but little from the arc a b.

In constructing this projection, it is usual to make the cone coincide with the central or mean parallel of the country it is intended to map, and accordingly, all the distances along that parallel are as exactly laid down on the map as on the sphere itself, whereas those on the extreme northern and southern parallels will be a little too long, by an absolute quantity, however, so much the less as the spherical zone is the more contracted in the direction of the latitude, and *vice versa.*

There are, however, other modes of conceiving the conic projection. Of these, the best is that which was adopted by Delisle de la Croyère for a general map of Russia. According to this method, the cone is supposed to be *inscribed* instead of being *circumscribed,* and it is made to enter and leave the sphere in such a manner that it coincides with it at *two* parallels, each of which is intermediate between the central one, and one of the extremes. By this means, the distances on the map are perfectly correct along the two parallels, where the surface of the cone coincides with that of the sphere, as at C and E (fig. 12), while at the intermediate parallel D 50, the distance is a little too short, and at the extreme parallels 30 and 70, a little too long. The errors are thus more equally distributed over the map; and when the extent of latitude embraced by the map does not extend beyond thirty or forty degrees, the representation approaches very nearly to exactitude.

Fig. 12



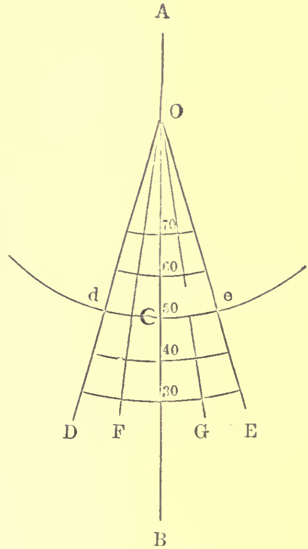
In the conic projections, strictly so called, the parallels are always arcs of circles, and the meridians straight lines drawn from the common centre of the circles, the apex of the cone. This rule has, however, been occasionally modified in the way we shall presently describe. The mechanical construction of the pure conic projection is as follows:—

When a hollow cone is placed upon a sphere, the side of the cone forms a tangent to the angle comprised between the axis of the cone and a perpendicular let fall from the point of contact of the cone with the surface of the sphere to the centre of the sphere, and is a co-tangent of the complement of that angle. Thus, in fig. 11, the side A B of the cone A B C, is the tangent of the angle A O B, and co-tangent of the angle B O W. But the arc W B expresses the latitude of the central parallel B 40 C, with which the cone coincides; and as this holds good, whatever be the parallel chosen, it follows that in determining the projection, in the case of a circumscribed cone, the side of the cone must be made equal to the co-tangent of the latitude of the middle parallel. The absolute length must be found in degrees and minutes of latitude thus:—

Draw an indefinite line A B (fig. 13) to represent the central meridian of the map, and from any convenient point, say C, through which it is intended to make the central parallel (say that of fifty degrees) pass, set off above and below, and at such distance apart as shall represent ten degrees of latitude, according to the proposed scale of the map, the points through which the other parallels are to be drawn. This done, say—As the circumference of a circle, or 3·1416, is to its diameter or 1, so are the 360 degrees of the circumference to x degrees, the number contained in the diameter. This will be found to be 114·591 degrees, and accordingly the radius will contain the half of this, or 57·295; and this being multiplied by ·839, the co-tangent of 50 degrees, (the latitude of the central parallel,) gives 48·070505, or 48° 4′ 13″, which, being taken from the marked off latitudes as a scale, and set off from

C towards A, determines the length of the side of the cone or point O, from which the parallels through 60, 40, &c. are to be struck, and to which all the meridians must converge. Strike from the point O, thus found, an indefinite arc through C; next find the angle which the extreme meridians of the intended map must make on either side with the central meridian O B. For this we must consider, 1st. That the number of degrees contained in two arcs of equal length is as their radii, and that while any arc of the parallel C on the sphere has the cosine of its latitude for radius, the corresponding arc of the cone developed will have the side of that cone for radius. Now, the side of the cone has been shown to be the co-tangent of the latitude of C. Hence, if we suppose the map to contain forty degrees of longitude, the angle corresponding on a plane surface to that number of degrees, in the parallel of 50°, will be as the co-tangent of 50° is to the cosine of 50°; or, what is the same thing, as 1 (radius) : ·766 (sine of 50°) : : 40° : 30° 38′ 21″, the angle required.

Fig. 13



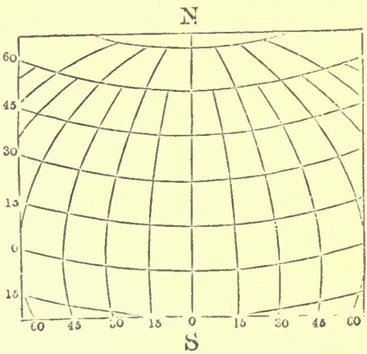
Set off half this angle on each side of O B, and draw O D and O E for the extreme meridians, they will intersect the indefinite arc in d and e, the space between which will represent, or be the development of the forty degrees of longitude required for the map. Next divide C d and C e each into two parts, the spaces thus obtained will be ten degrees of longitude each; through them draw the other meridians O F and O G. Finally, from O describe arcs, concentric with d e, through the several points marked off at 60, 40, &c. on the central meridian; then will the space contained between the extreme meridians and parallels be the conic projection or development of a corresponding portion of the spherical zone, comprised between the latitudes of thirty and seventy, and embracing forty degrees of longitude, and this development will be a correct representation of the corresponding spherical surface, except in as much as the parallels above and below the central one will be a little too large.

A simpler mode of drawing the meridians is to take from a table the number of miles contained in one degree of longitude at the mean parallel, (or find it by the rule—radius is to cosine of latitude as 60 is to x,) and ten times this (taken from the scale which served to determine the degrees of latitude on the central meridian), set off twice on each side of C on the indefinite arc, will give the points through which to draw the meridians O F, O G, O D, and O E.

In order to find the side of an *inscribed* cone, as at fig. 12, say—As 57·295 (the degrees of the equator contained in the radius of the sphere) is to the co-tangent of the central latitude, so is the cosine of the arc contained between the central latitude and either of the parallels through which the cone is to pass, to x. This distance from the middle parallel, measured on the central meridian produced, will give the apex of the cone, from which to strike the curves representing the parallels.

With a view to obviate the errors in distance, measured on the outer parallels as above alluded to, Murdoch proposed, besides the inscribed cone already mentioned, other methods of conic projection. Euler, also, and others, have entered into profound researches, and given directions for different modifications of the projection we are now considering; but as they only deprive it of its simplicity, without effectually correcting its errors, we shall not describe them, still less the method of Ptolemy which resembles the conic projection. There is, however, one modification of Ptolemy's method, due originally to Flamstead, but subsequently improved, which, being still employed, deserves notice. It consists in the substitution of curves for the straight lines representing the meridians, and is thus effected:—

Fig. 14



Having drawn, as before explained, a vertical meridian N S, (fig. 14,) and described the central parallel with a radius equal to the co-tangent of the latitude of that parallel, and also described the several other parallels as concentric arcs, passing through their proper points on the central meridian, mark off (as many times as is necessary for the longitudinal extent of the map) on each side of this meridian, and on every parallel, the length of ten or fifteen degrees of longitude, according to the law of their respective decrease, which for each parallel is as the cosine of the latitude to the radius. Then through these points describe curves for the several meridians. In our figure, the parallels and meridians are drawn at fifteen degrees apart, and the areas on the globe are represented by equal areas on the projection, but as the forms are dilated in proportion as they recede from the centre, distances can only be measured along the parallels or the meridians. This defect is still further increased by the little attention paid by the generality of map-makers to the point from which they describe their parallels, which, instead of being at the distance of the co-tangent of the central latitude, is determined by the convergence of any two meridians, arbitrarily taken. The distortion that results is particularly seen in the ordinary maps of Asia.

The next and last projection we shall describe is—

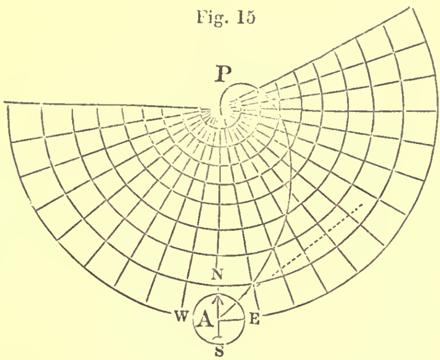
The Cylindrical, or Mercator's Projection.—This projection being destined solely for the use of mariners, and having comparatively little interest in a geographical point of view, might be altogether omitted in our present enumeration, were it not that every atlas contains it, and that many persons consult it in preference to the planispheres, when they would have a more satisfactory idea of the relative bearings of those parts of the globe whose contiguity is so awkwardly interrupted by the diverging circumferences of the two hemispheres.

The cylindrical projection was introduced by Mercator, whose name it bears, in 1556. In order to understand the necessity which existed for a projection differing entirely from any of the preceding, it must be remembered that navigators require charts by which they may direct their course, and lay it down with facility. So long as they have to sail due north or south, east or west, the ordinary projections might answer their purpose, but this is no longer the case when the place for which they have to steer lies between the cardinal points. If a vessel starting from any point of the equator, for instance, were to steer a direct N.E. course, such vessel, if land did not intervene, would describe a spiral round the northern hemisphere, and arrive ultimately at the Pole.* This curve is called the *Loxodromic* line. The way in which it is engendered is this. The meridians all run due

* Mathematically speaking, it could never reach the pole, as for this, it must steer due north.

N. and S., the parallels E. and W., these circles cutting each other at right angles; but while the parallels, as their very name implies, are everywhere at equal distances from each other, the meridians approach nearer and nearer the higher the latitude. Now, as a vessel steering constantly N.E. must move along everywhere by a line 45° from the meridian, and as the direction of every meridian differs, so the vessel's course, after first starting from the equator, will describe the spiral, or loxodromic, curve, and this will be the case on whatever *rhumb* the vessel may steer, for she will always have to intersect the meridians under the same angle, which she can only do by describing the curve. Were she to proceed in a straight line, she would cut every meridian she passed under a different angle, and, consequently, never make the port for which she was bound.

Fig. 15



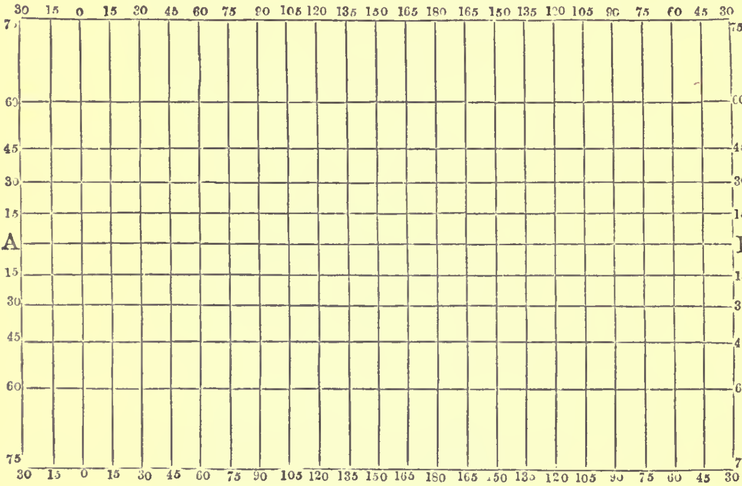
To render this sensible, fig. 15 represents a portion of the sphere projected stereographically on the plane of the equator, in which P is the pole. Now it is evident that if a vessel start from the point A, and steer constantly in a N.E. direction by compass, her course must constantly form an angle of 45° with the meridian; but as every meridian forms an angle with the one just passed, so, in order to form with them successively the same angle, the vessel must in fact change her direction every instant, and describe a curve. If she were to proceed on a straight line, she would make with every meridian successively a greater angle than 45°, till at length she would find herself at some place due east of that from which she set out; to effect which, however, she would have to change her compass-bearing every moment.

For the facility, therefore, of determining and laying down his course, the mariner required such a projection as would enable him, while steering by his compass, to deal with straight lines only on his maps, and accordingly Mercator, who had before introduced the stereographic projection, invented the cylindrical, as we shall now describe it.

Let us suppose a cylinder to circumscribe a sphere in such manner that the axis of the two shall exactly coincide, and the cylinder be in contact with the equator. If now the planes of the parallels be extended beyond the surface of the sphere till they meet that of the cylinder, their intersections with it will form a series of circles parallel to each other and to the base of the cylinder: and if, in like manner, the planes of the meridians be extended till they intersect the cylinder from top to bottom, the intersections will be straight lines equidistant from each other. If, next, the cylinder be slit open in the direction of one of the meridians and laid out flat, it will represent a cylindrical projection of the globe, in which all the parallels will be straight lines, and the meridians also straight lines perpendicular to the former. But while the distances of the parallels from the equator would be the sines of the latitudes, and accordingly so much the nearer to each other as they approached the poles, the meridians would be everywhere equidistant; that is to say, the relation of the parallels and meridians would be the very reverse of what is required in order that the proper relative proportion between them be preserved. For as the length of the degrees of longitude diminish as the parallels approach the poles, whereas, on this projection, this length is made equal on all the parallels, it becomes necessary to *lengthen* the degrees of latitude on the projection in the same proportion as the degrees of longitude really diminish on the sphere, to effect which is extremely easy in practice.

A line A B, (fig. 16,) is drawn of the length required for the development of the equator, according to the intended dimensions of the map. This line being now divided into 36 or 24 equal parts, for as many meridians at 10° or

Fig. 16



15° apart, (in our figure we have taken 15° in order to have fewer lines,) draw the meridians perpendicular to A B. Now take from a table of meridional parts the requisite distances of the several parallels and of the tropical and polar circles from the equator, and set them all off on the outer meridians to the N. and S. of the equator; join these points and the lines are all projected. Nothing now remains but to select the first meridian according to circumstances, and then to graduate the top and bottom borders of the map in the usual way, E. and W. from the first meridian, and to indicate the degrees of latitude N. and S. of the equator upon the two extreme meridians.

The meridional parts in the table just alluded to, (and which is also called a table of increasing latitudes,) are the number of minutes of a degree of longitude at the equator comprised between that great circle and every parallel of latitude up to 89°. It would be foreign to our object to enter here into any detail of the mode of calculating the table.

From the principles of the projection just described, it will be evident that the relations of length and breadth, that is, the figures of the several countries, are perfectly accurate; but that, as the length of the degrees of longitude and those of latitude are greatly exaggerated towards the poles, the relative magnitudes of countries near them, as compared to those near the equator, are grossly incorrect. But this, to the mariner, is of no consequence; his object is to be able to lay down the route he has traversed, in straight lines, and to see the straight-line bearing of the point he is immediately bound for, so as to shape his compass-bearing accordingly, and this the charts on Mercator's projection enable him to do with the greatest ease and most unerring certainty. It is evident that, owing to the inequality of the degrees of latitude and longitude, no *distance* from one place to another can be ascertained but by calculation.

We have stated that a Mercator's projection of the globe is often consulted by the geographer, and we are most desirous, for his purpose, that it be always extended in longitude so as to exhibit *both* the Atlantic and Pacific oceans in their integrity. With this view we would not only carry the longitude 180° east and west of Greenwich, but repeat the last 80° of east longitude on the western side, reckoning back from 180° E. to 100° E. By this means the continuity both of the lands and the oceans would be represented in the most satisfactory manner. Mercator's projection, when designed solely for charts, contains only the details of the coast, islands, soundings, and rhumb lines; but for geographical purposes, they should differ in nothing from other maps, but in the mode of projection.

Having thus explained the nature and construction of the most customary projections, we will merely observe, that there have been proposed and effected several modifications of them; but, generally speaking, if these rectify errors in some particular respect, they increase them in others, or else they offer practical difficulties of execution, which are not compensated by any sufficiently important advantage.

Choice of Projections.—From what has preceded, it will be evident that all the projections are not alike suitable for all purposes. In order to represent the whole surface of the Earth at one view, we must use either the planispheres or Mercator's projections. As regards the former, we have already stated our opinion that the Stereographic projection is the best; though, for our own use, we prefer a Mercator's projection to any map of the two separate hemispheres. When the planispheres are used, the projection is usually made on the plane passing through the twentieth meridian of West longitude from Greenwich, by which arrangement the continuity of the great continents, called the Old and the New Worlds, is uninterrupted. As maps of the world are constructed for the purpose of exhibiting the relative positions of countries, and the bearings of their principal ports and cities, the general forms and extent in longitude and latitude of the grand divisions of the land and of the water, &c., it follows that minute details are not required. Maps of the world, therefore, should contain nothing beyond the contour of the land and water as correctly as possible; the islands with which the ocean is studded, the great streams, the great mountain-chains, the ports and harbours, the capitals and more important towns. Hence it is not necessary that maps of the world should be large; but we shall treat of the scales of maps presently.

In choosing the projections for the maps of the grand divisions of the Earth, and for particular countries, attention must be paid to their form and their extent in latitude and longitude, in order that the defects of the projection may, as much as possible, be thrown into those parts where they will be of the least importance. With this view, the conic projection has been generally chosen, either pure, or in some one of its modified forms, according to the taste or preference of different geographers and map-makers.

Map of Europe.—For Europe, the pure conic projection is unquestionably the best. It is produced by the development of a cone, supposed to intersect the sphere at the latitudes of 45° and 65°, these being intermediate between the mean latitude of Europe, 55°, and the extremes, 35° and 75°. On such a map of Europe, the distances on the two parallels of 45° and 65° are precisely the same as on the sphere, while the deficiency on the intermediate, and the excess on the extreme parallels, being distributed generally over the map, and in themselves very trifling, are of no practical importance. The rectangular spaces on the globe, formed by the intersections of the parallels and meridians, are represented by similar rectangular spaces on the map, and consequently there is no distortion of form. Finally, distances measured in straight lines on the map, very nearly coincide with the shortest distances as measured on the surface of the sphere. No other projection could combine so many advantages, and accordingly we find this projection generally adopted for maps of Europe.

Some geographers may perhaps be content with the development of a *circumscribed* cone, tangent to some parallel near the centre of the map. In this case, we think the best would be that of 50°, by which means the greater correctness would be found in the more important parts of Europe, while the errors in excess would be thrown into the comparatively little important regions of the extreme North on the one hand, and, on the other, over the waters of the Mediterranean and the Black Seas, and the extra European countries, as Asiatic Turkey and a portion of Northern Africa. The central meridian of our maps of Europe generally passes through the twentieth degree of East longitude from Greenwich.

Map of Asia.—The same mode of proceeding, as that we have just described for a map of Europe, may be adopted for one of Asia, making the cone intersect the sphere at the parallels of 25 and 60. It is true, that as Asia embraces a greater extent of latitude than Europe, the errors of deficiency and excess on those parts of the map that are furthest removed from the parallels intersected by the cone, will be somewhat greater than in the map of Europe. But if we exclude the Eastern Archipelago, we find that the extreme South latitude of Asia comprises only the Malayan peninsula, the southern point of Hindostan and the island of Ceylon; while beyond the fifty-fifth parallel of North latitude, there is nothing but the little known frozen steppes of Siberia. We cannot, therefore, see why the pure conic projection, which offers so many advantages, should not be adopted in preference to that distorting modification of it, which we have explained at fig. 14, in which the meridians are projected in curves. It is certain that this method presents upon the map *areas* equal to those on the sphere; but this advantage is counterbalanced by the impossibility of measuring distances except along the parallels and meridians. The custom, however, is to make use of Flamstead's modification. The central meridian for a map of Asia is usually that of 85° East of Greenwich.

Map of Africa.—The position of Africa, extending, as it does, to nearly forty degrees North, and as many South of the equator, renders it impossible to apply to it, as a whole, any modification of the conic projection. If it were projected on two cones meeting by their bases on the plane of the equator, these cones when developed would present parallels whose curvature would be in opposite directions, those to the North of the equator being concave towards the North pole, and those to the South convex towards that pole; whence it follows that the equator would be represented by two diverging curves, touching only in a point, and the contiguity of the continent consequently broken in a most unseemly and inconvenient manner. Northern and Southern Africa are sometimes given separately, and in such case the conical projection is applicable with advantage. But if, on the one hand, the conic projection be not possible for Africa as a whole, so on the other, if the cylindrical were adopted, it would exhibit all the defects of a Mercator's projection, while its peculiar advantages would have no application. A particular projection therefore, is employed, which so far resembles the Orthographic projection described by us at fig. 2, that all the parallels are straight lines; but while the parallels on the Orthographic projection approximate nearer to each other as they recede from the equator, they are all made equidistant in the projection used for a map of Africa. The meridians are projected in curves passing through points on the parallels determined by the rule of decrease in the degrees of longitude at the different latitudes. The central meridian is at fifteen degrees East of Greenwich.

This projection has been employed by J. B. Nolin for each of the four quarters of the world; its great objection is in the disfigurement of the forms by the obliquity of the meridians in respect to the parallels, particularly towards the extremities of the map, and which renders it impossible to measure distances except along the parallels.

MAP OF NORTH AMERICA.—As this portion of the world, like that of Asia, lies between the fifth and eightieth parallels, the map may be projected exactly like that of Asia, either according to the pure conic, or to Flamstead's modification of it. If the first be chosen, we would say, that upon the principle already alluded to, of throwing the errors into those parts of the map where they will be of the least consequence, it would be advisable to make the cone intersect the sphere at the thirtieth and fifty-fifth parallels instead of the twenty-fifth and sixtieth, and for this reason, that while the greatest amount of error in longitudinal distance would be removed to the barren and little known regions of the North, on the one hand, and to the very narrow portion south of the thirtieth parallel on the other, the distances along the broad and most important part of the region, comprising the whole of the United States, and the settled portions of Canada, would be more correct than if the cone intersected the sphere at parallels more distant from each other. Mr. William Hughes, whom we have great pleasure in mentioning as one of our most scientific geographers, and whose opinion has in general great weight with us, recommends placing the northern entrance of the cone at the sixtieth parallel, but by the adoption, as we recommend, of the fifty-fifth instead of the sixtieth, accuracy is brought still more within the important parts of the map, while the errors in longitudinal distance will still be but trifling at sixty degrees, beyond which, the nature of the country renders the errors in distance of very little moment. Most geographers, however, prefer Flamstead's modification for the map of North America, as for that of Asia. The central meridian for a map of South America is that of 100 degrees West of Greenwich.

MAP OF SOUTH AMERICA.—As by far the greater part of this continent lies to the South of the equator, the modified conic projection is sometimes employed for it; but the parallels being very slightly curved, owing to the great length of the radius from which they are drawn, it possesses very little advantage over the straight-line parallels adopted for the map of Africa, and accordingly the latter mode is, by most map-makers, preferred for the map of South America. The central meridian is that of 60° West, and as the land at the southern extremity of the continent extends but a short distance from this central meridian, the distortion arising from the difference in the diagonals of the quadrangular spaces will not be great, nor indeed, if it were, would it be of much importance, considering the little consequence of strictly correct general measurements of Patagonia.

From what has been said, it will be evident that the conic projection can be applied without any material practical disadvantage to the mapping of Europe, Asia, and North America. It is still better adapted to the less extensive regions of the Earth's surface, provided they be not situated immediately on the equator. And, moreover, that whenever the extent in latitude does not exceed thirty or thirty-five degrees, there is very little difference indeed between the distances measured on the map and those on the sphere. For countries on the equator, it is advisable to employ the projection described for the maps of Africa and South America.

In practice it will often be found, that the centre from which the parallels should be described are at such a distance, that it becomes impossible to strike the arcs in the usual way, and accordingly recourse is had to expedients which answer the same purpose, and the details of which will be found in works *ad hoc.*

It is customary with some map-makers to represent the islands of the Pacific on a Mercator's projection, extending to forty or fifty degrees on either side of the equator, and such is the minuteness of these islands generally, that their forms and dimensions cannot be influenced by errors of projection; but their distances and bearings from each other are important, and accordingly we ourselves prefer employing for this great region the projection recommended for the map of Africa.

DIFFERENT KINDS OF MAPS.—The term *Map* is more particularly applied to representations of the land or land and water together, while that of *Chart* is limited to the water surface only, including indications of currents, soundings, anchorages, rocks, shoals, buoys, lighthouses, and other objects of importance to the mariner, for whose use they are specially designed.

Maps are of two kinds, *Geographical* and *Topographical*, and the former are either *general*, such as the maps of the hemispheres, the four quarters of the world, and the great empires and states, or *particular*, (called also *Chorographical*,) such as the maps of provinces, counties, &c. Topographical maps differ from those called Geographical by their more numerous details. In order that every feature, both natural and artificial, of the surface be represented, the scale of the map must be proportionably large, and hence topographical maps usually embrace a smaller extent of country than geographical maps, though there exist topographical maps of most European kingdoms. Generally, however, they are confined to much smaller surfaces, as counties, parishes, the environs of capitals and large towns, fields of battle, &c. Between the geographical and the topographical map there is an intermediate kind, termed *semi-topographical*, which contains more detail than the geographical, and less than the topographical.

Besides the maps required for pure geography or for topography, there are others constructed for special purposes, involving locality as an essential element. These purposes may be political, civil, military, statistical, ethnographical, historical, physical, &c., and their several subdivisions: in the present work, however, we must confine ourselves to geographical and topographical maps.

As the difference between geographical, chorographical, semi-topographical, and topographical maps, consists not in the size of the maps, but in the amount of detail they represent, so the possible amount of this latter depends entirely upon the scale to which the map is engraved.

On the Continent, it is the custom to state the scale of maps in proportional parts of nature. The scales of general and chorographical maps range from a two-millionth to a two-hundred-thousandth. The first, which is equivalent to about thirty miles to an inch, admits of the insertion of principal mountains, rivers, great towns, and remarkable places. A scale of a two-hundred-thousandth, or about three miles to an inch, admits of the introduction of lesser towns and villages, noted hills, rivers, woods, marshes, main-roads, &c.

Topographical maps range in scale from a one-hundred-thousandth, or 1·5 miles to an inch, to one-ten-thousandth, or six inches to a mile, which is the scale of our Ordnance map of Ireland. This latter scale admits the representation of the minutest details; every accident of the ground, every hamlet, every small stream, every by-path, may be laid down on such a map. Maps upon a larger scale than one-ten-thousandth are rather to be considered as plans.

Whatever be the scale on which a map is engraved, it is generally a reduction from original drawings on a much larger scale: sometimes from regular surveys, laid down on so large a scale that the minutest topographical details are delineated. Maps of little known countries, that have never been regularly surveyed, are either drawn and reduced from the rough sketches of the routes of travellers, and points laid down by them from distances and bearings, or are protracted by the map-maker from the traveller's note-book. Generally speaking, all maps, as they now exist, (of extensive regions,) are the result of a combination of astronomically determined positions, of regular surveys, and of travellers' routes and relations, and they are successively improved as the spread of civilization offers greater facility for the exact determination of positions. When we compare any of our modern maps with those of ancient construction, we are struck with their dissimilarity, and the extraordinary distortion in the shapes of countries as formerly laid down, and we are apt to consider our modern maps as perfect. They certainly come much nearer to the truth than the older maps, and it is perhaps not too much to say, that, omitting the details of certain coasts little frequented, or still unexplored, the coast lines of the globe are pretty correctly mapped as to general outline. In like manner the latitudes and longitudes of all capital towns and ports are, perhaps, as nearly correct as imperfection in instruments will permit. Some few are found to be incorrect owing to the imperfect state of the instruments, otherwise good, with which the observations were taken at the time, and in some cases to want of ability in the observers. Such incorrect positions, however, are becoming every year fewer, as fresh observations are made with improved instruments and greater care; and the time is probably not far distant when every place of note will be set down in its proper position on our maps as nearly as possible. It is, however, far otherwise with the other details of some of the most extensive regions of the earth. Thus, the interior of South America, though, to the eye, well filled in upon the map, offers but a distant approximation to truth; and when, in after years, the axe shall have cleared the secular forests of that portion of the New World, and the vast regions that extend from the Andes to the Atlantic, shall be covered with the abundant harvests and the habitations of a dense population, the maps of the country then constructed will, upon a comparison with those now existing, show our descendants how wide of the truth were our maps in the position of many places, and how totally different the true course of its rivers from what we now figure them with such show of accuracy. In like manner, a great portion of North America, and the whole of the interior of Africa, remain yet untouched by the astronomical observer and the surveyor, and the same may be said of the greater part of Asia. As these several regions become explored by the scientific traveller, the maps of them are improved. The greater part of Europe alone and of the United States may be said to be correctly mapped from trigonometrical surveys. Indeed, if nothing were set down on the maps of other parts of the earth but what has been really determined in a satisfactory manner, the maps of them would present, for the most part, so much blank paper. We have often thought it were greatly to be desired that some enterprising and competent geographer would publish a set of maps in which the really known, the tolerably exact, and the merely presumed, should be distinctly marked; it would prevent the loss of time incurred by going over again what is known, and would point out what yet remains to be done for the exact representation of the earth's surface, and the correct setting down of man's various habitations.

Reduction of Maps in general.—We cannot go into the details of the geodetic operations by which a country is surveyed. This belongs to treatises on geometry and trigonometry; suffice it for us to say, that where the materials exist, topographical maps are reduced from the plans trigonometrically surveyed on the ground. Chorographical maps are produced by the assemblage and reduction of the topographical maps, and geographical, or general maps, from the union and reduction of chorographic, or particular maps, and it is in these reductions from the larger to the smaller scale that the details incompatible with the latter are omitted. We will first state briefly the mode in which these reductions are made, and then pass on to the construction of maps of countries which have not yet been topographically surveyed.

Having the original drawings of a topographical survey, the map to be made from them may either be, as is sometimes required, on the same scale, or on a reduced scale; in the first case, all that is requisite is, to unite the several parts of the survey into a whole, or into sheets, each of which is formed of two or more portions of the actual survey. To effect this, each portion of the survey must have at least two points in common with the portion which is to join it, and these points may be made to coincide, either by joining the two portions of the survey together, or by transporting the points on the clean paper which is to receive the contents of the sheets to which they belong in common. In this latter case, a line must be drawn through the two points, and extending beyond them as far as requisite, and having, in like manner, drawn lines through the two points on each of the original sheets, similar squares or other figures, starting from one of the points in question, must be drawn over the original survey, and over the clean paper to which it is to be transferred. The smaller these squares or other figures are made, the more exact the copy is likely to be. If we would avoid covering the original drawing with lines, a plate of glass, already marked into squares, may be applied to the original, taking care that the squares on the clean paper correspond exactly with them. All that is now to be done, is to copy each square successively by the eye. Essential points, however, should be transported by compass measurements. These operations must be continued till the whole is completed, taking especial care, as we have said, that there be always two points on each separate portion which correspond, or are repeated, on the separate portions contiguous to it.

When a reduction is required, it is very simply effected by making the squares or figures to be filled up on the paper, though they must always be the same in number and disposition, smaller in proportion to the extent of reduction required, remembering that the reduction of the surface is inversely as the square of the linear reduction. Thus, if the sides of the reduced quadrilateral figures are half the length of those on the original drawing, the surface of each square will be the quarter of the original. If the sides of the reduced squares are one-third, the surface will be one-ninth, and so on.

In France the separate portions of a survey are at once transferred upon the copper in the manner we have described, both when the scale of the engraved map and that of the original drawing are the same, and when there is reduction.

It does not always follow that, because the scale is reduced, any of the details of the original survey should be omitted; for the reduced scale may still be such as to admit of their distinct representation. Sometimes it is necessary to increase the scale of a map: but this is always attended, more or less, with the disadvantage of magnifying any errors that may exist, whereas the contrary operation of reduction diminishes, and sometimes wholly obliterates them.

Of Topographical Maps in particular.—The great advantage of topographical maps consists in the numerous details they supply; and, above all, in presenting the *relief* of the surface; that is, the heights and depressions so necessary to be known for all engineering and military purposes. A very great deal might be written on the modes of representing the mountains, the hills, and all the minor undulations of the ground on the flat surface of a map, but our space will not allow us to go fully into this subject. Various modes of drawing and engraving the hills have been, and still are adopted; but they may be classed under two principal heads. In the one, all that is aimed at is picturesque effect; in the other, a greater or less amount of mathematical precision has been *attempted*. In both, the disposition of light and shade is the mode by which effect is produced; but while, in the one case, the proportion of this light and shade has no other rule than the caprice or taste of the draftsman and engraver, in the other it is systematically regulated. In both the arbitrary and the systematic modes, the light is sometimes regarded as falling obliquely, and sometimes as falling perpendicularly. The following tabular view will, however, best convey an idea of the various modes adopted:—

Arbitrary.	Etched lines alone, these being . . .	Arbitrary in direction. „ „ in length. „ „ in thickness, and „ „ in distance apart. The light falling at an angle of 45°.	1.
Systematic and Arbitrary.	Etched lines alone, these being . . .	Systematic in direction; being the projections of the curves of greatest slope. Arbitrary in all else. The light falling at an angle of 45°.	2.
	Contour lines and etched lines employed together. This mode is . .	Systematic in the contour lines, which are at equal altitudes, but the altitudes varying according to the scale of the map and the nature of the country. Arbitrary in the etched lines in everything but their length, which is limited by the contour lines, between which they are drawn. The light falling at an angle of 45°.	3.
Systematic.	Contour lines alone .	Systematic, as in No. 3, the lines being drawn at equal altitudes, but which vary according to the scale of the map and the nature of the country.	4.
	Contour lines and etched lines employed together .	The contour lines as above. Etched lines. 1. Direction. } Length. } determined. Thickness equal. Spaces one quarter the co-tangent of slope. No regard to light.	5.
		Etched lines. 2. Direction. } Length. } determined. Thickness proportional to the sine of angle of slope. Spaces as the cosines. Light vertical.	6.
	Etched lines alone .	Determined in direction, length, thickness, and spaces.	7.

Besides the above seven modes there are several others, but which must be all classed under the arbitrary, except one, which is mechanical, and of which we shall say a word presently. In some of these the effect is produced by aquatinta shading, in others by stippling. In some maps the hills are represented in perspective; in some the shading is effected by etched lines, straight and waved, and dots, and all other modes which the engraver can devise to produce effect.

Of the several systems above mentioned, we may observe that, where picturesque effect is all that is wanted, the arbitrary modes are superior to the systematic; indeed, some maps executed according to this arbitrary method, represent, in the most striking and satisfactory manner, every undulation of the soil, from the gentlest rise to the highest and most abrupt eminences. They accordingly give a very perfect idea of the country, but are of no use for the exact purposes of the engineer, or for the operations of an army. This is easily conceived. The engineer who has to construct a canal, a railway, or any other kind of road, to form reservoirs, to drain marshes, &c., can be satisfied with nothing less than positive levels, and these the arbitrary modes of drawing hills, however effective they may be, do not supply. In like manner, the general must be able to see upon his map where artillery and other wheel carriages can pass, where his cavalry can act, and where none but his light infantry can advance; what heights command or are commanded, &c.; he therefore, like the engineer, must know the positive amount of the slopes, and must accordingly discard the more beautiful, though to him useless topographical maps, for those where he sees the actual slope and elevation of every foot of the ground.

As an example of arbitrary shading, we may mention the Ordnance map of England, which can be seen at any time. In this topographical map the effect is produced by etched lines; the light is supposed to fall upon the ground under an angle of 45 degrees, and on the map to come from the left hand upper corner; the shading is regulated accordingly, the greatest depth being given to the loftier and steeper eminences. Another and very beautiful example of arbitrary shading may be seen in the semi-topographical map of Sardinia, lately executed by General Marmora. In both these examples the shading is by etched lines. A map of very excellent effect as regards the hills, and which I shall have occasion to mention for another reason, has lately been executed at Vienna; in it the hills are in imitation of stippling, and the effect is truly excellent.

Of the systematic modes, we shall mention only numbers 4, 5, and 7, of our table; and first, of the method by contour lines alone, or the representation of the elevations of the surface by curves of equal altitude. This method, admitting of a very near approach to geometric accuracy, has for engineering purposes a decided advantage over every other, though in some respects it is not without its inconveniences. As it has been much talked about lately, and is again coming into use, its history, and some details respecting it, may not be unacceptable to the reader.

The first idea of the contour system is attributed by some to Philip Buache, but by La Croix to M. Ducarla, who, he says, considering that if a line were drawn joining all those points on a chart which are marked as having the same depths of water, the contour thus traced would be that of a section cut off by a horizontal plane everywhere distant from the surface of the water by so many fathoms, or feet, as are marked by the soundings—conceived a means equally ingenious and satisfactory of geometrically representing the elevations of the ground, or the *relief* of a country. We shall occasionally employ this term *relief*, because it is both laconic and appropriate, and because we have no other single word, as far as I know, that answers so well. Whether it be to Buache or Ducarla that we are indebted for the first idea of the contour system, it was first published by M. Dupin Triel, in 1784. It consists in projecting vertically upon the plane of the horizon, lines passing through points equally raised above the level of the sea; lines, in fact, which would mark the limits of the ocean, if, by any cause, it should rise to the several heights indicated, in the same way as the lines joining equal soundings would become its successive limits if it were to sink to the depths of those soundings.

The imaginary horizontal planes whose intersection with the elevations of the ground form the curves projected on the map, rise one above the other by equal quantities; the actual amount of the rise, however, depends upon both the nature of the ground and the scale of the map. It is indeed self-evident, upon a little consideration, that in the case of very gently sloping ground, if the altitude of the section be considerable, the curves must necessarily be very far apart from each other, whereas in elevations nearly perpendicular, the projection of sections taken at the same height, one above the other, would almost touch: those of a vertical cliff will in all cases coincide and form but one curve. Accordingly it is found convenient to increase the vertical height of the sections as the hills are more steep, and to diminish it as the ground is more gently undulating.

The necessity of varying the heights according to the scale of the map is evident for a similar reason. For, if while the height of the sections remained the same, the horizontal scale were enlarged or contracted, the same inconvenience would be produced. The vertical distances of the horizontal sections depend also upon the particular purpose for which the map is intended. Thus, while on the plans intended for certain engineering works, the sections may be from two to four or five feet of vertical altitude, in topographical maps they may be much greater. The pure contour system may even be used in general maps, but then the vertical heights are necessarily very considerable. In Dupin Triel's map of France, on a scale of about one-two-millionth, the first sections, beginning with the sea-level on the coast, rise by ten toises each, where the ground is nearly flat; further inland, where it rises more rapidly, the curves indicate sections taken at twenty toises, then at fifty, then at one hundred. The first are observed in the north-western portion of the country, and the latter in the southern and south-eastern, where the more rapid slopes of the Pyrenees and Jura occur. It is evident that whatever be the scale of the map, contour lines alone cannot convey that expression of relief that results from shading, unless they be exceedingly numerous and close. On a scale of one-ten-thousandth, or about 6⅓ inches to a mile, the relief may be satisfactorily figured by contour lines alone. We do not, however, recommend their adoption where effect is to be studied, they should be reserved for those purposes that require exact levels, as for draining, canal and road making, the *défilement* of fortifications, &c., and in these cases the distances of the curves from each other are much too considerable to picture relief. On the Ordnance Survey the contours lately introduced represent sections taken at the altitude of twenty-five feet.

When contour lines are drawn upon chorographical maps, it is evident the sections have not been levelled, that is to say, the horizontal planes of equal altitude have not been determined by the usual process employed for small distances. The curves are drawn through points whose altitude has been ascertained by barometrical or trigonometrical means, and the sections are not flat parallel planes, but portions of concentric spheres, whose surfaces are parallel with the convex surface of the ocean. It is much to be regretted that curves of equal altitude, such as those on Dupin Triel's map of France, are not more generally applied; they would throw great light on a vast number of some of the most interesting problems of physical geography. We have a map of Ireland, on the scale of ten miles to an inch, on which five successive curves are drawn at the heights of 250, 500, 1000, and 2000 feet, and the belts between these curves being tinted, produce a very effective picture of the positive and relative elevations of different parts of the country. A map of Hong-Kong has also been contoured in a very successful manner, the scale being four inches to a mile, and the section one hundred feet vertical. Indeed, the system we are considering is admirably appropriated for islands, particularly when they are small, for the whole coast-line forms a closed curve, giving the lowest horizontal plane, or starting point, in all directions; whereas in sectional maps, that is, maps of a portion of country, the rectangular edges of the map intersect many of the curves. This inconvenience is in part obviated by the addition of numbers to the curves; the same numbers denoting, of course, the same levels.

Closed curves may represent depressions, as well as elevations, and this is one of the disadvantages of the system; but if the curves are numbered, a little attention will suffice for determining whether the closed curves belong to elevations or depressions. If the number on the innermost or smallest curve be *greater* than that of the curve next to it, the curves are those of an elevation; but if, on the contrary, the number on the innermost curve be *smaller* than that of the curve next to it, the curves are those of a depression. Captain Vetch, of the Royal Engineers, has proposed to add to the contour lines, short etched lines on the side on which the ground falls, which effectually prevents all ambiguity on the subject.

Upon the whole, then, the system of contour lines alone is by no means to be recommended as a means of representing pictorially the inequalities or the relief of the surface on maps; but when positive levels are required, we know of no mode possessing equal advantages. It does not therefore belong to maps constructed for general geographical purposes, but to maps designed for special objects. We now pass on to the consideration of the fifth system of our table.

The French, who attach much higher importance than we do to correct representation of the inequalities of the surface in topographical maps, have at various times considered the subject in committees called together by the Government, and composed of the heads of all those scientific departments for whose purposes good maps are essential, such as the etat-major, the corps of engineers, civil and military, the mining department, the woods and forests, the department of bridges and highways, and the heads of the several great schools, such as the Ecole d'Application of the Geographical Engineers, the School of the Etat-Major, that of the Mining Corps, that of St. Cyr, &c. These committees have on some occasions sat for three or four years, going most minutely into every detail of the subject, and having the same portions of ground drawn and engraved upon a variety of scales, and according to every variety of mode.

We cannot, of course, enumerate all the opinions that were emitted by these most competent persons, of the respective advantages and disadvantages of the several systems, and their numerous modifications; suffice it in this place to say, that no system has yet been devised that is wholly unobjectionable; that, however, which was at length adopted by the majority, and which is at this moment sanctioned by the Government, is that which bears the number 5 of our list.

This system is calculated to offer, as far as possible, the double advantage of geometrical accuracy and picturesque effect. It is a combination of the contour lines with the *hachures* or etched lines, these latter producing the requisite tints of shade, which convey to the eye the effect of relief, and that with so much truer effect, as this very shading is subject to rule, and is determined in strict relation to the contour lines themselves. These latter being determined and drawn upon the map, the space between them is filled up with etched lines, whose length is determined by the distance between two contiguous contours, while their direction is perpendicular to the contour lines; they are accordingly the projections of the lines of greatest slope, of those, in fact, which water, acted upon by gravity alone, would follow in running down the surface. The thickness of these lines is not determined by any rule in the system we are now considering; but whatever it may be, it is uniform throughout, the tint of the shading being effected by the greater or less distance left between the strokes, and this is (except in the extreme cases we shall presently notice) invariably one-fourth of the distance of the two contiguous contour lines, between which they are drawn. When the vertical heights of the horizontal sections whose projections form the contour lines of the map are equal, it is evident that the contour lines will approximate so much the closer as the slope of the ground is the more rapid; and as the distance between the strokes is regulated by that of the contour lines, it is clear that the nearer the contour lines, the closer will be the *hachures* (etched lines, or strokes of shading) to each other, and consequently the darker the tint or shade produced by their means. Therefore, the steeper the slope, the darker the shading, and that without any direct reference to the way, either slanting or vertical, in which the light is supposed to fall. When the contour lines are distant from each other, the strokes of shading, being always one-fourth of the distance between the contour lines, will also be far apart, which of course produces a very faint tint, such as is required for the representation of a very gentle slope.

We have stated that, in extreme cases, the rule of one fourth of the distance of the contour lines is not observed, and for obvious reasons. So long as the contours run in straight, or nearly straight lines, the strokes which are perpendicular to one of them will also be perpendicular to the contiguous one, and the distance of one stroke from another will be everywhere the same. But when the contour lines form curves, the distance of one fourth being taken on the upper line, and the strokes drawn perpendicular to it, these strokes naturally diverge as they descend, so that at their contact with the next curve their distance is greater. If the distance between these curved contours be not great, the divergence of the strokes of shading is of little consequence; but if the contours are wide apart, and the strokes therefore long, the divergence becomes an object worthy of attention; and accordingly, in such case, the distance of one fourth is taken, not upon the contour lines themselves, but on one drawn for the purpose midway between the two, so that the strokes are brought closer together, and the inconvenience of excessive divergence is remedied.

The other extreme case is the opposite of the one just explained—namely, when two consecutive contours approach nearer than two millimetres, (about the ·08 of an English inch). In this case, as it would be next to impossible to draw four strokes of shading in so small a distance, the law of one fourth gives place to an increased thickness in the strokes themselves, by which the very dark tint required for the shade of such rapid slopes as the contiguity of the contours indicates, is equally well effected.

Such, then, is an idea of the fifth system on our list, and which is that generally adopted in France, and also in the United States, where they have learnt it from the French; and some of the topographical maps lately executed at New York, according to this system, are extremely beautiful. The sixth system of our table, which is that advocated by Colonel Bonne, was sanctioned by the French government, in 1828, for the Dépôt de la Guerre, more especially for such maps as were to be engraved. It differs from the fifth, but they both combine the two great requisites of geometrical accuracy and picturesque effect. The contours being preserved, are easily traceable by breaks in the continuity of the shading strokes or etched lines; every gradation of level is marked for engineering and military purposes, while the shading figures at once the undulations of the surface and points out the several degrees of inclination of all the slopes of the ground. Let us now pass on to the seventh system of our list.

In Germany and some other countries, the mode of representing the inequalities of the surface in topographical maps, differs essentially from the French systems we have just noticed. That generally adopted, though slightly modified in different places, is known as Lehmann's, or the Saxon method. In it there are no contour lines; the slopes or inequalities of the surface are represented by etched lines, or *hachures,* alone, but then the thickness of these, and their distances apart, are regulated according to scale, so that a determined proportion is maintained between the rapidity of the slopes and the intensity of the shading by which they are represented. The direction of the strokes is that of the greatest slope; their thickness and distance apart is determined as follows:—

The light is conceived as falling vertically upon the ground, and, accordingly, the different parts of the surface will be more or less illumined as they are more or less inclined to the supposed vertical rays of the sun. A horizontal surface receiving the full effect of these rays, will, in nature, be the lightest, and is therefore represented on the map without any shading; while a highly inclined cliff, receiving few of the vertical rays, will be very dark in nature, and is accordingly represented by a very dark shading on the map. To determine a regular gradation, however, between the most and the least illumined surfaces, the following system was determined on.

The angle of 45° was regarded as the greatest natural slope of the ground, and this was supposed unillumined. From this inclination down to the horizontal, all intermediate slopes were supposed to be illumined inversely as the angles of elevation, and hence the angle of any slope less than 45°, and its supplement, or what it wants of that number, were considered as the proportional terms of light and shade on any declivity. Thus the proportion of light and shade on a declivity of 5° was said to be as 40 to 5, or 8 to 1;—on a declivity of 10° as 35 to 10, or $3\frac{1}{2}$ to 1;—on a declivity of 15°, as 30 to 15, or 2 to 1, &c. These suppositions,—viz., that a slope of 45° is the greatest natural slope of the ground—that such a slope receives no vertical light—and that the quantity of light received by all slopes of less inclination than 45° is in proportion to such inclination, are perfectly gratuitous, the facts being—1. That 60 is the greatest natural slope of the soil;—2. That a slope of 45° receives a very considerable quantity of vertical light; and—3. That the amount of vertical light received by any slope whatever is exactly in proportion to the cosine of the angle of such slope. Hence it is clear, that though the

Saxon method of representing the relief of the ground be systematic, it is by no means natural: it is, in fact, a conventional system, whose practical execution is thus effected:—

All slopes of 45° and upwards are represented on the map by absolute black. All slopes below this, down to the horizontal, are represented by graduated tints of shade growing lighter as the declivity is less, till, at the horizontal, the paper is left perfectly white. As it would be impossible to represent every minute difference of inclination from 45° to horizontality, or to pass from absolute black to perfect white, so that the eye could at once detect the difference between contiguous shades, the tint is effected by nine different grades of shading, each indicating a difference of 5° in the slope. The mechanical means employed to produce these nine different tints is by *hachures* drawn in the direction of the greatest slope, and the thickness of these *hachures*, or etched lines, bears the same proportion to the white space left between them that the angle of the slope to be represented bears to what it wants of 45°. Thus—

Angles	Hor.	5°	10°	15°	20°	25°	30°	35°	40°	45°
Proportion of Black	0	1	2	3	4	5	6	7	8	9
Proportion of White	9	8	7	6	5	4	3	2	1	0

If the slope to be represented be one of 30°, its complement, or what it wants of 45°, is 15°, which being the half of 30°, the black lines will be twice as thick as the white spaces left between them, and as 45° is represented by perfect blackness, and from this to perfect whiteness is divided into nine grades of shades, it is clear, each of these grades becomes lighter than the other by one ninth; 45° having the whole nine parts black, 40° will have eight black and one white—35° will have seven black and two white—30°, six black and three white, and so on, as in the above table; whence it is seen that, while the shading for a slope of 30° is produced by *hachures* whose thickness is to the space between them as 6 to 3, or 2 to 1, that of a slope of 15° is produced by *hachures* whose thickness is to the white space between them as 3 to 6, or as 1 to 2. The tints thus become successively lighter as the rapidity of the slope diminishes, and although the progression is not a natural one, it is invariably determined by a conventional scale, so that, if strictly adhered to in practice, not only the relative steepness of the hills is picturesquely represented so as to produce the sentiment of relief, but the positive amount of the inclination is shown; and further, as the length of the slopes on the maps is the horizontal projection of such slopes, it is evident that this, the Saxon, or Lehmann, system, supplies the means of obtaining as correct a profile of the ground as the contour system of the French. Unfortunately, however, the practice of this method does not answer to the theory. In the first place, it is exceedingly difficult in execution. No draftsman, whatever skill he may have acquired, or however careful he may be, can keep strictly to the thickness of the strokes, and to the distance between them, required by the scale, and without the most perfect accuracy in this respect, the system loses its chief advantage. The labour of drawing such myriads of small strokes fatigues the eye, and diminishes its faculty of discriminating the thickness of the strokes and the breadth of the spaces between them; the hand becomes unsteady, the pen wears thicker, the ink evaporates while you are working, and thus, insensibly, you are drawing a slope of 5°, 10°, or 15° greater steepness than you should do; and even supposing the most favourable case of very exact and clever draftsmen, there is seldom uniformity between the several parts of the same map when executed by different persons; the engraver also may falsify the whole; and if we add, that when the slopes are not taken in the field with instruments, but merely by the eye, they cannot be mathematically correct, and that, accordingly, a profile drawn from the map, may give heights very different from what they are in nature—it will be evident that the German method, though ingenious, though systematic and beautiful when carefully executed, is liable to so many defects in practice, as still to leave room for something more perfect, more easy of application, less tedious, less expensive, and more readily understood by the public at large, for whom, after all, maps are made. Various modifications of the method just described have been attempted, but with little success. To detail them, and a variety of other systems, would require a great deal more space than we can devote to the subject. Nevertheless, we must say one word on anaglyptography as applied to maps. The perfect resemblance of relief which is obtained by this art, is well known in the case of medals and coins. But the first idea of its application to the purposes of geography seems due to Mr. Greenough.

At a meeting of the British Association at Bristol, in 1836, that gentleman expressed, in the Geological Section, a hope that the process in question might be applied to the delineation of mountains; and at the meeting of the same body at Liverpool, in the following year, Mr. Dawson, one of the ablest draftsmen employed in the ordnance survey, having acted on Mr. Greenough's suggestion, exhibited a small map produced by the anaglyptographic process, and representing a portion of Wales. Subsequently, a much more perfect specimen was executed by the direction, we believe, of Colonel Colby. Mr. Lowry (the father) executed for Professor Phillips a small anaglyptographic map of the Isle of Wight, and other maps have since been done, particularly one of a portion of the Pyrenees in four sheets. In producing the appearance of relief, nothing can equal the process we are speaking of; but there are two circumstances which will ever prevent its application to maps becoming general. In the first place, a correct model of the country must be first produced, for it is by applying the instrument to a model that the engraving is produced. Now, it is at once evident that the expense and time required for modelling, not only a whole country, but any large district, must ever preclude the application of the anaglyptographic process fôr maps of such extensive surfaces. Secondly, the very perfection, strange to say, of the effect produced is against its use for maps. It is well known, that if an intaglio receives the light from the left, it has the appearance of a relievo lighted from the right, and, in like manner, a relievo, in certain circumstances, assumes the appearance of an intaglio. Now, the anaglyptographic process gives so true and beautiful an effect of relief, that it is sometimes necessary to pass the hand over the surface, in order to be convinced that it is flat. But from this very perfection it follows that, unless the light fall upon the map in a manner conformable to the shading of the map, all the hollows become reliefs, and the reliefs hollows; so that, seen in certain positions, the valleys assume the appearance of sharp ridged chains, with all the rivers and streams running along their summits. This very remarkable effect is most striking in the anaglyptographic map of the Pyrenees. Such maps, therefore, have the great inconvenience, that they can only be looked at in one direction as regards the light, and when they are to be suspended, they can be so, only on one particular side of the room as regards the light. In some cases, we believe, maps executed by this process have had engraved upon them, directions as to the way of looking at them. These, then, are inconveniences which cannot be got over, and accordingly the mode of engraving we are considering will never become general, and need not therefore engage us any longer.

We cannot here go further into this subject, nor is it necessary in a strictly geographical point of view that we should; for whatever be the system employed for representing the relief of the ground, and whatever interesting details topographical maps may exhibit, they must all be rejected when these maps are reduced for the construction of geographical maps. Some few of the principal features, such as the most prominent elevations of the ground, the high roads, &c., are retained in what are termed the semi-topographical maps, which hold a middle position between the topographical and the geographical map. The former also contains all the smaller towns, and even the villages, which, in geographical maps, cannot be set down, by means of the smallness of the scale.

Maps are constructed in an order the reverse of their details. Thus, a topographical or a semi-topographical map is a reduction from the actual survey; a chorographical map is a reduction and assemblage of topographical maps, and a geographical map, a reduction and assemblage of chorographical maps, and all details which a diminished scale renders too minute to be easily appreciable or correctly expressed, are necessarily omitted.

Of Chorographical Maps.—We have already explained the process for assembling and reducing the several portions of a survey, to form from them a topographical map, but when we would assemble and reduce these latter, in order to construct a chorographical map, we have, moreover, to subject the operation to the projection we adopt. For this purpose; having projected the permanent parallels and meridians of the intended map, and traced as many intermediate ones as may be deemed necessary, draw upon the topographical maps, and in their true direction as regards the north, straight parallels and meridians perpendicular to each other, and corresponding with those of the projection; then copy what is contained in the squares of the topographical map into the corresponding quadrilateral spaces of the projection. As the squares of the one do not exactly correspond with the quadrilateral spaces of the other, we must, if great accuracy be required, ascertain the distance of the point to be set down, from the sides of the square within which it is placed in parts of a degree of latitude and longitude, and then take similar parts from the parallels and meridians on the projection.

Of Geographical Maps.—The passage from the chorographical map to the geographical, is similar to that just described for the construction of the former. It must be observed, however, that as errors may have been committed either in the original topographical maps, or in the reduction of these to form a general map; it is advisable to check such errors by marking at once on the projection, whether it be for a chorographical or a geographical map, a certain number of important points in their true astronomically determined positions, so that if the intermediate spaces and objects as they exist on the maps to be reduced and copied, are either too proximate or too remote, the distances may be extended or shortened, so as to bring them to their proper limits, and by spreading the errors over the whole surface, diminish their individual importance. There are different ways of effecting this correction, but we are compelled to refer for such details to works treating expressly on the practice of map-making.

What has just been said applies only to maps of such countries as have been trigonometrically surveyed; but as this is the case for a very small portion of the Earth's surface, other means must be resorted to when regions less perfectly known are to be mapped.

Construction of Maps from Various Materials.—It is in the construction of maps from a variety of different materials, all more or less imperfect, that the talent, the knowledge, and the critical acumen of the map-maker are most conspicuous. We use the term map-maker, instead of that of geographer, advisedly; for in our estimation they are by no means synonymous. The geographer is not merely conversant with the positive and relative positions of the several objects on, and features of, the Earth's surface, but he is also acquainted with the particular character of the several regions of the globe, as regards climate and productions; he understands the physical laws by which the several phenomena are regulated, and the influence of the soil and aspect in modifying the meteorological action, &c. Now, the mere map-maker has no such knowledge, nor is it perhaps, strictly speaking, absolutely necessary that he should possess it, not but what it would be all the better, nay, infinitely better, if he did. We could, it is true, name one or two, who, in addition to the practical knowledge they possess of map-making, add an extensive acquaintance with all that a geographer should know, but they form the exception, not the rule: nor do we make the observation in disparagement of the talented and conscientious map-maker; his merit is great, his duty arduous, and, if well performed, he is justly entitled to the best thanks, not only of the public, but of the geographer himself, for whose studies he supplies indispensable materials. Alas! that there should be so few, so very few good map-makers. Of all those who supply the public and cater to their appetite for maps, how many are there who produce anything of their own? Not one in ten—not one in fifty. Nor is this all. Not content with embodying in their productions the labours of others, (a plagiarism, by the way, tolerated by usage, and without which we should have but three or four names to all our modern maps,) they do not even copy correctly. Indeed, the carelessness, not to say the want of common honesty, with which some maps are got up and sent out among the public, is a crying evil; but—and we regret to say it—so small is the amount of knowledge possessed by people in general of this department of science, that if not one map in ten be good for anything, there is not one person in a thousand capable of detecting the errors, or discovering the discrepancies of the maps they purchase. If there were sound critics in this matter, map-makers would perhaps be more careful, and find it better for their reputation, if not more to their interest, to publish less in quantity and superior in quality. When we shall have explained what is required of a good map-maker, it will soon be seen how far it is possible to believe that anything like care can be bestowed upon those maps which are issued to the public with a kind of railway precipitancy, so soon as any particular interest is attached to any particular region. But to return.

The construction of the map of a country that has never been trigonometrically surveyed, requires the use of a great variety of materials, and a profound knowledge of their respective value. These materials are the existing maps, the positions, as deduced from the use of Ephemerides, the measurements and relations of travellers; and where all these differ, as they invariably do, more or less, much knowledge, much time and labour, and great sagacity are required in arriving at even an approximation to the truth, through such a mass of conflicting documents. Suppose the longitude and latitude of a place to have been determined by eight or ten different persons at different times, and that none agree. It will not do, as is sometimes recommended, and is the almost invariable practice, to take a mean of the several determinations, for this may give a position far wider of the truth than some of those already laid down. If, of the twelve different positions assigned to Mexico within the last century, a mean had been taken between the extremes of longitude, the position, instead of being rectified, would be set down about two hundred miles to the West of its proper place, and further removed from the truth than any one of the twelve positions assigned to it, except two; and a mean of the extreme latitudes would place it further North than any, but one. The same may be said of an infinity of cases, especially of those in which the errors, as is frequently the case, lie all one way. The conscientious map-maker, therefore, will ascertain how the several positions were respectively determined—if astronomically, how, when, and by whom. As to the *how*, some methods give more correct results than others: as to the *when*, what instruments could the observer have had at the time; they may, nay, in most cases, must have been very defective compared with those of the present day: what astronomical tables existed at the time, from which the observers could make their calculations, and how far could these Ephemerides be depended on? As to the observers themselves, were they known as exact and able, or were they persons who, from want of education and capacity, were entitled to no confidence? If the longitudes were determined by the transport of time, what amount of reliance can be placed on the watches then in use? and how far can the place to which the time was referred, be regarded as accurately laid down—or if incorrect, are the amount and direction of the error ascertained? If the positions were determined by itinerary measures, what were they, and is their true value positively known? Sometimes the only measure has been days' journeys on foot, or estimated by the pace of the horse, the camel, &c. Was the route, in this case, hilly or level? How were the bearings taken, &c.? Nor is it enough that the map-maker satisfy himself by a first process of the confidence he can place on any of their several methods. It may happen that the very results which differ most widely, have been arrived at by means entitled to most credit. Then must he have recourse to collateral arguments derived from other sources, before he come to a conclusion in favour of the one or the other, and is perhaps obliged, after all, to split the difference.

Now it is clear, that this sifting of contradictory evidence is no easy task, and implies extensive information, great patience, and intense application. It will not always do to cut the matter short, by taking the latest observation as probably the most correct. The position of Mexico as laid down by Velasquez and Gamma in 1778, was correct in latitude, and only about fifteen miles too far to the West, while Arrowsmith (the elder), in 1803, places it about thirty-three miles too far North, and forty-five too far West, and the *Connoissance des Temps* for 1804, while it gives the latitude nearly correct, places it in longitude a whole degree too far West. We repeat it, then, little reliance can be placed on any maps, but such as are published by intelligent, painstaking, and conscientious map-makers; their number is very limited, and they are entitled to the gratitude of all who have a just notion of the great importance of correct maps. But a map may be correct, and still not be a good map in every sense of the word, as we shall presently explain.

We have hitherto spoken of the construction of maps from regular surveys from the assemblage and reduction of other maps, and from various sources, still including the use of already executed maps. We have now to say a word on mapping from the mere information of travellers.

Mapping from the Information of Travellers.—The delineation of countries that have not been surveyed in any way, depends entirely on the relations, the notes, the information received, and the sketches made by travellers. From these sources of knowledge the first details of a country are laid down, and from them the map becomes filled up, and corrected as fresh information is acquired. A few years since, the map of Australia presented one great blank; but the Sturts, the Eyres, the Leichardts, the Mitchells, the Strzeleckis, and other adventurous, indefatigable, and well-qualified travellers have, by their most hazardous and difficult explorations, enabled our map-makers gradually to lay down some important features of that vast island, and consequently increase our knowledge of that singular and even yet little known region. We could also point to Sir R. Schomburgk's travels in Guayana, and Dr. Beke's in Abyssinia, and indeed many others, as examples of the enrichment and correction of our maps by the mere researches of travellers in the absence of regular surveys.

The value of the information supplied by explorers is not always the same; some possess greater acquirements than others, and some have better or more extensive opportunities than others of applying their ability. It can of course be the lot but of very few to unite the varied knowledge of a Humboldt, and bring home as the result of their travels, new facts gleaned from every department of nature, and throw new light upon the questions relating to the several races of mankind, their language, arts, customs, and institutions. Almost every traveller is remarkable for some speciality, and, according to the bent of his inclination, directs his principal attention to this or that particular object; but we have here to deal chiefly, if not exclusively, with his ability as a topographer.

If the traveller be possessed of good instruments for observing the latitudes and longitudes of the several remarkable points of his exploration, and knows how to use them properly, this gives very great value to his indications; for, if his observations can be relied upon, they not only serve to check the data afforded by his bearings and itinerary distances (if he has noted these), but enable us to lay down the points with precision without the aid of any bearings and distances, and of assigning to them their proper places on a conic or any other projection, without those reductions that are indispensable when the distance of points otherwise ascertained is such, that the spherical surface of the earth must be taken into account.

If the traveller be not supplied with the requisite instruments for the astronomical determination of his latitudes and longitudes, or is unacquainted with the use of such instruments, his points must be laid down by bearings and distances. This is a very common mode in rapid exploration, and the result will be the less incorrect, as the cross bearings have been more multiplied and taken with the greater care, and according as the itinerary measurements, whatever these be, are properly reduced with regard to the nature of the ground traversed. A long route thus laid down can hardly be esteemed tolerably correct, unless it terminate at some spot whose position is pretty well known; in this case, its more glaring errors may be compensated. In like manner, if the traveller return to his starting point by another route, the one will serve to correct the other. If, subsequently, another traveller start from some very different direction from the first, and come to any point laid down by him, this new route furnishes an additional means of corroboration or correction, and thus by degrees the map is improved, and tolerable accuracy is at length obtained.

As the traveller proceeds, he does not confine himself strictly to his direct route; he often leaves it to explore to his right and left. He notes the remarkable hills and other objects he sees around him, judges more or less correctly of their distances, and sets down their bearings. He notes the rivers he passes, their direction, their depth, and breadth, and the strength of their currents, marking carefully the day and hour of all his observations. He gleans, moreover, all the information he can from the natives, carefully stating his reasons for believing or discrediting their assertions. Sometimes the traveller maps his route himself, and this greatly assists the professional map-maker's labour. But it too often happens, not only that notes are all the traveller brings home, but that, either through inadvertence on his part, the notes are incorrect, or he may have neglected some important feature, such as a river, or may have stated the direction of it to be the very reverse of what it is, or he may have set down as a fact what he heard from natives, who may, through ignorance or design, have made a false statement. One part of the traveller's notes may be directly contradicted by another; indeed, the sources of error are numerous, and yet it is from such materials that the map-maker is often called upon to protract a traveller's route through an unknown region, and lay down topographical features where there was only a blank before. Great discrimination is therefore required of him, and it is only the rare few who are able and willing to bestow upon their maps that great amount of labour, which, in so many cases is indispensable, and which, after all, only assures an approximation to truth.

Having thus far initiated the reader into the art of mapping, which, as we have before stated, cannot here be treated of *in extenso*, we shall explain what we meant by saying that a map might be correct, and yet not be a good map.

A Correct Map not always a good one.—A great error prevails almost universally in respect to maps—namely, the desire of making them answer all sorts of purposes at once. Most persons expect to find on a map every place, no matter how insignificant it may be; and if their own hamlet or the village where they reside be not set down, are inclined to look upon the map as incomplete. Then, again, they would have all the political divisions and subdivisions, and as many of the physical features as possible, as also historical and statistical indications, &c. Now, there cannot be a more ill-conceived exigence. We have already stated, that a geographical map should contain nothing beyond the capitals, principal towns, ports, harbours, capes, and other prominent features; the general chains of mountains, and principal rivers, and high-roads, and the limits of empires and states. Anything beyond this tends only to confusion. We could mention a striking example in the case of a modern chorographic map, which we have every reason to believe very accurate; we know it to be beautifully executed; but the publisher, from a desire to meet the ridiculous wishes of his numerous patrons, has inserted every hillock in the land, every petty glen and fillet of water, the projected railroads, as well as those executed, the celebrated battle fields, the lighthouses along the coast, the merest villages, and even gentlemen's seats, &c.; and all this on a map of no greater scale than twelve miles to an inch, producing altogether a mass of grey confusion, a crowd of names, many of them insignificant, and which can hardly be read without a glass. This, therefore, though a correct, is not a good map.

SCALE OF MAPS.—The scales of maps must naturally vary with the particular nature of the maps, and should be determined by that alone. Such is the case with all maps constructed in France under authority. But, in our own country, where there exists an exaggerated aversion to centralization, no matter for what purpose, and where the government are too glad of such an excuse for leaving undone many things which they alone could effectually accomplish, everything appertaining to maps is left entirely to the discretion of map-makers, publishers, and vendors, who, in perfect ignorance for the most part of the importance of the scales of maps, do not give the matter so much as a thought; with them the scale is nothing, the size everything, and this is regulated with a view to mere convenience, by the dimensions of the paper they think proper to employ in each individual case, whether for single maps or atlases. So almost invariably is this the case, that when the writer once made inquiry of several map-makers, respecting the scales generally employed by them, of which he requested to be favoured with a list, the answer received from all was to the effect, that to give a list of the several scales they had employed, would be to give a list of all the maps they had published, as they did not believe they had ever issued two on the same scale, though they had made several of the same size.

This is the fault of the publishers much more than of the map-makers; the former employ one of the latter to prepare a map or an atlas. I want it, say they, to be on a sheet of so many inches by so many, or we want a quarto atlas, an imperial quarto, an oblong quarto, a large folio, a small folio, an imperial octavo, &c. The map-maker, thus restricted to size, has to consider how much margin he will leave, and this, with the given dimensions of the paper, determine the size of the engraving; within this size the country must be crammed, whether it contain fifty or only ten degrees of latitude or longitude, and accordingly, in no case is there any relation between the length of the degrees and any definite scale. Thus, for example, an octavo atlas is ordered; the size of the map within its border is $9\frac{1}{4}$ inches by $7\frac{1}{2}$ (the maps being folded in the middle). Now, a map of England and Wales, reduced to these dimensions, will be on a scale of 44·8 miles to the inch. Europe, in the atlas, must be brought within the same dimensions, and here the scale will be 347 miles to an inch, and so of all the other countries and regions included in the atlas, no two of which will be on the same scale, and not in a single case, perhaps, reducible to even an arbitrary scale of inches, without fractions, much less bearing any regular proportion to nature.

The inconvenience of different scales, even, when they are limited and defined, is almost unavoidable in the case of an atlas; but the number of scales may be greatly reduced, as in the better system lately adopted by Mr. Sharpe, of whose atlas we shall say more presently.

The larger the scale of a map, the greater the number and variety of the details it may admit. But it does not follow that because the scale of a map be large, the map must necessarily contain much detail; some very large maps contain much less than some very small ones.

Class maps, or those intended for the instruction of classes in schools, for lectures, &c., are executed on very large scales, in order that such features and names as are traced upon them may be sufficiently distinct to be seen at a distance, and with the same intention they scarcely contain any but the more remarkable features of the region, and no names but those of the most important places and objects.

Library Maps, that is, such of them as are intended to be suspended upon rollers, or otherwise, are usually on a large scale, and, generally speaking, are semi-topographical maps. Their use being for general purposes, they are more full in respect to places than geographical maps, but as they represent large regions they cannot exhibit topographical details.

County Maps are topographical, and accordingly their scale must be large. Such maps are chiefly employed for suspending in town halls and in the board-rooms of the local magistracy, &c.

Road Maps, like library maps, are, or should be, semi-topographical, but their scale is usually determined by the extent of country to be drawn on a portable size for the use of travellers; for portability being a desideratum, it is evident that a road map of all Europe must hardly take up more room in a traveller's baggage, or be less convenient for constant reference, than a road map of our island.

The scales of maps then must vary with their nature and objects; but, unless in a few exceptional cases, the scales best adapted for the different kinds of maps should be regulated upon a principle, and not be left to the arbitrary determinations of any compiler of maps.

One of the great advantages of maps is their pictorial nature, the eye readily receives, and the memory easily retains particular forms, and thus a person who only occasionally consults maps, can immediately recognise a country by the general form of its outline, without the assistance of any name, while a person still more conversant with maps, knows at once where to place his finger on any remarkable town, by remembering its distance from, and position in reference to, some particular portion of the general outline, &c. But these advantages are greatly lessened by the indiscriminate use of all sorts of scales. Every one must have experienced, whenever, in the course of his researches, he has to consult different maps of the same country, the puzzling effect of different scales, and the loss of time in finding out the spot he is looking for, and to which his eye would immediately have guided him, if the scales had been the same, or even some aliquot part of each other. Thus, if after looking for Valladolid on a map of one scale, we go to another map on a very different scale, the probability is, that we shall be some little time in finding it. We may very well know that this city is on the Esgueva, near to its confluence with the Pisuerga, but it will be as difficult to find these tributaries of the Douro as the town itself. Whereas, if the second map referred to were on the same scale with the first, we should put our finger on Valladolid at once. Or, if the second map bore some definite proportion to the first, we should be greatly assisted in our search by knowing what that proportion was. Again, it is very desirable to have a correct idea of the relative size of different countries, and nothing tends more to falsify our conceptions on this subject than the multiplicity of arbitrary scales in use among us.

The Dépôt de la Guerre, in France, have determined that general maps, i. e. those of the four quarters of the world, shall be on a scale of one-two-millionth, or that two millions of metres on the ground shall be represented by one metre on the map, and all other maps on scales determined by successive decimal reductions, or aliquot parts of this. Thus, a degree of latitude of the general map being taken as unity, a degree of any other general map is ·5, ·2, or ·1 of such unity; by which means a regular proportion is maintained throughout the whole series.

If we were to adopt a system similar to that of the French, the radius of the earth would be represented by ten feet six inches, a duodecimal division of which might afford a series of convenient scales for all our maps.

We have stated that, in Mr. Sharpe's Atlas, the number of scales has been greatly reduced, and we gladly hail this as a step in the right direction. The maps of this Atlas are called by the author, *Corresponding Maps*

There are in all fifty-four, constructed upon only four different scales, and according to these scales, the maps are designated by the names of Continental, Intermediate, Divisional, and Enlarged. Of the first kind there are ten; of the second, seven; of the third, twenty-seven; and of the fourth, six; besides which, there is one, that of Switzerland, whose scale is much larger than the rest—two hemispheres and a Mercator map of the world. The linear scale of the Intermediate maps is twice that of the Continental; that of the Divisional, five times that of the Continental; that of the Enlarged, fifteen times that of the Continental, or three times that of the Divisional. The arrangement of this Atlas results in a somewhat different distribution of countries and regions from what is customary, and which, if it has its advantages in some cases, is, perhaps, inconvenient in others. Of the general accuracy of the Atlas we are not prepared to speak, nor would this be the place, under any circumstances, to enter into its details. We observe that the latest discoveries are inserted, and therefore presume that the compilation has been carefully made. We merely notice this Atlas on account of its peculiar features, of which there are two others, besides the small number of scales. Thus, instead of two hemispheres, as usual, we have here four equal sections of the earth's surface; an arrangement not new, though seldom adopted, and which has both its advantages and its defects; the former consisting in greater accuracy as to the form of the several regions of the earth than is possible according to the usual projection, while its defect is the interruption of continuity of the great eastern continent. In the present case, however, this is not, perhaps, of much consequence, the separation being at the fifty-fifth meridian, close upon the confines of Europe and Asia, northward of the Caspian. It is true Persia is cut in two, and a slice of Arabia scinded. The next particular feature of the Atlas is in the adjustment of the scale of English miles to every separate map.

When the earth is considered as a perfect sphere, all the great circles are of the same extent, and accordingly one degree of a meridian is of equal length with a degree of the equator. But the case is otherwise when the true figure of the earth, which is somewhat flattened at the poles, is taken into consideration; for then the meridians are no longer arcs of circles but of ellipses; the arcs, having less curvature as they approach the poles, are arcs of larger circles, and consequently a degree of latitude near either pole is larger than a degree of the equatorial arc, so that if a degree of the latter contain 69·15 British miles, the degrees of the elliptical meridian will differ from this, and be so much the longer as they are nearer the poles. With a view, therefore, to greater accuracy of admeasurement than is customary, Mr. Sharpe has given upon each map the exact number of British miles contained in a degree of its middle latitude. This effort at increased accuracy is praiseworthy, as denoting what we so much wish to see, a desire on the part of map-makers to make their maps as perfect as possible. But, at the same time, when we consider that the very element of the calculation for the number of British miles in each degree of latitude—viz. the amount of depression at the poles, is still matter of dispute, being variously given, as $\frac{1}{304}$, $\frac{1}{321}$, $\frac{1}{335}$, &c., and that, in any case, the fractional difference for a degree amounts only to a few hundredths of a mile, and lastly, that measurements on a map can never be exact,—we do not see that any very material advantage is gained by the system here adopted. Nevertheless, we repeat our conviction that the reduction in the number of scales is an important point effected, and in so far is an example worthy of imitation.

In cases such as that of the Atlas just mentioned, we think it would be a great improvement if the smaller scaled maps were made to serve as indexes to those on the larger scales, by drawing faint lines on the former to show the boundaries of the latter, with corner numbers of reference.

Whatever be the scale of a map, it is much to be desired, for more reasons than one, that such scale be invariably stated. In the first place, it saves the time and trouble of finding out the scale by measurements; secondly, when we know the scale, we can carry it pretty correctly in the eye, so as at a glance to have a tolerable idea of the distances of places from each other; thirdly, it enables us at once to add the scale to the other details in making a descriptive catalogue of maps, and such a catalogue, without the scales being given, is imperfect in one of its most important items.

Be it, moreover, observed that, though most maps have scales affixed to them, they seldom announce any definite proportion; that is, they say, for instance, geographical miles, British miles, &c., of each of which the scale contains a certain arbitrary number, and the smaller divisions are sometimes *units*, sometimes *fives*, or *tens*, or *fifteens*, &c., and if an inch measure be taken in the compasses and applied to the scale, it falls in with none of its subdivisions. In order to supply this deficiency of our maps, the writer has constructed a Chartometrometer, which, by merely applying it to the central meridian of any map, indicates (with sufficient accuracy for all practical purposes) the scale of the map in number of geographical and of British miles to an inch.

With respect to these British or rather English miles, it may be well to remark, that different map-makers state them differently. Thus, in one Atlas we find on some of the maps 69 English miles to a degree; on others, 69·1, and 69·12. Another Atlas has simply '*scale of British miles*,' without stating how many of them go to the degree. Another, again, has everywhere 69 British miles to the degree; while a fourth has 69·2; a fifth, 69·5; and Sharpe's Atlas, as we have just seen, states the number of British miles to a degree differently on the different maps. Geographical treatises also give the proportions variously. In the midst of this confusion it is not easy to say who is right; the probability is, that not one is strictly correct; for, admitting that our standard measure of length be well determined, the measurements of various arcs of meridians are not so perfectly correspondent as to comprise any exact or invariable number of English miles. The differences, however, are too trifling in amount to be of any practical importance in such measurements as are made upon maps; for even if the amount of depression at the poles were exactly ascertained (which it is not, being variously stated, as we have shown, at $\frac{1}{304}$, $\frac{1}{321}$, $\frac{1}{335}$, &c.), and if the number of British miles to a degree of latitude in different parts of the elliptical meridian were most accurately determined, still straight-line measurements on a map can never be exact by reason of the distorting effects of projection. A more or less close approximation to truth is all that can be obtained, and, indeed, is all that need be sought; and while the scales of British miles vary in two different maps, as, for instance, 69 miles to a degree on map A, and 69·5 on map B, the probability is that in some one direction, or in some particular part of map A, the scale of map B is nearer the truth than that indicated on map A itself, and *vice versa*. It must be borne in mind that we are here alluding only to the small fractional differences in the several statements of the number of British miles to a degree, and that when we assert that these differences are of little practical importance, we are by no means to be understood as saying that the scale of maps is a subject of indifference; on the contrary, we have endeavoured to show that it is a subject of great importance in many respects.

Graduation of Maps.—The graduation of maps is little less arbitrary than their scales; in one point, however, uniformity prevails, it being the practice to divide the meridians and parallels in the same manner. These divisions themselves vary:—thus, the parallels and meridians are drawn sometimes at every degree, at other times at every second, every fifth, or every tenth degree. This is a matter which, of course, depends much upon the scales of the maps. When the scale is small, the parallels and meridians may conveniently be drawn at every tenth degree, on a medium scale at every fifth degree, and on larger scales at every single or every second degree, and this seems to be the general practice; but that it is arbitrary is evident from the fact of maps by different compilers being differently graduated, though on the same, or nearly the same scale. When the division is by *tenth* degrees, then each of these grand divisions, on the borders of the map, may be subdivided into two portions of five degrees each, and each of these again into five parts or single degrees. When the division is by *fives*, each may be subdivided into five single degrees, and these again into halves, or 30 minutes or geographical miles. When the parallels and meridians are drawn at every *second* degree, then, on the borders of the map these may be divided into two portions, representing each one degree, and these again subdivided into three parts of 20 minutes each, or into six parts of ten minutes each. When the division is into *single* degrees, these may be subdivided into six for 10 minutes each, or into twelve for 5 minutes each.

The object of graduation is the finding of the longitude and latitude of places on the map; but unless in cases where the parallels and meridians are both straight lines, (as in a Mercator projection,) it answers but very inefficiently the purpose intended. When the parallels are straight lines, as in most maps of Africa and South America, the latitude is easily found by placing the edge of a ruler (sufficiently long to reach from the place to the nearest border of the map) against the place and everywhere equidistant from the nearest parallel, when the graduation on the border, at the point intersected by the ruler, shows the latitude.

In the Conical Projection, even when the meridians are straight lines, the latitude cannot be taken from the border of the map, for as this intersects the parallels under very different angles from what the meridians do, the space comprised between any two parallels on the map is much greater at the border than elsewhere; indeed, the exact latitude can hardly be found but by drawing an arc concentric with the parallels on the map, and passing through the place; but in order to do this, the common centre of the parallels must be found, which it is always difficult and often impossible to do.

The longitude may be approximately found on the conic projection, when the meridians are straight, by placing a ruler of sufficient length close upon the place, and in such wise that it may intersect the same degree of longitude marked on the top and bottom borders of the map. In those maps where both the meridians and parallels are curved, the border graduation of the map only supplies the means of a very rough measurement or guess at the longitude and latitude of any place. It would be a decided advantage if the central meridian of all maps were graduated for the latitude, and this might very easily be effected without the slightest inconvenience or disfigurement of the map; and when the other meridians are curved, the graduation for longitude should be marked on some convenient part of every parallel, between any two contiguous meridians. By this means, and with the aid of a pair of compasses, the latitude and longitude of any place might be found pretty exactly.

Conversion of Longitudes.—In the graduation of maps, the longitude unfortunately is not always reckoned from the same meridian. Thus, Ptolemy fixed his first meridian at the Fortunate Islands (the Canaries), as being the most westerly country known in his time, though the precise point is still doubtful.

Louis XIII. ordered that the first meridian should be drawn through the Island of Ferro, the westernmost of the Canaries. Delisle had made out the longitude of Paris twenty degrees to the eastward of this; but subsequent and better information gave 20° 5′ 50″ for the longitudinal difference of the two places. The first meridian was accordingly shifted 5′ 50″ to the East, so that, at the present day, the meridian of Ferro is quite conjectural, and passes by no remarkable place.

By the Dutch the first meridian was made to pass over the Peak of Teneriffe.

Gerard Mercator chose for the first meridian that which passes over the island Del Corvo, one of the Azores, because, in his time, the needle there showed no variation.

At the present day, however, almost every country considers as first meridian that which passes over its own capital or observatory. Thus, the French reckon from Paris, the English from Greenwich, the Spaniards from Cadiz or Toledo; the Russians have hitherto, like ourselves, reckoned from Greenwich, though occasionally from Ferro; but it is probable, now that they possess a magnificent observatory at Pulkova, near St. Petersburg, they will reckon their longitudes from that place. The Anglo-Americans reckon from Washington, the Venezuelans from Caraccas, and, as M. Jomard observes, the Australians may perhaps ere long have their own first meridian.

The following table will show the longitudes of the principal first meridians with reference to Greenwich:—

WEST.					EAST.			
Toledo	3°	59′	7″	Greenwich	Paris	2°	20′	23″
Cadiz	6°	17′	22″		Pulkova	30°	29′	38″
Ferro	18°	9′	37″					
Del Corvo	31°	3′	00″					
Caraccas	66°	41′	37″					
Washington	77°	2′	1″					

When to this diversity be added, that some geographers reckon the longitude eastward all the way round the equator from 0 to 360, while others count both eastward and westward, 180 degrees each way, and that some deduce their longitude from some particular meridian not considered as the first by any people, it will be easily conceived what confusion exists in this matter. Indeed, the perplexity is often great when we would know the longitude of any place, as reckoned from different meridians, or in different ways from the same meridian. Some map-makers (and this is a great oversight) do not even state upon their maps from what first meridian the longitude is reckoned. When the first meridian and the mode of counting are known, a calculation is necessary whenever we would refer the longitude given, to what it would be if reckoned in a different way, or from some other first meridian.

The longitude reckoned all the way round is called the *Geographical Longitude;* that which is reckoned only half-way round, East and West, is called the *Nautical Longitude*, and accordingly, as we have to deal with the one or the other, the mode of reduction is different.

In the first case, (that is, reckoning the longitude all the way round,) when we would find, from the longitude as given from any particular first meridian, what it would be reckoned from any other first meridian, the rule is—

Take the difference of the two first meridians, and if the one from which we are desirous to count be to the westward of that given, *add* the difference to the given longitude; but if it be to the eastward, *subtract* it.

1st Example.—The given longitude of Calcutta is 271° 32′ East of Paris. Query—what is its longitude from Greenwich?

Greenwich is 2° 20′ 23″ *West* of Paris, consequently 271° 32′+2° 20′ 23″ = 273° 52′ 23″.

2nd Example.—Moscow, given longitude from Ferro, 55° 14′ 45″. Query—what is its longitude from Paris?

Paris is, 20° 30′ East from Ferro; accordingly 55° 14′ 45″—20° 30′ = 34° 44′ 45″.

If, after the addition, the whole be more than 360 degrees, which may often happen, then the rule is—

Subtract 360 degrees from the larger sum, and the remainder will be the longitude sought. Thus—

3rd Example.—Madrid is 353° 57′ 40″, Geographical Longitude, East of Paris. Query—what is its longitude, counted after the same method, from Ferro?

Ferro is 20° 30′ *West* from Paris. Then 353° 57′ 40″+20° 30′=374° 27′ 40″;

this is more than the whole circle; accordingly 374° 27′ 40″—360°=14° 27′ 40″, the geographical longitude from Ferro.

Again: if the given longitude be less than the meridianal difference to be subtracted, the rule is—

Add 360 to the longitude, and then subtract the difference.

4th Example.—The Island of Gomera is 32′ from Ferro. Query—what is its longitude from Teneriffe?

32′+360°=360° 32′, and the difference of the meridians being one degree, 360° 32′—1°=359° 32′, which is the geographical longitude of Gomera from the Dutch first meridian of Teneriffe.

In the case of *Nautical Longitude* to be reduced to *Geographical Longitude*, we may observe, that when we reckon from one and the same first meridian, the geographical and the nautical longitudes are the same as far as 180° East. In the case of *West* longitude, the rule is—

Subtract the given West longitude from 360, and the remainder will give the geographical longitude. Thus—

5th Example.—Icy Cape is 161° 30′ *West* of Greenwich. Query—what is its geographical longitude?

360°—161° 30′=198° 30′.

It is self-evident that by the inverse operation, geographical longitudes above 180° may be turned into nautical longitudes by subtracting them from 360. Thus—

6th Example.—The geographical longitude of Icy Cape is 198° 30′. Query—what is its nautical longitude?

360°—198° 30′=161° 30′, West.

But if the case regards two different first meridians, or starting points, then the rule is—

See first whether the meridian to which we would refer the longitude be to the East or to the West of that from which it is given; then *subtract* the difference of the meridians, when they are of the same name, and *add* when they are of contrary denominations. Thus—

7th Example.—Constantinople is 29° *East* of Greenwich. Query—what is its longitude from Paris?

Now Paris is 2° 20′ 23″ *East* from Greenwich; therefore

29°—2° 20′ 23″=26° 39′ 37″.

8th Example.—Cape Horn is 67° 21′ 15″ *West* from Greenwich. Query—what is it from Paris?

67° 21′ 15″+2° 20′ 23″=69° 41′ 38″ West.

It sometimes happens that the place whose longitude is to be reduced lies between the meridian given and the one to which we would refer it; being to the East of the one, and to the West of the other. In this case the rule is—

Subtract the longitude from the difference between the meridian given, and that to which the place is to be referred, and change its denomination. Thus—

9th Example.—Dover is 1° 18′ 30″ *East* from Greenwich. Query—what is its longitude as referred to the meridian of Paris?

The difference of the two meridians of Greenwich and Paris is 2° 20′ 23″, therefore 2° 20′ 23″—1° 18′ 30″=1° 1′ 53″ *West* from Paris.

What happens in reference to places situated between the meridian given, and that to which a place is to be referred, may also happen in respect to their opposite meridians. Thus, when instead of subtracting, we have to add to the given longitude the difference between the meridian from which it is reckoned, and that to which we would refer it, we sometimes find it greater than 180 degrees In this case the rule is—

Subtract the sum from 360°, and change the denomination. Thus—

10th Example.—Tortoise Island is in 177° 57′ *West* longitude from Greenwich; what is its longitude from Paris?

As in this case, the difference of longitude between Paris and Greenwich is additive, 177° 57′+2° 20′ 23″=180° 17′ 23″, which being more than half the equatorial circle, must be subtracted from 360°. Thus—

360°−180° 17′ 23″=179° 42′ 37″ *East* longitude from Paris.

From the above examples it will readily be seen, how very desirable it is that some *one* first meridian be adopted by all nations; this desideratum has been frequently and loudly insisted upon by the most eminent geographers of Europe, but it is to be feared, alas! that absurd national prejudices will ever stand in the way of so desirable a reform, as it does in that of many other important changes.

Details of Maps.—A very great deal might be said on the details of maps, such as the choice and size of the character used for the names of the several objects; the limitation of the double lines of rivers to the extent of their navigation; the modes of indicating the mountain chains, &c. The colouring of maps; the kind of paper best suited to maps of different kinds; the best methods of mounting, arranging, and cataloguing them, and many other matters; but to go into these details would be to lengthen the present article far beyond the limits to which we must of necessity restrict ourselves. For the same reason, we have been unable to give any history of the progress of map-making, or to say anything of ancient maps, such as the *Catalans*, the *Portulans*, &c. Indeed, as we stated at the commencement of the present chapter, the subject of Chartography, fully treated, would of itself fill a large volume, and require to be illustrated by many and expensive plates.

We cannot, however, close the present article without protesting against the general want of attention to the orthography of maps. Surely something like greater uniformity in our manner of writing foreign names might be effected. The Royal Geographical Society have long since established a rule for the orthography of Oriental names, which is both simple and judicious, and if adhered to in maps, in books of eastern travels, and in geographical works, would go a great way to diminish the confusion of which every one so justly complains The system to which we allude is as follows:—

Geographical Orthography.—The orthography, as far as possible, is reduced to a fixed standard, each letter having invariably its corresponding equivalent. The consonants are to be sounded as in English, the vowels as in Italian. The accents mark long vowels, and the apostrophe the letter 'aïn; *gh* and *kh* are strong gutturals; the former often like the Northumbrian *r*, the latter like the Scotch and Welsh *ch*: *a* as in far; *e* as in there; *i* in ravine; *o* in cold; *u* in rude, or *oo* in fool; *ei* as *ey* in they; *au* as *ow* in fowl; *ai* as *i* in thine; *ch* as in child.

What has thus been done for eastern names, might in like manner be effected for those of the Slavonic nations, Russia, &c. But to expect improvements of this kind, would be to look for an amount of zeal and industry on the part of our map-makers for the real interests of the science, which we are not likely to find.

We must now conclude this brief memoir on maps, which, imperfect as it is, will, we hope, prove acceptable to our readers.

PHYSICAL GEOGRAPHY.

PART I.

OF THE EARTH'S SURFACE.

CHAPTER I.

INTRODUCTION.

§ 1. General outline of the subject.—2. Divisions of the subject.—3. Planetary condition of the earth.—4. Elemental conditions of matter.—5. Mechanical conditions of matter, and divisions of science thence resulting.—6. Advantage arising from the study of Physical Geography.

GENERAL *Outline of the Subject.*—If, in a system of geography it is thought necessary to explain in detail those facts which bear upon the occupation of the earth by man, it is not less important to communicate a general view of the various mutual relations of the inorganic and organic bodies met with on the Earth's crust, however these may sometimes have been neglected by writers whose views were limited to the more technical part of the subject directly before them.

Such general views and discussions it is the object of PHYSICAL GEOGRAPHY to furnish, and to this the science thus designated is properly limited. It regards the human race in its relations with external nature. It has, however, no concern with human history; nor does it directly introduce those important commercial interests which bind together different branches of the great human family. It deals not with artificial boundaries of nations, or with the position and relative importance of those localities where men congregate in multitudes. It makes no reference to the habits of men, or the distinction of races, except when these, in their turn, affect the general grouping of organic beings on the globe.

The scope and objects of this science are, however, sufficiently interesting, and bear in no trifling degree on the most important interests of men.

Physical geography is the history of the earth in its whole material organization;—as a planet, inasmuch as it affects, and is affected by, the other planets of our solar system, and all other bodies in space; as a mass of matter, whose external crust exists in various mechanical conditions acting on and affecting each other; as the seat of organic life, consisting of certain tribes of vegetables and animals adapted to its present state; as subject to certain mechanical and chemical changes which modify the conditions of organic existence; and, lastly, as containing and exhibiting in its solid portion a history of itself in former states, and when inhabited by different organic beings, thus affording memorials of events and changes that have occurred at and near its surface during the lapse of a vast period of time, if not from the very commencement of its existence as a planet.

2 *Divisions of the Subject.*—The fundamental knowledge required to comprehend the science of physical geography consists, then, of many and varied facts concerning—1st, the planetary conditions of the globe; 2nd, the nature, properties, and chemical and mechanical conditions of the portions of matter which make up the Earth's crust; 3rd, the general form and manner of distribution of the solid, fluid, and aeriform parts which are presented for observation at and near the surface; 4th, the nature and distribution of

existing races of vegetables and animals; and 5th, the former grouping of these organic bodies, as determined from their remains existing within the Earth's crust, and discoverable by investigation and inference.

3 *Planetary Condition of the Earth.*—The material universe comprises a vast but unknown multitude of bodies, made evident to our senses by their power of emitting or reflecting light, but connected together also by the universal action of one great law—that of gravitation. All these bodies, although at immense distances apart, act upon each other in very important ways. They are collected into groups, of which the one to which our Earth belongs consists of a central body, the Sun, which is self-luminous, and a number of smaller bodies, the planets, revolving round it, and only reflecting light; but themselves, in many cases, the centres of motion of others, still smaller, called moons or satellites. The group altogether is not remarkable amongst the heavenly bodies, and our Earth offers no peculiarities of importance either with regard to magnitude, position, or other essential qualities.

The Sun, the central body of this system, is of great magnitude compared with any of the bodies revolving round it, and it seems to be the only one of the whole number which is capable of emitting any considerable amount of light and heat. Although many times larger than all the members of our system together, it is not so dense as most of them, and in consequence of the external surface being luminous in a high degree, it has not been found possible hitherto to do more than measure its dimensions, distance, and relative density. Of the other bodies, most of the planets revolving round the Sun in various periods appear to possess many analogies with each other and with our Earth; while the satellites or moons, of which the Earth has one, revolve round the planets, and appear to differ from them in some respects. Comets are wandering bodies, apparently self-luminous. They revolve in elliptic and irregular orbits round the Sun, and are so extremely anomalous, that little has hitherto been determined concerning them except that they are probably gaseous. The stars appear to be self-luminous, but their distances are far too great for us to be able to determine anything with regard to their mechanical and chemical condition, leaving us only to assume their vast magnitude and the extent of the systems to which they belong.

Thus, then, the Earth, unimportant as it is as an individual member of the countless hosts of heaven, becomes to us, its inhabitants, not only important as our dwelling-place, but as the only object in space concerning which we have the means of minute investigation; for however the distant views of other bodies may communicate true general notions of their real state, we can observe and investigate only those things presented to us here and capable of direct and experimental handling. Thus it is that our ideas of the conditions of matter are limited to those commonly presented to our senses, and our notions of forms of life are similarly confined, nor does it seem altogether possible for us to imagine other conditions or other forms without running into extravagant and even ridiculous exaggeration. It is not, however, really essential to the existence of a planet, and it may not be needful for organic existence, that matter should be invariably presented in the ways in which we are accustomed to see it. The conditions that obtain on our Earth may not be universally met with; the ultimate elements of which another planet is composed may be different from those here found; the proportions in which those elements are combined in the most abundant and characteristic materials are still more likely to be different; the proportion of light and heat, the extent and nature of chemical and electrical action, may be capable of infinite variation; and when the limits of one planet are passed, the forms so familiar to us as to seem essential to matter may entirely alter, and new and unimagined contrivances appear, producing results not less perfectly and beautifully adapted to existing circumstances.

4 *Elemental Conditions of Matter.*—In order to understand how this may be, it is necessary to be familiar with the true actual conditions of matter and life on our globe; and thus arise, at the outset, various considerations

concerning the materials of which the earth is built up, the ordinary and rare combinations of the material elements, their mutual action, the causes of internal change and modification that can be traced amongst them, and the mechanical condition of the various kinds of material, and their mechanical action on each other.

So soon, then, as we commence investigations of this kind, we find ourselves, in fact, launched on an inquiry which includes within its wide embrace two special sciences of immense extent and vast importance. CHEMISTRY, in its highest sense, and MINERALOGY are required at the starting point, and must form the basis of all accurate knowledge of the Earth. These teach us that the materials of the Earth's crust are combinations of various substances, and that the cause, as far as we can discover, of their peculiar condition is connected with the presence of an imponderable agent, which, whether called by the name of light, or heat, or electricity, or chemical force, is not less connected with, and derived from, other bodies of the universe, than are the known effects of that great law of gravitation, which knits together into one group all material bodies.

Thus, the result of the very first inquiry is to complicate the problem, and refer us back to those very bodies concerning which we know so little. But it is altogether in harmony with everything yet discovered in nature that there should be these mutual relations, and no real isolation. The same kind of mutual influence is met with everywhere, and appears to form a chain of evidence evincing a marvellous unity of design in the whole creation.

5 *Mechanical Conditions of Matter, and Divisions of Science thence resulting.*—When, however, by a reference to all that is known of the laws of chemical force, and the nature of chemical combinations, and when, by careful examination of those substances which are most abundant and most important in nature, we have obtained a knowledge of the materials which form the Earth's crust, we are next introduced to a phenomenon of the mechanical condition of these substances, which is of the most singular interest, and is productive of the most essential characteristics of organic existence, and also of a constant modification of the Earth's crust. In consequence of the nature of the combinations, and the actual temperature of the Earth's surface, the three mechanical conditions of solid, fluid, and aeriform are assumed by different kinds of matter, the result being that we have a solid crust of irregular form, the irregularities being partly occupied with water, and the whole invested with a transparent veil of air. The mutual action of these is the source of a great multitude of phenomena to be described under various distinct heads. The science of METEOROLOGY, or the phenomena of the atmosphere; HYDROLOGY, or the phenomena of water, including not only the sea and rivers, but all other portions of the aqueous covering of the globe; together with a description of the modifications of the existing surface by various causes, thus require minute attention amongst the facts of physical geography. The actual distribution of land and water on the globe, the configuration of continents, islands, &c., the description of the mountain ranges, and the river systems, the great plains of the Earth, the valleys, and other striking phenomena of form and configuration, these complete another of the main branches of the subject.

The internal structure of the Earth, and the reaction caused by the conditions of matter beneath the surface—involving much of the past history, as well as the present state of our globe—is another department of the subject; while the generalizations obtained by an accurate and detailed study of every organic body that comes under man's observation, whether actually now endowed with life, or having existed only in distant ages, and long since extinct—all these together make up the physical history of the earth, or, in other words, the science of physical geography.

6 *Advantage arising from the Study of Physical Geography.*—The study of such phenomena as those here alluded to may be regarded not merely as promoting the interests of man in reference to his material wants, but also

as greatly affecting his general intellectual advance. This has been well remarked by Alexander Von Humboldt, whose knowledge of external nature is, perhaps, greater than has been acquired by any man of our own or former ages, and who, in the introduction to his *Cosmos*, has admirably touched upon the advantage of such knowledge and the objections that have been raised to it. I shall not hesitate to avail myself of the expressions of so admirable a writer to illustrate this part of my subject. He remarks that, 'it is the intuitive and intimate persuasion of the existence of these relations which at once enlarges and elevates our views and enhances our enjoyment. Such extended views are the growth of observation, of meditation, and of the spirit of the age, which is ever reflected in the operations of the human mind, whatever may be their direction.

'Special accounts of districts, and minute statements concerning those portions of external nature presented for our investigation in a single country are, no doubt, the most available materials for a general physical geography; but the most careful successive accumulation of such descriptions would be as far from affording a true picture of the general conformation of the irregular surface of our planet and the general conditions of matter at, above, or beneath its surface, as a list and account of all the species of plants or animals found in different districts would be from communicating knowledge concerning the general geography of plants or animals.'* This latter subject, the geography of plants and animals, involves the grouping of organic beings—the extracting from minute individual accounts that which is common to them all in regard to their climatic distribution—the investigating the numerical laws, or the proportion of certain forms, or particular families, to the whole number of species—the assigning the geographical position of the district, where in the plains each form reaches its maximum number of species and its highest organic development. So, also, the final aim of physical geography is to recognise unity in a vast variety of phenomena, and by the exercise of thought, and the combination of observations, to discern that which is constant through apparent change.

If, however, we would comprehend existing nature, we must not separate the consideration of the present state of things from that of the successive phases through which they have previously passed, and thus we have the word *history* fitly introduced with reference to nature, and the phrases 'natural history' or 'history of nature' strictly adapted to descriptions such as we contemplate. The organic world—that portion of nature endowed with the mysterious principle of life—is, as every one is aware, constantly exposed to change, so far as the individual is concerned; and a careful study of the relations that exist amongst organized bodies shows that this principle of change extends also to those natural groups of similar individuals, which we denominate species. But it is not only in the organic world that matter is constantly undergoing change, and becoming resolved into its elements, in order that these elements may enter into new combinations—such is the case, also, with the inorganic materials, which are never permanently in repose, and which have undergone many and important modifications, evidenced by the condition of those strata of sedimentary rocks which compose a large part of its crust, and which also contain numerous early forms of organic life now totally lost, but originally associated in groups which have successively replaced each other.

Vast, therefore, and complicated in a high degree are the phenomena, and grand are the generalizations with which we have to deal in considering fully the subject before us. It is founded on absolute facts, and on the observation of what actually takes place and exists, but it involves the expression of many phenomena co-existing in space, and an account of the simultaneous action of numerous and conflicting natural forces. A view of the effects of time, and

---

* See Humboldt's *Cosmos*, Col. Sabine's translation, vol. i. p. 47.

the analogy of the effects of time and space with regard to the distribution of organic beings, together with a general history of all terrestrial phenomena in their mutual relations, render it at once a uniform and comprehensive science.

Little has hitherto been attempted on the plan proposed in the present work, to present in one view the principles of geographical science, and afford means of studying this science on its true basis. Many important facts of physical geography have, however, been accumulated by various authors, and have lately been arranged, both in Germany and England; and while in the present outline the plan and method are altogether distinct, including also a wider range than has hitherto been thought necessary, the author has been indebted to his predecessors, and to the works of many naturalists and travellers, for the substance of what is given. The *Cosmos,* and other works of Alexander Von Humboldt, Johnston's *Physical Atlas,* Hoffman's *Physikalische Geographie,* and in some cases Mrs. Somerville's *Physical Geography,* as well as several admirable articles in the *Penny Cyclopædia,* will be found freely quoted, though generally not without acknowledgment.

CHAPTER II.

FORMS AND MODIFICATIONS OF INORGANIC MATTER.

§ 7. Limits of our knowledge with regard to the earth's structure, and importance of heat as an agent of change. — 8. Forms of matter. — 9. Forces affecting matter, and effect of change of temperature. — 10. Sources and causes of heat. — 11. Chemical action. — 12. Polarity. — 13. Material substances usually in combination at the earth's surface. — 14. Elementary substances. — 15. Oxygen gas, and its important combinations. — 16. Combustion. — 17. Nitrogen, hydrogen, and chlorine, with their combinations. — 18. Non-metallic solid elements. — 19. Metallic elements the bases of earths. — 20. Metals. — 21. Mutual action of various forms of matter. — 22. Terrestrial magnetism.

Limits of our knowledge with regard to the Earth's Structure, and importance of Heat as an Agent of Change.—The knowledge that has been acquired with regard to the Earth is very limited in some important respects, but involves much interesting detail in others: it teaches much, but leaves also very much untaught; part of which is at present beyond our comprehension, and part we can never hope to learn.

We know, for example, the form of our Earth and the density of the mass, we can compare this density with that of matter at the surface, and we can also determine the absolute weight of the whole globe. All these conditions exhibit direct reference to temperature; and we learn by observation, that while the temperature at the Earth's surface varies at different parts, having relation to the solar rays, the temperature at a certain depth below the surface is in all parts of the Earth uniform; while below this stratum of uniform temperature, there is an increase of heat with increasing depth, not altogether regular and uniform, but sufficiently so as to render it highly probable, that at a considerable distance down the heat is sufficiently intense to produce fusion of even the most refractory substances met with at the surface. The increase being about one degree of Fahrenheit's thermometer for every fifty-five English feet of depth at all known depths, this, if continued in the same arithmetic ratio, would produce the melting point of granite at a depth of about twenty miles below the surface.

When, too, we remember that the temperature of the surface is so greatly affected by the position of the Earth with regard to the Sun, as to admit of innumerable climatal peculiarities, especially of those periodical changes we call *Seasons;* when we further consider the effect of light, and the important relations of light and heat with electricity, galvanism, and magnetism, the vast importance of the subject of heat will be understood, and the reason for devoting some space to a consideration of the forms of matter, and their relation with this and other imponderable agents, will be fully recognised.

8 *Forms of Matter.*—In the general views that may be taken of natural substances, certain relations appear which afford the means of arranging them in distinct classes, each distinguished by certain sensible and obvious qualities.

The first class consists of *Solids*, under which form most of the known part of the globe is presented. When in small masses, solid bodies retain whatever mechanical form may be given them:—their parts are separated with difficulty, and cannot be made to unite readily after separation. Some (called non-elastic) yield to pressure, and do not recover their former figure; others (called elastic) regain their form, after losing it by pressure. They differ from each other in degrees of hardness, in colour, transparency, and weight, and when having definite crystalline forms, in the nature of these forms.

The second class consists of *Fluids*, of which there are fewer varieties. These, in small masses, assume the spherical form: their parts possess freedom of motion; they differ in degrees of density and tenacity, in colour and degrees of transparency. They are usually regarded as incompressible. They are contained in or repose on solids, and assume the form of the vessel in which they are placed.

The third class includes *Elastic Fluids* or *Gases*, which may either exist free in the atmosphere, or be confined by solids and fluids. Their parts are highly moveable, they are compressible and expansible. They are all transparent, and very rarely present colour. They differ materially in density.

It has been supposed by some natural philosophers that there exists also a fourth kind of matter, which has been called *Ether*, occupying the spaces between those aggregations of matter which form suns, planets, comets, and satellites. The phenomena of light, heat, and electricity, and their relation to the Sun in our system, have been thought to require the existence of some intervening material substance in order to admit of the action of forces or powers recognised under those names.

9 *Forces affecting Matter, and effect of Change of Temperature.*—All matter is subject to the law of gravitation, by which one portion is attracted to another in proportion to its mass, and inversely as the square of the distance intervening. Matter existing at the Earth's surface exhibits also the action of a force called *cohesion*, which preserves the form of solids, and gives globularity to fluids. This force is, therefore, a prime cause of the permanency of the arrangements to which we owe the surface of the globe.

When any substance in a state which occasions the sensation of heat to our organs, is brought into contact with another body which has no such effect, the result of their mutual action from the difference of these conditions, is that the hot body contracts and becomes cooler, while the cold body expands and becomes warmer.

The effect of heat is, therefore, generally to cause the particles of bodies to separate from one another, and heat is communicated either by actual contact, or by means of rays transmitted from the one body to the other.

As, however, there is nothing to affect the weight of bodies in the communication of heat to them, and they occupy larger space, after being heated, than they did before, they must then become less dense.

In the case of matter in the liquid or aerial form, the communication of heat is found by experiment to take place by currents, or particles actually moving amongst each other. How far currents may be induced in bodies in a solid state is not easy to decide. The effect of circulation thus produced is easily recognised in the atmosphere, since the unequal heating of the Earth by the Sun produces wind; and it is seen also in currents produced in the ocean.

When a substance in a fluid or solid state is exposed to the action of heat, a change of condition takes place, the solid becoming at first fluid, and then assuming the aerial or gaseous state. When, on the other hand, fluid or aerial bodies are made to part with their heat, they assume in most cases a solid form. Thus most of the gases become fluid, water becomes ice, &c.

Generally, when a change of condition takes place in consequence of the addition or abstraction of heat from various bodies, the addition of heat produces expansion, and the subtraction of it contraction; but the amount of change of volume is different for different substauces, and material bodies change their states at very different temperatures. Owing to this it is that the matter at the earth's surface assumes the form of solid land, with a watery ocean floating on the surface and filling up inequalities, while the atmosphere floats evenly over the whole. We have here exemplified the three conditions of solid, fluid, and aerial.

Although, however, generally the alteration of volume in different bodies is uniform during similar changes of temperature—that is, although bodies generally contract regularly while heat is being regularly taken from them, and expand regularly during similar increase of temperature, this is by no means invariably the case. There are many exceptions, but one is of vital importance to every organized being on the Earth, and has had much to do with the general constitution of the Earth's crust. Water contracts regularly as it cools dowu to a certain point; it afterwards expands slowly as the heat is farther reduced, and as it congeals or assumes the solid form, it expands considerably, so that ice, instead of being heavier, is lighter than water, aud floats on its surface. Were it not so, the sea in cold latitudes would become gradually frozen into a mass of ice, which the bright and warm sun of summer would have little effect upon. In point of fact, however, water congeals only at the surface, where it is liable to be acted on by the sun and by warm currents of air, which tend to restore it to the fluid state. When the water in a lake, or in the sea, approaches near the freezing point, it begins at once to descend, diminishing in volume and becoming, therefore, heavier, so that no ice can be formed till the whole of the water has been cooled to the point where it possesses greatest density. When the ice is once formed, it increases in thickness very slowly, the solid form of water being a very bad conducter of heat.

10 *Sources and Causes of Heat.*—The cause of heat is by no means clear, and there are many modes of producing it besides exposure to the sun's rays. A piece of Indian rubber extended and suffered to contract rapidly several times, becomes hot; a nail is made red hot by hammering; the axle of a carriage takes fire by rapid motion, when the friction is uot diminished by grease; the sudden compression of fluids and gases also produces heat; and, on the other hand, when by the air-pump a receiver is rapidly exhausted of part of its air, the sudden expansion of the remainder produces a considerable diminution of temperature. All these facts prove that one immediate cause of the phenomena of heat is motion.

Since matter may be made to fill a smaller space by cooling, it is evident that the particles of matter must have space between them It is also possible that the particles themselves may be actually smaller than the intervening space in the ordinary condition even of solids, and thus in all cases currents of these particles may be produced during the transmission of heat and the action of other imponderable agents.

11 *Chemical Action.*—The various material substances met with in nature are not only in different mechanical conditions, but are also variously acted upon by each other If, for example, we take the three substances, oil, water, and soap-lees, it is easy to show that the oil and water will not mix or act upon each other; the oil will separate itself from the water and arrange itself according to its weight, the two fluids not in the least combining. On the other hand, the soap-lees will mix intimately with the water, having none of its properties altered. But if the oil and soap-lees are mingled, they wil.

unite, forming a soft solid substance, which is, in fact, a species of soap, and differs materially from either of its constituent parts. Many substances in nature have thus what is called *affinity* for each other, combining intimately, and the kind of attraction exhibited when two bodies have this affinity is called *chemical action.*

Different bodies, however, unite with different degrees of force, and one body is capable of separating others from certain combinations, so that mutual decompositions of different compounds take place under favourable circumstances, and new combinations and new compounds are formed. This has been called double affinity, and it involves a kind of preference of one body, or set of bodies, over another. It is thus often described as *elective affinity.*

Now, it is very important to understand the difference in kind, of those two forces which have been called respectively attraction and chemical affinity. Attraction, whether that of gravitation, cohesion, or what has been called adhesion (illustrated by the holding power of glue, mortar, &c.), never in any case effects a change in the properties of bodies. On the other hand, when two substances that have affinity are brought into close approximation, and the affinities come into play, great and decisive changes take place in the two bodies, and a new substance is formed, which may be altogether different in all its essential characteristics from either. This action is best effected when the particles are most free to act on each other, and thus the addition of heat or fluid often facilitates considerably changes of this kind. The order of affinity is a matter also of great importance and interest.

12 *Polarity.*—There is yet another force exerted on bodies, and tending to produce the condition of things observable at the surface of the earth. It is best described by the word *polarity,* and is exemplified by that form of polarity exhibited in a bar magnet, which tends to place itself (when suspended freely) in a certain position with reference to two opposite ideal points in space—the north and south pole—near the extremities of the ideal axis round which the earth revolves. The magnet also attracts to itself at one end, and repels from the other, the extremity of a similar piece of iron also magnetized. Chemical polarity, however, involves much more than ordinary magnetic action, and must in the present state of science be understood to include electricity and galvanism, as well as magnetism, if not light, heat, and chemical affinity. The form known as galvanism is that which exhibits most of the peculiar results of this force, while that called magnetism is not less interesting, as showing in some respects the most familiar, as well as distinctly marked phenomena of polarity, presented in a moderately simple form. Electrical attraction and repulsion are equally striking, and not less simple in illustration.

Electric or galvanic action is generally connected either with the evolution of heat or chemical decomposition, and is excited by heating or rubbing certain solid substances, and by the contact of others of different kind when immersed in certain fluids. Changes of temperature at the Earth's surface, however, elicit magnetic and electric currents, and these again produce results which are among the most interesting that are met with on the globe. The Earth itself may be regarded as a magnet, and terrestrial magnetism may thus be ascribed either to inequalities in the temperature of the globe, or to those galvanic currents which we regard as electricity moving in a circuit. Scarcely any important change can take place in the atmosphere without the disturbance of electric equilibrium.

13 *Material Substances usually in combination at the Earth's Surface.*—The intimate action of these forces, if they are distinct, or the various modes of action of this one most varied force, if indeed there is but one, have produced those combinations which are presented at the Earth's surface, and have formed this variety of condition which is there recognised. Thus it is that some solids are constantly on the verge of change, under ordinary conditions, while others are so permanent as to yield scarcely, if at all, to the

most extreme action of this force that we can bring to bear upon them. While, also, some bodies are occasionally permanent in the fluid form, others can hardly be preserved in that form when very slight changes of temperature occur, and some of the aerial or elastic fluids are so little affected by the abstraction of heat or increase of pressure, as not yet to have yielded to the greatest efforts that have been made, although others are readily altered and made to assume the liquid form. Some decompositions also are easily effected, while others are so only with extreme difficulty; so that the chemist, whose object it is to determine the ultimate constituents of matter, is often at a loss to know whether, after all his labours, he really obtains an elementary body, or has to account for effects produced by assuming the admixture of portions of a body whose properties are not yet even imagined.

Notwithstanding this doubt of the ultimate elements, since it is necessary for the purposes of science to have certain principles and generally acknowledged facts from which to proceed, it has been found convenient to regard all those bodies which no art has yet been able to decompose as elementary. Thus it is usual to speak of a considerable number of elementary substances, many of which, however, may be really compounds, and many are so extremely rare in nature, or present in such small quantities, that in general descriptions they may almost be neglected.

14 *Elementary Substances.* — Of the so called elementary substances, several are abundant and well known, and others are highly important in combination, though of themselves rarely or never seen. They are of two very distinct kinds—those which are metallic, and those non-metallic. The whole number certainly known at present is fifty-nine, of which forty-three are metals, and five gases; but of this number only about thirteen are abundantly present in the rocks that make up the mass of the Earth's crust. The rest are chemical or mineralogical curiosities, or else occur in quantities so small as not greatly to affect the whole mass, however useful and important to man.

The thirteen elementary (?) substances most abundantly distributed are the following:—

Four gases—*oxygen, hydrogen, nitrogen,* and *chlorine;*
Three non-metallic solid elements—*silicon, carbon,* and *sulphur;*
Five metals, important as alkaline bases—*calcium* (basis of lime), *sodium* (basis of soda), *potassium* (basis of potash), *magnesium* (basis of magnesia), *aluminum* (basis of alumina, the ingredient of clay);
One true metal—*iron.*

15 *Oxygen Gas and its important Combinations.*—*Oxygen gas* is beyond all comparison the most abundant material present at the Earth's surface, for although not met with in a free state, it is found mixed with nitrogen forming the atmosphere, with hydrogen forming water, and with silicon, calcium, sodium, potassium, magnesium, aluminum, constituting various substances known as silica or flint, lime, soda, potash, magnesia, and alumina. It also forms, with iron and other metals, a vast number of the most abundant of the ores and minerals. On the whole, as much as one-half by weight of the materials of the Earth's crust consists of this gas. Oxygen gas is colourless, and a little heavier than atmospheric air. It may be made to unite with all the other elements except one (fluorine), and in many cases its combination, atom for atom, with another element, forms what is called an alkaline base, while a larger proportion of oxygen produces the substances called acids. Other proportions of this gas with other elements produce neutral bodies (those which are neither acid nor alkaline), of which the most remarkable instance in nature is *water*, a mixture of oxygen and hydrogen. A number of other combinations, under the name of *salts*, also derive their important properties, and many of their most interesting peculiarities, from the presence of oxygen.

16 *Combustion.*—The phenomenon of combustion is one which it is

chiefly the province of the chemist to consider in reference to the various elementary bodies, but it is also very essential that we should have a general idea of its nature, in order to comprehend the mutual relations of light, heat, and chemical action. The combinations of oxygen with other substances are attended with an alteration of volume and the evolution of heat, and often, but not always, by a considerable amount of light; and in common language, when a body combines with oxygen, it is said to be burned, and instead of undergoing oxidation, is said to suffer *burning*, while a body which can combine with oxygen and emit heat is called a *combustible.* It is important to remember, that no loss whatever of ponderable matter occurs in combustion, and that the matter formed may always be collected and thus proved to have the weight of the oxygen gas added to that of the combustible, which has either been reduced to an ash, or has entered into new combinations during the process. There is no such thing as annihilation discoverable in nature.

17 *Nitrogen, Hydrogen, and Chlorine, with their Combinations.—Nitrogen gas* is a singularly inert substance. It is tasteless and inodorous, and is lighter than atmospheric air, of which it forms four-fifths, and in which it seems chiefly to act as a diluting medium. Forming so large a part of our atmosphere, it is necessarily a very important and abundant material, but it mixes with few elements, and its properties are chiefly negative. In many respects, it is remarkably contrasted with the third highly important gas, *hydrogen*, which, indeed, has been compared to metals, in its relation to other elements, although it is the lightest substance known in nature, and is highly inflammable.

Water—a substance universally distributed at the Earth's surface, and present there in large quantities—is the result of the combustion of hydrogen and oxygen gases. It is eminently a neutral body, and is to a remarkable extent capable of dissolving various proportions of other substances—a quality which is well illustrated in the composition of sea water, whose density is greater than that of pure water, by the addition of $3\frac{1}{2}$ per cent. of saline matter. It is probable that, at high temperatures, water is capable of holding in solution a portion of almost every substance in nature. It is chiefly the remaining gas, *chlorine,* combined with *soda,* which makes up the saline matter present in sea-water.

18 *Non-metallic Solid Elements.*—Amongst the substances presented in a solid form under ordinary atmospheric conditions at the Earth's surface, *carbon, silicon,* and *sulphur* are highly important, extremely abundant, and widely distributed. They are all of them also without those peculiarities which characterize *metals,* in the ordinary acceptation of the term. It will be as well to describe the more usual forms of these elements.

Carbon occurs in three very different forms in nature, being crystallized in the diamond; existing in a state of partial crystallization, but of a very different fundamental form, in graphite or plumbago (the common black lead); and in a very different state again in the varieties of mineral coal. It appears to be quite infusible at any temperature, or under any circumstances to which it has yet been exposed by the chemist, and seems to offer itself under this variety of aspects, according to the structure of the substance from which it is derived, and the mode of its preparation, when obtained artificially.

Carbon is abundantly present in all organic substances, and is a principal ingredient in the carbonates, of which limestone (carbonate of lime) is the most widely distributed, and the largest in quantity.

Sulphur is likewise an elementary substance, occasionally found native and pure, but more commonly combined with other elements. This is especially the case with regard to the most important metals, which are, with few exceptions, found associated with this substance. The metal *arsenic,* and another rare metal called *selenium,* exhibit very remarkable analogies with sulphur in their mixtures with metals.

Silicon is the name given to an elementary substance derived by removing its oxygen from pure silica, which in the state of flint or siliceous earth is one of the most abundant of all the matters that compose the Earth's crust. This mineral constitutes sand, all the different varieties of sand-stone and quartz rock, and, combined chemically with alumina, it forms a very large proportion of all clays. In its pure and elementary state it is of little interest, but in consequence of the number and importance of its combinations, it is beyond all comparison the most remarkable of the non-metallic elements. Combined with lime, potash or soda, magnesia, or alumina, and often with iron, it forms nearly all the other mineral ingredients of granite, mica-slate, volcanic rocks, shales, sandstones, and various soils—in other words, of all rocks, with the exception of pure limestones.

19 *Metallic Elements the Bases of Earths.*—The metal *calcium* mixed with oxygen (with which it combines so readily as not to be preservable, if exposed in contact with any known substance containing that gas) forms the substance called *lime*, and this again combined with carbon and an additional supply of oxygen (carbonic acid), is the ingredient of all marbles and limestones, including under that name chalk and other calcareous bodies of whatever kind. Combinations of other elements with lime are also abundant in nature, and of these sulphate of lime (gypsum or alabaster) is one of the most interesting.

Alumina, derived from an obscure metal, just as lime is derived from calcium, is rarely met with in nature, except as a very hard and precious mineral, called the oriental sapphire, which exhibits its true crystalline form. It is as silicate of alumina or clay that this material is most interesting in reference to the Earth's crust. In that form, however, it is universally and abundantly distributed.

Soda and *Potash* are two other substances which are very widely distributed; the former in sea water with chlorine, the latter in nitre (*saltpetre*). *Magnesia*, in like manner, is very plentiful, although the quantity is not so great as in the case of some other substances which may be regarded as proximate elements.

20 *Metals.*—*Iron* is the only metal which is at once so universal and so abundant as to be worthy of a rank among the principal ingredients of the globe. It is not found native in the Earth, though fragments are met with on the surface, containing this metal in association with other metals, but its ores are numerous, and its presence is everywhere recognised. It is quite unnecessary to define and describe a substance so universally known.

These various substances, the remaining elements, and numerous combinations of these and other elements, amounting, however, in all to a comparatively small number, are mixed together in certain definite proportions, and thus form what are called *minerals*, groups of which in mass are designated *rocks*. Minerals, in most cases, are capable of assuming definite forms, and become crystallized into certain recognisable shapes, the study of which, and of their relations with each other, forms the basis of the science of mineralogy. The consideration of those masses of minerals which we have described as rocks, the earths, clays, limestones, sandstones, &c., the various kinds of granite and slate, and all other great and widely-spread collections of like minerals, forms one department of geology, and is more immediately interesting in the study of physical geography.

21 *Mutual Action of various Forms of Matter.*—Reverting to the observations made in the beginning of the present chapter, it will be understood that the division of all matter present at the Earth's surface into three parts—namely, solid, fluid, and aerial—has its origin in certain conditions of temperature and certain chemical combinations. It is not, as we have now seen, an *essential* condition of matter that there are these various states, it is rather what may be called an *accidental* condition, but at the same time one particular state seems much more consistent than any other with the known properties of some of the elements, and also of some of their combinations. These various conditions, however, involve many modifications, chiefly mechanical, and the fact that air and water are capable of retaining small quantities of each other, and of various elements in solution and suspension,

without chemical change, causes some very important and highly interesting results. The crust of the Earth is greatly affected by the passage over it of air and water; these latter substances also greatly affect each other, and the whole mechanical structure of the crust is, in fact, due to the action of air and water, and air mingled with water, as modified by the changes of temperature resulting from the partial incidence of the sun's rays on the surface, and the more or less favourable condition of the atmosphere for transmitting light and heat, as well as of the Earth's surface for receiving them. Thus, it is that METEOROLOGY and HYDROLOGY become part of Physical Geography, and that the sciences relating directly to air and water require to be considered as portions of a more general science, whose object it is to describe general terrestrial phenomena. Thus also it is that CHEMISTRY is to a certain extent required for the same end, and that the laws affecting those forces which modify the material elements, must be in some measure explained and understood, before we can proceed to consider either the surface or structural phenomena of our globe.

22 *Terrestrial Magnetism.*—There is yet one more subject to be considered before passing on to the material phenomena of the globe. The researches of natural philosophers, chiefly of our own day, have brought to light a vast group of facts concerning the magnetic condition of the Earth, and have shown that which is now designated 'terrestrial magnetism,' must be regarded as one of the most important, if not absolutely the most important, of all the imponderable agents. We have already alluded to the phenomena of magnetism, commonly so called, and have said that the tendency of a magnetic needle to arrange itself in a certain direction, is connected with a subject of great extent and high interest. The Earth, in fact, exhibits a certain amount of magnetic force, and this is manifested at the surface by three classes of phenomena: varying *intensity* of the attraction; varying *declination*, the needle not always pointing to the same spot or pole on the Earth's surface; and varying *inclination*, or amount of departure of the needle from the horizontal plane. This latter variation is called the *dip* of the magnetic needle, and the declination is commonly spoken of as the variation of the compass. In other words, when a compass is referred to, in different parts of the Earth, or at distant periods, the needle will not be found always to arrange itself so quickly in its position of rest; it will not always point to the same point, and it will not, if suspended, freely repose in a horizontal plane, or at the same angle to the horizon. In illustration of this, it may be mentioned, that while in the year 1657, the needle pointed due north in London, this was not the case in Paris till twelve years afterwards, notwithstanding the small difference in longitude between the two cities. At the present time, the whole of Europe, except a small part of Russia, has west declination, while in Asia the declination is east.

But the most remarkable fact with regard to this constant shifting of the direction of the needle, is that there is an hourly change of position dependent on the apparent course of the sun and the lapse of time between the observations. The hour of the day may in this way be known between the tropics, and the movements of two small bars of magnetized steel suspended from a thread, even if they are suspended at depths beneath the Earth's surface, will measure accurately the distance which separates them. There are also parts of the Earth where the mariner, who has been enveloped many days in fog, seeing neither sun nor stars, and having no means of determining time, may know with certainty, by an observation of the magnetic inclination, whether he is to north or south of the port which he desires to enter.

The hourly changes of declination of the needle seem to be governed by the sun, while that luminary is above the horizon of any spot, but they also have reference to the actual position of the spot on the globe, and its distance from the magnetic poles. Throughout the northern hemisphere the mean movement of the north end of the needle from $8\frac{1}{2}$ A.M. to $1\frac{1}{2}$ P.M. is from east to west, and in the southern hemisphere, at the same time, from west to east. Thus, along a line near the equator there is no horary variation in declination.

The name of *magnetic poles* has been applied to those points on the Earth's surface where the horizontal force disappears. Of these there are two in each hemisphere, not far removed from each other, or from the true poles of the Earth, but unequal in the amount of their attractive force. The focus of greatest intensity in the northern hemisphere is in North America, near the south-west shores of Hudson Bay, in 52° N. latitude. The corresponding weaker focus is in Siberia, about 120° E. longitude from Greenwich.

It is known that the forces which attract the north end of a magnet and repel the south end, preponderate in the northern hemisphere, while in high latitudes, in the south hemisphere, the converse is the case. There is, therefore, in addition to the line of no declination, near the equator, another line of no preponderance of the northern or southern force, and it is found that both lines are extremely irregular.

The intensity of the magnetic force is measured by examining the oscillation of a suspended needle, and is determined with very great accuracy. The intensity increases towards each pole, and thus we have a line of least magnetic intensity near the Earth's equator, in addition to those lines already mentioned, and quite distinct from them.

Intimate relations have been discovered between the state of electricity of our atmosphere and the magnetic condition of the Earth, and it is known that while a conductor of electricity is rendered magnetic by the passage of an electric current through it, so also magnetism gives rise by induction to electric currents. The identity of electricity and magnetism is thus fully made out.

The important discoveries of Faraday on the condition of matter with regard to magnetic influences—magnetic force affecting all bodies as necessarily and directly as the force of gravitation,—has given new interest to this subject. According to the result of his experiments, all substances arrange themselves into two great divisions—*the magnetic*, in which the substances tend to place themselves parallel to the direction of the magnetic needle, at the spot where the experiment is performed; and the *diamagnetic*, where the tendency is to assume a direction at right angles to that of the needle.

By far the greater portion of the materials which compose the Earth's crust belong to the latter, or diamagnetic class; for even as respects the rocks and mountains, the quantity of magnetic matter needed to counteract the diamagnetic tendency is very large, and the ocean, lakes, rivers, and atmosphere exert their effect as diamagnetics, almost uninfluenced by any magnetic matter. Mr. Faraday has suggested the possibility of magnetism being, in fact, generated in the atmosphere by light proceeding from the sun, and passing rapidly through the air, but he wisely suspends any theoretical considerations until experiment has given a sufficient groundwork for them. However this may be, there can be little doubt that for all practical purposes we must regard the magnetic force as resident only on the surface, or rather just within the oxidised crust, which is all that we actually know of our globe. The Earth is not, as was once imagined, an inert mass, having, by some unimagined means, a peculiar power to attract iron towards its two poles of rotation. It is a mass of matter, every part of which is affected by magnetic force, and which is, throughout its external crust, hard and immoveable as that may seem, exposed to changes and modifications of the most extraordinary kind, and of great extent.

CHAPTER III

METEOROLOGY.

23. Constitution of the atmosphere.—24. Its chemical condition.—25. Its chief importance in Physical Geography.—26. Its relation to light generally.—27. Twilight.—28. Mirage.—29. Colour.—30. Atmospheric meteors exhibiting colour.—31. The phenomena of sound.—32. Motion of the air—Winds.—33. Land and sea breezes.—34. Trade winds.—35. Monsoons.—36. Hurricanes.—37. Relations of the atmosphere to water.—38. Dew.—39. Mists and fogs.—40. Clouds.—41. Rain.—42. Distribution of rain.—43. Snow.—44. Glaciers.—45. Hail.—46. Climate, and distribution of heat.—47. Conclusions.

CONSTITUTION of the Atmosphere.—We proceed now to consider that portion of the material universe present in an aerial form at the Earth's surface, and which has long been known under the name of *atmosphere*. The atmosphere is highly elastic, and therefore more dense near the Earth's surface than in its upper portions, where there is less pressure; but notwithstanding its great elasticity, there can be no doubt of its terminating absolutely at a small elevation compared with the magnitude of the Earth. The real extent of this gaseous veil has not indeed been very satisfactorily determined, and has been variously estimated at from forty to a hundred miles; but as the diameter of the Earth is eight thousand miles, the largest estimate does not assume it to be more than one-fortieth part of the radius, and there is no reason to suppose that it is nearly so much.

The weight of the whole atmosphere can be accurately determined, and the degree of pressure at any point is also a fact which offers little difficulty in determining. By depriving of air the closed upper extremity of a tube filled with mercury, which opens below into a cistern also full of mercury, the pressure of the whole column of the atmosphere may be measured against that of a column of mercury, and thus the pressure is found to be equivalent to about fifteen pounds on every square inch of surface.

The constituents of the atmosphere are as follow. Of every 10,000 parts of air in the ordinary state with regard to moisture, there are—

Oxygen	2,100
Nitrogen	7,750
Aqueous vapour	112
Carbonic acid gas	4
Carburetted hydrogen	4
	10,000

There is also a trace of ammoniacal vapour.

It was formerly supposed, that in whatever part of the Earth it is taken, at whatever depth or height above the mean level of the surface, or under other peculiar circumstances, the constitution of the atmospheric air was exactly the same. Although this is not quite true, it is very nearly so, the quantity of oxygen varying slightly, but perceptibly, in different seasons of the year, and over the sea, or in the interior of continents. So much change by oxidation is constantly going on at the Earth's surface, that it would be strange if this were not the case; but the absolute quantity of this gas compared with the surface and the materials exposed to its action, is far too great for the change to be readily perceived.*

* It may be interesting to repeat here the different localities from which the atmospheric air has been chemically examined, to show how little the proportion changes. The air from the Alps was analysed by the younger Saussure; from Spain, by De Marti; from France and Egypt, by Berthollet; from England and the coast of Guinea, by Davy; from the Peak of

In addition to the materials already mentioned, there are also traces of ammoniacal vapour and even of some other gases in the atmosphere; but these, although important in their influence on organization, are not to be considered as affecting the general physical condition of the air. It has also been supposed that the atmosphere contains, diffused through it, minute portions of the vapours of all those substances with which it is in contact, even including earths and metals. Although, however, unknown ingredients may be occasionally mingled with the atmosphere and impart to it deleterious properties, such ingredients being of too subtle a nature, and present in too small proportion, to be discovered by our imperfect instruments, it yet appears that a limit exists to the production of vapour of any tension by bodies placed in such a medium as the atmosphere, and that beneath such limit they are perfectly fixed.

24 *Its Chemical Condition.*—Two views have been entertained of the nature of the union that exists among the elastic bodies forming our atmosphere. It has been generally supposed to be a chemical compound, because the proportions are very nearly fixed, and the ingredients do not tend to arrange themselves according to their different specific gravities. It is, however, more probable that the mixture is, after all, mechanical, the various elastic fluids not having any attraction or repulsion towards each other beyond that of the simple action of the law of gravitation, and each of the ingredients exerting its own separate pressure, and behaving as if it were itself free, and formed a distinct atmosphere.

The most important and valuable investigations in the science of meteorology, have been founded on the assumption that there are two distinct atmospheres, one of dry air, and the other of aqueous vapour, and that these are mixed mechanically together; and also on the conclusion that the relations of these to heat are different, and their states of equilibrium incompatible with each other. Thus are produced those changes of condition consequent, as we know, upon changes of temperature, and also those other changes resulting in what is called *climate.*

25 *Its chief Importance in Physical Geography.*—The atmosphere may be chiefly regarded as important in Physical Geography in its relations with light and sound; with heat, as the means of distributing temperature; with water, as the means of distributing moisture over the Earth; and with electricity, as connected with the mode of action of this force in all its various forms. The motion that takes place in the atmosphere, and which we denominate *wind*, is thus a matter of vital interest, since it aids in these distributions, and affects also very directly many operations of man. The optical and acoustical phenomena of the air being, to a certain extent, independent of its motion, though not uninfluenced by it, may first be considered. We may then study the phenomena of the winds, and afterwards proceed to consider some points connected with the distribution of heat and water.

26 *Its Relation to Light.*—In its relations to light, our atmosphere plays a very important part, and greatly affects the action of several forms of the imponderable force; and whatever its origin or true nature may be, it is capable of transmission through certain bodies, thence said to be *transparent,* of which the atmosphere is one.

It is found that in being transmitted or passed through a transparent body, a change of direction of the ray of light takes place whenever the substance through which light passes becomes of different density, or when light passes from one medium to another of different density. Thus, when a stick is placed in water, and is not vertical, it will appear to an eye looking down

---

Teneriffe, and near the summit of the Andes, by Humboldt; and from the still loftier elevation of 22,000 feet, (attained in a balloon,) by Gay Lussac and Thenard; and all these gave results approaching as nearly as possible to each other. The observations of Lewy are those referred to as showing a slight difference in different parts of the Earth.

upon it as if it were bent, for the water is more dense than the air, and the body is seen only by means of the rays of light which proceed from it; and thus, also, if light pass through air of different density, the rays are bent at an angle or curved. A part only of the light, however, is transmitted, part of it being actually lost, part of it reflected, and a part dispersed. It is important to remember that, in proportion as light passes through a greater thickness of matter, as for example, of air of varying density, it becomes less and less in quantity, being gradually absorbed, dispersed, and reflected.*

It is usual to speak of the bending of light in its passage from one medium to another of different density, under the term *refraction*, while the throwing back of light from a surface is called *reflexion*. A ray falling on a body is said to be *incident*. The part transmitted is *refracted*, and that thrown back, *reflected*.

The course of a ray of light in its progress to the earth is, therefore, as follows:—The ray falls on the uppermost limits of the atmosphere, and meets there an elastic transparent fluid: at this point it is turned aside or *refracted*, a small part of it being, however, reflected back into space, a part dispersed, reflected, or distributed into the surrounding atmosphere, and a part absolutely lost. As it proceeds through the air towards the Earth, it passes continually into a denser atmosphere, because the pressure increasing, and the air being elastic, the dimensions diminish, and at each instant the ray becomes therefore more and more deflected, while more and more of it is absorbed, and more is also dispersed and reflected. The portion that reaches the Earth varies in quantity according to the extent of atmosphere passed through, and its density, and is therefore not constant; but whatever the amount be, this portion is reflected back from the surface of opaque bodi s, or transmitted, with still further loss, through transparent ones, and so again and again till it is completely dispersed or destroyed.†

Diminished splendour, and the false estimate we make of distance, from the number of intervening objects, lead us to suppose the sun and moon to be much larger when in the horizon than at any other altitude, though their apparent diameters to the eye when measured are then somewhat less. These and a number of other effects are results of refraction and the partial loss of light in passing through a great thickness of atmosphere.

In consequence of the dispersion of light by means of the atmosphere, we obtain all those varieties of half shade which alone enable us to make use of organs of vision constructed as ours are. If it were not for this, we should constantly have either full broad and dazzling light, or deep black shadow and impenetrable darkness. The objects from which light is emitted are few, and, with the exception of the sun, are rarely available, except by artificial means, so that in countries where the sun is often long absent, or where the clouds obscure its face during a large part of the day or year, the inhabitants would, in the cases alluded to, be in total darkness. A large quantity of light being, however, dispersed and reflected from particles of vapour in the air, there can hardly be found at any hour of the night, or at any season, a total absence of light, and there are no sudden and abrupt transitions to affect our delicate organs of vision.

27 *Twilight.*—During a fine, clear, calm day, in our northern latitudes, it may be observed, that as the sun approaches the horizon, the sky in the west assumes a yellow or red tint; towards the zenith, or directly overhead, it becomes whitish, and the sky is less clear; until just as the sun has fairly

---

* See *ante*, p. 76

† The quantity of light that passes through the atmosphere in different states may be thu estimated:—Of 10,000 rays falling on the surface of the Earth, 8123 arrive at a given point it they fall perpendicularly, 7024 if the angle of direction be 50°, 2831 if it be 7°, and only five rays arrive through a horizontal stratum. In consequence of so large a proportion of light being sometimes lost in passing through the atmosphere, many celestial objects may be altogether invisible from a plain, and yet be visible from elevated situations.

sunk below the horizon, a red colour is seen in the east opposite to the setting sun. This is the commencement of the phenomenon called *twilight*, and is owing to the existence and properties of the atmosphere, and chiefly to the light being reflected from its higher portions. It depends, however, on the position of the Earth with respect to the sun, and also the condition of the atmosphere at the time, how long this phenomenon shall continue; since, in the fogs of winter, darkness comes on almost immediately after sunset, while, on a clear summer evening, the broad light of day continues for more than an hour little diminished. A similar phenomenon of twilight occurs in the morning before sunrise.

Investigations concerning the absolute limits of our atmosphere have been greatly assisted by careful observations on the duration of twilight, but the subject is one of great intricacy, and the results which have been hitherto obtained are not absolutely conclusive.

28 *Mirage.*—It is not only the rays of light that proceed from a luminary without the Earth, but also those emanating or reflected from bodies at and near its surface, that are refracted by the unequal density of different parts of the atmosphere. The phenomenon of ordinary refraction, as it occurs in fluids of equal density throughout, is exceedingly simple, of whatever kind the fluids may be, when once the principle of refraction is understood; but this is not the case with some curious appearances connected with unusual and irregular refraction producing optical illusions, and not unfrequently assuming all the appearances of direct reflection. The word *mirage* has been applied by the French to such phenomena, and as there is no satisfactory English translation, we must be content to adopt it.

The illusions of mirage differ according to circumstances, and they are sometimes exceedingly strange and almost startling in their character, presenting an image of what really exists, but is entirely out of the range of ordinary vision. Sometimes, also, they exhibit parts of objects, broken, distorted, and out of place; sometimes they confuse in a singular manner the true outlines of objects, and occasionally they present a gorgeous and fairy-like spectacle—superb palaces, with their balconies and windows resting on the bosom of the broad ocean, lofty towers near them, herds and flocks grazing in wooded valleys and fertile plains, armies of men on horseback and on foot, with multiplied fragments of buildings, such as columns, pilasters, and arches. All these may be seen again repeated in the air above, and fringed with red, yellow, or blue light.

Phenomena so striking can be explained only by a reference to the condition of the atmosphere when in an unusual state with regard to moisture as well as density, and they may be conveniently arranged under one or other of the three following classes: vertical reflection, lateral reflection, and suspension.

The most simple example of vertical reflection is that often observed in hot sandy deserts, and occurring after the soil has become heated by the presence of the sun. In such cases, the prospect seems bounded by a sheet of water, and underneath each object, as the villages which in Egypt are generally built on small eminences, the apparent reflection is seen as if in water. A singular effect of this kind is described as having been noticed in India, where Captain Maunday states, 'A deep, precipitous valley below us, at the bottom of which I had seen one or two miserable villages in the morning, bore in the evening a complete resemblance to a beautiful lake. The vapour, which played the part of water, ascending nearly half-way up the sides of the vale, and on its bright surface trees and rocks were distinctly reflected.'

In horizontal reflections the image is presented sideways. In this manner Dover Castle has been seen from near Ramsgate, as if an intervening hill, which under ordinary vision cuts off a part of it, were actually removed; and in this way, too, the French coast has been seen distinctly, and in all its details, from near Hastings, although the distance is sufficiently great to render it invisible by ordinary refraction.

The phenomenon of suspension is not less remarkable, and is called in sea language, *looming.* It consists in the representation of an object immediately above its true place, either in its true position or reversed. Thus, Captain Scoresby describes that he on one occasion distinctly recognised his father's ship at sea, by its inverted image in the air, although the distance between the two ships was as much as thirty miles, and the ship was therefore far below the horizon of that from which it was observed.

All these phenomena, and their different modifications, depend on the different density of the lower strata of the air, and as this difference of density may be occasioned both by heat and moisture, and as heat may be reflected from a mountain side as well as from the horizontal surface of a plain, and from the sea as well as from the land; and further, as contiguous vertical columns of air, as well as horizontal strata, may be of different densities, it is easy to understand why mirage may be seen in very different situations, and why it presents such varied appearances. It will also be evident that any cause which re-establishes the equilibrium of density in the different portions of the air must cause the illusions of the mirage to vanish. Calm in the atmosphere is almost essential to the phenomenon in question, and it has been remarked that this perfect calm is often the precursor of a tempest.

29 *Colour.*—The ray of white light proceeding from the sun, and whose course we have traced through the atmosphere, has been found to consist, in reality, of several rays, some of which communicate to our eyes the notion of various colours, while others seem chiefly important in producing heat or chemical action. It is found, also, that these rays are differently affected by passing through, or being reflected from the same substances, some being more readily absorbed and lost than others. Thus, the impression on our senses in looking through the clear atmosphere, is that of blue, while the setting sun communicates red or golden light to clouds, according to the circumstances under which the light falls.

The colours which, being combined, make white light, are three, and are called blue, red, and yellow, but several well marked modifications of these exist, and it is usual to speak of seven primitive colours—viz., red, orange, yellow, green, blue, indigo, and violet.

All substances known, however opaque, allow some portion of light to pass through them, and all, however transparent, absorb and destroy some rays. The colours of bodies are derived from their power of absorbing certain rays more readily than the rest, and thus giving forth light, which, instead of being a mixture of colours in the proportions of white light, have some colour in excess, the idea of which they communicate to the eye. When light also passes through a transparent medium, such as a prism, a glass sphere, or a drop of water, it becomes decomposed, and in this way are produced some of the most striking meteoric effects in which colour appears. Bodies that reflect all the rays in the same proportion appear white, those that absorb all are black; a violet reflects the violet rays alone, and absorbs the rest; while a leaf reflects the blue and yellow rays, absorbing the red, and produces by a mixture of the two the compound colour known as green. Very careful observation has shown that there are dark lines in the image of the sun received on a screen after the transmission of a ray of light through a prism, and these by their permanence and uniformity appear to show that certain rays are absorbed in passing from the sun, or perhaps in traversing the solar atmosphere.

30 *Atmospheric Meteors exhibiting Colour.*—The *rainbow*, one of the most striking of the common but occasional meteors, is the first that requires notice. It is a circular arch of variously coloured light, visible in the heavens when the sun or moon is shining, and when at the same time a shower of rain is falling,—the spectator being placed with his back to the sun, and observing the falling rain. Besides the principal bow, a second bow with inverted colour is often seen outside the principal one. Both consist of concentric bands of the prismatic colours, arranged as they have been described to occur in the solar spectrum. The lower edge of the interior bow is violet.

It is not very difficult to comprehend generally the cause of the rainbow. A ray of sunlight entering a drop of water as it is falling to the earth is refracted as it enters, and the refracted ray is subsequently reflected from the inside of the drop on its opposite side, and then emerges and proceeds towards the eye of the spectator, placed as has been described. But the rays of colour being refracted to different points, and becoming a line of coloured light as they issue from the drop, a part only will really reach the eye of the spectator, and from one drop he will see one colour. The same will happen with all the other drops, and the eye will only be sensible of a band of coloured light having an apparent breadth about equal to four and a half times the sun's apparent diameter in the case of the inner bow, and an outer band about half as large again.

The appearance sometimes observed around the sun and moon, and termed *halo* or *corona*, is caused by the refraction of light by particles of water floating in the air. *Parhelia*—repetitions of the sun near the true place of that luminary, and *athelia* or false suns, are referred to the refraction of light by floating prisms of ice. These and a number of rarer results of the action of those laws which affect light, produce their effect in consequence of the peculiar condition of our atmosphere, its occasional and irregular contents, and its unequal density.

31 *The Relation of the Atmosphere to Sound.*—If the atmosphere were removed, and our organs of hearing remained as they now are, a death-like silence would appear to us to pervade nature; for all sound is connected with vibrations of particles of the air, producing waves throughout the whole mass, though each individual particle does not move far from its state of rest. The appearance of a field of ripe corn when agitated by wind, offers a good illustration of the condition of the atmosphere when transmitting sound, the only difference being, that each ear of corn is set in motion by an external cause, and is uninfluenced by the motion of the rest; whereas, in air, which is compressible and elastic, when one particle begins to oscillate, it communicates its vibrations to the surrounding particles, which transmit them to those adjacent, and so on continually.

The velocity of sound is uniform, and quite independent of its loudness; but whatever increases the elasticity of air, must accelerate the rate of the vibration, so that sound travels faster in warm weather than in cold. The speed at the temperature of 62° Fah. is 1143 feet per second, whereas at freezing temperature, sound only travels 1089 feet in the same time. It is an interesting fact that the rate of speed of sound is faster than would appear from theory, unless the result of the compression of the air in the transmission of the wave is taken into account. It has been already said that compression of an elastic fluid produces heat, and we have just seen that heat quickens the rate of transmission. Thus the actual rate at which sound travels is about one-sixth greater than it would have been, if the temperature remained unaltered during the compression of the atmosphere.

The transmission of sound, therefore, as well as the ten thousand other changes going on about us, are themselves engaged in originating still further changes, and calling into action powers and forces at first little suspected.

All fluids and solids transmit sound, and most of them far more rapidly than air. Water, for example, conveys vibrations of this kind four times, and some kinds of wood nearly seventeen times, as rapidly as air. Still, air is the only means on which we can depend, for without this, our auditory apparatus would be useless, or only available by the actual contact of material bodies in the solid or fluid state.

32 *Motion of the Air.—Winds.*—So long as the density of the air remains the same, there is nothing to disturb the equilibrium of the atmosphere, but if from any cause the equilibrium is disturbed, a movement results, which we call *wind.* If, for example, at any point of the Earth's surface the temperature is increased and the air above it heated, a displacement occurs, the warm air rising, and cold air rushing in from all sides to restore the balance. These

currents of air play a very important part in nature. They purify the air of towns; they modify and improve extremes of heat and cold; they disperse clouds, and they assist, by the distribution of pollen and seeds, and by a constant agitation of the different parts of plants, in preserving vegetation in a healthy state, and ensuring its continuance.

Winds are generally denominated from the quarter from which they blow. Thus, we speak of a north-easterly wind or a south wind, but there are also names given to some winds that are locally prevalent, or that exhibit any peculiar characteristics. Such are the trade winds, the monsoons, and others.

The wind blows not only from various quarters, but with every degree of force and rapidity, from the most gentle zephyr to the most destructive hurricane. The different kinds of winds in respect of quickness and force are spoken of under the terms breeze, gale of wind, and tempest or hurricane, respectively.

The direction of winds is determined by reference to an arrow or weather-cock placed on an elevated position, and where there are no adjacent buildings at so great an altitude to disturb the true direction of the current. The intensity of force is measured by an instrument called an *anemometer*, the principle of which is that of a small windmill, whose sails are moved more or less rapidly as the wind is more or less powerful.

However apparently various the causes of winds may be, they are almost all referrible more or less directly to changes of temperature. The Earth is constantly presenting a different portion of its surface to the direct rays of the sun, and is consequently exposed perpetually to alterations of temperature. These all affect the atmosphere, and produce an infinity of minor currents, influenced, however, by certain main currents, consequent upon the general regularity of the change undergone.

The winds which it is important to notice, as belonging to a general view of physical geography, are these: the land and sea-breezes, which occur daily on the coast and in the islands in tropical regions, certain periodical winds prevailing in some parts of Europe, some irregular winds observed in districts offering remarkable physical features, the trade winds, the monsoons, storm winds, hurricanes, and whirlwinds. Those irregular winds which blow from various quarters in temperate latitudes are not sufficiently referred to general principles to admit of description in this place.

33 *Land and Sea-breezes.*—The winds called *land and sea-breezes* are derived from the unequal action of the sun on the land and water, combined with the tendency of the atmosphere to preserve a state of nearly uniform density. During the day, in hot countries, the steady shining of the sun, especially when nearly vertical, heats the land much more than the adjacent ocean, and thus the atmosphere above the land becomes more rarefied, and from about nine A.M. the air from the sea flows towards the land, to occupy the partial vacuum produced. As the heat of the land goes on increasing, the force of the breeze increases also, and this continues till two or three, P.M. After that time, the temperature of the land diminishes, decreasing much more rapidly than that of the water, so that about sunset the breeze from the sea ceases. During the night, the sea and the air over it retain their temperature, but the land and overlying air become cooler, and the breeze then sets in from the land, the warmer and lighter air being again displaced by the cooler and heavier. This breeze from the land augments in force till near sunrise, when the temperature of the earth begins to increase once more, until about nine A.M., when the sea-breeze sets in. These breezes are not confined to the coast, as they converge and diverge in every direction, and extend far inland, but they must still rank as local phenomena.

There are some periodical winds lasting for very limited periods, and occurring in various parts of the Earth. In the eastern part of the Mediterranean, for example, a current sets in from the north-east, and blows every day from about the middle of July till the end of August, commencing at about nine A.M., and dropping at sunset. Similar winds blow in Spain and also in Asia from the east, but are of shorter duration. Such winds are probably caused by the rarefaction of the air under the tropic of Cancer, in consequence of the heat of the sun at the season during which they blow.

The most important of the atmospheric movements observed and referred to regular laws occur within a zone, whose general limits are the thirtieth parallel of latitude above and below the equator; although beyond these limits, some of the prevailing winds which there take their origin are often found to extend.

34 *Trade Winds.*—There are two regions in which the *trade winds* prevail; the one is north of the equator, reaching from latitude 10° north to the tropic of Cancer, and extending in the West Indies to near 30° north latitude, the other commencing a few degrees south of the equator, and extending generally to the tropic of Capricorn; but in the Pacific Ocean, reaching a little further to the south. Between these regions is a zone of variable winds and calms.

The zone of variable winds and calms, situated close to the equator, is a convenient point of departure in describing the periodical and regular winds. Although generally characterised by calms and light westerly breezes, sudden storms and squalls are not unusual, and vast quantities of rain fall there. The general result of the rotation of the Earth on its axis, from west to east, and the greater influence of the sun near the equator, cause the atmospheric covering of the globe to be, as it were, left behind, producing apparent winds near the equator. These, and the polar and equatorial currents that set in, and affect chiefly, and at first, the higher parts of the atmosphere, appear to produce the singular zone just referred to. It is situated entirely north of the line, owing, no doubt, to the peculiar form of the land in the northern hemisphere, and the great preponderance of land there.

The trade winds are perpetual winds occurring in the open tropical seas, north and south of the zone of calms, and are so called because they greatly promote navigation and trade. To the north of the equator, these winds blow in the eastern parts of the ocean from the north-east, but further to the west they become more easterly, and sometimes even blow from a little south of east. South of the equator they blow in the eastern parts of the ocean from south-east, but become more nearly due east towards the west. They blow with less force and steadiness in the eastern than in the western seas, and are only experienced at a distance from land and in the open ocean. They are generally stronger in the hemisphere where the sun is not vertical, and are also there less easterly. The weather is generally fine when the trade winds are blowing, but, as has been already observed, the intermediate belt of sea is remarkable for the quantity of rain that falls there.

The trade winds occur both in the Atlantic and Pacific Oceans, but vary considerably both in extent and force in these two great divisions of the water.

In the Atlantic, they are found to have a wider range on the American than on the European side, and on that side they blow from due east, while near the Old Continent the direction is north-east. Of the two regions affected by these winds, the northern is less regular than the southern, and towards its northern boundary is less boisterous and capricious. The latter, or southern region, also ranges much further north, commencing a little north of the equator, so that the northern district of the trades is even sometimes encroached on by it, and the winds meet.

In the Pacific, the trade winds are by no means so well determined as in the Atlantic, nor are they so extensive in proportion to the much greater breadth of open sea, or so much to be depended on. They appear to blow permanently only over that part of the ocean extending from about the meridian of the Galapagos to the Marquesas, or from longitude 91° to 130° W., afterwards becoming periodical winds, or monsoons. In the Indian Ocean, from the coast of Madagascar to the shores of Australia, the south trade winds prevail, but the northern do not exist. As in the Atlantic Ocean, the southern perpetual winds extend north of the equator, when the sun is in the northern hemisphere, having been met with as far as 3° 30′ N. lat. in the month of July; but in the opposite season, they recede to one or two degrees south of the line. The north-eastern trade wind is described as being more regular than in the Atlantic, aud its northern boundary less variable. The region of calms in the Pacific is little visited, and less known. It is certainly north of the equator, but probably nearer to the line than in the Atlantic.

The boundary of the trade winds in the temperate zoue, in both hemispheres, and in both oceans, varies with the seasons—the difference being considerable: and thus there occur regions, several degrees of latitude in width, alternately exposed to the sway of trade winds and of variable winds. The actual termination of the zone of trade winds is generally marked by a sudden change of wind This region of variable winds in the Pacific, and especially in the southern hemisphere, is generally much more uniform than in the Atlantic.

The trade winds are confined to the ocean, but regular and constant easterly winds also occur between the tropics in some countries, which probably owe their origin to the same cause. Such winds, however, do not extend beyond extensive level plains. Examples are seen in the easterly wind which blows all the year over a great part of the Sahara, or Desert of Africa, and a similar wind always blows on those vast plains of South America which are drained by the Amazon, and on those in the lower course of the Orinoko.

The cause of these winds is generally considered to be the constant rarefaction of the air between the tropics, where the sun exerts so much more power than in the temperate and frigid zones, and the consequent rushing in of currents of cold air, from the north and south, towards the equator. If the winds moved with the rapidity of the Earth, the currents would of course be north and south, but as this is not the case, and the Earth moves far more rapidly from west to east, the winds are left behind, and appear to blow from other points. Thus, they blow from the north-east in the northern hemisphere, and from south-east in the southern, while near the equator, and where influenced by land, they occasionally blow from due east, or nearly so.

35 *Monsoons.*—These wiuds differ from the trades, in being only periodical, while the latter are perennial. They occur chiefly in the Indian Ocean, but prevail also in the seas between Australia and China, which may, indeed, be considered a portion of the Indian Ocean. They are produced by the peculiar conformation of the land in that portion of the Old World, and by the predominance of land there, combined with the difference of temperature constantly existing between it and the sea in its vicinity.*

The monsoons nearly occupy the place of the northern trade winds in the district above defined. Between the southern trades and this tract of ocean, there are occasional calms, often interrupted by winds, which, when the sun is in the northern hemisphere, generally blow between south-west and north-west, and during the other six months between south-east and north-east. These are sometimes called the north-west and north-east monsoons, but they are not to be classed as monsoons in the proper sense of the term. The proper monsoons occur north of this region, and consist of a north-east wind blowing from November to March, and a south-west wind from the middle of April to the end of October.

The north-east monsoon extends a little south of the line. It becomes regular near the coasts of Africa sooner than in the middle of the sea, and near the equator sooner than off the shores of Arabia. It is most regular and powerful in the month of January, especially in the northernmost angle of the Indian Ocean. It is not accompanied by rain on the Indian coast, but

* Periodical winds, called monsoons, occur also on the coast of Mexico, blowing north-westwards along the coast from May to December, and south-eastwards from December to March. Others occur on the Brazilian coast.

blowing over a large tract of warm sea, it produces the rainy season on the eastern coast of Africa.

The south-west monsoon begins a little north of the equator, and soonest off the coast of Malabar. Its influence is felt on land along the course of the Indus. At sea it is a serene wind of moderate force, but it brings very heavy rain to the coast of Hindostan.

The change of the monsoons takes place between the latter part of March and September, and the early part of April and October; in some places a week or two earlier than in others. The change takes place gradually, and is accompanied by storms and tempests. On the wind ceasing to blow in one direction, the clouds in the upper atmosphere are at once observed to take an opposite course, but some weeks may intervene before the change is felt at the Earth's surface.

36 *Hurricanes.*—These are storm-phenomena that occur from time to time on most parts of the Earth's surface, but certain districts are remarkable for exhibiting all the phenomena of atmospheric disturbance on the grandest and most destructive scale. Under the names *Typhoon, Scirocco, Tornado,* &c. are sometimes designated storms having certain peculiarities depending on local conditions.

Hurricanes often travel far from the spot in which they originate, and their path is marked by desolation, although their consequences are often not unfavourable to health, by entirely changing and purifying the air in those districts exposed to them.

Hurricanes occur most frequently within the tropics, or rather near the verge of the tropics, and in the vicinity of continents and islands. In the northern hemisphere, the West Indian islands, and in the southern, the islands of Mauritius and Rodriguez, seem to be the foci of the most violent and destructive storms. In the former district these commence near the Leeward Islands, and travelling first W.N.W., pass out into the Atlantic round the shores of the Gulf of Mexico, and are lost between the Bermudas and Halifax. Near the Mauritius the hurricanes come from the N.E., travel S.W. by S., and return again to the east; while in the Bay of Bengal they come from the east and travel westward.

The period of hurricanes in the West Indies is from August to October, and early in June and July. In the Indian Ocean, these storms occur from December to April, and sometimes, though rarely, in November and May.

The range of these storms in the West Indies is from latitude 10° to 50° north, and longitude 50° to 100° west. In the Indian Ocean they extend over a tract of 3000 miles in length.

The motion of the air during a hurricane is by no means simple, and has induced the name of whirlwind to be given to some cases when this motion is recognised. It is produced by a mixed rotation on an axis and progression in a curved line, so that a kind of spiral results, the storm often seeming to return again a second, or even third time to the same spot, having in each of these returns a different and often contrary direction, while in places not far distant, there is not the smallest apparent disturbance of the equilibrium of the atmosphere. One of the results of this kind of motion is, that although the violence of the wind, in the active part of the hurricane, is sufficient to destroy houses, and tear up the largest trees by the roots, the rate of progress of the whole storm, from point to point, on the ocean is not greater than that of the ordinary atmospheric currents, varying, that is, from seven to fifteen miles an hour. The storm seems, therefore, to be a violent local disturbance of the equilibrium of the atmosphere conveyed along the Earth's surface, independently of, and in addition to, its own proper motion, which is round an axis.

The hurricanes of the coast of China are called typhoons, or tyfoons, and occur only, on an average, about once in three or four years, whereas not less than thirty great hurricanes have been recorded as occurring in the West Indian seas since the commencement of the present century.

There are some remarkable local storms also well worthy of notice. The *simoon* is one of these; it blows only in short gusts of unequal duration, and originates in the vast sandy plains of Northern and Central Africa. It makes its appearance during strong south-western winds, but only between the middle of June and the twenty-first of September. The gusts are burning hot, and have a putrid and sulphurous smell and suffocating feeling, occasioning profuse perspiration, difficulty of breathing, and often death, to those exposed to them.

The *harmattan* is a wind extending along the western coast of Africa, from Cape Verde to Cape Lopez, and its period of occurrence is from December to February. It blows from the side of the Great Desert, and is extraordinarily hot and dry, but not unhealthy.

These grand disurbances of the atmosphere are intimately connected with electric changes, and are often accompanied by the most magnificent exhibitions of atmospheric electricity. Important results connected with terrestrial magnetism are also found to be involved with these appearances.

37 *Relation of the Atmosphere to Water.*—It is manifest to every one in the latitudes in which we live, that the condition of the atmosphere with regard to moisture is constantly undergoing change, the air sometimes being so dry that the soil cracks and vegetation is parched, while at other times torrents of rain pour down and deluge the whole country. These conditions are, however, variable in every sense of the word, and different countries are very differently acted on by atmospheric changes.

Whatever be the sensations of dryness communicated by the air, there is always present a certain quantity of aqueons vapour, but this quantity is capable of great increase, and especially when the temperature is heightened. An atmosphere of steam is thus always mixed with the dry atmosphere of oxygen and nitrogen gas, and this steam atmosphere is sometimes suddenly and considerably increased, sometimes very rapidly diminished: sometimes it is made visible by sudden changes, while at others it continues so perfectly mixed as to be invisible to the eye. In these various stages of visibility, we speak of air as containing mist, fog, or cloud—mist and fog being conditions of the atmosphere when vapour is visible at the Earth's surface, while clouds are the visible masses of vapour of some definite form, and at a distance from the Earth.

There is a certain limit beyond which air of a given temperature will not hold aqueous vapour in perfect suspension, so that changes of temperature may cause the deposit of vapour previously held suspended and invisible, thus producing important alterations in the transparency and clearness of the atmosphere.

It is important also to consider that water in assuming a different mechanical condition—that is, in passing from the fluid state into the solid or aerial—involves very considerable electrical changes. The fluid water in its usual condition passes into the gaseous state at all temperatures; even when it is solid, this process goes on very readily; and since a large proportion of the globe is covered with water, the changes thus involved become considerable, and the equilibrium of the atmosphere is constantly undergoing disturbance from this cause alone. Perhaps, indeed, the mutual action of air and water produces many of the most marked and important atmospheric phenomena. The evaporation of water is accompanied with the apparent loss and temporary disappearance of a large quantity of heat, which is thence said to be *latent*, or concealed, and the conversion of steam into water and water into ice, reproduces or renders sensible this concealed heat.

To understand, therefore, the nature of aqueous meteors, it must be remembered that every change of condition of water involves changes to a great extent both of temperature and electricity. The most remarkable of the meteors are dew and hoar frost, mist and fog, clouds, rain, hail, and snow. With these are connected changes in atmospheric condition, made known and studied by the hygrometer, the thermometer, the barometer, and the magnetic needle. We shall here only very briefly explain the nature and cause of the phenomena themselves.

38 *Dew.*—Dew is the moisture deposited from the air, in minute globules, on the surface of various bodies, when that surface is colder than the atmosphere. This occurs chiefly at night, more especially in Spring and Autumn, but generally on clear, serene nights, when the difference of temperature between day and night produces a marked variation in the quantity of water which the air is capable of retaining in a state of perfect solution. When the vapour is made visible, the air ceases to be clear, and mists or fogs arise, but these are very different from dew both in their nature and appearance. The deposit of moisture is then only called dew when the water is precipitated on solid bodies and the air retains its transparency.

Since the formation of dew depends on the difference of temperature of the air and solid bodies with which it is in contact, and as solid bodies part with temperature with very different degrees of rapidity, it is clear that there ought to be a larger quantity of dew on those bodies which radiate heat readily than those which are slow in undergoing change; and this is indeed the case; for the polished surface of metals receives scarcely any dew, while wool, or any animal substance, or glass, radiating heat rapidly, receives large quantities. So also the interposition of any substance, such as a cloud, very sensibly affects the quantity of water deposited in this form, for it both interferes with radiation and reflects back again some heat. The dew is mainly deposited near the ground, since the radiation of heat from the Earth's surface in the evening and night produces there the greatest amount of cold. When the cold at the surface is below the freezing point, the dew freezes as it is formed, and thus are produced the beautiful appearances of *hoar frost*. The presence of a considerable quantity of vapour in the air, indicated by the deposit of large quantities of frozen dew, or hoar frost, after a clear night, has often been remarked as indicative of change of weather, and is not likely to be succeeded by steady and long-continued frost.

39 *Mists and Fogs.*—These phenomena are frequent results of a small change in the condition of the atmosphere near the ground, in those countries in which the soil is occasionally damp and comparatively warm, while the air is damp and cold. The damp air in contact with the Earth, on a calm morning, chilled by the colder air above, parts with its moisture, or, at least, the moisture assumes the form of visible vapour. Where there are vast multitudes of minute particles of carbon floating in the air, as in the neighbourhood of large cities, these mix with the vapour, and form those thick and almost opaque fogs so well known in London and other places. Thus, also, are formed thick mists in Newfoundland and on the eastern coast of North America, when the melting of icebergs, stranded on the great bank of Newfoundland, chills the air, and causes it to part with a large portion of the moisture it had before held in a transparent state.

40 *Clouds.*—Mists forming on mountains, either immediately or after being removed by drifting winds, often become true clouds, but clouds are not only formed in contact with the Earth, but often very high in the air; nor are they left in those places where they first appear. Clouds also assume an infinite variety of form, and, by decomposing or reflecting light, produce beautiful effects of colour; and they are no less remarkable for their combinations with each other, and the changes thus induced, which, as rain, hail, or snow, or electric and magnetic storms, are of very great interest in reference to the general structure and conditions of the Earth's crust: as in all cases the change of condition from visible water or steam to invisible vapour, or the converse, produces great alterations of temperature and electricity and these again react upon the rest of the atmosphere.

The clouds that are formed or float in the atmosphere, are collections of minute globules of water, preserved in equilibrium at a certain height above the Earth's surface, either because of the crossing of currents of air differently capable of retaining water, owing to differences of temperature, or because ascending currents of air prevent the further descent of vapour having a very small degree of density. During the day, the surface of the Earth generally receives a sensible addition of heat, which it parts with by radiation at night, and thus it is not unusual to see the clouds rising higher in the air as the day advances; while in the evening, after sunset, they descend and often deposit moisture.

Clouds differ so much in their appearance, their position, and their influence on weather, as to require consideration in some detail. They have been described under different names, in three groups, which appear tolerably distinct.

There is a group of clouds often seen in the upper regions of the atmosphere, and frequently in the finest weather. They are of the most delicate forms, and are known by various names to mariners and others who study the appearances of the sky. Thus mare's tail, mackerel sky, and other names, indicate their sweeping and fretted character, and they are seen also in long ranges, apparently radiating from the north magnetic pole, particularly during or after the phenomena of the Aurora, and when any great change in the magnetical condition of the atmosphere is going on.

These clouds originate from three to four miles above the sea level, and reach even to higher altitudes than this in mountain countries. They are common in the finest weather, and show the most distinct and sharpest forms when the air is driest. The technical name for such clouds is *cirrus*, or curl-clouds, and when wet weather approaches, they pass into horizontal sheets, descend lower, become denser, and lose much of their picturesque character. When seen in motion, they rarely agree in direction with that of clouds and air currents nearer the Earth.

The *cumulus*, or heaped cloud, is generally of much denser structure than the cirrus, and much nearer the Earth. Clouds of this kind convey large quantities of moisture to great distances, and act a very important part in modifying the effects of the sun's rays, often forming during the day and dispersing at night. In fine weather, they are of moderate elevation, varying from one to two miles, and they are then also of moderate extent, exhibiting well-defined roundish outlines. Before rain, they increase rapidly, sink nearer to the Earth, become fleecy and irregular, and pass into another form.

The clouds called *stratus* rest generally on the surface of the Earth or water, and thus resemble or replace mists. They are essentially night-clouds, and often pass into cumulus after sun-rise, but are greatly mixed with cumuli, forming in that case banks and ranges of cloud. It has been observed, that although these clouds and the combinations of them increase very much, and put on the most rain-like appearance, they do not actually rain so long as they retain a definite character and a separate existence.

41 *Rain.*—Rain is the deposit of moisture from clouds, in drops falling through the air; but before rain takes place, the clouds undergo a change, and pass into the state called *nimbus*. This is best seen in stormy weather, when the cumuli rise first into mountain-like masses, and afterwards change into those stratiform masses of vapour, which, occupying a middle state between cumulus and rain, are so commonly seen in changeable weather in our climate. Long ranges of delicate clouds in horizontal streaks occupy the summits, and ultimately form a crown, extending from the top in tufts, and the sudden union of such clouds immediately precedes, and is accompanied by a shower. Rain falls also occasionally, but rarely, without clouds.

When, as sometimes happens, a very large quantity of rain falls in a short period of time, it may seem difficult to comprehend exactly the physical cause, but generally the mingling together of great beds of air of unequal temperature, and in different electrical states, may be referred to as sufficient, because in the admixture of such beds of air, the united volume is not by any means capable of retaining the same quantity of water as the two separate beds had done. It is not, however, the case that admixture of air necessarily involves a fall of rain.

42 *The Distribution of Rain.*—Rain falls upon the Earth in exceedingly variable proportions; in some places the fall being periodical, in others almost

constant, and in others again, so rare as to be scarcely known, while in our country and many parts of both temperate zones, it is so variable and irregular as to induce us to assume the weather as the type of inconstancy. The quantity of rain that falls is also very different for different districts, at various seasons of the year, and in different years; depending much on local peculiarities, such as the insular or continental position of any particular spot, the mean annual temperature, the extremes of temperature, the prevailing winds, the form of the land, and its height above the sea level.

Speaking generally of that part of the habitable globe known by actual observation, we may refer to the northern and southern temperate zones as districts in any part of which rain may or does fall every day of the year, (thence called zones of constant precipitation,) and the torrid zone, where one-half of the year is characterized by extreme moisture, and the other by extreme drought. The northern zone of constant precipitation is the one of which the phenomena are best known, but many important observations have also been made in the corresponding southern zone, as well as between the tropics.

On the whole, the quantity of rain is greatest at or near the equator, and diminishes towards the poles; but too little is yet known of the mean annual rain-fall in extra-European districts, to admit of any general conclusion being drawn, or accurate comparisons made. There appears to be a much larger quantity of rain in the tropical region of the western than the eastern hemisphere, and a larger quantity in the northern than the southern zones of constant precipitation. More rain also falls on islands and coasts than in the interior of continents, on the slopes and summits of mountains than on the plains adjacent, and on the western than the eastern side of continents. In Europe, and generally in the north temperate zone, winter is the wettest season, and summer the driest; while on the east coast of Australia, the autumn and summer include the chief rain months.

Within the tropics, the rainy season follows the apparent course of the sun, and the rain is both most frequent and most abundant in the narrow zone of variable winds, already described as extending a little north of the equator, where also there are frequent thunder storms. Most of the land within this zone is the scene of almost incessant rain-fall; while in the open sea, north and south, when the trade winds are blowing, rain is extremely rare. In India, however, the monsoons greatly modify the order of the seasons, the western coast being watered by the south-east monsoon, between April and October, and the eastern by the south-west monsoon blowing from October to April. Between the coasts and in the interior of the peninsula of India, the rains are sometimes occasional through the year, and the climate partakes of that of both the east and west coast.

There are large tracts, forming a belt round the globe, in which rain is either never known to fall, or occasionally falls, but only in small quantities, and at long intervals. The most extensive of these districts includes the great Sahara, or desert of Africa, the deserts of Arabia and Persia, and that of Beloochistan. It occupies three millions of square miles. The great table land of Thibet is a similar district, occupying near two millions of square miles, and the table land of Mexico exhibits the same peculiarity over half a million of square miles. All these extensive regions are not, however, hopelessly barren, as might be expected from the absence of rain; for in many of them, the large deposit of moisture in the form of dew renders vegetation not only possible, but luxuriant.

43. *Snow.*—When moisture is precipitated from the union of atmospheric volumes of unequal humidity and temperature, it frequently happens in the temperate and frigid zones, that the temperature of the air is below the freezing point of water, and this may arise either from absolute cold or (at high altitudes) from greatly diminished atmospheric pressure. In these cases, the moisture will become frozen, and form into flakes of snow, each of which, when examined under the microscope, is found to be composed of a great number of separate and transparent crystals of ice. It is in intensely cold

weather that these are most remarkable, and many of the most interesting forms are only met with in the Polar regions. During the fall of snow, it is not unusual in temperate climates for the thermometer to rise considerably.

In all parts of the Earth, the rarefaction of the air at a certain height above the sea is sufficient to produce a temperature at which water exists in the solid form, but this limit of perpetual snow varies exceedingly with latitude and local position, rising within the tropics to upwards of 17,000 feet, and in the Polar regions descending to the sea level. The most remarkable instance of the elevation of this line occurs in the Himalayan chain, the loftiest in the globe, where the snow limit is lower by several hundred feet on the northern than on the southern side of the mountains, although from the position and the latitude, it might have been expected that the contrary would have been the case. The proportion of the absolute surface of the Earth covered with perpetual snow has not, we believe, been yet determined; and in consequence of the form of the land, and the position of the high mountains on the Earth, many of the most remarkable elevations do not reach the limit, while others, far less important, are more or less included in it. The following tabular statement will be found interesting, as giving an approximative view of the position of the snow-line in various latitudes.

Limit of Perpetual Snow.

Andes	15,000 to 20,000 feet.
Himalaya	12,000 to 16,000 ,,
Alps	about 8600 ,,
Norway	,, 5000 ,,
Patagonia	,, 3000 ,,
Iceland	,, 2000 ,,

Mount Erebus, in the South Polar land, rises 12,000 feet directly from the sea, covered with perpetual snow from its base to its summit.

44 *Glaciers.*—Glaciers are masses of ice, often commencing in such mountain valleys as are above the limits of perpetual snow, and reaching to considerable distances in the plains below. They have been described as icicles descending from a snow-covered roof; and as their mass and extent arise from the difference between the quantity of snow sinking into the valley in a year, and that of ice melted during the same time, they are dependent on the form of the valley, and the amount of shelter it affords, together with the mass of the snow above, and the facilities for descending the gorge, and may thus descend considerably below the snow-clad mountain tops, and advance far into retired and fertile valleys.

The most remarkable and extensive glaciers are those of the Alps, Norway, Iceland, Spitzbergen, Western Patagonia, and the shores of the Antarctic continent. The best known are those of the Alps. Except in Patagonia, the great chain of the Andes presents no glaciers, and in the Himalayan mountains there are but few, and those not extensive. The extent of glaciers in the Alps is estimated at about 14,000 square miles, and their number as 400.

45 *Hail.*—This phenomenon, which consists of the fall of frozen drops of rain, and occurs usually when the weather is warm, has often attracted attention. Connected as it is with great electrical disturbance of the atmosphere, and often with thunder storms, there can be no doubt that the main cause of the formation of lumps of ice in the air is the result of cold, produced by very sudden and rapid evaporation. The descent of hail, at least in some countries, appears limited to particular seasons and certain hours in the day; the chief hail storms having also very definite and narrow limits. Hail rarely falls on mountains in temperate climates, while in the equatorial regions it is equally rare for it to descend so low as 2000 feet. In some extreme cases, hailstones have been noticed measuring more than a foot in circumference, and weighing upwards of half a pound. These are occasionally round or polyhedral, but sometimes flat and angular, and there is great difficulty in accounting for the formation of such large masses.

The disturbance of electric equilibrium is accompanied by storms of thunder and lightning, as well as heavy rain, hail, and strong wind. These storms often take place very high in the air, having been seen in the temperate zone at a measured vertical elevation of 26,650 feet; but on the other hand, the stratum of cloud in which thunder takes place, is sometimes not more than 3000 feet above the plains.

46 *Climate, and Distribution of Heat.*—By climate, in a general sense, we understand all those states and changes of the atmosphere which sensibly affect our organs. These include temperature, moisture, variation and amount of pressure of the air, calmness of the air or the effects of prevalent winds, electricity, purity, and transparency of the air, and serenity and clearness of the sky. All such causes influence the human frame, and greatly affect the development and health of all organic beings.

Questions of temperature that affect climate must be considered on the average of a long period of time, and very different averages are obtained, according as we take the mean temperature of the whole year, of the summer months, or of the winter months. It has been found convenient to bring together the results of observation with regard to each of these points in different districts, connecting by lines the places where the same temperature obtains. In this way are formed those imaginary lines upon the Earth, known respectively as *isothermal lines* (lines of equal mean annual temperature), *isotheral lines* (those of equal mean summer heat), and *isochimenal lines* (those of equal mean winter cold). Other lines have also been determined, which assist greatly in determining, *à priori*, the climate of districts not previously known, amongst which are *isobares* (lines of equal mean height of the barometer at the sea level), but we consider only, in this place, the subject of temperature.

Owing to the position of the Earth with regard to the sun, different quantities of heat are received on different zones of the surface, varying according to latitude or distance from the equator. If the surface were uniformly level, and everywhere of the same conducting and radiating power, parallels of latitude would be at once isothermal, isotheral, and isochimenal lines, but as this is not the case, and as every unevenness of surface and every difference of material produce, both directly and indirectly, a difference in respect of temperature, it results that places, in the same latitude, rarely receive the same amount of heat in the year, and, even when they do, hardly ever have it similarly distributed. Examples of this are innumerable, and will at once present themselves to the reader's memory. The mean annual temperature of Quebec, in latitude 47° N., is nearly the same as that of Trondjem, on the coast of Norway, in latitude 63°. The temperature at Nain, on the coast of Labrador, is about 20° Fahrenheit lower than that of parts of Scotland in the same latitude, while the limit of perpetual ground-frost (32° Fahrenheit) in the northern hemisphere, rises in the Greenland sea five degrees of latitude above the Arctic circle, and on the sea of Okhotsk sinks no less than twelve degrees below it. So also the mean winter temperature of Pekin (in a latitude south of Naples,) is more than five degrees (Fahrenheit) *below* the freezing point, while that of Paris, 700 miles further north, is more than six degrees (Fahrenheit) *above* the freezing point; the mean temperature of the month of August in Hungary is nearly 70° Fahrenheit, while in Dublin, situated on the same isothermal, it is barely 61°. The winter temperature of Dublin, however, is more than 3½° higher than that of Lombardy, although its mean annual temperature is more than 4½° lower than that of the towns in the latter country. Thus, it is clear that the same mean annual temperature may be distributed in a variety of ways, in the different seasons of the year, while, owing to local influences, places on which the sun shines for the same number of hours during the year, may receive very different amounts of heat. It is found that, in the northern hemisphere, there are two poles of cold, round which the curves are grouped; the Western, or American pole, being in 80° N. lat., and 260° E. long., with a temperature of 3½° below zero of

Fahrenheit, ($35\frac{1}{2}°$ below the freezing point of water,) while the eastern, or Siberian pole is in the same latitude, but in 95° E. long., with a temperature of one degree of Fahrenheit, being thus five and a half degrees warmer than the other. The isothermal lines round these two poles, and their inosculation have not been accurately determined.

On the whole, the following table seems to give the most useful general idea of the distribution of heat on the globe; the different regions in the two hemispheres being distributed into zones according to their mean annual temperature:—

Designation.	Limits.	Mean Annual Temperature.
Hot or equatorial zone .	Between isothermal curves 77° both hemispheres	+ 79°·70 Fah.
Warm zone	„ „ 77° and 59°	+ 68°·00
Mild zone	„ „ 59° and 41°	+ 50°·00
Cool zone	„ „ 41° and 32°	+ 36°·50
Cold zone	„ „ 32° and 5°	+ 18°·50
Frigid or polar zone .	Within isothermal curve of 5°	+ 3°·20

It has been attempted to determine also the mean temperature of large portions of land. Thus, the temperature of the tropics generally, near the coast, is estimated at $81\frac{1}{2}°$ Fahrenheit, but in the interior is much higher. The mean temperature of the whole Earth has been recently estimated by Dove to amount to 58·2° Fahrenheit, being about 54° in the month of January, and 62° in July. Many interesting conclusions are obtained from the study of this branch of Meteorology.

As among the remarkable results shown by the recently published maps of Professor Dove, we may also here mention that the mean temperature of the northern hemisphere is nearly 60°, and that of the southern only 56°; that the mean winter temperature in the former is, however, less than 49°, and in the latter $53\frac{1}{2}°$, while the summer temperature in the northern hemisphere is 71°, and in the southern only $59\frac{1}{2}°$; the limits of deviation in the one case being 12°, and in the other only 6°. These tables are deduced from observations extending over a series of years at as many as 900 stations.

The changes of temperature above referred to are assumed and described throughout, if possible, for the level of the sea; but as we have already seen that on the higher slopes and summits of many mountain districts, in various parts of the world, snow not only falls, but there is a limiting plane above which it never melts, it is clear that there must also be gradual changes of temperature on the sides of mountains, and at all considerable altitudes. This is, indeed, the case; and elevation even to a very moderate extent often produces considerable modifications of climate.

It is a general rule, that the actual temperature of any part of the Earth's surface depends, partly on the mean annual temperature at the sea level, as determined by the isothermal line passing through it, and partly on the elevation above the sea, or the greater or less column of air that the solar rays pass through, the temperature diminishing one degree for about three hundred feet of vertical elevation. Many important local exceptions prevent this from being a calculation to be depended on, in any spot not yet determined by actual measurements; but, as a general rule, it is applicable between the tropics. Thus, many cities situated on elevated plains are cooler than would appear from the isothermal line passing through them, and thus also on the slopes of mountain chains, within the tropics, we find all varieties of climate, sometimes within two days' journey.

The winds which blow over a country pass sometimes over very large areas of warm sea, sometimes over cold seas, and sometimes over ice, while, in some cases, also, they have just proceeded over extensive ranges of land, either heated by the sun's rays, or chilled by the presence of perpetual snow. It is therefore evident that the climate will be very much modified by the nature of the winds that blow, inasmuch as these not only affect the temperature, but also very greatly influence, and even bring with them, the amount and regulate the distribution of moisture. The observations already offered on the subject of winds and rain, together with those which will be given when considering the phenomena of the ocean, have reference to climate, and the general conditions which render a country fertile or habitable.

It is commonly known and felt that both cold and heat are more intense when the sky is clear than when it is overcast with clouds, and thus it arises that those countries where the winds bring large quantities of moisture, and are met by others differently constituted in this respect, and where, consequently, clouds and mists are frequent, the climate will be essentially different from that of countries in which the same mean annual temperature is accompanied by a clear sky. England and Holland are examples of this difference.

47 *Conclusion.*—The meteorological portion of Physical Geography, which we are now bringing to a conclusion, shows that the various processes going on in the vast aerial ocean, are so intimately connected, that each separate meteorological process is at the same time modified by all the rest. This complication of causes and effects renders it very difficult to interpret fully and clearly the different phenomena, and almost prevents any such prediction of atmospheric changes as is required or demanded for agriculture and navigation, or even for the conveniencies of life. Those, therefore, who look only to an immediate result and power of prediction, may believe that this branch of science has made but little progress. But the results of science are not always in this way immediately and positively applicable, and although many facts and laws of extreme practical interest have been made known already in the pursuit of meteorology, the main value of the science must still be placed in the knowledge of the phenomena themselves, and the extent and truth of those partial generalizations which have been suggested, and which have yet to be examined and verified.

Among these general results it appears that considerable deviations from the mean distribution of temperature are rarely local in their occurrence, but extend uniformly over large areas, reaching their maximum at some determinate place, receding gradually until its limits are reached, and then when these are passed, extending into great deviations in the opposite direction. It appears, too, that similar relations of weather extend more often from south to north than from east to west, but there is no reason for supposing that a severe winter will be followed by a hot summer, or a mild winter by a cool summer.

With regard to instruments, it is important to remember that the barometer indicates to us what takes place in upper and distant regions of the atmosphere, while the thermometer and hygrometer give purely local results; but as important changes of weather do not usually arise merely from local causes situated at the place of observation—their origin occurring rather in disturbances of the equilibrium of the currents of the atmosphere and electrical changes begun afar off—various and long-continued observations, and a careful comparison of results, are absolutely required for accuracy in meteorology.*

---

* The recent introduction of the *aneroid barometer*, an instrument for measuring the pressure of air by means of a partial vacuum—avoiding the column of fluid hitherto employed—is worthy of some notice in this place.

At the present time, and judging from the instruments hitherto made, there seems no probability of the ordinary mercurial barometer being superseded, but the application of the aneroid principle to improved machinery promises to be ultimately very important, on account of the convenience of form and facility and safety of transport. For these reasons, the aneroid may be carried by the traveller to measure the height of mountains, and obtain much other useful and desirable information, which the inconvenient form and fragile nature of either the common or mountain barometer render difficult to procure.

CHAPTER IV.

ON THE FORM AND DISTRIBUTION OF THE LAND.

§ 48. What is meant by 'land.' — 49. Distribution of land. — 50. Continents. — 51. Islands. — 52. Inequalities of the surface of land. — 53. Low plains and steppes. — 54. Deserts.— 55. Silvas. — 56. Llanos. — 57. Pampas. — 58. Savannahs, or prairies. — 59. High plains, table lands, or plateaux of the Old World.—60. Table lands of America.—61. Mountain systems of the earth. — 62. General connexion of the mountains of the Old World.— 63. Mountain chains of the New World.—64. Mountains of Australia.

WHAT *is meant by Land.*—Under the term *land*, is included every variety of mineral substance and rock formation usually existing in a solid form upon the Earth, and not covered constantly by water; and it is matter of familiar knowledge that the surface of the Earth thus presented, is exceedingly irregular in outline and elevation, being collected into some extensive continental masses, and a vast multitude of smaller areas, called islands. The form and position of the continents—their extent both in magnitude and direction—the position of the several portions of their surface with respect to the sea-level—the nature, extent, and direction of their elevations above, and depressions below, this general level—together with the position, the mode of grouping, and the irregularities of surface of the different insular areas—these are all points of interest with respect to the land, and together they involve a description of the physical peculiarities of this portion of our globe.

49 *Distribution of Land.*—The land is very unequally distributed in the two hemispheres separated by the Earth's equator; the proportion of land to water on the northern side being very much larger than on the southern; so also the absolute quantity of dry land on the eastern side of the Atlantic is much larger than on the western; and if an observer were stationed vertically above a point in England, not far from the Land's End, in Cornwall, and could thence see one half the globe, he would have before him almost all the land; while, on the other side, would be scarcely anything but a few islands and a portion of Australia and Patagonia visible above the water.

Many facts have been noted in reference to this subject. The whole area of land on the Earth has been estimated at about $51\frac{1}{2}$ millions of square British statute miles, and of this quantity more than three-fourths lie to the north of the equator. Only about one twenty-fourth of the whole area of land consists of islands (Australia being excluded). If we compare the north with the south temperate zone, we find the proportion of land nearly as thirteen to one; while, on the equator, about five-sixths of the circumference is water. It appears also that only one twenty-seventh of the existing land has land directly opposed to it in the opposite hemisphere.

50 *Continental Land.*—Of the whole area of land, that portion which, being connected together and continuous, is called *continent*, consists of two principal portions, one on the eastern side, containing Europe, Asia, and Africa, sometimes called the Old World, or the great continent; and the other the western, including the two Americas, and known under the name of the New World.

The principal direction of the old continent is from east to west, or, more precisely, from north-east to south-west; while the western continent extends from north-north-west to south-south-east. Both continents are terminated towards the north at about the seventieth parallel of latitude, and both run into pyramidal points towards the south, having submarine prolongations indicated in South America by islands, and in South Africa by shoals. The area of the greater (the old) continent, together with its adjacent islands, is about thirty-three millions of square miles; that of America, only fourteen millions and a half; and Australia, with the Polynesian Archipelago, barely four. Of the portions of the old continent, sometimes called separately continents, Asia forms one-half, Africa three-eighths, and Europe only about one-eighth of the whole.

The pyramidal termination, southwards, of all the principal land on the globe, is a very remarkable fact; and it has been observed, that the southern extremities of Africa, Australia, New Zealand, and South America, form a regular gradation, each reaching nearer the South Pole, in the order here expressed, and the projecting points are as nearly as possible in the same meridian in the two hemispheres. Pyramidal terminations obtain also in the peninsulas of Arabia, Hindostan, Malacca, and California, and in the chief masses of land in the Mediterranean, as Italy and Greece.

The form and indentation of the coast lines are phenomena of considerable interest, especially as they bear on commercial enterprise; and the existence of those peninsulas and irregular projecting tongues of land, or detached islands, which abound chiefly on the coasts of Europe, Eastern Asia, and Eastern North America, is worthy of notice, in reference to the progress of the civilization of mankind. All the shores of Europe are deeply indented by bays, and there are also a number of inland seas of very considerable magnitude, so that our continent has a greater proportion of maritime coast than any other district of the same magnitude. The European coast line measures, indeed, nearly twenty thousand miles. The coast of Asia also exhibits large seas, bays, and gulfs, which are sheltered by a chain of islands, rendering navigation dangerous. The whole length of Asiatic coast amounts to about thirty-three thousand miles. The coast of Africa measures nearly fifteen thousand miles in length, and is little indented except along the coast of Guinea and in the Mediterranean. The American coast is very different in different parts, and its whole length is upwards of forty thousand miles. The shores of the Icy Ocean are very complicated, and other parts of the eastern coast, as far as Mexico, exhibit a considerable number of gulfs and inlets, but the shores of South America are very entire, except at the southern extremity. On the whole, the result of investigation on this subject shows that the western coast of the Old World, in Europe, is the most deeply and frequently indented, and the best adapted of any on the globe to the wandering habits of mankind.

51 *Islands.*—The islands, or portions of land separated by water from the great continental areas, vary in character very greatly, some being arranged in distinct groups and series, having common peculiarities, others being related rather to the adjacent mainland. These may be considered to form two principal sets—viz., the elongated or continental islands, generally belonging to the nearest considerable mass of land, and the round or pelagic slands, forming systems, generally occurring in the open ocean, and apart from continental lands. The former are generally in series, and appear in some places to give indication of extensive submerged continental lands, as in the long suite of islands which, beginning to the south of New Zealand, sweeps round the east and north sides of New Holland, including New Caledonia, the New Hebrides, the Solomon Islands, New Zealand, New Guinea, &c., and the yet more remarkable islands beginning with the Philippines, extending northwards through Formosa, the Loo-Choo and Japanese Islands, and so to the Kurile Islands. The chain of islands of which the Moluccas, Java, and Sumatra form the principal in point of magnitude, the important island of Madagascar, off the coast of Africa, the main chain of West Indian Islands, in the Gulf of Mexico, and the long ranges of islands on the northern coast of North America, are further examples in distant countries; while in Europe, the chains of islands on the coast of Scandinavia, the British islands, the elliptic islands between Italy and Spain, the islands

on the east coast of the Adriatic, and the islands of the Greek Archipelago, complete the series of this class of insular land.

The principal islands belonging to the second or oceanic group are, the Friendly, the Society, the Marquesas, the Sandwich, and other groups in the South Pacific; the Canary Islands, the detached islands in the Indian Ocean, the Galapagos, and, generally, the multitudinous group of single volcanic islands in various parts of the world; and also the groups of coral islands. These form two groups, distinguished by their origin, and generally not less distinct by their vertical elevation.

Perhaps, the general plan and nature of these different kinds of islands will be best understood if we consider them as due in the first case (continental islands) to the slow elevation or depression of large masses of land on a linear axis, by the tilting up of one edge of a plane. The other two cases are also understood, if we consider the one as resulting from the local elevation of certain small areas on a point of upheaval, and the other as the consequence of slow depression of areas of broken land without much tilting, and while circumstances were favourable for the rapid increase of growth of marine animals.

The facts connected with the actual horizontal configuration of the land are perhaps more important in Physical Geography than has often been thought, and the evidences derived from the observations on island distribution are not the least remarkable. The lines already alluded to, one extending from New Ireland to the New Hebrides, and the other to the Sandwich Islands, each range north-west, with perfect parallelism, for 2000 miles, at a distance of 3500 miles apart, and indeed this same direction (north-west) obtains to a greater or less extent through the world, not only in islands, but in those higher elevations above the mean level which come under the denomination of mountain chains. The phenomena connected with these we shall describe presently.

52 *Inequalities of the Surface of Land.*—Not only is it the case that the land, whether continental or insular, offers various peculiarities of horizontal configuration, but each mass of land also presents some distinct features of inequality of level. Occasionally, but very rarely, large tracts may be observed extending in every direction, at nearly the same level, and removed but little above the surrounding water. Much more frequently there occur undulations in every extensive area, and also different degrees of absolute elevation above a mean level. Such varieties produce the phenomena which are described under the names of *plains* or *table lands*, and these are rent asunder by valleys and gorges, or pierced through by mountain chains, and broken into picturesque forms of hill and dale.

These general inequalities of surface are exhibited in their most typical and characteristic form in those districts where their details can be studied, and their origin therefore be made the subject of speculation; but they are often mingled together with more or less of indistinctness, and thus their true characters become concealed or lost. It is only in large tracts of land that they are seen in all their grandeur: in islands and small parts of continents, where more than one prevails, the great force of the phenomenon is not appreciated.

There is much mutual relation amongst these varieties of vertical profile, and also much reference in all of them to the structural peculiarities of the Earth's surface. Thus, they require careful consideration, and the different facts that have been recorded concerning them, possess direct interest, not only as affording examples of the physical outline of our globe, but also in their bearing on those conditions which affect man as its chief inhabitant.

53 *Low Plains and Steppes in Europe and Western Asia.*—A very large quantity of the land is distributed as low plains near the sea level, and often not far from a coast line. These occasionally present hills of moderate altitude, in most cases not reducible to any general system. Sometimes these hills are long waves or undulations, and often perfectly uniform in structure

for many miles. Under the name of *plains,* are designated the low flat lands of Northern Germany and Russia, and of Lombardy; the flats of Tartary are called *steppes;* those occupying the central parts of Northern Africa are *deserts;* those in the northern part of Southern America, *silvas,* or forest deserts; those of other parts of South America, *llanos* and *pampas;* and those of North America, *prairies,* or *savannahs.* Many are the peculiarities of these districts, but they have in common the important physical feature of wide extent, uniform general level, and small elevation above the sea.

These tracts of flat land may be considered as including several distinct areas. In the northern part of the Old World they are traceable from the shores of the German Ocean, through Holland and North Prussia into Russia, thence into Siberia, and so at intervals, only broken by low elevations, to the coast of the Pacific in Behring's Straits. Within these limits, they occupy an area of not less than four and a half millions of square miles, and while on the one side Holland would be overflowed by the sea if it were not for its dykes, so on the other, near Astrakan, the plains sink still lower, and the country around the Caspian Sea and the Sea of Aral, forms a vast cavity of 160 000 square miles, all considerably below the bed of the ocean: the surface of the Caspian Sea itself, at the lowest point, being depressed 348 feet.

Towards the eastern extremity of Europe, the great plains assume the peculiar character of a desert, consisting of level wastes destitute of trees. These *steppes* begin at the river Dnieper, and extend along the shores of the Black Sea, including all the country north and east of the Caspian and Independent Tartary, and passing between the Altai and Ural mountains, occupying all the low lands of Siberia. Hundreds of leagues may be traversed eastwards from the Dnieper without variation of scene, and a dead level of thin but luxuriant pasture, bounded only by the horizon, fatigues the eye of the traveller day after day by the same unbroken monotony. So long as the vegetation remains, horses and cattle beyond number give animation to the scene, but winter comes on in October, and the whole area then becomes a trackless field of spotless snow. Fearful storms rage, and the dry snow is driven by the gale with a violence which neither man nor animal can resist, while the sky remains clear, and the sun shines cold and bright above. The summer's sun is as severe in its consequences in these wild regions as the winter's cold. In June, the steppes are parched, no shower falls, nor does a drop of dew refresh the thirsty earth; the sun rises and sets like a globe of fire, and during the day is obscured by a thick mist. Thus, in some seasons, the drought is excessive, and the air is then filled with dust and impalpable powder, the springs become dry, and the cattle perish in thousands. Death triumphs over animal and vegetable nature, and desolation tracks the scene to the utmost verge of the horizon.

Of the whole extent of these plains, a very wide range is hopelessly barren; the country from the Caucasus, along the shores of the Black and Caspian Seas (a dead flat, twice the size of the British islands) being desert, and destitute of fresh water, while between the Caspian Sea and the Lake of Aral, there is, for the most part, an ocean of shifting sands, often driven by appalling whirlwinds.

The Siberian or Asiatic portion of the great northern tract of low land in the Old World, occupies more than seven millions of square miles, and is rarely visited except along its outer boundary. Parts of the tract are occupied by a rich black mould, covered with grass and trees, but other and larger portions are hopelessly and desolately barren.

To the lowlands belong almost the whole of Northern Asia to the north-west of the volcanic chain of the Thian-schan; the steppes to the north of the Altai and of the Sayan chain; the countries which extend from the mountains of Bolor, or Bulyt-Tagh, ('cloud mountains,' in the Uigurian dialect,) which follow a north and south direction, and from the Upper Oxus, whose sources were found by the Buddhistic pilgrims, Hiuen-thsang and Song-yun, in 518 and 629, by Marco Polo in 1277, and by Lieutenant Wood in 1838;

in the Pamer Lake, Sir-i-kol, (Lake Victoria,) towards the Caspian; and from Tenghir, or the Balkhasch Lake, through the Kirghis Steppe, towards the Sea of Aral and the southern extremity of the Ural mountains. As compared with high plains of 6000 to 10,000 feet above the level of the sea, it may well be permitted to use the expression of 'lowlands,' for flats of little more than 200 to 1200 feet of elevation. If the word plateau, so often misemployed in modern works on geography, is to have its use extended to elevations which hardly present any sensible difference in climate and vegetation, the indefiniteness of the only relatively significant denominations of highlands and lowlands, will deprive physical geography of the means of expressing the idea of the connexion between elevation and climate, between the profile or relief of the ground and the decrease of temperature. Humboldt, to whom we are indebted for the above information on this subject, remarks, 'When I found myself in Chinese Dzungarei, between the boundary of Siberia and Lake Dsaisang, at an equal distance from the Icy Sea and from the mouth of the Ganges, I might well consider myself in Central Asia. The barometer, however, soon taught me that the plains through which the Upper Irtysch flows are hardly more than from 800 to 1200 feet above the sea. Further to the east, the Lake Baikal is 1420 feet above the sea.'*

The low lands on the south-side of the great back-bone of mountains, running east and west through the Old World, are of very different kinds, in some respects, from those already described. They exhibit a more tropical character, and are strikingly contrasted in their different parts,—either rich in all the exuberance that heat, moisture, and soil can produce; or covered by wastes of barren and burning sands:—some of them being in the most advanced state of cultivation, and others in the wildest garb of nature.

The Great Desert of Northern Africa forms, perhaps, the most striking example of one of these conditions. The alluvial plains of China contrast this perfectly, and are paralleled in some respects by the vast and rich low tracts near the mouth and lower valley of the Ganges and Brahmapootra, and the plains of Hindostan. The latter are rich and highly cultivated, offering little that is extraordinary beyond the fact of their wide extent. The former, or desert lands, require more detailed notice.

54 The Sahara, or great African Desert, occupies the central part of Northern Africa, reaching from the rocky country confining the Nile valley to the very shores of the Atlantic. Its length is upwards of 2500 miles, and its greatest breadth 1200 miles. Its area has been stated to amount to two and a half millions of square miles, and it runs out into the Atlantic, being continued by extensive sand-banks far beyond the coast.

For the most part, the tract is level and low, but is broken occasionally by stony ridges, more than one of which crosses it in 15° E. long., and by the presence of a little clay these admit of vegetation. The desert is thus divided into an eastern and western part—the eastern, or Lybian Desert, being the smaller, and the most favoured. For the most part, its surface is not covered with sand, but formed of hard horizontally bedded sandstone rock, perfectly smooth and level. At intervals, small spots occur watered by springs and enlivened by the presence of vegetation. These are generally depressions below the surface, and are called *Oases*. The largest is nearly a hundred miles long, and from one to fifteen miles wide, but the others are much smaller.

The western portion of the Sahara contains some narrow tracts along its northern border, adapted to cultivation, but the rest of the district is almost entirely unfit for any kind of agricultural or horticultural employment. The soil is sometimes of fine sand, on which low ridges appear like the waves of an agitated sea, but in other places it is much harder, and more gravelly—though still perfectly and hopelessly barren. In several spots, beds of salt

* Humboldt's *Aspects of Nature*, vol. i. p. 76.

occur, three of which are known and have been described, and there are also brine springs, and thick incrustations of salt on the ground, produced by evaporation.

On these interminable sands and rocks no animal—not even an insect—breaks the dread silence, nor is a tree or a shrub to be distinguished during days of incessant travel. In the glare of noon, the air quivers with the heat reflected from the red sand, and the night is chilly, under the clear sky sparkling with its host of stars. In these plains the traveller is frequently deceived by the deceptive appearance of water produced by mirage.

55 *Silvas of the Amazons.*—The plains of America differ distinctly from those of the Old World, and are known under various names, each referring to some physical peculiarity. Commencing with the northern or tropical part of South America, we find there a range of low land covered with forest, (thence called *Silvas,*) occupying more than a million of square miles, and drained by the most gigantic river on the Earth, the Amazons. This tract is so subject to inundations, that probably not less than 200,000 square miles are annually laid under water, but the whole is covered with exceedingly thick wood, rendered perfectly impenetrable by brushwood and innumerable creepers. The amount of rain falling during the year, the intense heat of a tropical climate, and an inconceivably rich soil, here produce an exuberance of vegetable and animal life, which actually offers a bar to civilization, not less effectual than the gloomy sterility of the African deserts. The native Indians seem irredeemable, and sunk in the most wretched barbarism, and there appears no prospect whatever of any improvement in the district, since man can find no spot on which to commence his operations.

56 *Llanos.*—These are tropical plains, situated chiefly on the left bank of the river Orinoco, and they are continuations northwards of the forest plains of the Amazons. Their area amounts to near 350,000 square miles, or about twice the extent of France, and although a small portion forming the delta of the Orinoco is wooded, the remainder of the whole region is entirely destitute of trees.

One portion of these plains, the Llanos Altos, rise gradually from the banks of the river, but so gently that the rise is imperceptible to the eye, amounting only to an elevation of five hundred feet in a distance of more than one hundred miles. At this point flat low banks arise, elevated only five or six feet, but extending at a dead level for about thirty or forty miles, and forming a water shed. On the other side, the plains descend towards the Caribbean Sea, somewhat more rapidly than to the south, but still imperceptibly. The summit forms a very low table-land, consisting of sand mixed with calcareous rock, and is barren, with the exception of a few hardy grasses, the rain that falls not forming into pools and fertilizing the land, but sinking into the sand to some beds of impermeable argillaceous rocks, and then running off in springs or rivulets to the plains below.

The larger and more level portion of the Llanos lies along the base of the rocky elevations, which commence the chain of the Andes, and extend from 9° N. lat. to the equator. These, though further from the ocean, are much lower than the Llanos Altos, the lowest portions being only two hundred and twenty-four feet above the sea, (from which they are distant five hundred miles,) and rising to the south and west to the height of five hundred feet. These plains are so nearly level, that the currents of two rivers in their lower course are imperceptible, and the waters flow back towards the sources, when the wind blows strongly in that direction, or when the Orinoco, to which they are tributaries, becomes swollen. In these plains, no rock, no stone, not even a pebble is seen ; there are no inequalities, except some low hills of sand, rising a few yards above the common level, and some slightly elevated grounds, having an area of one hundred square miles or more, which can only be discovered by a practised eye, and whose surface is completely flat. The soil is a mixture of sand and calcareous rock, with some mould. Grass grows everywhere, but there are no trees, or even bushes, except a few isolated palm-trees, at great distances from each other, and some bushes on the banks of the rivers.

57 *Pampas.*—The Pampas are treeless plains, which extend from 22° S. lat. to the most southern limits of the American continent, occupying a total length of two thousand miles. The breadth, throughout this vast distance, is very various, rarely however less than two hundred and forty miles, and between latitudes 26° and 38° amounting to nearly double that. The area, estimated roughly, is about 750,000 square miles, or nearly four times the whole extent of France.

There is necessarily great difference in climate, and also in the nature of the surface and the vegetable productions, in plains extending thus through thirty degrees of latitude, (one-sixth of the half great circle from pole to pole.) The southern portion is called the Pampas of Patagonia, and present the appearance of a number of step-like terraces, running north and south, each slightly rising to the south, generally very sterile, but occasionally clad with verdure. The surface is diversified by huge boulders, tufts of brown grass, low bushes armed with spines, brine lakes, white snowlike incrustations of salt, and black lava platforms like plains of iron. The plains are, here and there, intersected by a ravine or a stream, but the waters do not fertilize the soil. The transition from heat to cold is rapid and extreme, and piercing winds rush in hurricanes across the district. Towards the north, the Pampas of Buenos Ayres are separated from those of Patagonia by several ridges of table-land, and present an extensive surface of ground, not without irregularities, though these are too slight to be denominated hills. A large portion of the southern part of this district is occupied by swamps and fens abounding in lagoons and wide-spreading salines; one of the swamps or lagoons alone (that of Ybera) occupying one thousand square miles, and being entirely covered by aquatic plants. These swamps are greatly swollen by the annual floods of the rivers, which inundate the Pampas, destroying vast numbers of cattle, but leaving behind thick beds of fertilizing mud.

Beyond the river Salado, the face of the country changes, the swamps ceasing, and being succeeded by very slightly undulating and dry plains, covered with luxuriant grass, and occasionally by thistles eight or ten feet high, used as fuel. Further to the west, there occurs an extensive pastoral, and also an agricultural district, separated by a line drawn on the meridian of 66° W. long., the pastoral district being to the east. The surface of the latter is almost everywhere a dead level, but large shallow salt lakes occur in very small depressions, one of them being fifty miles long and twenty miles wide. The soil is good, consisting of a dark friable mould, without a pebble: no trees occur, and there are no permanent water-courses. The district affords admirable feeding ground for horses and cattle, which were introduced by the Spaniards, and have replaced the llamas, the indigenous ruminating quadrupeds of the country. It is calculated, that there are a million of horned cattle, and three millions of horses fed on these plains.

The western or agricultural district is less level than the pastoral; the soil, consisting of loose sand impregnated with saline matter, being entirely unfitted for the growth of grass, although when irrigated it is exceedingly fertile, and particularly adapted for the growth of fruit-trees. This tract is succeeded to the north by a salt desert, consisting of a wide plain, extending about 200 miles from east to west, and 140 miles northward, which is level and smooth as a floor, and snow-white with superficial salt, stretching its treeless and shrubless wastes on all sides to the horizon, unbroken by any object save a few stunted, straggling, and leafless bushes. Throughout the whole district no grass grows, and there is a great scarcity of water. Rain has been known not to fall for eighteen months, and dews are entirely unknown.

58 *Savannahs, or Prairies.*—The prairies, or, as they are sometimes called, savannahs, are vast tracts of plain country of inconsiderable elevation,

occupying the central part of North America, estimated by Humboldt to amount to nearly two and a half millions of square miles, and extremely varied in climate, in character, and in productions. They have been divided into three classes—1. The heathy or bushy; 2. The dry or rolling, generally destitute of all vegetation but grass, and by far the most common and extensive; and 3. The alluvial or wet prairie, abounding in pools, and the frequent resort of the wapiti and other deer, and of wild horses.

The vast savannahs on the banks of the Mississippi are covered with long grass; and in the southern districts, as well as on the banks of streams, are occasionally clothed with trees, but these are rare exceptions to the general monotony. A salt efflorescence is often exhibited on their surface, and they frequently possess a deep rich soil.

Many of the plains of North America are covered by forest vegetation, but this has been greatly cleared in the United States, as the white man has advanced. The forests are not throughout of the same character; sometimes consisting of a rich variety of magnificent trees, while over many hundreds of square miles there extend vast monotonous tracts of sand, clothed only with gigantic pines, and characteristically denominated pine-barrens.

59 *High Plains, Table-Lands, or Plateaux of the Old World.*—A very considerable portion of the dry land upon the globe consists of land extending for great distance at a considerable elevation above the sea. Such land often presents a greatly varied surface, and is generally connected with important mountain chains. An example of such table-land in Europe is seen in the central plateau of Spain, consisting of a tract of nearly 100,000 square miles, elevated from 2000 to 3000 feet above the sea, and nearly surrounded by mountains. Other plateaux of enormously greater dimensions, occur in other parts of the world.

This table-land of Spain is varied by mountain ridges, (*sierras,*) some of them of considerable height. There is a want of cultivation in many parts, owing to the small quantity of rain that falls; and the whole area may be described as monotonous and naked, although corn and wine are produced in abundance in some places, while others serve for pasture. This table-land is more fertile on the Portuguese side.

The high land of Spain is continued, though at a much lower elevation, through the South of France, but chiefly by hill and low mountain ranges. The table form being rather characteristic of the eastern than the western portion of the great continent, first begins to exhibit the peculiar and striking features of such tracts in the Balkan range of mountains, which rises very abruptly from the shores of the Adriatic, and is everywhere rent by deep and tremendous fissures, transverse to the principal direction of the high land.

From this point an elevated plateau is continued, with few intervals, across Asia, as far as the Pacific Ocean; its breadth gradually expanding till it amounts to 2000 miles. It is interrupted in some places by lofty mountain chains, and its altitude varies greatly, but is throughout considerable.

The western portion of this vast tract forms the table-land of Persia, and extends from the shores of Asia Minor, nearly to the right bank of the Indus. It occupies an area of 1,700,000 square miles, and is generally 4000 feet above the sea, but in some places rises to 7000 feet. The eastern portion is very much larger, (amounting to 7,600,000 square miles,) and in some places attains an elevation of 17,000 feet.

It must not be understood that these high lands present generally an absolute level, or resemble in this respect the steppes, deserts, or savannahs, already described. They are often bounded by mountain ranges, and the highest mountains of the world rise out of them. They occasionally also exhibit in their wide extent many mountain features.

Among the westernmost portions of the great Asiatic table-land may be observed the cold, treeless plains of Armenia, 7000 feet above the sea, and the great salt desert, and adjacent sandy deserts of Irak and Kerman, in

Persia. Throughout this wide area, there is scarce any cultivation, the brick-red sand being drifted about by the wind into wave-like hills, or the soil being covered with a thick efflorescence of common salt and nitre.

The oriental plateau of Thibet is separated from that of Persia by a spur of the Himalayans, and from the plains of Hindostan by the main chain of the Himalayans, rising in some places to the height of 28,000 feet. The Altai mountains separate the district from Asiatic Siberia, while on the east they are closed in by the almost unknown mountain chains of western China. The height of this vast plateau above the sea varies from about 4000 feet in the northern portion to as much as 15,000, or even in some places 17,000 feet near the Himalayans, and the district is traversed by three mountain ranges.

A plateau of considerable, but very unequal elevation, having the names of Gobi, Scha-mo, (sand desert,) Scha-ho, (sand river,) and Hanhai, runs in a S.S.W., N.N.E. direction, with little interruption, from Eastern Thibet towards the mountain knot of Kentei, to the south of Lake Baikal. This swelling of the ground is probably anterior to the elevation of the mountain chains by which it is intersected; it is situated, as already remarked, between 79° and 116° longitude from Paris, 81° and 118° east from Greenwich. Measured at right angles to its longitudinal axis, its breadth is, in the south, between Ladak, Gertop, and H'lassa, the seat of the great Lama, 720 geographical miles; between Hami, in the Celestial Mountains, and the great bend of the Hoang-ho, near the In-schan chain, hardly 480; and in the north, between the Khanggai, where the great city of Karakhorum once stood, and the chain of Khin-gan-Petscha, which runs north and south in the part of the Gobi traversed in travelling from Kiachta, by Urga, to Pekin, 760 geographical miles. The whole extent of this swelling ground, which must be carefully distinguished from the far more elevated mountain range to the east, may be approximately estimated, taking its inflexions into account, at about three times the area of France.

No portion of the so-called Desert of Gobi (parts of which contain fine pastures,) has been so thoroughly explored in respect to differences of elevation, as the zone of nearly 600 geographical miles in breadth, between the sources of the Selenga and the Great Wall of China, and it has been determined that the mean height does not amount to more than about 4000 feet, instead of double that elevation, as was at one time supposed. It appears also that Thibet is not at all an unbroken plain, or table-land, but a district intersected by mountain groups, belonging to distinct systems of elevation, and containing but few plains, while the loftiest of them are not more than 13,340 feet above the sea level, and the mean elevation of the plateau is not more than 11,510 feet.*

Table-land is not unfrequently characteristic of islands as well as continents, and on the coast of Europe the Faro Islands, situated due west from Norway, exhibit this feature, rising at once 2000 feet, and presenting nearly the same elevation over a great part of the group. The north-western part of Scotland and the central portion of Ireland also, partake of similar character, but the elevation is not so considerable.

Africa exhibits moderately elevated table-land, over the whole, or nearly the whole of its southern portion, but the greater part of that continent is as yet unexplored by white men. North of the Cape of Good Hope, the land rises to about 6000 feet, and the continent has recently been crossed by Dr. Smith, on the tropic of Capricorn, and by some native travelling merchants about 12½° further north. At the Cape, the breadth is about 700 miles, and in the last-mentioned latitude about 1600 miles, and within these limits the table-land appears unbroken by any lofty range of mountains, although frequently rent by precipitous, deep ravines.

The southern portion of Africa is somewhat better known, and presents

---

* *Aspects of Nature*, ante cit., vol. i. p. 79.

some lofty plains, projecting into the lower flat ground, like promontories. One of these terminates with the Table Mountain, at the Cape of Good Hope.

60 *Table-Lands of America.*—The table-lands and plateaux in the New World are not so extensive as in the old, but a wide and lofty tract occupies the greater part of Mexico, extending also to California. It begins at the Isthmus of Tehuantepec and reaches northwards for 1600 miles, expanding towards the north to a breadth of about 360 miles. The most easterly part of this plain is 7500 feet above the sea, and it rises towards the west till it becomes 9000 feet high in Mexico, whence it diminishes gradually to 4000 feet. In California it is about 6000 feet above the sea. It is throughout torn by narrow, deep cavities, and the descent to the low lands is on all sides (but especially the east,) exceedingly precipitous.

South America is not without table-lands of some importance, though more remarkable for great altitude than extent. One of the most extraordinary, that of Desaguardero, has an absolute altitude of 13,000 feet. Its breadth varies from 30 to 60 miles, and it stretches 500 miles along the top of the Andes. The whole area includes 150,000 square miles, and presents a considerable variety of surface. The city of Potosi stands on this plain, at an elevation of 13,350 feet, and lofty mountains rise on each side of it.

The table-land of Quito is another remarkable instance of extensive high ground. It is 200 miles long and 30 miles wide, at an elevation of 10,000 feet and is bounded by a range of the grandest volcanoes in the world. Mexico also affords extensive plains several thousand feet above the sea, and in North America the great plains gradually rise towards the north and west till they assume the character of plateaux.

Of these plains some portions are generally fertile, but very large tracts afford no traces of natural vegetation, and offer little promise. In some cases, rain is exceedingly rare.

61 *Mountain Systems of the Earth.*—The most elevated portion of the Earth's crust consists either of lofty ranges exhibiting a serrated or saw-like summit of jagged edges, rising directly from plains; of elevated ridges flanking table-lands; of ridges subordinate in height, having, notwithstanding, important physical characters; or of isolated peaks, or cones, not connected by intervening high ground. It is important to understand the term 'mountain chain' as being independent either of absolute or relative height either above the sea level, or with respect to adjacent plains, for there may be ridges of very low elevation which are in the strict sense mountains, and there are, on the other hand, many ranges of hills which are properly so called, although far more lofty than many mountain chains,* the mountain character not depending on absolute height above a fixed level, but rather on distinct physical features. Mountain chains also may and do extend far out to sea beyond their prominent and lofty ridges, and in this and many other ways are highly important and very distinct features of the Earth, greatly affecting its condition as the habitation of organic beings.

Strictly speaking, there are but two great systems of mountains on the globe, one in each great continent, although there may also be traced a multitude of others, some parallel to, and some making angles with, the principal directions. The mountain chain of the Old World, or Eastern Continent, has its main axis running east-north-east and west-south-west, while that of the New, or Western Continent, is north-north-west and south-south-east. The length of the former is about 9000 miles, and that of the latter 10,000 miles. The one rises in its highest part to not less than 28,000 feet, while the other nowhere attains a greater elevation than about

* It is also important to remember that a mountain range is not necessarily a water-shed, nor does a water-shed require mountain country.

25,250 feet. The height of the elevated land thus bears some general proportion to the whole mass of land above the sea level.

There are certain features common to all mountain chains, which it may be well to consider before passing to the particular ranges themselves. They are rarely simple, but consist of distinct and often short ridges of high ground, running in the same direction, and nearly parallel to each other, rising at intervals to culminating peaks by the union of several convergent or radiating ridges. They exhibit also from time to time narrow transverse branches, or spurs, often of very great altitude, and forming, in fact, transverse mountain chains, which stretch far into the plains beyond.

The two sides of great mountain chains generally differ much in the rate at which they are inclined to the horizon, the one side being much more precipitous than the other. In the mountain chain of the Old World, for example, the southern side is generally scarped, and the northern side sloped, while in the Andes, the western side descends almost precipitously to the Pacific, while towards the Atlantic the slope is comparatively slow.

The mass of land, as measured by the relative elevation of different portions above the sea, has been made the groundwork of calculations whose object is to determine the mean height of various continental and other areas, and an enumeration of the effect of the various parts on the whole, as exhibited in the way of adding to the mean elevation, is one means of ascertaining the relative importance of mountain chains and other elevated districts.

The position of the mean height of all the solid parts of the Earth's crust above the sea, has been estimated by Humboldt at about 1000 feet; that of all Europe, 671 feet; of Asia, 1132 feet; of South America, 1151 feet; and of North America only 748 feet.

The effect of the plateau of Spain on all Europe, measured in this way, is estimated at 36 feet, while that of the whole chain of the Alps is only 20 feet. In Asia, the great central plains are estimated to contribute 120 feet of elevation. These results are, of course, only approximate.

62 *The General Connexion of the Mountains of the Old World.*—The great mountain system of the eastern hemisphere may now be described a little more in detail. Commencing with the western boundary of land at the Atlantic, we find the Atlas chain in Africa, the central Spanish mountains and the Pyrenees in Europe, nearly parallel to each other, and each connected with very lofty ranges further east, but all at length uniting and forming the commencement of the great Asiatic range, of which the Himalayan chain is the central and loftiest portion.

The Atlas range is lofty, complicated, and important, and forms a broad belt, having three principal divisions, which occupy the whole interval between the Sahara and the Mediterranean. The loftiest portion is the most inland, and forms, in Morocco, a mountain knot 15,000 feet high; the other portions are less elevated. The crest of the range is composed of granite and crystalline rocks, but the flanks are of stratified deposits of newer date.

The Spanish peninsula is almost entirely occupied by the table-land already described, and parallel ridges of serrated mountain peaks, terminated northwards by the Pyrenees; the latter being a chain of considerable elevation, the mean height of whose summit line is about 7000 feet. On the whole, this western extremity of the great mountain system of the Old World is remarkable for its great breadth and for the way in which it projects into the Atlantic, rather than for its altitude above the sea level.

The Pyrenees are continued eastwards at first by inconsiderable elevations and low table-lands, but these soon connect themselves with the western extremity of the Alps, whence the ground ascends rapidly by successive chains of mountains, commencing with the lofty range of which Mont Blanc and Monte Rosa are culminating points, extending through the various ranges of the Oberland, the Tyrolese, the Julian, the Noric, and other Alps, into the Balkan, and stretching southwards by very important spurs, of which the

Apennines and the mountains of Dalmatia are the most considerable, but of which other traces are also seen in the islands of Sardinia and Corsica.

The subsidiary ranges, whether parallel to or diverging from the principal chain of the Alps, include between them a somewhat extensive tract of low ground, and also a certain amount of higher table-land, but the position of the mountain chains, and their height above the sea, are the only points to which we now refer. These mountain chains consist, not only of those already mentioned, but also of the Jura (a somewhat transverse chain, subsidiary to the Alps,) and the Carpathians, which, turning southwards, partly complete the range towards the east, and partly connect the European mountain system with that of Asia. This communication is effected by the elevated land of the Crimea, conducting the Carpathians to the Caucasus; by the Balkan, passing into Asia Minor; by the mountains called Anti-Taurus; and also by the Taurus chain, which, by distant though appreciable links in Sicily, Crete and Greece, connects the south Spanish mountain ridges with those of Asia Minor. In this way there appear to be in the European system three principal and nearly parallel ranges, the northern one being the loftiest. There are also several important subsidiary ranges, and one principal transverse range, that of the Scandinavian chain, running north and south, but of considerable altitude compared with the Alps and other lofty mountain chains. There are four principal and parallel chains that intersect the interior of Asia, following with tolerable regularity an east and west direction, and connected by transverse elevations at a few detached points: these are the Altai, the Thian-schan, the Kuen-lin, and the Himalaya. There are also four or more running north and south, of which the Ural, the Bolor, and the Khingan, are three, and the fourth is Chinese.

63 *General Outline of the Mountain Chains of the New World.*—The mountain systems of the western continent are fewer, more simple, and more readily traced than those of Europe, Asia, and Africa. The mass of land being much longer in proportion to its area, and the outline of the land on the whole less broken, no doubt contribute to this, but the comparative simplicity of geological structure is not without an important bearing on this condition.

The Rocky Mountains, which begin on the shores of the Arctic Ocean, nearly under the 70th parallel, commence the American system, and connect it by islands with that of Asia. They continue south-eastwards in an unbroken line, separated only by the plains near the north end of the Gulf of California, from the high plateau of Mexico. These lands, themselves very lofty, support also some high ridges and peaks, occupying the country as far as the Isthmus of Panama, where hills of low elevation, piercing through low plains, intervene before the commencement of the Andes.

The Andes.—This great chain may be considered as commencing with the plains of Mexico, at the point where the Rocky Mountain system ceases to be traceable, and passing through the narrow strip of land which separates the two Americas by means of the volcanic range of Guatemala. The chain enters South America at the Isthmus of Panama, and continues in a steady and almost unbroken line of high elevation, forming successively the Andes of Colombia and Quito, of Peru and Bolivia, of Chile, and of Patagonia, sinking down into the ocean beyond the southern extremity of Tierra del Fuego, after having traversed the whole continent from north to south, a distance of 4500 miles.

The general character of the Andes is that of a number of parallel mountain chains of great elevation and small breadth, often uniting into knots, and often containing between them plains of vast elevation and considerable extent; but this character is not seen so strikingly in the southern as in the northern portion of the country, so that for 2000 miles, or from Cape Hoorn to the parallel of 20° south, the chain is single, narrow, and uniform.

Besides the main and continuous chains of the Rocky Mountains and the Andes, there are also in North America the Alleghanies, or Appalachian chain, and in South America those of Guiana and Brazil, which appear to be independent; besides that of Venezuela, which is an eastern branch or spur of the principal range of the Andes.

The Appalachian, or Alleghany Mountains, consist of a series of low undulations of nearly uniform elevation and parallel to each other, rarely more than 3000 or 4000 feet high, extending under various names in a north-easterly direction. from about 35° north latitude to the mouth of the St. Lawrence and the coast of Labrador. The eastern range is known, in its course northwards, under the names of the Blue, the Catskill, and the Green Mountains, respectively. The breadth of the range is generally from 100 to 150 miles.

As subsidiary mountains of South America we must mention here the great system of Parime and that of Brazil. The former of these is a group of not less than seven chains of low mountain elevations, rising generally to a moderate height above the plain (which is 2000 feet above the sea), but having some much loftier elevations, of which an inaccessible peak, Mount Marivaca (10,500 feet high), is the most remarkable. The Brazilian mountains, so far as they are known, consist of ranges running north-east and south-west, of which the highest peaks rarely attain to the height of 6000 feet, and which average only from two to three thousand.

Between the two Americas, and in the line of the principal islands known as the Great Antilles (Cuba, St. Domingo, and Porto Rico), there is an important mountain system, running west-north-west and east-north-east, parallel to a similar range of less elevation, rising above the sea only in Jamaica. Of these, the mountains of Cuba rise to the height of 8000 feet, and those of St. Domingo to 9000 feet, while the elevations in Porto Rico are less considerable. The Jamaica mountains form a very sharp east and west ridge, running across the island at an elevation of from 5000 to 6000 feet, while some of the transverse spurs are as much as 7000 feet high.

64 *Mountain Systems of Australasia.*—It now only remains to describe in a few words the chief physical peculiarities exhibited in the mountain systems of the vast group of islands in Australasia. Australia itself, the chief mass of land in this district, exhibits apparently the same characters of table-land that are presented in Africa; where the extent of the land is large, the elevation tolerably uniform, and the coasts little broken into deep and narrow inlets. In other words, it presents sudden and precipitous mountain ranges towards the coast, which are not repeated inland, but slope gradually towards the interior. Thus, in New South Wales generally, and especially in the south-eastern part of this district, there is a north and south mountain range, which seems to be situate about 100 miles from the shore, and which rises to a height varying from 3000 to 6000 feet and upwards. In South Australia there is a similar range near Adelaide traced for some distance. The mountain systems in other parts of the Archipelago are little known, except that in New Zealand there is a range nearly parallel with that of New South Wales.

In addition to the great mountain systems traceable for considerable distances on the Earth's surface, there are in many places detached mountains, or groups of mountains, chiefly volcanic, either rising directly from the sea, or from extensive flat and often elevated plains. These being all connected with that reaction of the interior of the Earth on its exterior, which it will be convenient to consider under a distinct head are for the present neglected in the account we have given of the plan of arrangement of those distinct mountain groups, which project in ridges above the general surface of the Earth's crust in a given district, whether that surface be above or below the level of the sea.

CHAPTER V.

HYDROLOGY.

§ 65. General phenomena of the ocean.—66. Action of the wind on the ocean.—67. The tides.—68. The Atlantic Ocean.—69. The Pacific Ocean.—70. The Indian Ocean.—71. The Arctic Ocean.—72. Marine currents.—73. Whirlpools.—Calms.—74. Inland salt seas. Bays, and gulfs.—75. Springs.—76. River basins.—77. River systems of the Atlantic group.—78. River systems of inland seas of the Atlantic.—79. Rivers of the Asiatic system.—80. River systems of the Pacific Ocean.—81. River systems of the Indian Ocean.—82. Rivers not communicating with the ocean.

GENERAL Phenomena of the Ocean.—The principal part of the water on the globe occupies large depressions on the solid surface, known under the name of *Oceans*. These are connected together by comparatively narrow passages, and are therefore really united, forming one wide and continuous expanse of sea. The different parts are, notwithstanding, known by distinct names, the most important being the Atlantic, Pacific, Indian, and Arctic Oceans. There are also some internal seas, or lakes, of considerable extent, as the Mediterranean, the Baltic, and others, which are almost entirely enclosed by land, and are filled with salt water, besides the great gulfs and bays of North America, and others better known, but far less extensive in Europe.

It appears by calculation, that the actual surface of the globe being reckoned at about 197,000,000 square British statute miles, as much as 145,000,000 square miles are covered by the waters of the ocean. It appears further, that out of about ninety millions of square miles of surface in the South half of the torrid zone and the South temperate zone together (the space between the equator and the Antarctic circle), nearly seventy-seven millions of square miles (almost seven-eighths) are water, while in the North temperate zone, the quantity of land is nearly equal to that of water. It is, therefore, evident that a great irregularity prevails in the distribution of land, and no reason has been suggested why this particular arrangement, rather than any other, has resulted. One consequence of this distribution of the water will be seen when we consider the phenomena of the tidal wave.

The depth of the ocean varies exceedingly, and its bed is broken, like the surface of the land, into plateaux, forming shoals, and ranges of mountains as well as isolated mountains, appearing above the surface in islands, and groups of islands. The structure also of the land is often continued into the sea, beyond the extremities of continents, as in the Agulhas bank beyond the south extremity of Africa, and also the islands of Tierra del Fuego. In other cases, there is a rapid and very complete termination of the high ground on the coast in the course of a very small distance. Many parts of the ocean have been fathomed, but in some places a line, whose length nearly equals the elevation of the loftiest peaks of the Himalayan chain, has failed to reach the bottom. Around our own coast the depth is very variable, not amounting to one hundred feet over great part of the German Ocean, while towards Norway, where the shore is bold, the depth is more than five thousand feet at a very short distance from the coast. The deep water commences also at a short distance from the shores of Ireland.

The ocean, over all parts of the Earth, contains a certain proportion of salt, which is not the same, however, for different seas, and even varies in different seasons and at various depths. The proportion is generally about three or four per cent., but is larger in the southern than the northern hemisphere, and in the Atlantic than the Pacific. The greatest proportion in the Pacific is in latitude 22° N. and 170° S. of the equator, and the smallest is in the Polar Seas, where the saltness is affected by the melting of the Polar ice. The surface is often less salt than the deeper parts of the sea, owing to the flowing into the ocean of large quantities of fresh water from rivers. In this case, the fresh water being lighter, floats on the surface for a long distance before becoming thoroughly mixed. Deep seas are generally more saline than those that are shallow, and inland seas than the open ocean, but this is not invariably the case, as it depends on the proportion that the river-water flowing into the sea bears to the evaporation from its surface, and also partly to the influx of salt water. Thus, the Mediterranean, especially in the deeper parts, is much more salt than the open sea, but the Baltic is much less so.

The temperature of the water is generally different from that of the atmosphere above it, and is greatly affected by depth and local circumstances. The temperature of deep water is constant, and in most parts of the ocean, within the temperate and torrid zones, is much lower than that of the surface.* The temperature diminishes, however, very irregularly in different seas, being so unequal, that one degree of the thermometer (Fahrenheit) answers sometimes to seven, and at other times to fourteen, fathoms depth, and even more. Still it has been considered, that in general the temperature decreases six times as rapidly in the sea as in the atmosphere, and thus we much sooner arrive at the stratum of invariable temperature (a limit which corresponds to 'the snow line' in ascending into the atmosphere). Under the equator this stratum is at the depth of 1200 fathoms—thence it rises towards the surface, and reaches it in the southern hemisphere (where the water is most open) in latitude 56° 26′, and then gradually descends again to latitude 70°, where it is 4500 feet below the surface. The temperature in the latitude mentioned is 39° 5′ at all depths. At the equator, the water at the surface is at 80° Fahrenheit, and therefore much above that of the stratum of invariable temperature; but at the pole, on the other hand, the water is much colder at the surface than at the depth mentioned above. Submarine currents setting from the pole to the equator, returning at a higher level to the pole, are concerned in the production of this condition.

66 *Action of Wind on the Ocean.*—The sea is constantly undergoing a certain amount of movement, produced by various causes, some of which, and these among the most remarkable, are external to our planet, although producing results upon it of the greatest possible importance. Others are connected with the mere surface action of the atmosphere when disturbed, and moving rapidly over the water, striking it at an angle. These results, producing what are called wind and storm waves, have been well described in a recent work on *Physical Geography* by Mrs. Somerville, and as she has expressed in a few words all the most striking phenomena on this subject at present known, we cannot do better than borrow her words:—

'Raised by the moon and modified by the sun in the equatorial seas, the central area of the two oceans is occupied by a great tidal wave, which oscillates continually, keeping time with the returns of the moon, having its motion kept up by her attraction acting at each return.

'The friction of the wind, however, combines with the tides in agitating the surface of the ocean, and, according to the theory of undulations, each produces its effect independently of the other; wind, however, not only raises waves, but causes a transfer of superficial water also. Attraction between the particles of air and water, as well as the pressure of the atmosphere, brings its lower stratum into adhesive contact with the surface of the sea. If the motion of the wind be parallel to the surface, there will still be

---

* This, however, is not everywhere the case, for Humboldt observed, in crossing from Corunna to Ferrol, that the surface water varied from 54½° to 56° Fahrenheit, while the deep water was 59° to 59½°, and the atmosphere 55°.

friction, but the water will be smooth as a mirror; but if it be inclined, in however small a degree, a ripple will appear. This friction raises a minute wave, whose elevation protects the water beyond it from the wind, which consequently impinges on the surface at a small angle: thus, each impulse combining with the other, produces an undulation which continually advances. Those beautiful silvery streaks on the surface of a tranquil sea, called cats-paws by sailors, are owing to partial deviation of the wind from a horizontal direction. The resistance of the water increases with the strength and inclination of the wind. The agitation at first extends little below the surface, but, in long-continued gales, even the deep water is troubled; the billows rise higher and higher; and as the surface of the sea is driven before the wind, their 'monstrous heads,' impelled beyond the perpendicular, fall in wreathes of foam. Sometimes several waves overtake one another, and form a sublime and awful sea.

'The highest waves known are those which occur during a north-west gale off the Cape of Good Hope, aptly called the Cape of Storms by ancient Portuguese navigators; and Cape Hoorn seems to be the abode of the tempest. The sublimity of the scene, united to the threatened danger, naturally leads to an over-estimate of the magnitude of the waves, which appear to rise mountains high, as they are proverbially said to do. There is, however, reason to doubt if the highest waves off the Cape of Good Hope exceed forty feet from the hollow trough to the summit. They are said to rise twenty feet off Australia, and sixteen feet in the Mediterranean. The waves are short and abrupt in small shallow seas, and on that account are more dangerous than the long rolling billows of the wide ocean. The undulation, called a ground-swell, occasioned by the continuance of a heavy gale, is totally different from the tossing of the billows, which are confined to the area vexed by the wind, whereas the ground-swell is rapidly transmitted through the ocean to regions far beyond the direct influence of the gale that raised it, and it continues to heave the smooth and glassy surface of the deep long after the wind and the billows are at rest. A swell frequently comes from a quarter in direct opposition to the wind, and sometimes from various points of the compass at the same time, producing a vast commotion even in a dead calm, without ruffling the surface. Waves are the heralds that point out to the mariner the distant region where the tempest has howled, and they are not unfrequently the harbinger of its approach.

'In addition to the other dangers from polar ice, there is always a swell at its margin. Heavy swells are propagated through the ocean, till they gradually subside from the friction of the water, or till the undulation is checked by the resistance of land, when they roll in surf to the shore, or dash in spray and foam over rocks. The rollers at the Cape de Verde Islands are seen at a great distance, approaching like mountains. When a gale is added to a ground swell, the commotion is great, and the force of the surge tremendous, tossing huge masses of rock, and shaking the cliffs to their foundation. The violence of the tempest is sometimes so intense as to quell the billows and blow the water out of the sea, driving it in a heavy shower, called spoon-drift by sailors. On such occasions, saline particles have impregnated the air to the distance of fifty miles inland. The effect of a gale descends to a comparatively small distance below the surface; the sea is probably tranquil at the depth of 200 or 300 feet: were it not so, the water would be turbid and shell-fish would be destroyed. Anything that diminishes the friction of the wind smoothes the surface of the sea: for example, oil, or a small stream of packed ice, which suppresses even a swell. When the air is moist, its attraction for water is diminished, and, consequently, so is the friction; hence the sea is not so rough in rainy as in dry weather.'*

67 *The Tides.*—We have already mentioned the fact of the existence of a great tidal wave oscillating continually, and produced by the periodical

---

* Somerville's *Physical Geography*, 1st edition, p. 239.

movements of our satellite the moon. If the Earth presented a uniform globe, with a belt of sea of great and uniform depth encircling it round the equator, this wave would be perfectly regular and uniform. The sun carrying with it one such wave, and the moon another, there would be four tides, so modified, however, as to produce two principal ones compounded of the four. The actual case is, however, very different from this imaginary condition, so that the heights of successive tides vary, indeed, in some proportion to the way they would do in the simpler case, but the direction of motion and the state of high water are exceedingly various. It is very difficult to form an adequate notion of tidal phenomena, without elaborate tidal charts, the materials for which have only been partially accumulated; but we may by description give some idea of the true case. Looking at a globe or map of the world, we observe no uniform belt of sea round the equator; but on the contrary, the great continents cross the equator at nearly right angles, the Atlantic Ocean remaining as a comparatively narrow basin, while the Pacific is greatly intercepted by coral reefs, islands, and sunken continents. In point of fact, the great reservoir of water in which regular tidal action occurs, is not only in the southern hemisphere, but nearer the Antarctic circle than the equator. The source of the tides is therefore to be sought in the expanse of sea occurring within the south temperate zone, where the great central agitation seems to commence, and whence on all sides it appears to flow northwards. The Atlantic thus receives from the south its great wave of tide, which gradually becomes a curve, whose convexity is more and more northwards, until after passing the tropic of Cancer, the advance of the wave is so greatly retarded on the coast by the narrowness of the channel, that a portion of it has reached the latitude of the southern extremity of Greenland by the time that another portion has scarcely passed Cape Blanco on the African coast, and Cuba in the West Indies. The great wave of tide passing northwards, in this narrow channel, thus forms an enormous stream tide on the shores of Britain and North America, but it has, by this time, become so complicated, that it is difficult to trace its relations with the moderate and regular undulation produced originally by the attraction of the moon. So also in the Pacific, the tide is so checked by the sub-marine irregularities of surface, that for a considerable part of that vast ocean, there is scarcely any wave of the kind exhibited. In the Indian Ocean, on the other hand, the tide wave, little interrupted by such causes, makes its way in an irregular curve to the shores of India, and there divided by the pyramidal form of the peninsula of Hindostan, one portion proceeds up the Bay of Bengal, and the other towards the Persian Gulf; the former having no escape, and not dissipated by irregularities in the form of the land, gradually increases in height as the bay narrows, and finally reaches the mouth of the Ganges, where it expends its force on the shores in the form of the well known and terrific *bore* of the Hooghly. In point of fact, therefore, the tides, although formed entirely by the attraction of the sun and moon, by no means follow the apparent course of those bodies after their original genesis. After the wave has once entered the canal of the Atlantic, it moves continuously northwards, with very various velocity, but at first at the rate of nearly a thousand miles per hour. In the first twenty-four hours, it has brought high water to Cape Blanco on the west of Africa, and Newfoundland on the American continent. In the morning of the second day, this great wave having been driven eastwards, reaches the western coast of Ireland and England. Passing round the northern Cape of Scotland, it reaches Aberdeen at noon, travelling in precisely the opposite direction to that of its first progress, and also opposite that of the sun and moon. Still proceeding onwards, at midnight of the second day, it reaches the mouth of the Thames, and on the morning of the third day brings the merchandise of the world to the port of London. It thus takes more time to reach London from Aberdeen than to pass over an arc of 120°, (8000 miles,) between 60° south latitude and 60° north. The velocity of the progress of this wave is greatest where the water is deepest, and where the configuration of the shores offers the fewest obstacles.

68 *The Atlantic Ocean.*—We must now consider those phenomena that are peculiar to the different parts of the great Ocean. The *Atlantic,* although its boundaries are not completely marked by nature, is yet perfectly distinct and easily described. It is that area of water occupying the space between the western shores of the Old and the eastern shores of the New World, and reaching from the Arctic circle to the icy shores of the Antarctic land. The limit to east and west beyond the land of the two continents to southward (in latitude 34° and 55° S. respectively,) is considered to be a continuation of the meridian of longitude of the Cape of Good Hope and Cape Hoorn, (20° E. and 70° W. from Greenwich). This ocean, including its inland seas, covers about thirty millions of square (British statute) miles.

Extending thus for nearly 140 degrees of latitude, the breadth of the Atlantic will be seen to be comparatively small. The two continents which form its shores approach nearest one another between Greenland and Norway, in latitude 69°—71°, and are there only 800 miles apart. Widening gradually, but then again contracting, the breadth about 5° S. of the equator, between Brazil and Sierra Leone, in Africa, is still only 1500 miles. At 30° N. latitude, where its breadth is greatest, (between Florida and the coast of Africa,) the width is 3600 miles.

The elongated valley form of this ocean long since attracted the attention of Humboldt, who observed that not only do the projections and protuberances of one coast correspond with recesses on the other, but that the nature of the mountains and plains also corresponds. This is chiefly the case with regard to Africa on the east, and the northern part of South America on the west. There are few mountains in the bed of the Atlantic, or, at least, few that show themselves as islands above its surface. The principal of these form volcanic islands and groups, and, except those in the northern part and the West Indian group, are placed near the shores of Africa, and are probably the last indications westward of the great mountain system crossing the Old World.

The depth of the Atlantic is in some parts very considerable. In latitude 27° 26′ S., longitude 17° 29′ W., it was sounded by Sir James Ross, and found to be 14,550 feet; 450 miles west of the Cape of Good Hope it was 16,062 feet, (332 feet more than the height of Mont Blanc;) while in latitude 15° 3′ S., and longitude 23° 14′ W., a line of 27,600 feet failed to reach the bottom.

The form of the land on the northern shores of the Atlantic is worthy of notice, having a tendency to linear extension, not only in the several islands of Nova Zembla, Spitzbergen, and Greenland, but also the main land of Norway, which is split as it were into shreds by deep inlets (*fjords*). Scotland exhibits, in its northern and western islands, a similar peculiarity of form. The shores of this ocean are also very deeply indented by large seas, of which the Baltic and the Mediterranean are the most remarkable.

In consequence of the contorted and complicated line which the shores make, the length of coast enclosing the Atlantic is very considerable, and is indeed much more so than that of the Pacific, notwithstanding the far greater magnitude of the latter ocean. The eastern coast line of the Atlantic is 32,000 miles in length, and the western, or American, 23,000 miles, making a total of 55,000 miles.

The Atlantic receives the rivers of a certain portion of the land enclosing it, and the area of each river basin includes all that land the water of which naturally flows into the river. In Europe and Africa, there are no rivers of first-rate magnitude emptying themselves directly into the Atlantic, since the Rhine, the largest of them, has a course of only 700 miles, while the Nile, the Danube, the Dnieper, the Rhone, and others, run into the Mediterranean, the Volga into the Caspian, and the Elbe and Oder into the Baltic. On the American side numerous gigantic rivers pour directly into the Atlantic a vast body of water, draining almost the whole of the New World.

There are several exceedingly important currents in the Atlantic, but these will be best considered after we have described the phenomena of the

Pacific and Indian Ocean. The winds of the Atlantic have been already the subject of some notice in speaking of atmospheric influences.

A very extensive area of the Atlantic, extending from 19° to 36° N. latitude and from 30° W. longitude to the Bahama Islands, (occupying in all 360,000 square miles,) is covered at intervals with a species of marine plant, (*fucus natans,*) called sometimes the *sargasso*, or *gulf-weed*. The quantity of marine vegetation, and consequently of animal life, in this vast range, especially in two principal fields near the termination of the Gulf Stream, and where two portions of the stream meet, is truly astonishing. The real origin of this accumulation is not known, but in its results it is sufficiently interesting, as it affords food and shelter to a multitude of marine animals. The Atlantic Ocean is divided by geographers into two portions—one north, the other south of the equator, and called, therefore, respectively the North and South Atlantic Ocean. There is no natural division corresponding to this artificial arrangement.

69 *Pacific Ocean.*—The Pacific Ocean covers more than half the surface of the globe, and its area may be roughly estimated at ninety millions of square miles, occupying the space between the shores of America on the one side, and the coasts of Asia and Australia on the other. Its northern boundary is Behring's Straits, which, between East Cape, in Asia, and Cape Prince of Wales, is not so much as forty miles wide; but from this point the coasts rapidly diverge, and at 54° 30′ N. latitude, between the peninsula of Alashka and Kamtschatka, are more than 1200 miles apart. Continuing to diverge, the breadth from California to the coast of China, on the tropic of Cancer, is 8500 miles; and this remains pretty constant as far as the south tropic, where the distance from Sand Cape in Australia to the coast of Chile is 8200 miles. Towards the southern extremity, the limits of the Pacific are understood to be the meridians of longitude passing through Cape Hoorn and South West Cape, in Tasmania, and the ocean terminates, as the Atlantic does, at the icy shores of the Antarctic land.

The Asiatic border of the Pacific is fringed in a very remarkable manner with islands, almost enclosing a range of seas, or small basins, which correspond with and replace the deep inland seas of the Atlantic. Long peninsulas also project from the main land, and these, as well as the islands, (and the coast itself where they do not occur,) are dotted at intervals with active volcanoes, of which a very large proportion of the whole number known on the globe are there placed. Although, however, the Asiatic and North American coasts are much broken, the South American is for the most part bold and rocky. The total length of the coast line, including that of the whole Indian Ocean, is estimated at 47,000 miles, about 8000 miles less than that of the Atlantic.

While the south-western and western portions of the Pacific are so thickly strewn with islands that the number of them is not at all known, even approximately, the eastern, northern, and southern portions are singularly free from islands, the sea for fifty degrees of longitude west of the American coast (exceeding very greatly the whole Atlantic in extent,) having only one group of any importance, (the Galapagos,) and that extremely small. Of the island district, which extends chiefly between the tropics, and reaches from the west boundary of the ocean to longitude 135° W., there are two principal groups, the one consisting of flat, low islands, in groups more or less connected with sunk coral reefs, often of great depth, and the other of high and volcanic islands, occasionally surrounded with a fringe of shallow coral. A space extending more than 1000 miles in length and 600 in breadth, south of New Guinea, and between the north-eastern coast of Australia and the New Hebrides group, is remarkable for the innumerable multitude of coral reefs, islands, and banks it encloses, and this may possibly be the last remains of a sunken continent, of which the eastern part of Australia, New Guinea, and other islands formed a part, but which has now almost entirely disappeared over a large portion of its area. The Pacific would appear to possess a depth corresponding in some degree to its vast area.

70 *Indian Ocean.*—That portion of the great ocean which extends southwards from Asia to the Antarctic Circle, and eastwards from Africa to Australia, thus occupying the interval between the Atlantic and Pacific, is called the Indian Ocean. Including the Red Sea, Persian Gulf, Bay of Bengal, &c., it occupies an area of about 23,000,000 of square miles, and is thus nearly as large as the Atlantic itself. It includes several very large and important islands, as Madagascar, Borneo, Sumatra, Java, Ceylon, &c., and some important systems of islands, and it receives the drainage of several of the principal river-basins of Asia, as the Ganges, Brahmapootra, Indus, and Euphrates. The chief points of interest connected with this ocean have reference to its currents.

71 *Arctic Ocean.*—The tract of sea within the Arctic Circle, bounded by the northern coasts of Europe, Asia, and America, includes an area of about 3,000,000 of square miles, and is called the Arctic Ocean, or Icy Sea. It is connected with the Pacific by Behring's Straits, and with the Atlantic by the wide strait between Greenland and Norway. The corresponding tract of ocean at the opposite pole is called the Antarctic Ocean, and is estimated to occupy about 2,000,000 square miles. Its exact limits have not been very accurately determined, as the ice extends much further from the south than it does from the north pole.

72 *Marine Currents.*—The water of the sea is not only constantly kept in motion by the attraction of the sun and moon, producing the tidal waves, and by occasional disturbances the result of winds, but there are also large bodies of water, as well in closed seas as in the open ocean, which are continually moving onwards in a fixed and constant direction, some of them depending on causes not less permanent than the globe itself, and others, although originated by the form of land and local influences, remaining constant for periods of time far longer than any records of man can reach. There are also periodical currents of greater and less importance.

Of these various currents, some are merely superficial, slow in their motion, easily turned aside by natural obstacles, such as sand-banks, projecting headlands, &c., and resulting generally from constant winds; others are deep, broad, and sometimes even rapid; their temperature is different from that of the ocean through which they make their way, and they proceed like rivers through a great continent, keeping a course which sometimes extends for thousands of miles. The former are called drift currents, the latter stream currents. The most important of the stream currents are those which occur in the Atlantic, or, at least, it may be considered that, as these are best known and most affect navigation, they require the most extended notice. Many of these currents, however, commence in other seas, and thus connect the waters of different parts of the great ocean. Thus, the Gulf Stream, perhaps the most important of all, must be regarded as originating in the Indian Ocean or even in the Pacific, and the Arctic currents bring ice and cold water far into the Atlantic from the Arctic Ocean. Omitting, for the present, those currents which have their origin in the waters which pour into the sea from the great rivers of the Earth, we will consider now the principal marine currents in their relation with one another.

Commencing in the northern part of the Bay of Bengal, a current sets southwards for some distance, and passing round the south of Ceylon, turns westwards to near the coast of Africa. This current, however, depends upon the monsoon, being a northerly current during the south-west monsoon, from February to October, and southerly during the rest of the year. Between Madagascar and the mainland of Africa there sets another current, which, under the name of the *Mozambique Current*, continues close along the African coast in a south-westerly direction during the whole year. A little farther south it becomes a true southerly current, having near the coast a mean velocity of from 18 to 20 miles per day, which at some seasons is greatly exceeded, a case having been known of a ship drifted by this current 139 miles in 21 hours, a velocity only paralleled in the maximum of the Gulf Stream. Near Algoa Bay, and off the Agulhas Bank, this current passes into the *Cape*

Current, which is formed, indeed, of its junction with the currents from the seas south of Madagascar. A part of the Cape Current is deflected by the Agulhas Bank, and passes round by the Cape of Good Hope into the *South Atlantic Current*, but the main portion turns southwards in latitude 21° to 24°, and then, passing eastwards, forms an important counter-current, mixing with the *South Atlantic Counter Current.*

The Cape Current is from 90 to 100 miles broad, and in different parts of its course flows at the rate of from 60 to 100 miles per day. Outside the Agulhas Bank the temperature has been observed to be about 80° above that of the ocean. The counter current running eastward has a breadth of from 200 to 240 miles, and a velocity of 50 miles per day.

The South Atlantic Current is a continuation of the Cape Current towards the north and north-west, along the coast of Africa. In latitude 10° south it has ceased to be traceable at the surface, and then commences the *Main Equatorial Current.* This important part of the stream currents of the Atlantic may be distinctly recognised off the coast of Africa, a little south of the equator. It runs nearly on the equator, and parallel with another (the *Guinea Current*), which terminates a little to the north, near the mouth of the Niger; and for a distance of more than 1000 miles these two currents exhibit the remarkable phenomenon of parallel streams in contact with each other, flowing with great velocity in opposite directions, and having a difference of temperature of 10° or 12°. The Main Equatorial Current proceeds on both sides of the equator to 22° west longitude, and then sends off the *North-west Branch Current*, and, declining to the south, runs parallel with the coast of South America beyond the tropic of Capricorn. At Cape St. Roque, however, a portion of the stream runs parallel to the northern coast of South America, till it disappears near the mouth of the Amazons, being covered and crossed by the volume of fresh water proceeding from that river. The north-west branch of this current flows at first north-westwards, and afterwards towards the north, till, in about 30° north latitude, it merges in a drift current; its breadth varies from 200 to 300 miles. The length of the Main Equatorial Current, measured from the coast of Africa to its termination near the Caribbean Sea, is about 4000 miles; and that of the *Brazil Current*, its southern portion on the coast of America, is nearly 1000 miles; its breadth at the commencement is about 160 miles, at about 5° west longitude it has increased to 360 miles, and at the point of separation of the north-west branch amounts to 450 miles. The mean velocity of the whole course of the current may be reckoned at 36 miles per day, but between 10° and 16° west longitude in the summer season, it varies from 44 to 78 miles, and has even been recorded at 90 miles per day. The velocity of the north-west branch is much less, commencing at from 20 to 24 miles per day, and gradually diminishing. Throughout its course to the Caribbean Sea this is a cold current, the average temperature being from 4° to 6° below that of the ocean; its northern portion passes into what is called the *Guiana Current*, which extends about 500 miles, with a velocity varying from 10 to 36 miles per day. This current enters the Caribbean Sea, and is there lost sight of.

In addition to the currents already described, and uniting them between the Cape of Good Hope and the coast of Brazil, is the *Southern Connecting Current*, which is but little known, and flows chiefly to eastward about 150 miles south of the Cape of Good Hope, into the Indian Ocean. We have seen thus that a great body of water proceeds across the Atlantic from east to west, spreading out northwards and southwards as it approaches the great barrier of land presented by the continent of America. The form of this land, the vast recesses of the Caribbean Sea and the Gulf of Mexico, separated from the main ocean by the chain of the West Indian islands and the peninsula of Florida, conceal the further progress of these currents. But an important and very considerable current has been traced, setting round the Campeche Bank into the Gulf of Mexico, and assisted by the river current of the Mississippi passing out into the Atlantic between Florida and Cuba. Running within the Bahama Bank, the water thus issuing into the open ocean continues parallel with the coast of North America, till it meets the St. George and Nantucket banks, when its course is directed eastward. After passing the southern extremity of the bank of Newfoundland, it continues in the same direction to about 38° west longitude, between 35° and 43° north latitude, and at this point it turns to south-east and south, and, passing the westernmost of the Azores, is soon afterwards lost in the Atlantic. This remarkable and important stream-current is well known under the name of the *Gulf Stream.* It extends on the whole upwards of 3000 miles, and occupies 78 days in its progress, thus averaging a daily rate of 38 miles, but the velocity varies greatly, amounting to 120 miles per day at the end of the Gulf of Florida, and not more than 10 miles per day in the vicinity of the Azores. The maximum temperature of the stream is in the strait of Florida, and is then 86° or 89°, considerably above that of the ocean in the same latitude; 10° farther north, it is still as much as 84°; and, although both temperature and velocity decrease as the stream progresses, the temperature remains constantly very much above that of the ocean outside the current. It is the influence of this stream upon climate that renders the British islands green and fertile, while the shores of Labrador in the same latitude, or the shores of America, are fast bound in the fetters of ice; its influence is not therefore confined to the line of its direct course, but is felt along the shores of Europe even as far north as Spitzbergen. The Gulf Stream must be considered to terminate, as we have said, in about the 25th meridian of west longitude, but two other currents are traceable on the western coast of the Old World; one called *Rennel's Current,* commencing near Cape Finisterre, running northward along the coast of Spain, and thence along the west coast of France. After crossing the English and Irish channels, and the south coast of Ireland, this current enters the open ocean, and joins the other, or *North African Current,* which runs first southwards, following the coast of Africa, but then, continuing parallel with the shores of that continent, it turns eastwards, and forms that remarkable contrast to the Equatorial Current already alluded to. Rennel's Current has a velocity of about a mile an hour, in certain winds, and the North African Current about half that velocity in the northern part of its course, but afterwards a rate of as much as 50 miles per day.

The remaining Atlantic currents are two, the *Arctic Current,* and that which, passing round Cape Hoorn, may be regarded as an *Antarctic Current.* The former is understood to originate in the ice which surrounds the North Pole; it sets south-westwards, from between Iceland and Greenland, and arriving at Newfoundland, divides into two branches, the main stream passing between the great and outer bank of Newfoundland into the Gulf Stream, and afterwards again dividing, one portion flowing southwards to the Caribbean Sea, while the other forms the *United States Counter Current,* which extends between the Gulf Stream and the coast to Cape Hatteras and Florida; this current conveys southwards enormous masses of ice, bringing with them immense quantities of stone and earth, which are sometimes stranded in shallows or on banks, and sometimes, melting gradually, pass down into low latitudes, and temper the heat or chill the air of those countries along whose shores they pass. The *Cape Hoorn Current* is an easterly current along the southern extremity of America and the Falkland Islands, but it has originally proceeded from the Antarctic Polar Sea, and thus brings with it very large quantities of drifted ice. Its velocity appears to vary very greatly, from 12 to about 56 miles per day, and it probably mixes with the waters of the southern connecting current.

The currents of the Pacific Ocean are not so well known as those of the Atlantic, nor do they appear to be by any means so considerable or so important in navigation. The most interesting is that which, commencing as a drift current from the Antarctic Pole, near the newly discovered Victoria Land, becomes a coast current of cold water between latitude 40° and 50° south, and then runs northwards along the western coast of South America, lowering the temperature of the land, and apparently producing an effect exactly the converse of that which the Gulf Stream produces on the coast of Europe. At the surface this current is slow, often not amounting to more than a third of a mile per hour; but at the depth of from 12 to 15 fathoms it is more considerable and in the same direction. In some part of its course this current runs at the rate of 14 to 18 miles per day, and it is traceable along the coast from Valparaiso almost to the equator, when it turns westwards into the open ocean of the Pacific, but remains sensibly affecting the temperature to a distance of several thousand miles; the difference in temperature between the current and the mean annual temperature of the atmosphere is throughout considerable.

73 *Whirlpools.—Calms.*—Whirlpools are produced by opposing tides, winds, or currents, but the former most generally. They are rare in all seas, and not by any means so destructive now as they seem to have been in ancient times, when the principles of navigation were less understood.

Although the greater part of the ocean is disturbed constantly by these various causes, there are not wanting very extensive areas, especially within the tropics, and far from land, when dead calms prevail, and the sea remains for days in a state of unruffled stillness. The low flat tidal wave is then so large, and so regular in its heaving, that it seems lost, and thus an appearance of perfect quiet is presented.

74 *Inland Salt Seas.—Bays and Gulfs.*—Although we have already had occasion to allude to those deep inlets of the sea that occur in various parts of the world and form inland seas, it is still necessary to refer to them again in some little detail, to give an idea of their comparative dimensions and importance.

Of the inland seas connected with the Atlantic, the Mediterranean is the largest and the most beautiful. It occupies 950,000 square miles, but is nearly divided into two seas by the projecting land of Italy, continued by shallows to the opposite coast of Africa. The temperature of the water is higher by 10° or 12° than that of the Atlantic, and the evaporation is excessive. It is one consequence of this and of the comparative smallness of the river drainage emptying itself in the Mediterranean, that its waters are as much as four times as salt as the ocean. Many parts are exceedingly deep.

The Baltic is a long narrow inland sea, occupying about 200,000 square miles in the centre of northern Europe, and receiving the drainage of more than a fifth of the whole continent. Its depth nowhere exceeds 115 fathoms, and is generally not more than forty to fifty fathoms. It is one-fifth less salt than the ocean.

The Black Sea, the Sea of Azof, the Caspian, and the Aral, together form one depression, which is only partly filled with salt water. The whole area of water in the two former lakes is near 250,000 square miles, and in the Caspian 180,000 square miles. The waters are brackish; the depth, especially of the Caspian, is considerable, but decreases towards the shores gradually, and in terraces.

Baffin's Bay, twice the size of the Baltic, and Hudson's Bay, also of vast dimensions, penetrate the North American continent at Davis' Straits, while the Gulf of Mexico, occupying 800,000 square miles, and the Caribbean Sea, whose area is more than a million and a quarter miles, are still more extensive indentations nearer the equator, shut in by islands, and resembling in this respect the Yellow Sea, the China Sea, and the Sea of Japan, on the east coast of Asia.

75 *Springs.*—A glance at the distribution of water upon the Earth will show that there are two very distinct parts of the subject, one of which we have already considered—namely, the phenomena of the great mass of salt water forming the ocean and its branches,—while the other, relating to fresh water, still remains to be considered. This second group of phenomena is also twofold, including the sources whence the fresh water upon the Earth is derived, and also the brooks, streams, and rivers which convey the water across the land, and pour it into the sea. Lakes of fresh water, and other accumulations dependent on the form of land, also require some consideration.

The first commencement of running water upon the Earth's surface is generally from springs, which issue occasionally from hill sides, sometimes from crevices in the Earth of no great magnitude, but sufficient to allow of the out-pouring of a large body of water, and sometimes from large natural cavities in very considerable quantities. However little these different sources may seem to have reference to the rain falling on the surface of the Earth in their vicinity, they are, in fact, with very few and unimportant exceptions, thus derived. It is only a part of the rain that runs off directly from the surface into streams and rivers, and thus manifestly swells their magnitude; and although no doubt this quantity is increased by that portion which, falling as snow, and collected on mountain-tops in the colder parts of the year, is gradually melted in the warmer seasons, there still remains a very large proportion. A portion of this again is soon received into the atmosphere by evaporation, but a very considerable quantity sinks down within the crust of Earth, and is conveyed along underground, re-appearing in the springs already alluded to. The absolute quantity of rain falling upon the Earth is, as has been already stated (see *ante*, p. 210), exceedingly great, and that portion of it which runs off to the sea by means of rivers in the west of Europe, is supposed not to exceed one-third, although doubtless very much greater in climates where the rain falls more heavily. The proportion that sinks beneath the surface, and re-appears at a distance, must also be large, so that, on the whole, the actual circulation of fresh water upon the globe, evaporated from the ocean, conveyed through the air in clouds, and falling upon the land as rain, is important, not only as affecting the fertility of the Earth, and its adaptability as a habitation for organic beings, but also absolutely in its effect upon the physical features of the Earth. This latter subject will require careful consideration in a separate chapter.

76 *River Basins.*—It will be at once evident that so far as rivers depend for their supplies on the direct accessions they obtain from surface water, the whole area of the land may be divided into districts, each of which, in consequence of the form of the enclosing high ground, conveys all the water that falls upon that district, either into a depression within its area forming a lake, or into a channel which conducts the water to the ocean. The whole Earth may thus be divided into ocean beds and river basins. Almost all the running waters or rivers of the globe of considerable importance, communicate directly or indirectly with the ocean, sometimes, indeed, passing through and being apparently lost in lakes, but ultimately flowing into that grand receptacle which has supplied the water, and which must again receive it. This is not, however, invariably the case, and thus we have oceanic and continental systems of river basins. These are both so important that we must now proceed to consider them in some detail.

It is a well known fact, frequently determined by actual experiment, that a much larger quantity of rain, *cæteris paribus*, falls on hills and high plains than on the lower plains, and hence it arises that the high table-lands and mountains of every district are even more directly concerned in the natural drainage than might at first be supposed, and thus it also results that the water-shed, or that line along high ground which determines the ultimate direction of the rain that falls, is an important element in such considerations as those we are now entering upon. If we look upon a map of the world, or a good globe, we find there must be natural divisions forming those groups or basins to which we have alluded, and which, as we have already remarked, are of two kinds, one communicating immediately with the ocean, into which the rivers empty themselves, which may therefore be called *oceanic river systems*, including each of them a number of rivers; and another, including what may be called *continental river systems*, forming large basins, in which the drainage is confined entirely or chiefly within continental tracts of land, without proceeding to the ocean. In every case, the springs, brooks, and rivulets whose waters contribute to the formation of a single river, and the land which is drained by these various water-courses, form the area of drainage, and the line inclosing this area forms the water-shed.

We proceed now to consider the principal river basins in various parts of the world, and these we may regard as forming eight distinct groups—namely, the groups of the Atlantic, Pacific, Indian, and Arctic Oceans; those of the Black Sea, the Mediterranean, and the Caribbean inland seas, the latter including the Gulf of Mexico; and the great continental groups, of which the chief is in Central Asia, where a number of rivers empty themselves into the Caspian Sea, the Lake of Aral, and the lakes in the eastern part of Central Asia, in the desert of Gobi, without reaching the ocean.

77 *River Systems in the Atlantic Group.*—The Atlantic group includes a considerable number of river systems of great importance, both in Europe, Africa, and America, and the following table gives a connected view of the extent and relative importance of those amongst them which are best known.

PRINCIPAL RIVER SYSTEMS IN THE ATLANTIC GROUP.

NAMES OF RIVER SYSTEMS.	Extent of river basin in square miles. (Geographical.)	In Geographical Miles.		
		Direct distance of river from source to mouth.	Extent of development of stream.	Extent of windings of stream.
I. EUROPEAN RIVERS.				
Neva	67,200?	315?	440?	128
Rhine	65,280	360	600	240
Vistula	56,640	280	520	240
Elbe	41,860	344	684	340
Oder	39,040	280	480	200
Loire	33,940	320	520	200
Dwina	33,440	280	560	280
Niemen (Memmel) .	32,180	240	460	220
Douro	29,250	260	440	180
Garonne	24,450	200	320	120
Seine	22,620	220	340	120
Tagus	21,760	360	480	120
Guadiana	19,360	240	420	180
Guadalquiver . . .	15,040	180	260	80
Weser	13,120	200	280	80
Minho	11,840	108	192	56
Pregel	5,920	60	100	40
Thames	5,000	112	192	80
II. AMERICAN RIVERS.				
Marañon (Amazons)	1,512,000	1518	3080	1562
La Plata	886,400	1028	1920	892
St. Lawrence & Lakes	297,600	8[illegible]0	1800	940
Tocantins	284,480	990	1120	130
Orinoco	252,000	368?	1352	984
St. Francisco . . .	187,200	872	1400	528
Paranahyba . . .	115,200	560	744	184
Essequibo	6[illegible],650	350	420	70
Delaware	8,700	180	265	85
Connecticut . . .	8,000	231	270	39

NOTE.—By the extent of development of a stream, is meant its length from source to mouth, including all its windings and turnings. This, compared with the direct distance between the source and the mouth, shows the amount of the windings, and enables us to determine the influence which the river exercises on its district. But to understand this, we have to consider not only the length of the principal channel, but also the surface extent of its tributary

Of the rivers mentioned in the above table, the *Rhine* takes its rise in the Alps from two principal sources; one of them on the north side of the St. Gothard, from a glacier at the height of 7650 feet, the other from the Rheinwald glacier, near St. Bernardin. The river has a rapid declivity to the Lake of Constance, on emerging from which, its bed is suddenly depressed at the celebrated falls of Schaffhausen, and the river then runs westward to Basle, whence, turning northwards, it is navigable to the German Ocean, being interrupted only in passing through the narrow defiles between Bingen and the town of Bonn. The chief tributaries to the Rhine are the Moselle, the Maine, the Necker, and the Meuse.

The *Elbe* rises on the western slopes of the Riesengebirge, from upwards of thirty springs, one of which has an elevation of 4500 feet, but the greater part of this river runs through a very flat country, and its estuary is encumbered by sand-banks.

The *Neva* is, with the exception of the Rhine and Rhone, the only important European river which is connected with considerable lakes. It rises in the hilly district extending between the Volga and the Dwina, and thence, under various names, proceeds northwards to the lakes Onega and Ladoga, entering the Gulf of Finland at St. Petersburgh. Although its river basin is of great extent compared with that of most of the European rivers, the Neva presents few points of interest in Physical Geography. The remaining European systems are also not remarkable for any physical peculiarities, and will be again alluded to in the Descriptive part of this work. The rivers of the British islands drain only small river basins, those of the Severn and Thames being somewhat smaller than that of Pregel; they also are chiefly interesting in reference to Descriptive and Political Geography.

It will be at once observed, on reference to the above table, that the river basins in the New World are enormously larger than those in the Old. The *Marañon*, or *Amazons*, alone, has for its area of drainage a district nearly three times as large as that of all the European rivers which empty themselves into the Atlantic; this vast river, the largest on the globe, is, in some places, six hundred feet deep, it is navigable more than two thousand miles from its source, and is nearly one hundred miles wide at its mouth. More than twenty superb rivers pour their waters into it, and the torrent that rushes from it into the ocean is borne along upon the surface in nearly a direct line, in spite of the currents that cross its course at right angles, its stream rendering the water perceptibly less salt than that of the ocean, at a distance of more than three hundred miles from the shores of America.

Although no river approaches in magnitude the gigantic Amazons, the river *Plata*, the fourth largest in the world in the extent of its river basin, and combining two important rivers, the Paraná and the Uruguay, is still worthy of more than passing notice. Like the Amazons, it receives at its affluence rivers which, in extent and magnitude, are of the first class. At Buenos Ayres, two hundred miles from its mouth, and along its whole course from that river to the sea, its breadth is never less than one hundred and seventy miles. It is subject to dreadful inundations, the Paraná, after the rains, rising every season and covering not less than 36,000 square miles of land. The water is exceedingly muddy, and can be traced in the Atlantic to a distance of two hundred miles from the coast of America.

The five next river systems of greatest importance in South America, the

---

channels. Thus, the direct distance of the Rhine is shown by the table to be 360 miles, or 80 miles more than the Vistula; the development of its course is also 80 miles greater than the Vistula, but its windings are less, notwithstanding that the area drained by the former is much greater than that by the latter river. This table, and the deductions here expressed, as well as other tables of like nature which succeed, are given on the authority of Mr. Johnston's edition of Berghaus's *Physical Atlas*. The measurements are in geographical miles, of which sixty are reckoned to a degree of latitude. The geographical mile contains 6086 feet, and the British statute mile 5280 feet.

Tocantins, the Orinoco, the Paranahyba, the Francisco, and the Essequibo, do not together drain a greater area than the Plata and its tributaries. The Orinoco is, however, interesting for another reason than its extent, as it exhibits in the upper part of its course the very rare example of a natural canal, uniting it with another great river system. This canal, called the Casiquiare, connects the Rio Negro with the Orinoco. Its length is 120 miles direct distance, or 176 including the windings, and its width is 100 yards where it branches from the Orinoco; but on approaching its junction with the affluent of the Rio Negro, which forms the connecting link of the two systems, it amounts to nearly 600 yards. In addition to this curious network complicating two great and distinct river systems, the Orinoco in its detours follows such a direction that the course of the stream is apparently turned, and although the general direction of the stream is north-east, its mouth is found almost in the same meridian as some of its sources.

The largest of the North American river systems communicating directly with the Atlantic (that of *St. Lawrence,*) is much more remarkable for the great chain of lakes through which it passes than for any other phenomenon it presents. Of the 297,600 square miles which it drains, no less than 94,000 are covered with water, and the river runs through these lakes, bearing different names, and resembling rather a series of lake straits than any continuous stream. Of these lakes, the largest is Lake Superior, whose length is 400 miles, and mean depth 900 feet, and the smallest (with the exception of Lake St. Clair) is 100 miles in length and 500 feet deep. The Lake Superior is the westernmost of the whole chain, and is the largest body of fresh water in the world. It discharges its waters through the strait of St. Mary into Lake Huron, which receives also the waters of Lake Michigan, the next in magnitude to Lake Superior. The waters of Lake Huron (which is 240 miles long and 100 feet deep,) pass into Lake Erie, and thence, by the Niagara River, into Lake Ontario, forming in its course of 33½ miles the celebrated Falls of Niagara. The River St. Lawrence, which drains all these lakes, is not known by that name till after passing Montreal, but then, forming a broad estuary, it enters the Gulf of St. Lawrence, at Gaspé Point, by a mouth more than 100 miles in width. The other principal rivers of North America, belonging to the Atlantic group, offer nothing especially worthy of remark in this place.

The depression occupied by fresh water in the great lakes of the St. Lawrence system in North America is a phenomenon of considerable importance in the physical geography of this part of the globe. The principal lakes, Lake Superior, Lake Michigan, and Lake Huron, have a mean depth of nearly 1000 feet, and cover an area of 75,000 square miles; their surface is considerably less than 600 feet above the sea, and thus their bed has a mean depth of more than 400 feet below the level of the ocean. Lake Ontario, whose elevation above the sea is only 230 feet, but whose depth is 500 feet, presents to us another area of 6300 square miles, 270 feet below the sea level. This remarkable depression is paralleled by one other similar case, that which has been observed to the east of the Mediterranean, where the Dead Sea occupies a hollow more than 1000 feet below the sea level, and the whole interval between the Caspian Sea and the Lake of Aral is a depression from which the ocean has been recently drained.

In addition to the rivers already described as emptying themselves into the Atlantic, we have also several on the coast of Africa. There are some of them more important, and connected with larger river basins than the largest of those occurring in Europe, but they are much less completely known. The largest of them is the *Quorra*, or *Niger*, which, though not so extensive as the Nile, has, in all probability, a more extensive river basin. It is supposed to rise in about 9° N. latitude and 9½° W. longitude; but there are probably more sources than one of so extensive a stream. It flows along a course of as much as 2300 miles, and receives many very large affluents. The current of the river is moderate, and offers no impediments to navigation, and the river flows through more than one considerable lake. The *Senegal*, 850 miles in length, which drains two lakes and an extensive district, is the next largest river on this coast; and the *Gambia*, whose course is estimated at 600 miles, is also connected with a river basin of great extent. The *Gareep*, or *Orange River*, near the thirtieth parallel of S. latitude, has a long course through the table-lands of South Africa; and the *Zayre*, or *Congo River*, is a very important stream. Both the latter are, however, too little known, either with regard to the length of their course, or the extent of the country they drain, to enable us to offer tabular statements resembling those given above of the European and American streams.

78 *River Systems of Inland Seas opening into the Atlantic.*—Let us next consider those river systems which empty themselves into the great inland seas of the Atlantic Ocean. The general facts concerning them are given in the annexed table:—

Name of River.	Area of the river basin in square miles.	Direct distance of river in miles.	Extent of development of river.	Extent of windings.
Mediterranean Group.				
Nile	520,200	1320	2240	920
Po	29,950	232	352	120
Rhone	28,160	218	560	352
Ebro	25,100	268	420	152
Euxine Group.				
Danube	234,080	880	1496	616
Dnieper	169,680	548	1080	532
Don	168,420	408	960	552
Dniester	23,040	360	440	80
Group of the Gulf of Mexico and Caribbean Sea.				
Mississippi-Missouri	982,400	1412	3560	2148
Rio del Norte	180,000	1220	1840	620
Magdalena	72,000	560	828	268
Motagua	7,040	196	260	64

Of the river systems of the Mediterranean group, that of the *Nile* is by far the most remarkable, from the great regularity and importance of the annual inundations in the lower part of its course, which fertilize Egypt. The absence of permanent streams as affluents for the last 1200 miles of its progress to the Mediterranean is also a remarkable fact. At its entrance into the Mediterranean, this noble river expands into a delta, which has been for a long period rapidly and steadily increasing. The sources of the Nile have been the objects of research to scientific travellers, and it would seem that one of its two principal head-streams rises in the table-land of Abyssinia, but the other is supposed to take its origin in the Mountains of the Moon. As it enters Egypt, the Nile runs in nine or ten cataracts or rapids, over a succession of terraces; but these cataracts of the principal stream are not so remarkable as those of the Tecazze, one of its tributaries.

The *Po*, draining a very considerable area of Northern Italy, is chiefly remarkable for its torrents and the delta at its mouth. It rises on the eastern side of Monte Viso, about 6000 feet above the sea, and is a rapid and irregular stream.

The *Rhone* rises in the Rhone glacier, 5500 feet above the sea. After passing through the Lake of Geneva, it enters France, and passes southwards into the Mediterranean. It is a very rapid stream, flowing at the rate of 120 feet per minute.

The *Danube* rises in the Black Forest at an elevation of 2850 feet above the sea, and running through the plains of Bavaria, it receives the two important rivers of the Isar and the Inn, proceeding from the Tyrolese Alps. For a considerable part of its course, it flows in a narrow valley, between two mountain ridges; but, after passing Vienna, it proceeds through open flat plains, except where in the celebrated defile of the iron gate, it crosses the eastern continuation of the great Alpine chain. It enters the Black Sea by no less than seven mouths, passing through an extensive swampy district, forming a delta.

The *Dnieper* and the *Don*, as well as the *Dwina* and the *Volga*, have their sources in low, flat districts, and present nothing remarkable in their course. The *Dniester* rises on one of the declivities of the Carpathians, and after running with a rapid current, and with a considerable body of water during the whole of its course, enters the Black Sea by a small delta.

The American rivers emptying themselves into the inland seas of the Atlantic are, like those which enter directly into that ocean, far more important in their magnitude and the extent of their drainage, than those of the Old World. The *Mississippi*, taken with its tributaries, forms the largest river system in North America, and one of the greatest in the world. The parent stream receives in its course two rivers, the Missouri and the Ohio; the first of which, coming in from the north-west, greatly surpasses the Mississippi itself, while the other is also a gigantic river, and the largest of its eastern affluents. The Missouri rises in two branches within a mile or two of the sources of the Columbia, and runs for 3000 miles before it joins the Mississippi; it is a very rapid river in the whole of its course, and itself receives several important affluents. The average velocity of its current may be estimated at $4\frac{1}{3}$ miles per hour, but in times of freshets, is accelerated to $5\frac{1}{2}$ miles per hour. The Mississippi has its source in two small lakes, about 1500 feet above the level of the sea, in latitude 47° 10′ north, and longitude 96° west. It runs through Lake Winnipeg, and flows with great velocity, forming several small falls. Before the waters of the Missouri mingle with it, it receives the St. Peter's river, the Wisconsin, the Illinois, and other streams, and its valley is bounded by high bluffs, intersected by deep ravines. After the junction of the Missouri, the course of the united stream becomes gentle, and the valley more open; and in its progress towards the Gulf of Mexico, it continues to receive very important rivers, of which the Arkansas and the Red River are those which have the longest course; the mouths of the Mississippi project far into the Gulf of Mexico, in a long and very remarkable delta, on which is built the city of New Orleans. Near its mouth, this vast river becomes a rapid, desolating torrent, loaded with mud. Its violent floods, produced by the melting of snow in high latitudes, sweep away whole forests, rendering the navigation very dangerous; and the trees matted together in masses many yards thick are floated down, and at length deposited over the delta and in the Gulf of Mexico, in an area of many hundred square miles.

The *Rio del Norte* is the largest of the Mexican rivers, but is too full of rapids to permit of any kind of navigation for a great part of its course. It rises in 40° north latitude, near the sources of the Arkansas, and of the Rio Colorado. Like many other of the great rivers of the world, it is subject to occasional freshets, but these do not extend to its lower course.

The *Magdalena* and the *Motagua* drain, the former, the north-western extremity of South America, the latter, the promontory of Yucatan. The Magdalena rises in the central chain of the Andes, and receives several streams in its course; the Motagua rises in the mountains near Guatimala, and flows into the Gulf of Honduras.

79 *The River Systems of the Arctic Ocean.*—The following table expresses, as far as they are known, the important facts connected with the Arctic system of rivers:—

Names of River Systems.	Extent of river basin in square miles.	Direct distance of rivers from source to mouth.	Extent of development of streams.	Extent of windings of streams.
Asiatic Rivers.				
Obi	924,800	1276	2320	1044
Yenesei	784,530	1228	2800	1572
Lena	594,400	1280	2400	1004
Kolyma	107,200	440	800	208
Dwina	106,400	380	864	484
Indigirka	86,400?	560?	908?	348
Olenek	76,800	600	1000	400
Anadir	63,360?	...	...	...
Petchora	48,800	360	600	240
Mesen	30,580	...	...	...
N. American Rivers.				
Mackenzie	441,600	964	2120	1156
Saskatchevan . . .	360,000	924	1664	740
Churchill	73,600	668?	848	180
Albany	52,800	380	560	180

Of the Asiatic rivers that empty themselves into the Arctic Ocean almost all are, as will be seen, of great magnitude and extent, but the nature of the country over which they pass, consisting for the most part of dreary plains, and the northern declivities of extensive table-land, conspires to render them almost useless for the support of vegetation, and therefore for the abode of man. The *Obi* and the *Irtish*, forming together the largest river of the Old Continent in the extent of its drainage, if not of its development, has so small an absolute elevation when it leaves the Altai mountains, from which it takes its rise, that for a distance of one thousand two hundred miles it has a fall of only four hundred feet, and although the bed of the river is very deep, the current is necessarily slow, and its banks are readily and constantly overflowed, forming immense marshes characterising a large part of Siberia.

The *Obi* is the most westerly of the three great rivers of Siberia, and the *Yenesei*, which drains the district to the east of the basin of the Obi, is little inferior in the magnitude of its basin, and has even a greater extent of development; some of its branches, which are numerous, have a very rapid course, but below Irkuktsh the current gradually decreases in rapidity. At its mouth, this river enlarges into an estuary twenty miles wide, and more than two hundred miles long. In its upper course, it passes through the Lake of Baikal, the largest and most remarkable of all the mountain lakes.

The *Lena*, the most easterly of the Siberian river systems, takes its rise from mountains a little to the west of the Lake of Baikal, and thence proceeds first in a north-easterly and then in a northerly direction to the sea. It is navigable for a considerable part of its course, receiving a number of important tributaries, and terminates in an extensive delta traversed by several arms of the river, three of which are navigable. Both it and the Yenesei are frozen near their mouths for nearly nine months of the year. The other rivers of Asia, emptying themselves into the Arctic Ocean, are of inferior extent and importance.

The *Mackenzie* is the largest river system which contributes its waters to the Arctic Ocean in the western hemisphere. It is formed by the union of several small streams, each designated by its own name, which rise on the eastern slopes of the Rocky Mountains, and after passing through Athabasca Lake, form Slave River, which again on leaving Great Slave Lake is called the Mackenzie.

The *Saskatchevan* rises with two branches in the Rocky Mountains, and these uniting at a distance of four hundred and fifty miles from their sources, run through Lake Winnipeg, and thence continue under the name of the Nelson River, into Hudson's Bay. The *Churchill* is another stream nearly parallel, passing through and draining several lakes, and at length terminating, like the Saskatchevan, in Hudson Bay.

80 RIVER SYSTEMS OF THE PACIFIC.

NAME OF RIVER.	Extent of river basin in square miles.	Direct distance of rivers.	Extent of development.	Extent of windings.
ASIATIC RIVERS.				
Amour	582,880	1200	2380	1160
Yang-tse-Kiang . .	547,800	1550	2880	1312
Hoang-Ho	537,400	1150	2280	1160
Tche-Kiang . . .	99,200	480	960	488
AMERICAN RIVERS.				
Columbia	194,400	576	1360	784
Colorado	169,200	512	800	288

The river systems of the Pacific Ocean are, as will be seen, of very great extent and importance in the drainage of Asia, but running through a territory so jealously guarded as China, very little is known of the country through which they pass. The *Hoang-Ho* and the *Yang-tse-Kiang* have their sources and their mouths in very close approximation, both rising in the extensive terraces on the eastern slope of the table-land of Central Asia, and emptying themselves into the sea between latitudes 32° and 35° N. These rivers are tidal to the extent of four hundred miles from their mouths, but they bring down with them a vast quantity of mud, which they deposit chiefly at the entrance of the Yellow Sea. They are separated during a great part of their course by a mountain ridge, which serves as a water-shed for a distance of several hundred miles.

The *Amour*, the third important river of Asia, empties itself into the Pacific by the Sea of Okhotsk. It rises in the Russian dominions, but runs for the greater part of its course through China; and there passes through a number of lakes, receiving many unknown and hitherto unnamed rivers, which take their rise from the edge of the great table-land of the Gobi. The *Tche-Kiang* system drains the tract of country south of the Yang-tse-Kiang, and its most important stream is best known under the name of the *Cambodia* river. This river, after traversing elevated plains, where it is navigable, rushes through the mountain barriers which border these plains, and crossing a wide valley, enters the Gulf of Siam by three principal arms.

The only important river of North America which contributes its waters to the Pacific Ocean is the *Columbia*, or *Oregon*, which rises in the most rugged steeps of the Rocky Mountains. It forms many rapids and cataracts, and is only navigable as far as Point Vancouver, a distance of about one hundred miles, to which point the tide reaches. The Colorado descends from the south side of the water-shed in latitude 41°, from the north side of which many of the tributaries of the Columbia take their rise, and after a considerable course enters the Gulf of California, traversing a country almost entirely uuknown.

81 River Systems of the Indian Ocean.

Name of River.	Extent of river basin in square miles.	Direct distance from source to mouth.	Extent of development of streams.	Extent of windings of streams.
Ganges, including Bramahpootra	432,480	824	1680	856
Irawady	331,200?	1100	2200	1028
Indus	312,000?	900?	1960?	864
Menam	216,000?	620?	940?	320
Euphrates	195,680	600	1492	892
Godavery	92,800	510	748	360
Kistna	81,600	410	688	228

Of these rivers it may be stated generally, that although the Ganges and Bramahpootra drain the largest area, the *Irawady*, which waters the Birman empire, and falls into the Bay of Bengal, and whose sources are in the same chain of mountains with those of the Bramahpootra, has both a longer direct distance and a greater extent of development. Its course, however, for the first eight hundred miles, is through couutries not familiar to Europeans, although it is known to pass through a noble and rich plain, contaiuing no less than four capital cities. From the city of Ava to its delta, which is very extensive, and presents fourteen principal channels, the river is more than four miles broad, but is encumbered with islands. It receives several important affluents.

The *Ganges* and *Bramahpootra* form a remarkable double system of rivers, whose sources are at great distances, but which converge to a common delta at the head of the Bay of Bengal. The Ganges commences at once in a very rapid stream, not less than forty yards across, proceeding from a huge cavern, in a perpendicular wall of ice. Thence it flows in a south-easterly direction through the plains of Bengal, receiving in its course a multitude of tributaries, of which no less than twelve are more considerable than the Rhine. The Bramahpootra takes its rise in the north of the Birman empire, probably from the eastern extremity of the Himalayan chain, and after wiuding for five hundred miles through Upper Assam, it enters the plains of Bengal and unites with the Ganges, about forty miles from the coast. The united delta of the two streams commences two huudred and twenty miles in a direct line from the Bay of Bengal, and extends for more than two hundred miles along the coast. The volume of water discharged by the Bramahpootra during the dry season is not less than 150,000 cubic feet per second, while that discharged by the Ganges, in the same time and under similar circumstances, is only 80,000. The quantity of mud brought down by the joint stream through the delta, in the wet season, is not less than 600,000 cubic feet (20,000 tons) per second, and the Sunderbunds, an innumerable multitude of river islands, forming a wilderness of jungle and forest trees, mark the extent to which such alluvial mud has been accessory in producing the present appearance of the mouths of these rivers.

The *Indus* and the *Sutlej* take their rise in the Snowy Mountains at the western extremity of the Himalayan chain, and both, fed by streams of melted snow from the northern side of this chain, flow westwards along the extensive valleys of Thibet. The two streams unite in the Punjab, and thence to the ocean the Indus does not receive a single accessory, but passes through a sterile desert. It empties itself into the ocean by a considerable delta, 60 miles in length, and occupying 120 miles of coast.

The *Euphrates* and *Tigris* form together the only important river system in Western Asia. The former rises in the heart of Armenia, and after running over a great extent of table-land, descends in rapids through the Taurus Mountains to the plains of Mesopotamia. The Tigris rises further to the east, and after piercing the same chain of mountains at Mosul, descends also to the plains of Mesopotamia. The two streams unite near the city of Bagdad, after which they run 150 miles, in one stream, to the Persian Gulf.

82 *Rivers not communicating with the Ocean.*—It now only remains to consider those rivers which, terminating in great inland seas of fresh water, and not proceeding thence to the ocean, form complete systems of drainage, entirely confined to the interior of extensive tracts of land. Examples of this kind occur in Africa and America to a small extent, but are nowhere so remarkable as in Central Asia, where nearly 1,200,000 square miles of country are drained by six river systems, three of which run into the Caspian, two into the Sea of Aral, and the sixth into a comparatively small lake, north of the great desert of Gobi. Another tract, nearly equal in extent to half this area, and continuous with it, appears to have a multitude of streams, which are either lost in small lakes after proceeding for a short distance, or disappear entirely in the great sandy deserts which they traverse.

Of these rivers, the *Volga* drains an area of nearly 400,000 square miles, and, with the exception of the Danube, has the largest volume of water of any river in Europe. The extent of its development amounts to 2400 miles, and its source (in latitude 57° N.) is nearly 1000 miles from the Caspian Sea, into which it discharges itself by no less than sixty-five mouths. The other important river system terminating in the Caspian Sea (the *Ural*) rises in the southern Ural chain, in latitude 55° N., at an elevation of 2132 feet above the level of the sea. The whole course of the river, including its windings, is probably not less than 900 miles. It forms, for a considerable part of its course, the boundary line of Europe, and, towards the south, is enclosed by steppes, and flows in a bottom varying from half-a-mile to two and a half miles in width. It enters the Caspian by a small delta, the islands of which are covered with salt swamps.

The principal feeders of the Sea of Aral are rivers not inferior to the largest in Europe; one of them, the ancient *Iaxartes*, is, in the area which it drains, of somewhat greater importance than the Danube, and its development is not less than 1200 miles. It flows from the east, through a country tolerably fertile, especially near its mouth, but that fertility is confined to a narrow band, and is bounded by deserts perfectly arid. The other river, the *Oxus* of the ancients, now called the *Amori*, enters from the south. It drains nearly 200,000 square miles of country, has an extent of development of 1400 miles, and the direct distance from its source to its mouth is more than 800 miles. The only other important river in the continental system of Central Asia is that which empties itself into the small lake of Lob, proceeding from the west eastwards. Little is known of this district, but the area drained is estimated at 177,120 square miles, and the development of the stream at 1080 miles.

There are not wanting continental systems of drainage in the New World, but they are comparatively small and unimportant. In North America, a small area of this kind occurs between the Gulf of California and the Rio del Norte; and the elevated lakes of the great plateau of the Andes, between latitude 13° and 31° S., receive a number of streams which do not afterwards proceed to the ocean. The Lake Titicaca, the largest in the South American continent, occupying an area of about 4600 square miles, and its surface 12,800 feet above the Pacific, is the recipient of the streams of a considerable district; these proceed by the River Desaguadero to a distance of about 180 miles into a small lake, and are there lost. The Catalena Lake, the Tor Lake, the Blanca Lake, and others in the same plateau, offer similar examples on a much smaller scale.

CHAPTER VI.

ATMOSPHERIC AND AQUEOUS ACTION.

§ 83. General nature of atmospheric and aqueous action. — 84. Changes produced by atmospheric action. — 85. Changes directly effected by alterations of temperature and exposure to cold. — 86. Glaciers and icebergs. — 87. Changes produced by the eroding action of moving water. — 88. The transporting and distributing action of moving water. — 89. Changes produced by water acting by the aid of substances held in solution. — 90. Indirect effects produced by water.

GENERAL Nature of Atmospheric and Aqueous Action.—The action of the air loaded with a larger or smaller quantity of water, and constantly changing in temperature, and the incessant motion of water in its various forms, whether as it passes under ground and emerges in springs, or moves along the surface, conveying particles of solid matter and depositing them in some new place, produce, on the whole, a very great amount of change upon the Earth's surface, greatly modifying the physical features of the globe, and influencing those conditions essential to the well-being of animal and vegetable life. A consideration, therefore, of what may thus be called *atmospheric and aqueous action* is an essential part of Physical Geography.

The mechanical action of water exhibits results in several different ways; for in one part of the world we find the sea with its restless waves beating against the shore, constantly removing a portion of the coast, and depositing it as mud in the immediate vicinity; while in other places, rivers carry along with them a quantity of earthy matter, manifested by their turbid appearance, and this earthy matter cannot fail to be deposited where the progress of the river is checked as it passes through nearly level plains, or when its stream meets the ocean, and its course onwards is thus completely terminated. The water carries mud along with it, however, only for a limited time, and strictly in consequence of its being in motion. Whenever, therefore, that motion becomes slower, a portion of the mud is deposited, and where it is stopped, the remainder must necessarily fall. Thus a river sometimes terminates in a triangular area of mud, called a *delta;* sometimes banks of mud, greatly impeding navigation, extend transversely across the mouth of the river, and are thence denominated bars; while sometimes there exist only a multitude of narrow channels, none of them deep enough to be navigable at the entrance. Where neither of these conditions occur, the mud is generally removed to a distance by powerful marine currents.

The action of water is not unfrequently dependent on meteorological changes; and amongst the most powerful agents of decay in cold climates or on mountain summits, must be ranked the expansion that takes place in water shortly before and during the act of congelation. In this way it is that although in temperate and cold climates the quantity of rain falling may not of itself be sufficiently great to produce, by simple mechanical abrasion, any considerable removal of the soil, yet the severity of the frost and the inequalities of the temperature may more than compensate for this diminished source of degradation. Hence, among aqueous changes we have to consider also the phenomena of *glaciers* and *icebergs*, by whose means vast quantities of broken fragments of rock, often of large dimensions, are first removed from the parent rock, and then conveyed by the assistance of marine currents to very considerable distances. We have also to take into consideration the action of running water, as well directly and periodically by rivers, as occasionally by unusual floods. We have, too, to consider the effect of the sea upon coast lines, and of tidal and marine currents under various circumstances, whether these take place in the open ocean or in inland seas which communicate with the ocean. Lastly, a certain amount of chemical change is produced by water, either by acids contained in it, or by the affinity of water and of the gases which it holds in solution for the various substances it encounters.

84 *Changes produced by Atmospheric Action.*—There is a constant tendency in all decomposed or disintegrated substances to be removed by the agency of rains and superficial waters to a lower level than they previously occupied, and finally to be transported into the sea. There is no rock, not even the hardest, that does not bear some marks of what has been termed weathering, or of the action of the atmosphere upon it. The amount of surface-change so produced is exceedingly variable, depending much on local causes. Thus, one rock may undergo complete disintegration in a certain situation, though composed of nearly the same materials as another rock of the same kind, of which the change has been comparatively trifling. When we contemplate the present surface of our continents and islands, we cannot but be struck with the great effects that have been produced upon them by the agents commonly known as *existing causes;* and among these effects, the weathering and degradation of land are very remarkable, attesting a lapse of time far beyond the usual calculations. The tors of Dartmoor, Devon, may be referred to as excellent examples of the weathering of a hard rock. These are composed of granite, which, as Dr. McCulloch has observed, are divided into masses of a cubical or prismatic shape. 'By degrees, surfaces which were in contact, become separated to a certain distance, which goes on to augment indefinitely. As the wearing continues to proceed more rapidly near the parts which are most external and therefore most exposed, the masses which were originally prismatic, acquire an irregular curvilinear boundary, and the stone assumes an appearance resembling the Cheese-wring (Cornwall). If the centre of gravity of the mass chances to be high, and far removed from the perpendicular of its fulcrum, the stone falls from its elevation, and becomes constantly rounder by the continuance of decomposition, till it assumes one of the spheroidal figures, which the granite boulders so often exhibit. A different disposition of that centre will cause it to preserve its position for a greater length of time, or, in favourable circumstances, may produce a logging stone.' The weathering of these tors is so exceedingly slow, that the life of man will scarcely permit him to observe a change; therefore the period requisite to produce their present appearance must have been very considerable. The surface of the whole country round these districts attests the same great lapse of time. Whatever may be the nature of the rock, it is disintegrated to considerable depths; porphyries, slates, compact sandstones, trap rocks,—all have suffered; but the valleys appear to have previously existed, and the general form of the land to have been much the same as it now is.

This destruction of the surface is common to most countries; and if the rock so weathered be limestone, there is, not unfrequently, a reconsolidation of the parts by means of calcareous matter deposited by the water that percolates through the fragments, and which dissolves a portion of them. At Nice, the fractured surface thus reunited is so hard, that, if it occur on a line of road, it must be blasted by gunpowder for removal. There are some fine examples of this reconsolidation upon the limestone hills of Jamaica; as, for example, near Rock Fort, and at the cliffs to the eastward of the Milk River's mouth.

The felspar contained in granite is often easily decomposed, and when this is effected, the surface frequently presents a quartzose gravel. D'Aubuisson mentions that in a hollow way, which had been only six years blasted through granite, the rock was entirely decomposed to the depth of three inches. He also states that the granite country of Auvergne, the Vivarrais, and the eastern Pyrenees, is frequently so much decomposed, that the traveller may imagine himself on large tracts of gravel.

Some trap-rocks, from the presence of the same mineral, are so liable to decomposition, that there is frequently much difficulty in obtaining a specimen. The depth to which some rocks of this nature are disintegrated in Jamaica is often very considerable.

This decomposition is attributed to the chemical, as well as mechanical action of the atmosphere. The oxygen of the atmosphere produces considerable alteration in rocks, more particularly observed in those containing iron, which are thus often reduced from a hard to a soft substance. With the slow and quiet changes effected by electricity on the surface, we are very imperfectly acquainted, but most of us have heard of destructive effects during a thunder-storm, of shivered rocks, and of fragments hurled from the heights into the valleys beneath. In these electrical discharges, the lightning often fuses the surface of rocks. Thus, De Saussure found a compound rock on Mont Blanc fused on the surface, white bubbles being on the felspar, and black bubbles on the hornblende. Similar observations have been made by other geologists in other parts of the world.

At Peninis Point, St. Mary's, Scilly Islands, there is a curious example of that decomposition of granite which antiquaries have termed rock-basins, and considered the work of the Druids. The Kettle and Pans, as these depressions are there named, occur in the large blocks of granite on the top of this promontory; they are generally three feet in diameter, and about two feet deep; they are mostly circular and concave, but there are others much indented at the sides. 'Some have perpendicular sides and flat bottoms, some are of an oval form, and others of no regular figure. Many of the blocks are six or seven yards high, eight or nine yards square, and several of them have four, five, six, or more of these cavities in them. A large rock, near the extremity of this group, has two basins of an immense size, besides several smaller ones. The upper and larger one appears to have been formed by the junction of three or more large basins. It is irregularly shaped, and about eighteen feet in circumference, and six feet deep. When the water in this basin has attained the height of three feet, it discharges itself by a lip into a lower basin, more regularly formed, the back of which is about five feet high, but which is incapable of containing more than a depth of two feet of water, owing to the declivity of the surface of the rock.' As a proof that similar decomposition sometimes takes place on the sides of a block, the author above cited mentions an oval cavity, six feet long, five wide, and nearly four feet deep, thus situated.

There is scarcely a substance, which, having been exposed to the action of the atmosphere for a considerable time, does not exhibit marks of weathering. It will even be observed on cliffs of sandstone, in which the cement varies in induration or otherwise, producing the most grotesque forms, which must be more or less familiar to the least observing. Variations in temperature much assist the chemical decomposing power of the air.*

85. *Changes directly effected by Alterations of Temperature and Exposure to Cold.*—We have just seen how rapidly disintegration of solid rocks may take place by atmospheric agency, and it may readily be imagined that when during frost, and by a sudden and rapid decrease of temperature, the water which had percolated into and filled narrow crevices, formed near the surface by ordinary exposure, was at first diminished, and afterwards almost instantaneously increased in volume, the rocks would split asunder with irresistible violence, and thus the effect be greatly increased. Various mechanical results are derived both directly and indirectly in this way, since

---

* De la Beche's *Manual*, pp. 45—47.

not only are fragments split off from large masses of hard rock, but whole beds are altered in position, and way made for the subsequent removal of others of softer material, to which the running water of warmer seasons is now able to penetrate. On the shores of very cold seas, the cliffs are frequently formed more or less entirely of frozen mud, and the heats of summer generally tend to modify them, and even greatly reduce their dimensions, while on their reconstruction in the succeeding winter, way is made by the increase of crevices, both in number and extent, for the still further destruction of the whole mass.

All the changes and modifications produced by inequalities of temperature may, however, be regarded as destructive, effecting, even when the change is least marked, periodical removals of very large quantities of gravel and stones by the ordinary streams traversing a country, and in other cases tearing away enormous quantities of solid rock, and preparing them for further transport by rivers or ocean currents. It is only where the climate is more excessive than with us in England, that these modifications can be seen on a sufficiently large scale to attract general attention. In Russia, towards the mouth of the Dwina, there is an annual disturbance of the banks of that river, which is sufficiently extensive to be worthy of notice, for we find there long ridges or ledges of stones on the banks of the river about 30 feet above its summer level; the water, when at its height, penetrates into the chinks of thin beds of horizontal lime-stone, and in winter, becoming frozen and expanding, great disruptions of the rock occur, and stony fragments, often of large dimensions, are entangled in the ice. In the spring the fresh swollen stream inundates its banks, and so expands the water that the icy fragments are thrown up 18 or 20 feet above the level of the stream. In the course of five or six hours, the water will rise suddenly 14 or 15 feet, with the ice one compact mass upon it, and when the pressure increases, the ice is actually torn asunder, the crash that results resembling the roaring of artillery. What occurs on so considerable a scale in the river Dwina, and in other Russian streams, has been observed to a yet greater extent in Lapland, where granitic boulders, weighing several tons, have been seen suspended like birds' nests in the branches of pine trees, 40 feet above the summer level of the streams; and in Canada, on the St. Lawrence, as well as in the great rivers of Siberia, where the volume of the water is greatly more considerable, the changes of temperature more complete and more rapid, and where everything in nature is on a far grander scale, the consequences are still more marked. The packing of the ice in the St. Lawrence is a phenomenon of this kind, and when the broken ice is carried away by high tides in the spring, blocks of stone weighing many tons are frequently removed to a very considerable distance. The phenomenon of ground ice, however, or ice which, in spite of the expansion of water in freezing, remains entangled at the bottom of streams, proves that this action of water in the solid form is not confined to districts where the winter cold is excessive, but may extend even to such latitudes and climates as our own. Where, however, the circumstances are less unfavourable for the production of such appearances as in some of the Siberian rivers, large stones are occasionally lifted from the river bed by the ice amongst them, and thus may be floated along for a great distance. Among the results of packed and ground ice may be mentioned the removal of gigantic blocks of stone weighing very many tons, sometimes shifted several feet in a season by the American rivers.

86 *Glaciers and Icebergs.*—When in very cold climates, or in mountain districts of great elevation, the rocks are exposed to frequent change of temperature near the freezing point of water, there must of necessity be a very considerable destruction produced, and this so much the more as the rocks are less covered with vegetation, or a coating of soil or gravel. This will be at once admitted, if we consider the constant absorption of water into crevices, the expansion of the water, and consequent widening of the crevices, and the

ultimate splitting off by this mechanical degradation. No one who has not himself had the opportunity of witnessing such phenomena, can do full justice to their enormous extent and influence, and the mere repeated observation of the forms of the rock will not itself give an idea, since the forms originally produced by the causes here referred to are perpetually repeated, although the actual surface of rock itself observed, and perhaps sketched at one visit, is closely imitated by that presented at another. Glaciers have been well described by Professor James Forbes as 'icy streams moving downwards, and continually supplying their own waste in the lower valleys, into which they intrude themselves like unwelcome guests.' They act chiefly as mechanical agents, transporting to a distance, and preparing for further travel, a vast multitude of blocks of stone, fragments of rock, gravel, and mud, and are amongst the most powerful agents employed by nature for this purpose. The quantity is often so great as almost entirely to conceal the mass of the ice under the prodigious load which, during a long descent, is accumulated upon it, while the dimensions of the transported masses are often gigantic, one having been seen by Professor J. Forbes on the glacier of Viesch, 100 feet long, and 40 or 50 feet high, and another being described containing nearly a quarter of a million of cubic feet of green slate, which has been conveyed by the glacier of Schwarzberg, although this glacier has since retreated at least half a mile, leaving the intervening space covered with smaller blocks.

The dimensions of glaciers are, however, required to give some idea of the amount of result they produce; their number also, if it were possible to enumerate it, might assist us in this conception. In Switzerland, these remarkable bodies vary in length from a few hundred yards to as much as twenty miles, and in width extend sometimes to as much as three miles. They may be seen in almost all the principal and a vast number of the secondary valleys, and everywhere produce the same results and exhibit similar appearances.

But Switzerland, although it offers very interesting examples of glaciers and glacier action, which may be visited with convenience and described at leisure and in detail by the observant traveller, is neither the only nor the most remarkable. On the south-western extremity of South America, we find 'a range of hills only from 3000 to 4000 feet in height, in the latitude of Cumberland, with every valley filled with streams of ice descending to the sea-coast. Almost every arm of the sea which penetrates to the interior higher chain, not only in Tierra del Fuego, but on the coast for 650 miles northwards, is terminated by tremendous and astonishing glaciers; and in Eyre's Sound, in the latitude of Paris, not only are there immense glaciers, but about fifty icebergs have been seen at one time floating outwards, one of which was at least 160 feet in total height, and these were all loaded with blocks of granite and other rocks of considerable size, different from the clay slate of the surrounding mountains.'*

On the coast of Greenland, at Spitzbergen, and in other places in the Arctic Ocean, where the temperature of the water is below the freezing point of fresh water, and also along the whole line of coast of the Antarctic Islands, there are constantly broken off vast fragments of ice which float away into warmer climates, conveyed by marine currents.

Three kinds of accumulation of ice are met with under these circumstances —the vast expanse of frozen surface-water detached from the shore, forming what are called ice-fields; smaller fragments of these, denominated ice-floes; and the lofty and massive portions, really broken off from glaciers, being the icebergs of the cold seas. Each contributes to illustrate the power of water as an agent of change on the Earth's crust, but the ice-fields and floes convey little or no detritus to a distance. The icebergs, on the contrary, whether numerous and of small extent, as they are successively broken

* Darwin's *Journal of the Beagle.*

off in a sea warmer than the temperature of frozen fresh water; or allowed to swell into gigantic dimensions, as they creep along the sea-bottom, till the smaller specific gravity of this vast accumulation of ice, which is a little less dense than the sea water, causes a huge fragment to break off, and rise into an island—in either case abound with rocks and gravel.

The appearance and magnitude of such icebergs, in the Arctic Ocean, has been described as very variable, some having been seen aground in water three hundred fathoms deep, and others floating one hundred and twenty or one hundred and fifty feet above water, indicating a depth of nine hundred to one thousand feet, and a weight of not less than forty to fifty millions of tons. During the summer, round the shores of Cape Farewell, and throughout the year down Davis's Straits, these marvellous engines for distributing broken fragments of rock, course each other rapidly into the open ocean, and thence they proceed along the coast of America to latitudes as far south as that of Devonshire. By this time they have been most of them sufficiently broken and melted to lose their characteristic features, and gradually fade away from observation. From the Antarctic land similar drifts occur to still warmer latitudes, and very large floating bergs have been seen off the Cape of Good Hope, one of which is mentioned as having been two miles in circumference, and one hundred and fifty feet high, while others, if not of such great area, rose from two hundred and fifty to three hundred feet above the sea, and were therefore of great volume below.

The climate in high southern latitudes is, however, extremely severe compared with that of the northern hemisphere, since in Sandwich land, in latitude 59° S., corresponding in parallel to some parts of Scotland, the country was described by Captain Cook as covered many fathoms thick with everlasting snow, from the summits of the mountains down to the very brink of the sea-cliff, and this at the beginning of February, the hottest season of the year; and even in the island of Georgia, five degrees nearer the equator, or in the same parallel as Yorkshire, the line of perpetual snow descends to the level of the ocean. Still further towards the Antarctic Pole, as in the sixtieth parallel of south latitude, the temperature of the summer months ranges between 11° Fahrenheit and the freezing point of water, so that throughout the wide range extending from the two poles of the Earth half-way to the equator, there is a constant deposition of gravel and rock, removed and conveyed by the agency of ice. This although chiefly known in its effects in the northern hemisphere, must be far more considerable in reality towards the south, since the most southern glacier, which comes down to the sea in Europe, is nearly twelve hundred and fifty miles nearer the pole than those which are found on the west coast of South America; but evidence is not wanting of enormous results in that part of the world also, gigantic boulders occurring in the islands of Tierra del Fuego, on the high plains of Santa Cruz, and on the island of Chiloe, associated with a great unstratified formation of mud and sand, containing rounded and angular fragments of all sizes. In the vast ocean along which these bergs and islands of ice are conveyed, there must be distributed an enormous deposit of such materials, which are continually added to and occasionally reach the surface, as the undulations of the Earth's crust present new surfaces to the denuding and levelling power of the waves.

87 *Changes produced by the eroding Action of moving Water.*—Running water, whether the occasional result of rain recently fallen, and making its way to some continuous stream, or consisting of the stream of water itself in its progress to the ocean, exercises partly by simple attrition, and partly by the abrasion of sand carried along by it, a very considerable mechanical action. This action is twofold, either being of the nature of erosion, or the eating out a channel for the progress of the water, or else involving the deposit of mud and stones, tending to fill up the bed of a river, a lake, or an estuary. The waves of the sea beating upon a coast, whether produced by wind or by tidal

action, also produce a considerable amount of destruction, and marine currents eat out, from time to time, very large quantities of matter from the sides and bottoms of the channels through which they run, especially when these are soft, or when the current is rapid or steady. The eroding power of running water is sometimes seen in connexion with great floods in different parts of the world, as well as in ordinary river streams and marine currents, but the power is chiefly manifest in the beds of streams. A few facts, illustrating the nature of the results, will be interesting and instructive.

The rapidity with which even the smallest streams hollow out deep channels in soft and destructible soils, is well exemplified in volcanic countries, where the half-consolidated ashes present but slight resistance to the torrents which flow down the mountain sides. Sir C. Lyell mentions some interesting examples of this kind in his *Principles of Geology*, (seventh edition, page 200, *et seq.*) Amongst them he states, that after the eruption of Vesuvius in 1824, heavy rains produced streams of water, which, in three days, cut a new chasm through strata of tuff and ejected volcanic matter, to the depth of twenty-five feet. He also quotes the case of the Simeto, the largest of the Sicilian rivers, which, in the course of about two centuries, has eroded through lava a passage from fifty to several hundred feet wide, and in some places from forty to fifty feet deep. A remarkable instance of the force of water eating its way through a very considerable thickness of rock is mentioned also by Sir Thomas Dick Lauder, in his account of the great floods of Morayshire, in August, 1829. He states, that in one spot, the river Dorback, which before the floods swept round a conical-shaped hill, in a course of seven hundred and thirty yards, leaving a narrow neck of clayey gravel not more than a hundred feet in thickness, had nearly breached its way, but that, during the floods, the whole of the neck of land was likely to be destroyed. In order to save this, the river was assisted in its operations by human agency, and by one blow of a pick-axe the barrier, reduced to a dam of a foot thick, and just of a sufficient height to sustain the water, was burst at once. In the course of fifteen or sixteen hours, the channel was converted into a wide and complete river course, and within four-and-twenty hours the river had worked its way back to the depth of eight feet below the level of its old bed, now a dry channel. By the next February, the new channel was twenty feet below the level of the old river bed.

By far the most striking example, however, of this action of water, and of the progressive excavation of a deep valley in solid rock, is seen in the river and Falls of Niagara. The river flows over a flat table-land, in a depression of which Lake Erie is situated: where it issues from the lake it is nearly a mile wide, and is three hundred and thirty feet above the level of Lake Ontario, into which it empties itself at a distance of about thirty miles. For the first fifteen miles the surrounding country is almost on a level with its banks, and the river glides along with a clear and tranquil current, falling only fifteen feet in as many miles. Approaching the Rapids, it rushes over a rocky and uneven limestone bottom, and is then thrown down perpendicularly one hundred and sixty-five feet into a ravine, varying from two hundred to four hundred yards in width, and from two hundred to three hundred feet in depth. The river continues through this gorge in the table-land, for a distance of about seven miles, and the table-land then terminates in a long line of inland cliff facing towards Lake Ontario. On emerging from the gorge, the river proceeds, for the rest of its course, into Lake Ontario, through a flat country, nearly on a level with the waters of the lake. In this case, the structure of the rocks which form the table-land is such as to render it perfectly clear, that the falls have gradually receded from the escarpment, or cliff of the table-land, to their present position, and that they must, in the course of time, reach the upper lakes. When that is done, the water will have worn for itself a complete channel, not much unlike some of those water-worn ravines met with in other countries, the result of similar mechanical force acting at an earlier period of the Earth's history.

The mechanical action of water on exposed cliffs is sometimes very strikingly illustrated, as well directly on the rock exposed to the ceaseless dashing of the waves, as indirectly when rocks are undermined, and then fall by the action of gravity. Of the former, innumerable examples are to be found along almost every extended coast line in the world, while the undermining action, if not so widely traceable, is in many cases much more effectual.

The prevalence of strong westerly gales coming in from the Atlantic, and driving large waves upon the north-western coast of the British Islands, has broken the hard rocks of the Shetland Islands and those on the west coast of Scotland into deep caves and lofty pinnacles, so that almost every promontory ends in a cluster of rocks, the fragments of the former land. A sublime scene of this kind is described by Dr. Hibbert as occurring in the Shetland Islands, in what is called the Grind of the Navir, where a mural pile of porphyry, left as the last rampart against the inroads of the ocean, has been breached through in spite of its extreme hardness by the repeated assaults of the waves, and the breach is widened every winter, large stones being separated from its sides, and carried along to a distance of as much as 180 feet. The fantastic forms that are observed in the isolated granitic rocks in the whole of this district are due to the devastation thus produced, and the islands at first separated from the main land, and afterwards torn to pieces in this manner, must ultimately be carried away to form new beds at the bottom of the deep ocean.

On the east coast of Scotland, although more sheltered, the waves have produced great devastation; and in Yorkshire and Norfolk, the wearing of the coast has proceeded to a very considerable extent, even within such time as the position of towns and villages on the coast is recorded by historical documents.

Almost the whole coast of Yorkshire, from the mouth of the Tees to that of the Humber, is in a state of general dilapidation; and it is only at a few points that the grassy covering of the sloping talus marks a temporary relaxation of the erosive action of the sea. The chalk cliffs are worn into caves and needles in the projecting headland of Flamborough, and between that promontory and Spurn Point, the waste is extremely rapid, while Spurn Point itself threatens some day to become a mere island; in which case, the ocean entering the estuary of the Humber, must cause great mischief.

In old maps of Yorkshire, many spots are marked as the sites of towns and villages, which have long since disappeared. Several towns of note, upon the Humber, are now only recorded in history; and a port which was so considerable in 1332, that Edward Baliol and the confederate English Barons sailed thence to invade Scotland, and which in 1339 was selected by Henry the Fourth to land at, to effect the deposal of Richard the Second, is now represented by an extensive range of sands, dry at low water. In Norfolk, also, the decay of the cliffs is incessant and rapid. Between Weybourne and Sherringham it was computed, in 1805, that although the sea was gaining upon the cliffs, a period of seventy years would be required for the sea to reach the spot where an inn was built. In the year 1829, however, only a small garden was left between this building and the sea, seventeen yards having been swept away within the previous five years. At one point in the harbour of Sherringham, there was a depth of twenty feet in 1829, where forty-eight years previously there had been a cliff fifty feet high, with houses upon it. On the same coast, also, and near the same spot, several villages have disappeared, and large portions of parishes on the coast have been swallowed up. A little further to the south, a village has been partly swept away during the present century; and the town of Dunwich, which is now a small village, without the vestige of any better condition in former times, was once the most considerable port on this coast. Other parts of the east coast of England, and the mouth of the Thames, exhibit similar phenomena; the Goodwin Sands being, doubtless, a remnant of land once projecting beyond the chalk cliffs of the Kentish coast at Ramsgate, while the cliffs themselves, a little further to the south, are continually and rapidly being removed. Without dwelling farther on these accounts, which, however, are not only interesting but highly instructive as exemplifying important physical changes, we may conclude, so far as the British islands are concerned, by mentioning, and with some respect, the reports universal in the south-western extremity of our island, of a tract of land having extended beyond the present Land's End in Cornwall for a distance of nearly thirty miles to the Scilly Islands, though the intervening channel is now 300 feet deep. Accounts of the fragments of ancient pottery, and even portions of houses brought up by dredging, certainly lend some show of probability to this tradition, even if they cannot be regarded as altogether conclusive.

It may well be imagined, and is certainly the case, that our own coasts are not the only ones subject to great alteration from the beating of the waves, and the ceaseless inroads of the sea. The power of water to destroy a coast line, is even more distinctly exemplified where the coast is low and flat, as in the case of Holland; for there large tracts of land, and whole islands, have been removed at a single inundation; and in one case no less than seventy-two villages were overflowed in one season, (in 1421,) thirty-five of which were irretrievably lost and disappeared for ever, their place having been since permanently occupied by a sheet of water, called the Bies Bosch.

The bed of the Zuyder Zee, also, was in the time of Tacitus a portion of the mainland, only partly covered with fresh water, but the sea has entirely obliterated the former isthmus, which is now changed into a water passage, more than half the width of the straits of Dover, the breach being first completed about the year 1282, and afterwards widened. The important delta of the Rhine, although rapidly increasing in some places by the continued accumulation of solid matter, is thus greatly checked and interfered with by the ocean, which removes, in many cases, in a very short time, what has perhaps taken very many years to be deposited. Of all the United Provinces, Friesland and Groningen have suffered and continue to suffer most from these floods. Exposed to the full rage of the north, north-west, and west winds, the waters of the angry Atlantic and Polar seas rush towards these provinces, pour through the inlets of its barrier-reef—the Helder (Hels-deur—hell's door), the Vlie, and the more northern gates—heap themselves upon the inland Zuyder Zee, burst or overtop its dykes, and spread themselves over the country, sometimes to the very borders of Hanover. On these occasions thousands of men and cattle perish, the gates of the barriers become widened, and the dominion of the inland sea enlarged.

Thus, in 1230, a hundred thousand men perished, chiefly in Friesland. In 1277, the tract of land which now forms the Dollart, was swallowed up. In 1287, the Zuyder Zee was enlarged, and eighty thousand persons destroyed, with cattle innumerable. In 1395, the passage between Vlieland and the Texel and Wieringen became so widened, that large ships could sail to Amsterdam. In 1470, twenty thousand men were swallowed up, nearly all in Friesland; and in 1570, an equal number in that province alone. In the latter year, the water rose six feet above the dykes, covered even higher parts of the country with seven feet of water, and in Groningen destroyed nine thousand men and seventy thousand cattle. In 1686, it rose eight feet above the dykes, destroyed six hundred houses, dug the dead out of their graves, and converted Friesland into one wide sea. The seventh Christmas flood, in 1717, caused still wider damage in these northern provinces, burst through most of the dykes, laid the town of Groningen several feet under water, and destroyed twelve thousand men, six thousand horses, and eighty thousand sheep and cattle. And the struggle has not even yet ceased; for when the winds and floods conspire to increase the volume of water over the horizontal tract near the river's mouth, no human agency can prevent the destruction that must ensue.

In other parts of Europe, history records invasions of the sea not less extensive and scarcely less disastrous than those from which the Netherlands have so often suffered. Thus, in the eighth century, a tract of land was carried away on the north-west coast of France, near Mont St. Michel, and connecting that high land with the main coast; and in the Bay of Biscay the sea has in some places advanced so as to have destroyed a breadth of two miles of coast within a century.

At the head of the Adriatic there was a town anciently called Adria, and said to have been built on the sea shore by a leader of the ancient Etruscan race, about the time of the Trojan war. The present town, standing on the rubbish of two others, is now nearly sixteen miles from the nearest mouth of the river Tartarus, probably the oldest bed of the Po, and now terminating six miles within the farthest point of land projecting into the sea. Of late years, in making excavations at the depth of several feet below the present surface of the town, a former level was found, with numerous fragments of Etruscan and Roman pottery; and at a still greater depth, a second floor, where all the earthenware fragments proved to be Etruscan alone, and there were vestiges of a theatre. (?) In these facts, both the raising of the soil and progress of alluvial deposits are demonstrated, in waters but little disturbed by marine currents, and within a space of 3000 years.

Many other points on the coast of Europe would give abundant evidence of similar kind, but these are sufficient to prove how extensively the eroding power of water may assist to modify, not only a coast line, but the country to some distance inland.

On the shores of the two Americas, in various places, we have evidence of change to an enormous extent. The tidal waves and the marine currents have thus acted on the north-western coast, and the vast extent of sandy alluvial territory from the Gulf of Mexico to the summit of Long Island appears as if it were a late deposit, in part the debris of the Mexican and Caribbean portions of the continent, carried north, and thrown off when the Gulf Stream was formed. At the mouth of the Mississippi, the sea, of small depth along the whole coast, continues to recede before the delta of the river; and the Florida and Carolina shores, northward, form a series of lagoons on the ocean side. The stream rushes onwards in a north-east direction, and with a gradually decreasing velocity and temperature, (though both are still very perceptible off New York,) until it is finally neutralized at Nantucket, and the last particles of deposit suspended in it are precipitated to form the banks of Newfoundland. A continent torn asunder and washed away could alone furnish the immense alluvial surface and submarine banks here noticed. The rivers of the United States and Canada are not of a nature to have added more than feeble deltas, such as that of the Hudson at Sandyhook.

The shores of the Arctic Ocean between Asia and America and the intervening shallow sea offer proof of recent incursions of the sea in this part of the globe, and under circumstances where the change from other causes is likely to be rapid. There can be little doubt that the breach between the two continents, if not actually made, has been, at least, greatly widened by the action of currents setting southwards from the Polar Sea.

The mere action of the waves at the mouths of the great rivers both of Asia and America is unquestionably very considerable, but it belongs rather to the transporting and distributing action than the mere destructive force of this agent, and this will come under consideration in the next section.

It is sufficient now to remark, that all over the world there is a perpetual destruction of every exposed fragment of solid matter, and that, in this way, the modification of coast lines has been large, even within the narrow limits of human and recorded observations.

88 *The Transporting and Distributing Effects of Moving Water.*—The running waters of a river convey along with them the particles removed from their immediate banks, and the country over or near which they pass; and the quantity of matter thus carried along, and consequently the rapidity with which it may form such deposits, varies with the length of its course,

the volume of its waters, the nature of the country through which it flows, the velocity of its own upper current, the quantity of rain which falls in a given time in the regions from which its waters come, and the violence or rapidity of descent with which they fall from the heavens. Thus, a thousand gallons of the waters of the Oxus, when in flood, are said to hold in suspension two hundred and fifty pounds of mud (Burnes); of the Yellow Sea, fifty pounds (Staunton); of the Ganges, twenty-two pounds (Everest); of the river Wear, in flood, sixteen pounds (Johnston); of the Mississippi, six pounds (Riddell), and of the Rhine, at Bonn, two-thirds of a pound, according to Mr. Horner.

There is, no doubt, considerable uncertainty as to the absolute correctness of these numbers. They show, however, that the transporting power of rivers varies very much, and is sometimes much greater than we should have supposed or could anticipate. Even the small proportion of matter brought down by the Rhine is equal to 146,000 cubic feet of solid matter in twenty-four hours; so that, in two thousand years it would form a bed of rock three feet thick and thirty-six miles square. It is by this sediment that the low banks of the Rhine, where it is beyond the reach of the tide, have been gradually raised and numerous channels filled up, and by these means also the islands at its mouth have been in great part formed.

Such is the origin of alluvial soil, properly so called, and in this way are produced those rich sea-bordering clays, whose fertility is such as to induce men to risk disease in swampy climates, and expend unwearied toil in snatching them from the watery dominion, and defending them by huge dykes, which are too often destroyed by the subsequent incursions of the sea.

This transporting power of water is, of course, seen chiefly in those rivers which bear down to the sea a considerable volume of water from high mountain districts. Many of the European rivers possess the required conditions, and produce by their deposits very considerable additions to the land or the adjacent bed of the ocean, and amongst them the river Po may be mentioned as having within the last few centuries frequently changed its course, causing great devastation. This river has also produced great accessions of land in that portion of the Gulf of Trieste in which it and the Adige (to which its delta is now united) empty themselves. The rate of increase of this delta is now, and has been for some time, much more considerable than in the middle ages, the mountain torrents having become more turbid since the clearing away of the forests of the Alps, and the waters being so far confined by artificial embankments that they no longer spread over the plains, and leave there the great accumulations which they have obtained in their course, but convey everything at once to the sea. It is calculated that the mean rate of advance of the delta of the Po, between the years 1200 and 1600 was about twenty-five yards per annum, but that the mean annual gain from the latter period to the present time has been as much as seventy yards. The delta of the Rhone offers another interesting example of the rapid increase of land at the mouth of a river within the historic period, and at the same time the partial filling up of a great lake. The Rhone, entering the Lake of Geneva at its upper end, is turbid and discoloured, but at the town of Geneva, where it passes out of it, is beautifully clear and transparent. As there is no perceptible current in the lower part of the lake, it is manifest that the mud and sand brought in by the river must be deposited; and as a proof that this deposit chiefly takes place at the head of the lake, we find there an ancient town, built by the Romans, which was once situated at the water's edge, but now, after eight centuries, is more than a mile and a half inland. But the Rhone receives tributary streams, bearing with them a large quantity of sediment, after it has passed Geneva; and thus, besides partially filling up that lake, it carries with it into France, and at length leaves in the Mediterranean, a very large quantity of mud and silt. There are many documents which prove that the base of the delta has advanced into the Mediterranean very considerably within the last eighteen centuries, Places which are described as islands a thousand years ago, and harbours constructed at that period, are now from three to six miles from the sea, and even a tower erected on the shore so lately as the year 1737, is already a mile remote from it.

The delta of the Rhine is, however, much more considerable than that of either of the rivers hitherto mentioned, and exhibits abundant proof of change by the increase of certain parts of it, and the constant shifting of the channels through which the river flows. The occasional encroachments of the sea, and the still further removal of the mud brought down by the river also tend to alter the delta. The present head of the delta of the Rhine is about eighty miles from the general coast line of that part of the continent, and forty miles from the Zuyder Zee. The whole of Holland, without exception, is on the delta of this river, and the thickness of the mud accumulated is very considerable, although the nature of the deposit varies a little at different depths. Many islands have been destroyed, new straits and estuaries formed, and the coast line greatly altered by the sea within a comparatively short period near this important stream. The Danube and the Nile afford other examples of the same kind and on even a larger scale. The delta of the former river occupies an immense area, its two extreme channels being distant from each other eighty miles; but the case of the Nile is still more remarkable, its delta occupying, with the lagoons, an area of 20,000 square miles, within which are contained all the cultivated lands of Egypt. The form of this delta, as described by the ancients, is, however, exceedingly different in almost every respect from that which is now to be observed, and the magnitude is also very different. It has always consisted of a perfectly level plain, nowhere offering the smallest natural elevation, with the exception of a few sand dunes near the sea. The soil of the delta is everywhere formed by the alluvial matter brought down by the river, and this each year is covered by a fresh coat when the annual inundation spreads over the land.

But considerable as are the deltas of these European and African rivers, those of Asia and America are still more remarkable. The Ganges and the Bramahpootra have been already mentioned as entering the Bay of Bengal through a considerable tract of country entirely formed by the mud which these rivers have brought down from the mountain country and the plains which they drain. The delta of the former of the two rivers, which is now continuous with that of the latter, extends for 200 miles between the two principal arms of the Ganges, which bound it on each side. When the river is low, the tide extends even to the head of the delta, a distance of 220 miles, in a direct line from the coast, but when swollen by the tropical rains the velocity of the stream is sufficiently great to counteract the tidal current, so that the movements of the ocean are altogether subordinate to the force of the river. We have thus during different periods of the year two distinct operations produced by the action of water. During the flood season, the delta increases greatly in height and area, while during the rest of the year the ocean scours out the channels and removes very extensive alluvial plains. The amount of deposits necessarily depends on the quantity of mud held in suspension by the waters of the river, and as in almost all respects the Ganges is favourably situated for receiving and conveying to the ocean very large quantities of transported material, the rate of increase might be expected to be, and is, more considerable than in almost any other river. In point of fact, the average quantity of solid matter suspended in the water near the mouth of the river during the rainy season has been estimated by Mr. Everest to amount to $\frac{1}{428}$th part by weight of the water discharged. As the number of cubic feet of water discharged per second in the four rainy months may be estimated at half a million, it is easily shown by calculation that during the hundred and twenty-two days of rain, upwards of six thousand millions of cubic feet of mud must proceed down the river and be deposited in or near the delta. It is difficult to form any notion of the true meaning of numbers so large; but in order to assist the imagination, Sir C. Lyell has estimated that this quantity of solid matter is equal in weight to fifty-six and a half times the great pyramid of Egypt if that were a solid mass of granite.* It will also assist the reader to form an idea of this quantity to know that if a fleet of eighty Indiamen, each freighted with fourteen hundred tons weight of mud, were to sail down the river every hour of every day and night for the four months continuously, they would only transport from the higher country to the sea a mass of matter equivalent to that actually conveyed by the waters of the river. It is probable that the waters of the Bramahpootra convey annually as much solid matter to the sea as those of the Ganges, but the delta is not so considerable.

The river Mississippi also exhibits on a very large scale examples of the power of running water, both in filling up lakes and forming an extensive Delta. The superficial dimensions of the true delta of this gigantic river amount to as much as about 14,000 square miles, and the quantity of solid matter annually brought down by the river is nearly four thousand millions of cubic feet. As the mean depth of the deposit of mud and sand is upwards of 500 feet, it would thus appear that the whole area might have been formed as we see it now in a period of about 67,000 years, but the delta is itself only a portion of the great alluvial plain in which it is placed, and this plain has also been formed by the sediments of the river, and must have required at the same rate more than 33,000 years for its accumulation. Sir C. Lyell has well observed, in reference to this subject, that the whole period during which the Mississippi has been transporting its earthy burden to the ocean, though, perhaps, far exceeding 100,000 years, must be insignificant in a geological point of view, since the bluffs or cliffs bounding the great valley, and therefore older in date, and which are from 50 to 200 feet in perpendicular height, consist in great part of loam containing land, fluviatile and lacustrine shells, of species still inhabiting the same country.

The Mississippi is remarkable not only for its delta, but also because in various parts of its long course, some considerable lakes are now in process of formation, while others are being rapidly drained. The most considerable example of the former phenomenon occurs in Louisiana, in the basin of the Red River, where Lake Bistineau, as well as several others, have been formed by the gradual elevation of the bed of the river, in which the alluvial accumulations have been so great as to raise its channel, and cause its waters during the flood season to flow up the mouths of many tributaries, and convert parts of their courses into lakes. Sometimes these lakes are merely reservoirs, alternately emptied and filled in the dry and flood seasons; but in other cases, some natural or artificial obstacle prevents the efflux of the water, and produces a permanent lake. The Lake Bistineau, already mentioned, is of this kind: it is upwards of thirty miles long, and has a medium depth of fifteen to twenty feet. Numerous cypress trees are seen even in the deepest parts, still standing erect under water, although they are now dead, and the tops of most of them are broken by the wind. It is indeed possible that subterranean movements may have assisted in the production of some of these lakes, but the causes mentioned appear to be the most important.

89. *Changes produced by Water acting by the Aid of Substances held in Solution.*—Springs of water charged with calcareous or siliceous matter may, under some circumstances, produce an effect by no means inconsiderable, especially in volcanic districts. Although, therefore, the total amount of the results thus produced is not very great, their local extent renders them worthy of a passing notice.

Auvergne, in central France, offers an example of calcareous incrustations and deposits from springs, which have formed an elevated mound of white

* The base of this pyramid covers eleven acres of ground, and its perpendicular height is about 500 feet.

limestone, two hundred and forty feet long, and at its termination sixteen feet high, and twelve wide. Tuscany presents other examples of the same kind; so that in some places of considerable extent the ground is completely coated with deposited rock of this kind, and sounds hollow beneath the feet. The river Elsa, a tributary of the Arno, flows through a valley several hundred feet deep, of which the whole containing district is of the same recently formed rock.

At the baths of San Vignone and San Filippo, also in Tuscany, springs issue of warm temperature, containing salts of lime and magnesia; and deposits of calcareous matter of very great thickness, occur in the immediate vicinity: one stratum of many layers, used as building stone, having a thickness of fifteen feet, and a portion of the main deposit descending in a different direction to the rest, being more than two hundred and fifty feet long, and sometimes two hundred feet deep. It is then cut off abruptly by a small river, so that a much larger quantity of calcareous matter than that deposited has evidently been removed to the sea.

Other streams, as in the Azores and the volcanic island of Iceland, consisting of greatly heated water, contain, held in solution in the water, a very large quantity of silica, and, indeed, more or less of this mineral is probably present wherever there is any quantity of the salts of soda in solution.

The silica in water is sometimes, but rarely, deposited, like the calcareous matter, in layers, producing chalcedonic masses, which often resemble stalactitic and stalagmitic incrustations, but more frequently it assists in cementing various materials aggregated together, and thus forming stone from loose sand and the conglomerates and breccias of various districts.

90 *Indirect Effects produced by Water.*—In addition to these examples of the direct action of moving water, in conveying to a distance fragments broken off from cliffs, or displaced by the more gentle action of rivers, it is worth while to notice, before concluding this chapter, some less direct results of aqueous action which assist greatly in producing change. Land-slips in which considerable tracts fall away from a coast by the undermining action of water are phenomena of this kind, but they have reference rather to the structure of the Earth than to the actual mechanical force of waves and currents. In the year 1839, an extraordinary occurrence of the kind took place on the coast of Dorsetshire, between Lyme-Regis and Axmouth. The cliffs here consisting of chalk, reposing first on sandstone, and then on loose sand, have for their ultimate basis extensive beds of clay, shelving towards the sea. Numerous springs of water, the drainage of the surrounding country for a considerable distance inland, came out along the shore, and in the course of an exceedingly wet season, so much of the sand had been removed, that a considerable portion of the cliff was partly undermined, and on the morning of the 24th of December, in the year mentioned, a crashing noise was heard, succeeded by numerous fissures opening in the ground, until a deep ravine was formed, extending nearly three-quarters of a mile in length, with a depth of from a hundred to one hundred and fifty feet, and a breadth exceeding two hundred and forty feet; and, after a short time, an elevated ridge was formed more than a mile in length, and forty feet high, by the pressure of the descending rocks producing an extended reef in front of the present range of cliffs.

PART II.

THE STRUCTURE OF THE EARTH.

CHAPTER VII.

THE CONDITION OF THE INTERIOR OF THE EARTH AND THE REACTION OF THE INTERIOR ON THE EXTERNAL SURFACE.

§ 91. Means of obtaining a knowledge of the Earth's interior. — 92. Internal temperature of the Earth as determined by deep sinkings. — 93. Thermal springs. — 94. Volcanoes. — 95. Volcanic products. — 96. Distribution of volcanoes. — 97. Subterranean connexion of distant volcanoes. — 98. Connexion of volcanoes with earthquake action. — 99. Nature of earthquake movements. — 100. Frequent repetition and wide range of earthquake action. — 101. Permanent change of level accompanying earthquake action. — 102. Origin of earthquakes. — 103. Partial, but permanent, elevation at a distance from volcanoes. — 104. Depression over large areas.

MEANS of obtaining a Knowledge of the Interior of the Earth.—We have now considered in succession various phenomena connected with the Earth's surface, including the atmospheric and watery oceans reposing on the land, and also some of the mechanical results of the mutual action of the different forms of matter presented to us: we have next to describe the condition of the Earth's crust, or, in other words, to give an account of the actual solid substance of so much of the superficial coating of our globe, as it is possible for us to become acquainted with, either by direct observation or fair induction. The observations required are of various kinds, but cannot, under any circumstances, have reference to such a depth from the mean level of the surface, as will justify us in assuming with certainty the condition of the great mass of the interior of the Earth. Since, however, we have in nature many opportunities presented to us for determining the Earth's structure for a depth of at least several miles, owing to the fact that various portions have been thrust up from beneath by subterranean force; and that by natural crevices and fissures in various rocks and by artificial sinkings to obtain mineral produce, by regarding the structure of cliffs, both marine and inland, and by marking the nature of soils and their relations with the underlying rocks, we have many means of determining facts as to the materials of this crust and their mode of arrangement, it becomes a very essential part of Physical Geography to consider the state of the interior of the globe in various parts of the Earth, whenever observation will allow us to do so.

92 *Internal Temperature of the Earth as determined by Deep Sinkings.*—Whenever there has been an opportunity by sinkings made to any considerable depth below the Earth's surface to determine the temperature, it has been found that while at the surface, the mean annual temperature is more or less widely departed from in different parts of the year, according to local circumstances, this variation becomes less and less considerable as we descend; so that after a time we arrive at a certain point, to which the heat of summer, and the cold of winter, do not in any degree penetrate, but the thermometer shows throughout the year the same point—namely, the mean annual temperature at the surface. This point is at different depths in various parts of the Earth. In the torrid zone, under the equator, it is often

not more than a foot from the surface, in our own climate it is from sixty to sixty-five feet; and thus connecting such points beneath the external surface of the Earth, there is also an imaginary surface or stratum of invariable temperature, above which the seasonal changes are felt, but below which any observations that can be made must be supposed to have reference to the absolute temperature of the Earth.

It is not, however, necessarily the case that we can, from such observations, judge of the true condition of the Earth at great depths. The vast period of time during which the sun has been shining upon our globe, and communicating, in whatever way, heat as well as light; the amount of chemical change unquestionably going on beneath the surface, excited by terrestrial magnetism; and other causes, of whose mode of action we know indeed but little, but which are not the less certain and important, and which certainly produce great molecular change:—these may have been sufficient to produce a certain amount of heat, which, however slowly it is propagated through so bad a conductor as the materials of the Earth's crust, may in the lapse of time have given to the mass, at least to some considerable distance in depth, an absolute temperature much higher than even the mean annual temperature of the tropics. Bearing in mind this possibility, it may be mentioned, as the general impression and belief amongst those who have investigated most carefully the facts of the case, that the internal heat below the stratum of invariable temperature, may really be considered as a guide to the condition of the interior of the Earth; and when, therefore, we find, as we do, that in descending below this stratum, the temperature gradually rises, increasing pretty regularly for some distance at the rate of 1° Fah. for every forty-five feet of depth, there appears reason to suppose that at a comparatively small distance from the surface of the Earth towards its centre, there must be heat sufficiently great to reduce to a state of fusion even the most refractory of those masses which present themselves as rocks at less considerable temperature. Assuming that the increase continues regularly in the same ratio, we should reach the boiling point of water at about two miles depth, and at a depth of twenty-four miles we should arrive at the melting point of iron. Now, when we consider that the Earth's diameter is nearly eight thousand miles, we shall see how little it is possible to judge of the state of the interior, even with the assistance of the conclusions drawn from such observations as have been mentioned; but it should be observed that the experiments upon which these conclusions depend are very numerous, and have been very carefully made, and depend not merely on such deep sinkings as are connected with mines, but also on Artesian borings, in which the temperature of the water is found to be constant, and seems entirely derived from passing through the strata of the Earth.

The experiments alluded to, do not exhibit a result absolutely uniform; the increase of temperature is by no means the same for the same depth, even in mines in the same district; and while the mean rate of increase in six of the deepest coal mines in Durham and Northumberland is one degree Fah. for a descent of forty-four English feet, it appears to be only one degree for every sixty-five feet in some of the deep mines of Saxony; while in others, in the same district, it was necessary to descend thrice as far for the same amount of increase. In Cornwall, careful observations, continued for eighteen months in the Dolcoath mine, at the depth of 1380 feet, gave as the rate of increase one degree for each seventy-five feet; but in other mines, in the same district, very different results are obtained.* On the whole, there is no doubt, from the irregularities manifested in every extensive series of observations, both in the absolute and relative increase of the internal heat of the

* In Ireland, observations made in the Knockmahon copper mines, in the county of Waterford, the increase, after making every allowance for the vicinity of the sea, was found in 774 feet, to be only at the rate of one degree for nearly 82 feet. It was found that the temperature was slowly diminishing, and remained more considerable in the lode than in the containing rock.—*Report of British Association for* 1844, p. 221.

Earth at considerable depths, that up to the present time, no general law can be considered as applicable, and therefore no general conclusion can be safely arrived at. Even the fact of the diminishing rate of increase for equal increments of depth, although apparently true of depths not exceeding 150 fathoms, has been called in question by Mr. Henwood, whose observations, extending over a considerable number of very deep mines, appear to have established the fact, that after 150 fathoms the ratio alters, that depth appearing, in Cornwall, to present a limit to the continued increase of temperature in the same ratio. It also appears to be the case in the mining district in question, that this depth in the mines hitherto worked (and in which, therefore, such observations were made,) is also the limit of the principal masses of metalliferous deposits, and thus arises a possibility of this minimum of ratio being, after all, nothing more than a local peculiarity, owing to the mode of distribution of metals and metalliferous ores.

93 *Thermal Springs.*—The temperature of water obtained by artificial boring has nowhere amounted to more than 82° Fah., and in this case, at (Grenelle, near Paris,) the depth being about 1800 feet, the rate of increase below the surface of invariable temperature showed 1° for 60 English feet; but very much higher temperatures than this occur in the water of springs in various parts of the Earth. In England we find, at Bath, water rising through crevices in stratified rock at the temperature of 66° Fah. In Germany, the springs at Töplitz, Ems, Aix-la-Chapelle, Wiesbaden, Carlsbad, and Borset, (Lower Rhine province,) exhibit temperatures of 71°, 81°, 85½°, 108°, 117°, and 121½° respectively; the mean annual temperature at the surface in these districts being not far from 50°. At Baden-Baden, where the mean temperature is somewhat higher, the hottest spring shows a temperature of 96½°, and at Buda, near Presburg, in Hungary, there are springs of 93½° and 95¾° respectively. In the north of France, at Plombieres, there are springs whose temperature is 95¼°, and others near Chaumont of 80°. Further south, near Aurillac, there is a spring showing 118°; and at Neris, in the department of the Allier, one of 89½°. At Thuez, in the Pyrenees, water rises at the temperature of 111½°, and at Ax, near Tarascon, 108°. In Italy, in Piedmont, there is a spring showing 107°, and at Abano, near Padua, one of 121°. The baths of Nero have a temperature of 121°; at Coquinas, in Sardinia, the water attains 98°; and in Ischia there are springs whose highest temperature is 94½°. At the base of Mount Olympus, there is a group of thermal springs, the water of one of which raises the thermometer to 113°; while in Iceland, and in other places more directly adjacent volcanic disturbances, it is not unusual to find permanent springs of nearly pure water within a few degrees of the boiling point, and even in some cases above it. These springs, for the most part, have been flowing without change for a very long period, and occasionally afford good evidence that during several centuries they have remained permanently at the same temperature, the quantity of the water also proceeding from them with undeviating regularity. This quantity varies of course exceedingly in different springs, amounting sometimes to several hundred thousand cubic feet per day, and in others being much more limited. In many, the water is charged with a sensible proportion of saline ingredients, but in others it is perfectly pure. The fact of there being so many localities, in different and distant districts, pouring water from the bowels of the Earth having a temperature higher than the mean temperature of the atmosphere at the surface, is sufficient proof that there are very widely acting causes of a uniform nature far beneath the surface, and that these causes may tend to elevate the temperature at those more considerable depths to which man has not been able to penetrate.

It would be improper to omit in this account of the phenomena of thermal springs some notice of these magnificent fountains of boiling water to which the name of Geysers is applied, and which burst from funnel-shaped hollows in the lava plains near Mount Hecla, in Iceland. The great eruptions of this fountain seem to take place once in about twenty-four or thirty hours, but not with any regularity, the discharge being greatly affected by the eruptions of the neighbouring volcano, and the periods having frequently undergone great change. The eruption is described by Krug von Nidda as being preceded by a hollow rumbling sound, and a number of explosions, accompanied by a violent quivering motion in the ground. The author then states, that 'having been driven from the spot by this movement, he turned at a little distance, and beheld a thick pillar of vapour shooting like an arrow to the clouds, and surrounding a body of water, which rose with a fluctuating motion to the height of eighty or ninety feet, some portions of the fluid rising even above this, or streaming in arches from the cloud. Sometimes the steam divided, and exhibited the aqueous column shooting upwards in innumerable rays, spreading out at the top like a lofty pine, and descending in fine rain; at other times it closed in thicker darkness round the centre, veiling it from the eyes of the spectator. The eruption continued about ten minutes, when the water sank down into the pipe, and the whole was again in repose, the basin being completely empty, and the water far down in the pipe, and slowly ascending.'*

With regard to this subject of thermal springs, it is right, however, to make the same qualified remark as that offered at the close of the last section. In some places, the temperature of natural springs proceeding from considerable depths beneath the surface is not greater than the temperature of the surface, and in some instances is even lower. If we take the case of all those springs which may properly be termed thermal, that is, of which the water is somewhat warmer than the mean annual temperature of the air at the surface, we shall find that whilst many of them occur in districts which now present no indications of what are generally considered volcanic phenomena, on the other hand, there are scarcely any, if any, volcanic districts in which hot springs do not abound. Many of those districts, however, in which no volcanoes now appear are really and very distinctly marked by volcanic phenomena of ancient date, while the rest are almost all of them either at the foot, or in the midst of some partially elevated tracts or mountain chains. Such mountains we shall have to prove in a future chapter are connected very directly with igneous action, often on a much larger scale than is manifested in volcanoes themselves. Even where this is not the case, there are still some geological phenomena indicating, although more distantly, such fractures and dislocations as result from igneous action.

94 *Volcanoes.*—The connecting link between thermal springs and eruptions of mixed gaseous fluid and solid substances, from conical elevations called volcanoes, is considered by Humboldt to be traceable in the so-called *Salses*, or mud volcanoes, of which examples occur in various districts, and which combine a number of phenomena bearing upon the general question of the condition of the Earth at some distance below its surface. One of these mud volcanoes was first formed about twenty years ago on the shores of the Caspian Sea, near Baku, and in this instance flames blazed up to an extraordinary height for the space of three hours, and during the following twenty hours rose about three feet above the crater, from which mud was ejected, while enormous fragments of rock were hurled to a great distance around. But such a condition of activity is rarely seen in mud volcanoes, which more usually consist of small mounds from eight or ten to thirty feet high, having small basins on their summits, from which mud (generally cold) and gaseous eruptions, accompanied by noise, are more or less constantly issuing. For fifteen centuries, a Sicilian Salse, near Girgenti, has been in this inferior stage of activity; and many others of the same kind are described in other parts of the world; the temperature of the mud, and of the gases erupted, being often higher than the mean annual temperature of the district.

True volcanoes are phenomena very different in kind, as well as enor-

---

* Krug von Nidda, Karsten's *Archiv.*, ix. 247. See the account of Iceland, Greenland, and the Faro Islands, in the *Edinburgh Cabinet Library*, 1840, p. 59.

mously greater in extent, and we may consider that they involve in every case a more or less continuous but permanent communication between the interior of the Earth, or some large cavity, and the atmosphere, and although such communication may be interrupted for months, years, or even centuries, it may afterwards recur with all its original energy. When traces of the first eruption exist, the volcano generally appears to have risen from the middle of a more extended area of circular or elongated form, elevated so as to form a cup-shaped cavity or crater, and an isolated cone presents itself in the centre of this, having at its summit a similar small hollow, also called by the name of crater. As offering a tolerably complete exhibition of volcanic agency, there are, perhaps, no more interesting and instructive examples than those of Santorin in the Greek Archipelago, and Kilauea in the Hawaiian (Owyhee) or Sandwich group of islands. The former, thirty-six miles in circumference, exhibits the form of a large and broken submarine crateriform mountain, in parts of which volcanic activity may be constantly observed. The latter presents the only well-marked instance on our globe of a large deep pit open to the sky, having clear bluff walls for the greater part of its circuit, with an inner ledge or plain raised above the bottom, which consists of solid lavas, with some cones of considerable size, and some pools of lava in a state of constant and active ebullition.

A more detailed account of both these indications of volcanic activity would prove very useful, in enabling the student to comprehend the sequence of volcanic phenomena, but the limits to which we are confined will not allow of this digression, and we can only quote the following notice of the Volcano (as it is called) of Kilauea, on the southern declivity of the table-land of Hawaii, whose elevation is eight thousand feet above the sea, and which occupies the centre of the island, measuring fifty miles in length, from south to north, and forty miles in its broadest part. Near the edges of the table-land are three volcanoes, the highest of which, Mouna Kea, is 13,587 feet above the sea, and is now extinct. It is near the eastern declivity, and is opposed by Mouna Roa, which is near the south-west corner, and is 13,175 feet high, and not in a state of very recent activity, but exhibiting an ancient crater not less than twenty-four miles round. On the western edge of the table-land is Mouna Huararaï, whose height is estimated at 10,000 feet, and which is now active. On the southern slope is situated Kilauea, which is a depression below the general surface of the slope of somewhat irregular shape, with almost perpendicular sides. The elevation of the slope, where this vast pit occurs, is 3873 feet above the sea. The steep descent to the crater is interrupted by two narrow plains or ledges, one of which is 715 feet below the upper surface, and the other about 100 feet. The surface of the volcanic lakes is forty-three feet below the last-mentioned ledge. The crater contains two lakes, the smaller of which is almost circular and nearly 1000 feet across—the larger is more than 3000 feet long, and in one place 2000 feet wide. These lakes are vast caldrons of lava, in a state of furious ebullition, sometimes spouting up to the height of twenty and even seventy feet. The fiery waves run with a steady current at the rate of nearly three miles and a quarter per hour to the south, enter a wide abyss, and ultimately pour into the sea. This remarkable volcano has, from time immemorial, been prodigiously active, though it has not, within the memory of living men, been known to overflow except in 1787, when a dreadful eruption took place, which lasted seven days.

There are few other instances of this kind on the globe, in an active state. On the surface of the moon there are strictly analogous appearances, represented on a much larger scale, some pit craters having been described, which measure from 5 to 150 miles in diameter, and 5000 to 24,000 feet in depth.

While this simmering and boiling of molten rock, and the formation of a crater, is carried on in the large caldron-like pits just described, other results of volcanic action are illustrated by the formation of conical hills, either in the blister-like swelling of a considerable area, or the rapid accumulation or eruption of a single mountain. Thus, we find recorded by Humboldt, a very striking instance of such subterranean movement, in the production of the district and mountain of Jorullo, in the plains of Malpais, which form part of the plateaux of Mexico. These plains are a hundred miles distant from the sea-coast, and 2500 feet high, and are bounded by basaltic mountains. No active volcano is near, and the whole occurrence presents a view of one of the most extraordinary physical revolutions recorded in the history of our planet; for it is rare, indeed, that man has an opportunity of seeing so extensive a change commenced and concluded within a period of time so short as that of the ordinary duration of human existence.

What took place at Jorullo has occurred in former times on an infinitely grander scale, not only in those districts where groups of volcanoes now pour forth fire and melted rock, but in a vast number of other places where this fire has long since spent itself. The phenomena of volcanoes must be considered, then, in reference to those which are extinct, as well as those now active; and the distribution of volcanoes becomes of interest, not only with reference to the present land, but to the form of the Earth's surface at all antecedent periods. We have already mentioned, that volcanoes are grouped in two forms, the one consisting of circular areas, in various parts of which true volcanic cones arise; the other, consisting of linear groups, sometimes continuous for very great distances. The former are exemplified in the case already given of Jorullo; the latter, involving the loftiest and the most remarkable phenomena of this kind on the globe, will require separate notice, the eruptions that take place from them being on a grander scale, and involving more complicated results.

A volcanic eruption generally commences with subterranean noise, and this is succeeded by dense columns of smoke, impregnated with various gaseous substances, often intermixed with a large quantity of aqueous vapour. Then follow showers of ashes, sometimes accompanied by large masses of rock, which are vomited forth with fearful noise and with enormous force. While these substances are thus being expelled from the hollow cup-like cavity at the summit of the cone, which terminates the volcano, melted rock (lava) at the same time issues either from a breach in the side of the crater, or from some fissure opened on the sides of the mountain. The order of the phenomena is not indeed invariable, but this may be considered as a general account of an ordinary eruption. In those cases in which the volcanic cone rises above the snow line, the heat of the mountain immediately before an eruption is often so considerable, that the snow melts with extreme rapidity, so that the eruption is preceded by torrents of water, often destroying houses, estates, and even whole towns, at a great distance from the volcano.

95 *Volcanic Products.* — To illustrate the true nature and relative importance of these different products of volcanic action, it may be worth while to consider separately the three very distinct kinds which may be designated as gaseous, including smoke and aqueous vapour; solid, consisting chiefly of ashes often in a minute state of division; and liquid matter, consisting of that molten rock so well known under the name of lava. Vivid sheets of flame have been frequently seen during volcanic activity, rising to a great height in the air. Many such appearances of flame are indeed considered by Humboldt as being due to reflections from burning matter projected high in the air during the eruption, and to ascending vapours illumined by the fire within the crater itself, rather than to true flame arising from the combustion of hydrogen. In some cases, however, as at Baku, there seems no doubt that columns of flame have risen to a sufficient height to be visible to a distance of twenty-four miles.

Under ordinary circumstances, the quantity of steam given off in puffs during an eruption is very considerable, and takes place at intervals of from twenty to thirty seconds. The greater part of the vapour consists of pure water, but gases are also erupted at the same time, consisting partly of carbonic acid gas, but including chlorine, nitrogen, sulphuretted hydrogen, and sulphurous acid. Sulphuric and muriatic acids, together with common salt and muriate of ammonia, are mixed occasionally with the pure water. The quantity of products of this kind that are thrown out in a single eruption are certainly very large, but cannot possibly be estimated; for, in many instances, such substances continue to be erupted for a very long period, especially in the case of volcanoes of moderate elevation, which thus seem to connect themselves with those instances of almost perpetual activity already described. The ashes ejected during eruptions differ greatly in every respect, not only in quantity, but also in the mode of eruption, being sometimes reduced to such extremely fine dust, that when thrown into the air, they rise through several successive strata of the atmosphere, in quantity sufficient to be transported by various atmospheric currents to almost equal distances, in different and even opposite directions, while at other times they fall back at once upon the volcano, assisting to raise its cone to a still greater height. In the latter case, the ashes are generally of moderate dimensions, and one third of the height of Mount Vesuvius is composed entirely of such material. Examples are not wanting in various parts of the world of the conveyance of fine dust from volcanoes to distances which would be incredible, if the testimony upon which they are recorded were not beyond all question; and, indeed, the cases are now so numerous, that although far from being easily explained, the facts must be taken as bearing upon the most important questions connected with volcanic activity.

As one of the most recent examples of this transport of fine dust through the air, and one which, although sufficiently extraordinary, is among the least marvellous on record, we may mention here, that on the 2nd of September, 1845, at nine o'clock in the evening, a thick cloud was seen advancing with a strong wind from N.W. by W. towards a ship sailing in latitude 61° N. and longitude 7° 58′ W. This cloud, when it reached the ship, covered everything with fine dust. On that same day had commenced an eruption of Mount Hecla in Iceland, at the direct distance of 500 miles from the ship; so that the cloud of ashes must have travelled at a mean rate of fifty miles per hour.

Far more extraordinary accounts than these are recorded of the lofty volcanoes in the Andes, and also in some of those in the islands of the eastern Archipelago. The volcano of Coseguina, on the west coast of Central America, was in eruption in January, 1835, after twenty-six years' repose. On the morning of the 20th of that month, a cloud rose in the direction of the volcano, which, seen at a distance of fifty miles to the south, presented the appearance of an immense plume of the whitest feathers rising with considerable velocity, and expanding in every direction. From that time to the morning of the 22nd, the cloud retained this appearance, but then a line of intense darkness replaced it. Immediately afterwards, a fine white ash was observed to fall, the black line rose rapidly, the light began to fail, and darkness commenced, and soon increased so much, that in half-an-hour it was blacker than in the thickest night. So intense was the obscurity, that men could touch without seeing each other, and the fowls went to roost as at night. This state of perfect darkness prevailed during the whole of that day, and until noon of the following day, at which time objects became visible at ten or twelve yards distance. In this state things continued for two days longer, but for ten or twelve days the light was partially obscured. During the whole time a fine white impalpable dust continued to fall. This fall of ashes was not confined to San Antonio, which, as has been said, was itself fifty miles from the volcano. Still nearer the central point, the darkness commenced earlier, but did not last so long; while in every place in the immediate neighbourhood the ground was completely covered with ashes, varying in thickness from a few inches to upwards of ten feet. The most extraordinary fact, however, with regard to this eruption remains to be told; for not only were the ashes conveyed in the direction of the wind to a distance of as much as 700 miles, at the rate of 170 miles per day, obscuring the sun in the island of Jamaica, and covering the earth with fine dust, but they were carried to windward for 400 leagues, thus proving that they must have reached to an enormous height in the atmosphere by the violence of the eruption. It is also recorded by the captain of a ship in the English navy, sailing in latitude 7° 26′ N., and 104° 45′ W. longitude, at a distance of 900 miles from the nearest land, and 1100 from the volcano, that his ship sailed forty miles through floating pumice, some of the pieces being of a considerable size. The actual amount of force with which such volcanic products as these are ejected, is not very easy to estimate, and the calculations that have been made on this subject are not so accurate as might be wished. That it is enormously great, however, there can be no question; and it is recorded by Sir William Hamilton, that stones were, on one occasion, thrown up so high above Vesuvius as to occupy eleven seconds of time in falling to the level of the crater. Allowing for the difference of atmospheric pressure in a mountain above 3000 feet high, this gives a force equivalent to the pressure of between three and four hundred atmospheres. Another example is recorded of the projection of a mass of rock, measuring 300 cubic feet, (and therefore whose weight was upwards of 200 tons,) from the crater of Cotopaxi, to a distance of nine miles.

The quantity of matter ejected from volcanoes in the form of lava is more readily measured than in either of the cases yet referred to. The lava streams break out in irregular intermitting springs of molten earthy matter, and frequently continue slowly running for days, and even weeks together. As examples of quantity, it may be mentioned, that in 1837, Mount Vesuvius poured forth as much as thirty-four millions of cubic feet, and in 1794, during another eruption, upwards of forty-six millions. In 1669, Mount Etna poured forth nearly a hundred millions; and in 1783, an eruption took place in Iceland, more remarkable for the extent of its lava current than any other on record, the stream having flowed along two channels, one of them fifty miles in length and twelve to fifteen miles broad, the other forty miles long and seven miles in breadth. In the course of this distance the fiery stream filled up a lake and obliterated a lofty cataract, turning the waters of two streams into vapour, and entirely occupying their beds. Although the thickness was very variable, being as much as five or six hundred feet in the narrow channels, and not more than ten feet in the plains, the lowest estimate of the measurement and weight of this mass is not less than twenty thousand millions of cubic yards, or forty thousand millions of tons of matter, poured out of the bowels of the Earth and spread over its surface within the short space of ten weeks.

96 *Distribution of Volcanoes.*—Having considered thus the nature of volcanic action, and of the substances which, under various circumstances are erupted from volcanoes, it remains that we should explain the mode of distribution of these phenomena upon the Earth's surface. The best mode of obtaining a general idea of this distribution is, by examining carefully a globe or map of the world, in which the positions of the various volcanoes at present or formerly active is distinctly marked, and such a map will be found in the atlas belonging to this volume.

The following table will give a notion both of the position of various volcanic groups, and the comparative number of distinct volcanic vents in different regions. It includes about 400 described cases of volcanic cones, many of which, indeed, have not been known to erupt within several centuries; but this does not necessarily remove them from such a list, as it is very possible for the internal fire to slumber for a much longer period between two epochs of outburst. By giving an idea of the actual distances within which the principal groups are placed, as well as the number in each case, perhaps this table will communicate a tolerably distinct idea of the importance of each group. In many cases, however, the volcanoes are very closely congregated in knots about the centre of the district, while towards its outskirts are only a few cones and craters.

List of the Principal Volcanic Groups, with the Linear Extension of each Group.

	Number of Volcanoes.	Linear Extension in British statute miles.
ATLANTIC OCEAN:		
Jan Meyen Island (Greenland)	2	?
Iceland	8	
Azores	2	
Canary Islands	7	?
Cape Verde Islands	1	
Ascension Island	1	
Trinidad Island	1	
Tristan da Cunha Island	1	
WEST INDIA ISLANDS	10	450
MEDITERRANEAN GROUP:		
Lower Italy	2	?
Lipari Islands	2	
Greek Islands	1	
RED SEA	2	
INDIAN OCEAN (WEST SIDE):		
Bourbon Island	1	
Mauritius Island	1	?
Rodriguez Island	1	
ASIATIC CONTINENT:		
Western Asia	3	
Central Asia	2	
Eastern Asia	?	
ASIATIC COAST:		
Kamtchatka group	21	900
Kurile Islands group	18	800
Japan Islands group	23	1700
Bonin and Mariana Islands	9	1000
Formosa	3	280
Luzon and the Philippine Islands	21	1000
Molucca Islands	12	700
North-west coast of New Guinea	4	
SUNDA ISLANDS GROUP:		
Floris and adjacent islands to the west as far as Serva	11	600
Sumbawa and others	9	350
Java	43	650
Sumatra	7	900
Andaman Islands	5	600
EASTERN ARCHIPELAGO:		
Groups of islands between New Guinea and New Zealand	4	
New Zealand	2	
Friendly Islands	2	
PACIFIC OCEAN:		
Hawaii (Owhyhee) group	4	
Society Islands	1	?
Marquesas Islands	1	
Easter Islands	1	
Galapagos Islands	1	
AMERICA:		
Aleutian Islands	35	1200
North American series	10	2000
Mexico	7	700
Guatemala	33	850
Quito	17	450
Peru and Bolivia	12	600
Chile	22	1200
Tierra del Fuego	3	400
ANTARCTIC LAND	3	

Those groups to which no linear extension is marked, are for the most part detached, and exhibit only imperfect communication with any other district. The groups connected by brackets are probably related, but too imperfectly to justify any statement as to their linear extension.

Looking, then, at these volcanoes as offering means of communication between the interior of the Earth and its surface, we find that while the whole number of such vents is larger, by a great deal, than could be anticipated by observations made on the western Continent, there are still very extensive districts of land, and doubtless, also, large areas of the sea bottom in which no such means are afforded for the escape of gaseous or other substances pent up within the Earth. And although it is certainly true that there are many parts, especially in Europe, where abundant proof is afforded of volcanic action during a period antecedent to the present, and thus the extinct volcanoes add much to the surface which we know to have been provided with vents within a comparatively short interval, there is yet daily increasing proof, that however powerful an agent volcanic force may be, it does not directly or necessarily affect the great mass of land upon the Earth. More than half, however, of the coast line of the existing land is covered at intervals sufficiently near to ensure subterranean communication at great depths underground, but the great area of land within the coast, and the sea bottom, so far as we know, is not sufficiently in relation with changes thus induced, as to justify our regarding them as essential to existing conditions. We shall proceed to show in the next chapter, however, that there are phenomena on record which connect this kind of igneous agency with another more directly influencing the general physical conditions of the Earth's surface.

97 *Subterranean Connexion of Distant Volcanoes.*—Many of the volcanic regions referred to, exhibit very distinct relations with each other, although far removed in point of distance, and separated or covered at the surface by rocks of very various character; but the volcanoes in the same system, or within moderate distances, are often so directly related as to exhibit a distinct reciprocation. Remarkable instances of this have been observed in some of the volcanic cones of the Andes, and this relation has also been shown in the case of the two most considerable European volcanoes.

98 *Connexion of Volcanoes with Earthquake Action.*—Earthquakes may be regarded as convulsions of the Earth, of the nature of undulations propagated in various directions from a central point or line beneath the surface of the Earth, and consist of a series of perpendicular, horizontal, and even rotatory motions, following each other in rapid succession, sometimes being so slight at the surface as only to be perceptible by those familiar to the phenomenon, but occasionally producing the most complete and frightful destruction over whole districts of the Earth. The origin of such phenomena must be regarded as an upheaving force, more or less sudden in its effects, and greatly modified by the extent of area over which it has at first acted.

Earthquakes and volcanoes stand in intimate connexion with each other, generally originating in or near the same parts of the Earth, often so distinctly related in order of time and alternation of results, that they are manifestly seen to belong to each other, so that when volcanic action is exhibited on a large scale, as in the linear groups described in the Andes, the Sunda Islands, and elsewhere, the activity of one volcano interferes with the action of another, and the commencement of a great eruption is generally preceded and often accompanied by earthquake undulations. As also we find, that volcanoes are almost confined to the coast line bounding the Pacific, so also, earthquakes are much less frequent in countries forming the central parts of continents. It is, however, by no means the case that earthquake action is really thus limited, only that the undulations are less common and less considerable in amount in these districts than in others nearer the coast.

If we begin by considering the nature of earthquake phenomena, as exhibited in the different kinds of undulations that have been described, and the local effects recorded to have been produced, we shall find that the subject—although one offering great interest to the general reader, and therefore well adapted for works in which continuous narrative is attempted—does not present that magnitude of interest which can entitle it to rank as a world-phenomenon, unless we connect with these local effects, those much more wide, and indeed universal, changes of level of the general surface of land, and of the sea bottom, to the action of which the form and physical features of the whole surface of the Earth are due. We propose, therefore, to consider, first, and somewhat briefly, the local phenomena that enable us to judge in some measure of the nature and extent of the causes in action, and we may then proceed to investigate the effects on a large scale, and the possible causes of the undulation of the surface generally.

In illustration of the important fact of earthquakes and volcanoes being connected phenomena, it is only necessary to refer to those volcanic districts in different parts of the world already described, and their history, so far as that history has been handed down to us. The vicinities of Etna and Vesuvius have been remarkable for many centuries for disturbances of this nature. Most of the cities, not only of Sicily, but also of southern Italy, have from time to time been the scene of destructive undulations, continued at short intervals for a considerable period, sometimes exceedingly sudden, and frightfully destructive. These have been in most cases directly succeeded by eruptions from neighbouring volcanoes, the earthquakes preceding the eruption, and the shocks increasing in violence, until the mountain relieves itself by discharging its contents; so also when volcanoes in constant or nearly constant action ceased to show signs of activity, earthquakes have generally been known to succeed. Thus, Stromboli had an interval of repose for the first time within the memory of man, immediately preceding a series of earthquakes which took place in the year 1783; and thus, also, the volcano of Pasto, in Peru, ceasing to emit a dense, black column of smoke, which had proceeded from its crater for some time, the terrible earthquake of Rio Bamba occurred, during which 40,000 persons perished. Perhaps, however, the best example of this chain of connexion between earthquakes and volcanoes is seen in the series of events which took place in 1811 and 1812, in the western world. The first of these events was the sudden elevation of the island of Sabrina, in the Atlantic, near the Azores, from a depth of 120 feet, the phenomenon being accompanied by violent earthquakes, and a disengagement of smoke and flame. From this time, severe shocks were felt in the Island of St. Vincent, near one of the most active volcanoes in the West Indian Archipelago, and these shocks extended to the North American continent, producing marked results in the valley of the Mississippi. In December, 1811, an earthquake took place in the Caraccas, and another in March, 1812, continuing several days, and entirely destroying the chief city of the province. And lastly, on the 30th April, 1812, the volcano of St. Vincent, which had been quiet for nearly a century, burst out with a tremendous explosion, which extended for 210 miles, into the plains of Calaboyo. This ended the disturbances, connected together at great depths, extending, as we have seen, from the Azores, and felt round the whole of the interior of the Gulf of Mexico.

It is needless to repeat examples of this kind, which all tell the same tale. Most of the great eruptions of modern times have been preceded by earthquakes, and most of the great earthquakes succeeded by volcanic eruptions.

99 *The Nature of Earthquake Movements.*—It has been mentioned that the undulations connected with an earthquake are of three kinds—namely, undulatory, perpendicular, and horizontal; the latter sometimes producing what appear to be rotatory or verticose movements. Of these, the first kind is the most common and the most harmless, the second is generally very destructive, while the third has rarely been felt, except in the most disastrous and appalling catastrophes.

Earthquakes are occasionally, but not always, accompanied by detonations and loud noise; the kind of noise that occurs is also different in different places, being sometimes rolling, and occasionally like the clinking of chains, sometimes abrupt, like thunder close at hand, and sometimes clear and ringing, as if obsidian or other vitrified masses clashed, or were shattered in subterranean cavities. In the Caraccas, there was heard over a district of 40,000 miles a loud noise resembling thunder, unaccompanied by any shaking of the ground, during the eruption of a volcano more than 600 miles distant; and at the great eruption of Cotopaxi, in 1744, subterranean noises, as of cannon, were propagated at great depth through the Earth for a distance of more than 400 miles.

The undulations of earthquakes are propagated in two very distinct ways, sometimes extending and being exceedingly violent for very great distances in linear direction, and sometimes extending from a focus almost equally in every direction. It is an important fact that the linear direction of great earthquakes generally corresponds with that of volcanic action in the vicinity. It is probable, however, that even in what may be regarded as central earthquakes, the impelling force is situated along a particular line of country always the same in successive disturbances. Most earthquakes follow the direction of the mountain chains in the countries which they traverse, but occasionally they cross this line at right angles; in the latter case, however, the shocks have generally been weak.

As it is important to bear in mind the difference which really exists between central and linear earthquakes, we may here give a short account of important earthquakes in which each of these directions has been observed. Thus, the great earthquake of Lisbon, which took place on the 1st November, 1755, was felt in a circular or oval area of enormous dimensions, commencing apparently in the Atlantic, off the coast of Portugal, and reaching to the West Indian islands, the lakes of Canada, the shores of the Baltic, and the hot springs of Bohemia. This, therefore, may well be considered as central on a very large scale, since a portion of the Earth's surface, at least equal to four times the whole area of Europe, was then simultaneously shaken. This earthquake has been described at great length, and the phenomena were in the highest degree interesting.

Another remarkable instance of a central earthquake, although of far less extent, took place on the 5th February, 1783, in Sicily, on which occasion Calabria, and about 200 other towns and villages, were destroyed within an area of 600 square miles and 100,000 persons perished. This earthquake, although so small in extent, exhibited all the peculiar phenomena of vorticose movement and vertical upheavals frequently repeated, which from their nature must of necessity result in great injury to any buildings on the surface. The surface, also, itself is in such cases rent asunder, and some portions have been removed to a distance in a manner exceedingly difficult to account for.

The earthquakes here described were more or less central, the form of the land disturbed being either circular or oval, and in these cases the progress of the shocks may be compared to that of ring-like waves produced on the surface of still water when a stone is thrown in, or when a solid is lifted from the bottom. Such waves, both in the water and on land, are both wider and fainter as their distance from the centre increases; and thus in the great Lisbon earthquake, while that city was so completely destroyed, others both north and south of it at moderate distances were only partially injured; while in Ireland, although the shocks were distinctly felt, they ceased to be mischievous, and at still greater distances the disturbing force was only visible in its effects on the waves of the sea or the water of deep springs. So also in the Calabrian earthquake, while the country at one particular spot was rent by deep chasms, and so violently shaken that the heads of the largest trees are said to have almost touched the ground on either side, and while not only was no kind of building able to resist the movement, but tracts of land were actually removed horizontally, so that fields planted with different kinds of corn had exchanged situations, yet, at a comparatively short distance, the towns were not injured, and in the country the shock was scarcely felt. It is also a remarkable and interesting fact with reference to central volcanoes generally, that the disturbances are by no means equal at equal distances from the centre, or universal at all intermediate places, proving both the true wave-like nature of the movement generally, and its partial interruption by the varying elasticity of the different rocks through which it passes.

Linear earthquakes are no less remarkable than central ones, and in some cases their phenomena are even more instructive. In 1837, a shock occurred in Syria affecting a line 500 miles in length by only 90 in breadth; while in South America there have been instances in which 1000 miles of coast have been affected by disturbances which have not been transmitted in an east or west direction to any considerable distance. On certain occasions that have been recorded, earthquakes have been felt at various points along lines of still greater length, and a most remarkable example of this kind occurred in the year 1835, when several towns were thrown down between Copiapo and Chiloe. On this occasion, the whole volcanic chain of the Chilian Andes was in a state of unusual activity, and almost at the same instant the island of Juan Fernandez, 365 miles from Chile, was violently shaken. More than 300 shocks were counted in this district between the 20th of February and the 4th of March, in the year mentioned. Before this, however, in the year 1822, the coast of Chile had been visited by a most destructive earthquake, felt simultaneously through a space of 1200 miles from north to south.

It is unnecessary to multiply examples of this kind, the facts, although very extraordinary, differing but little in different disturbances; and, in point of fact, the multiplication of accounts that have been given of particular earthquakes would not assist the reader in forming any conclusion as to the original cause of such phenomena. It will be more useful to give the general conclusions arrived at, by those who have studied this subject with a view to determine the bearing of earthquake phenomena upon the structure of the Earth's crust. The two most important points that have been determined are these—First, the much wider extent and influence of subterranean movements commencing or connected with earthquakes than is shown by the accounts recorded of those places where the undulation is felt; and next, the nature and amount of the upheaving force exerted, and the permanence of upheavals and depressions of the surface.

100 *Frequent Repetition and Wide Range of Earthquake Action.*—Examples are not wanting in various districts of repeated earthquake disturbances, at places far removed from recent or even recently extinct volcanoes, and some cases of this kind in the British islands, where there is a certain amount of regularity and periodicity in the phenomena, are well worthy of notice. Thus it has been observed, that of a number of earthquakes, occurring between 1812 and 1815, all, or almost all, took place within a few hours of the moon's first quarter, and have reference to great atmospheric changes, but the number of small shocks that have been felt and recorded in Scotland, within the last few years, give a better notion of the minuteness and frequency of such undulations, and render it probable, that if other regions in which elastic igneous rocks are present at the surface were the subjects of equally careful examination, there would be proof of an almost perpetual vibration over tracts of vast extent.

In the years 1841-42, between the 23rd July and 8th June, no less than sixty shocks have been recorded by Mr. Milne, as felt at Comrie, in Perthshire, twelve occurring on the 30th July, and the rest distributed at irregular intervals, varying from some hours to two months. Between the 1st of July, 1842, and 1st of July, 1843, thirty shocks were felt in the same spot, but at other places in the British Islands, within the same period (although not at the same time), other earthquakes were observed, some of them not inconsiderable in extent, the most remarkable being on the 17th of March, 1843, when Lancashire, Cumberland, Dumfriesshire, the Isle of Man, Belfast, and even the Channel Islands (Jersey and Guernsey), were all subjected to a considerable subterranean movement, variously described as resembling that of a ship in a heavy swell, even inducing nausea, and as like a loaded cart passing along a street. This earthquake was not felt at Comrie, although certainly much more extensive than many of those recorded at that place.

The observations continuously made in Perthshire, showed in the succeeding year (between August 1, 1843, and September 4, 1844) thirty-seven shocks, the most severe of which were on the 25th August, 1843, and 14th January, 1844. Of these, the earthquake of the 25th August was felt simultaneously, and with about equal intensity, over an area of one hundred square miles, and on the 12th June, 1844, when no shock took place at Comrie, a movement sufficient to excite general attention was recognised in Huntingdonshire and adjacent counties of England.

What is remarkable in these cases, is the very frequent repetition of small and strictly local vibrations. Such phenomena are no doubt related to the more widely known and frightful disturbances by which whole towns, with their population, have been in a few seconds destroyed, for these have often had scarcely wider range, and the shocks are not more frequently repeated.

But if some earthquakes have been thus limited, others again have produced results over a vast area. The great earthquake of Lisbon has been already referred to, and other similar if not equally disastrous occurrences have had an equal extent. It appears, in fact, that the propagation of the wave to which the vibration is due, is only limited by the nature of the rocks through which it passes, and the original circumstances under which the shock was produced.

Many cases have been recorded in various parts of the world, tending to show, that where once earthquake action exhibits itself, it is likely to recur. The slighter and more frequent the vibrations, also, the less probability there seems to be of any serious disturbances, but neither this nor any other apparent law can be depended on. We are told by Humboldt, that 'on the coasts of Peru, where rain scarcely ever falls, and where hail, lightning, and thunder are unknown, these atmospheric explosions are replaced by the subterranean thunder, which accompanies the trembling of the earth. From long habit and a prevalent opinion that dangerous shocks are only to be apprehended two or three times in a century, slight oscillations of the ground scarcely excite so much attention in Lima as a hail-storm does in the temperate zone.'*

The danger from earthquake action, and the relations borne to each other by disturbances of this kind at distant spots, are not without important reference to adjacent volcanoes. Among the most remarkable instances on record of an important and destructive earthquake, at a great distance from a known volcanic region, is that of Lisbon, but this city is, after all, not far removed from certain portions of the bed of the Atlantic, where true volcanic eruptions unquestionably occur. Active volcanoes, therefore, though they may perhaps be regarded as safety valves for the country in their immediate vicinity, do not by any means prevent the occurrence of severe earthquake shocks, which thence extend either in a circular or oval area to vast distances, interrupted and checked, it may be, by the condition and nature of the rocks traversed, but not failing to produce some effect on the surface, and on the various works of nature and art there exposed.

Among the most interesting of the permanent results thus produced, not only near volcanoes, but over large continental areas, are those elevations and subsidences which we proceed in the next section to consider.

101 *Permanent Change of Level accompanying Earthquake Action.*—The earthquake of 1835, that destroyed the town of Concepcion, in South America, and which had a north and south range, was felt over a tract of country equal in extent to the distance between the North Sea and the Mediterranean, and during this and other single earthquakes of the same

---

* *Cosmos*, Col. Sabine's translation, vol. i. p. 205.

kind, very extensive areas have been permanently affected by small elevations or subsidences. Such movements, in horizontal position, have been also repeated so frequently, that within a period geologically recent, they have upraised large portions of Chile and Peru several hundred feet; and however it may appear by other observations, that permanent elevation by no means invariably attends earthquakes, it must still be generally admitted that some change in relative level is the usual result of continued earthquake action. Examples of the permanence of the change produced during earthquakes may be seen in the condition of some parts of Cutch, near the mouth of the Indus, and other places on the delta of that river, and in a yet more striking instance recorded by a recent traveller in Brazil (Tschudi), to the effect that the bed of a stream, in one spot, is so altered in position, that the water, if it could now be made to occupy its former bed, must rise up a steep incline, having formerly taken the course it did when the land was in a different position, and at a lower level, and the water being now forced to find a new channel.

Although, however, there are few instances of repeated earthquakes without permanent elevation or depression, to a greater or less extent, the proofs of this change of level are often exceedingly difficult to obtain. Some such cases are chiefly valuable and interesting, not from their extent, but because they have occurred in countries often visited, and are supported by historic evidence of recent date. An examination of the present state of the temple of Jupiter Serapis, in the bay of Baiæ, near Pozzuoli, establishes the fact of an elevation of more than twenty feet (and at one point more than thirty feet) in the land on which the temple is built, and of several alternations of level occurring between the third century of the Christian era and the present time. It is not necessary here to repeat the details which have been frequently given with regard to this subject,* but distinct historical evidence is thus adduceable of considerable change of level of the land in the vicinity of the volcanic mountains of Vesusius and Etna, and the evidence reaches almost to certainty, that the elevation sometimes immediately accompanied destructive earthquake action.

Among the striking examples on record, of permanent change of level in earthquake districts, we may also mention the case of Concepcion Bay already referred to, where the ancient harbour, which once admitted large merchant vessels, is now occupied by a reef of sandstone, and a tract of a mile and a half in length, where the water was formerly four to five fathoms deep, is now a shoal, formed of hard sandstone rock. This is supposed to have been caused by the earthquake of 1751.

In almost every earthquake a considerable amount of destruction is caused by slips of earth and partial subsidences, which we have not alluded to, as not offering phenomena of sufficient magnitude to serve our argument; yet

---

* Although it has not seemed advisable to encumber the text with those often repeated accounts, the following general conclusions, extracted from Mr Babbage's account of the Temple (*Quarterly Geological Journal*, vol. iii. p. 213,) may be found useful, and will perhaps be deemed satisfactory, as illustrating the order of the various operations:—

1. The temple was probably constructed about the end of the second century after Christ.
2. A dark incrustation formed round the walls before the temple was ruined, and during a slow and gradual subsidence to a small extent.
3. The temple became filled with volcanic ashes to the height of about seven feet from the floor.
4. A great calcareous deposit formed in the fresh-water lake made by the hot spring.
5. Partial destruction of the temple.
6. Several of the columns corroded just above the calcareous deposit.
7. The area again covered by volcanic ashes to the height of about 10½ feet.
8. The temple again injured, and exposed to partial subsidence below the sea level. The columns perforated by marine animals.
9. Third filling up with ashes to the height of 20 to 35 feet above the floor of the temple.
10. Temple elevated to a height above its present position.
11. Temple laid bare in 1750 by excavations.
12. Gradual subsidence between 1828 and 1845.

some of these have been remarkable, as in the case of an earthquake in Jamaica in 1692, when the harbour subsided so far, that large store houses were after the disturbance buried thirty-six feet under water, and the mastheads of ships, that had been wrecked, were seen together with the chimney tops of houses, projecting above the waves. A tract of land 1000 acres in extent, also sank down, so that the sea rolled in and remained permanently over this spot.

102 *Origin of Earthquakes.*—That an earthquake is the result of violent, and generally convulsive, subterranean movement, of the nature of an explosion, and is often accompanied by the sudden rending of solid rocks, or the sudden expansion of gaseous bodies, there can be little doubt; and thus, although the ultimate cause may remain unknown, the proximate one may be considered as established. Such a movement taking place in a subterranean cavity, is necessarily propagated as a central undulation if the disturbance occur at a single point, but where a considerable distance is connected underground by continuous hollows or vaults, the explosion may be felt as linear in the manner already described. When, also, the wave or undulation commences at a great depth below the surface, and under the ocean, the bed of the ocean will be upheaved, perhaps without fracture, owing to the superincumbent pressure of a lofty column of water; but in this case, the whole column of water must be lifted up, and a sea wave produced. When again the shock passing through the Earth meets the air, a wave of sound may be generated, and thus three distinct waves are produced by a single and instantaneous explosion. The wave produced in the solid mass of the Earth will itself be propagated with very different velocity, according to the nature of the rock through which it passes, and the interruption it meets with.

Whenever, therefore, an earthquake shock occurs, a true Earth-wave is the first and necessary result. This wave, in its rapid transit from the centre or axis of disturbance to the spot where the undulations are finally lost, involves throughout its whole course a movement in space of every particle of matter affected, and the elasticity of each mass or stratum of rock traversed, will influence the mode in which the wave reaches the surface; so that, where a rock near the surface is brittle, there will be a fracture, where it is soft, there will be a manifest upheaval and depression, and these will remain as permanent alterations of level where the actual movement, in one or other direction, is prevented by the falling in or displacement of other rocks from recovering itself. The rate of propagation of the movement will be exceedingly rapid, amounting always to several miles per minute, and varying from twenty to twenty-eight, according to circumstances.

Where the Earth-wave comes to the termination of the solid portion of the Earth's crust under water, and lifts the overlying sea, the elevation may amount to a few feet, perhaps, and the water is necessarily lifted and let fall to this extent. The Earth-wave, however, continuing to pass along and moving more rapidly than this sea-wave, carries with it the small elevated portion of the water, leaving also behind it the waves thus produced, which follow at a short interval. So long as this goes on in deep water, scarcely any effect can be observed at the surface, but no sooner does the wave reach a shoal, or approach the shore, than the earthquake-wave becomes what is technically called a 'forced sea-wave,' which is a narrow ridge of water forced forward by the great wave, and communicating a shock to ships, as if they had struck upon a bank. This wave accompanying a shock upon a coast is not considerable, and as it reaches the coast while the beach is itself elevated by the earthquake, it scarcely appears or is felt as an apparent recession of the sea. It is followed, however, at an interval dependent on the distance of the centre of disturbance, by the great sea-wave, which if the shore be shallow, may roll in with irresistible force, and in its retreat carry with it the fragments torn up and destroyed by the previous earth-wave. Lastly, a sound-wave formed in the atmosphere, moving still more slowly than either of the others, succeeds the earthquake after a considerable interval of time, and like thunder, is only heard when the danger is past, although it often appears to the unphilosophical observer as a fearful addition, almost more to be dreaded than the real undulation.

It occasionally happens that areas of disturbance, or districts exposed to some repeated cause of earthquake, are sufficiently near to be within the range of the same Earth-wave. The various disturbances in that case produce their effects independently, but these may intersect, and either destroy or double each other. The magnitude of the wave propagated in the crust of the Earth, will be increased at the surface according to a general law in mechanics, by which vibrations transmitted in elastic bodies have a tendency to detach the superficial strata.*

103 *Partial but Permanent Elevation at a Distance from Volcanoes.*—While there is little difficulty in comprehending the possibility of various movements of the Earth's surface, where that surface is exposed to the undulations we have described, the case is different, if we find evidence of permanent alteration of level in countries far removed, not only from existing volcanoes, but even from those volcanic appearances which indicate the former existence of igneous disturbance. Such at first sight may appear to be the case with the Scandinavian peninsula and the west coast of the British islands, which afford in various places evidence of elevation, but which have only very recently been recognised as subject even to partial earthquake action.

In Northern Europe there appears to be an area of land whose length is more than 1000 miles, reaching from Gothenberg, in Sweden, to the North Cape, the northern extremity of European land, subject to slow movement. In breadth, this tract reaches across the Gulf of Bothnia, and it stretches in all probability far into the interior both of Sweden and Finland. The elevation increases in amount as we proceed northwards, and it is doubtful whether the amount of elevation is constant during equal periods of time. The result is seen in various ways, but most strikingly in what are called raised beaches or elevated coast lines, and the evidence on which the fact of elevation is proved requires now to be noticed.

So long ago as the commencement of the last century, a Swedish naturalist, Celsius, expressed his opinion that the waters both of the Baltic and Northern Ocean were gradually subsiding, and he inferred from numerous observations that the rate of depression was about forty inches in a century. This view was supported by various facts observed, but controverted by others, such as the absolute permanence of the water-level in some low islands for many centuries without change; it was impossible also that a permanent depression of the level of the sea could take place in the Baltic and the Gulf of Bothnia, without being general throughout those parts of the ocean in which the level was the same. The view of Celsius is not tenable according to the observations that have been more recently made, but the fact of a change in the relative level of land and water seems to be now distinctly proved, and in the year 1807, Von Buch, on his return from a tour in Scandinavia, announced his conviction that the whole country from Frederickshall, in Norway, to Abo, in Finland, and perhaps as far as St. Petersburg, was slowly and insensibly rising. He also suggested 'that Sweden may rise more than Norway, and the northern more than the southern parts.' He was led to these conclusions principally by information obtained from the inhabitants and pilots, and in part by the occurrence of marine shells of recent species, which he had found at several points on the coast of Norway above the level of the sea. He also mentions the marks set on the rocks. Von Buch, therefore, has the merit of being the first geologist who, after a personal examination of the evidence, declared in favour of the rise of land in Scandinavia. The attention excited by this subject in the early part of the pre-

* Humboldt's *Cosmos*, Sabine's translation, vol. i. p. 192.

sent century, induced many philosophers in Sweden to endeavour to determine, by accurate observations, whether the standard level of the Baltic was really subject to periodical variations; and under their direction, lines and grooves, indicating the ordinary level of the water on a calm day, together with the date of the year, were chiselled out upon the rocks. In 1820-21, all the marks made before those years were examined by the officers of the pilotage establishment of Sweden; and in their report to the Royal Academy of Stockholm they declared, that on comparing the level of the sea at the time of their observations with that indicated by the ancient marks, they found that the Baltic was lower relatively to the land in certain places, but the amount of changes during equal periods of time had not been everywhere the same. During their survey, they cut new marks for the guidance of future observers, several of which were examined by Sir C. Lyell fourteen years after (in the summer of 1834), and in that interval the land appeared to have risen at certain places north of Stockholm four or five inches. Sir Charles Lyell on this occasion convinced himself, after conversing with many civil engineers, pilots, and fishermen, and after examining some of the ancient marks, that the evidence formerly adduced in favour of the change of level, both on the coasts of Sweden and Finland, was full and satisfactory. The alteration of level evidently diminishes as we proceed from the northern parts of the Gulf of Bothnia towards the south, being very slight around Stockholm.

These facts with regard to the shores of the Gulf of Bothnia are paralleled and rendered more clear by what has been observed since in the northern extremity of Scandinavia. It there appears that not only a narrow strip of coast, but the whole of Norway, from Cape Lindesnæs to Cape North, and beyond that as far as the fortress of Vardhuus, has been in course of elevation during a period immediately anterior to the historic period. On the south-east coast this elevation has amounted to about 200 yards, and the marks which denote the ancient line of coast, and which have been seen and measured in many points, are so nearly horizontal, that the deviation from horizontality cannot be appreciated, a circumstance which renders it impossible to account for the change by assuming a number of small local or independent disturbances.*

There are also on our own shores numerous instances known locally as 'raised beaches,' which prove the partial and very considerable upheaval of the coast in Wales, Cornwall, and elsewhere. At Plymouth and in its vicinity, there are remains of a beach sloping towards the sea, of which the maximum height is thirty feet above the present high-water mark, and traces of similar beaches covered with pebbles and shingles and containing the shells of the neighbouring sea are met with all round the coast of Cornwall, some of them rising to fifty feet above the sea, and others only just removed above it; while similar appearances on the Welsh coast show that the change of level has reached there to as much as 1200 feet. The shores of the Irish Sea near the mouth of the Mersey, and the whole coast of Scotland, abound with similar instances, many of which have been recorded in sufficient detail to prove distinctly the general fact.

It would, indeed, appear that no part of the western coast of Europe, from France to the North Sea, is now at the same level as that it possessed some ages ago. The change in most places is, however, gradual, and the amount generally inconsiderable, the most remarkable instances being in the Mediterranean, where many cliffs covered with shells of recent species are not only high above the level of the sea, but extend uniformly for very great distances.

While, however, changes have been going on thus slowly, and for a vast period of years, on the north-western coast of the Old World, the southern extremity of America has been gradually assuming a form which

* Lyell's *Principles of Geology*, 7th edition, p. 495, *et passim.*

is manifestly due to the action of causes strictly analogous. In South America, indeed, everything is on a grand scale, and all recent causes of disturbance are there exceedingly active; but the examination of the surface with a view to discover, as far as may be, to what its peculiar appearance is owing, has brought to light a series of movements of the nature chiefly of permanent elevation, hardly traceable in other parts of the world. Recent shells—the shells of animals whose immediate descendants of the same race are now living in the Atlantic—are found on the shores from Tierra del Fuego northwards for 1200 miles, and at the height of about 100 feet in La Plata, and of 400 feet in Patagonia. The elevatory movements on this side of the continent have been slow, and the coast of Patagonia, up to the height in one part of 950 feet, and in another of 1200 feet, is modelled into eight great step-like, gravel-capped plains, extending for hundreds of miles with the same heights; this fact shows that the periods of denudation (which, judging from the amount of matter removed, must have been long continued,) and of elevation were synchronous over surprisingly great lengths of coasts. On the shores of the Pacific, upraised shells of recent species, generally, though not always, in the same proportionate numbers as in the adjoining sea, have actually been found over a north and south range of 2075 miles, and there is reason to believe that they occur over a space of 2480 miles in length. The elevation on this western side of the continent has not been equable; at Valparaiso, within the period during which upraised shells have remained undecayed on the surface, it has been 1300 feet, whilst at Coquimbo, 200 miles northward, it has been, within this same period, only 252 feet. At Lima, the land has been uplifted at least 80 feet since the Indians inhabited that district; but the level, within historical times, has apparently subsided. At Coquimbo, in a height of 364 feet, the elevation has been interrupted by five periods of comparative rest. At several places, the land has been lately, or still is, rising, both insensibly and by sudden starts of a few feet during earthquake shocks; a fact which shows that these two kinds of upward movement are intimately connected together. For a space of 775 miles, upraised recent shells are found on the two opposite sides of the continent; and in the southern half of this space, it may be safely inferred from the slope of the land up to the Cordillera, and from the shells found in the central part of Tierra del Fuego, and high up the river Santa Cruz, that the entire breadth of the continent has been uplifted. From the general occurrence on both coasts of successive lines of escarpments, of sand-dunes, and marks of erosion, we must conclude that the elevatory movement has been interrupted by periods when the land was either stationary, or when it rose at so slow a rate as not to resist the average denuding power of the waves, or lastly when it was in a state of subsidence.*

In estimating the value of the different hypotheses which have been offered to account for this remarkable phenomenon of the gradual upheaval of land, it must not be lost sight of, that the change, important as it is in reference to the organic world, is exceedingly small compared with the whole mass of the Earth. It is natural to conclude, however, that the upheaval being so directly connected with volcanic districts, where it is most manifest and considerable, (as in South America,) and occurring elsewhere in spots which are not without occasional earthquake movements, is connected in some way with the heated condition of the Earth's interior. This heat, however, may produce its effect in two ways, either by expanding gases and forcing the crust to be upheaved by their agency, or by the actual expansion of large and thick masses from the increase of heat which they very gradually receive during subsidence owing to the increasing nearness of warmer portions of the Earth.

It has been proved by experiment and calculation, that if a portion of the

* Darwin's *South America*, p. 246.

Earth's crust, 100 miles thick, and of the expansibility of sandstone rock, were heated 600° or 800° Fahrenheit, this alone would produce an elevation of between 2000 and 3000 feet. It is important to bear in mind these facts, and their bearing on Physical Geography.

104 *Depression over Large Tracts.*—The movement that goes on in the way of elevation over such extensive areas as those we have been describing, and which indeed appears to have acted with regard to many other wide tracts of flat land upon the Earth, is not unaccompanied by partial depression, occurring even in some districts where elevation is the prevailing movement. Evidences of this are seen in submerged forests, or indications of the former growth of trees where the sea now reaches; but other points of evidence, on a much larger scale, are not wanting. If, however, there is difficulty in measuring accurately the relative level of land and water, so as to discover a small elevation, the difficulty of proving similar moderate depression is still greater. In spite of this difficulty, there is not wanting proof that while elevation is going on on the eastern shores of the Atlantic, the western coast offers a converse phenomenon in the sinking down of part of the coast of Greenland for a space of more than 600 miles in a north and south direction. Observations were made on this subject by Captain Graah, during a survey of Greenland in 1823-24, and afterwards in 1828-29, and others by Dr. Pingel in 1830-32. It appears, from signs and traditions, that the coast has been subsiding for the last four centuries from the firth called Tugaliro, in latitude 60° 43′ N., to Disco Bay, extending to nearly the 69th degree of north latitude. Ancient buildings on low rocky islands and on the shore of the mainland have been gradually submerged; and experience has taught the aboriginal Greenlander never to build his hut too near the water's edge. In one case, the Moravian settlers have been obliged more than once to move inland the poles upon which their large boats were set, and the old poles still remain beneath the water as silent witnesses of the change.*

But far more striking, though not altogether dissimilar, memorials of this gradual change are found in connexion with the work of living and dead animals constructing a stony habitation in various parts of the tropical and adjacent warm seas. Here the coral animals begin to build in moderate depths off the coast, either of the mainland or the innumerable islands of those seas, and appear to flourish best where most exposed to the ceaseless and violent dash of the waves. Increasing with enormous rapidity, the living wall or reef soon expands laterally, but is not continued downwards to a greater depth than about thirty fathoms, except in the case of small and detached individuals of different species.

Now, it appears that in spite of this limit of the depth of living coral reefs, vast areas are interspersed with such reefs, so that in the space of ocean extending from the southern end of the Low Archipelago to the northern end of Marshall Archipelago, (a length of 4500 miles,) every island, with one exception, is atoll-formed, atolls being circular groups of coral, with a salt water lake within them, the water within the lake being generally very shallow, while almost immediately outside the island, the depth is very considerable, and sometimes unfathomable. To give some idea of the true extent of phenomena of this kind, we may mention that some of these atolls are oval-shaped, measuring from fifty to eighty miles in length, and nearly twenty miles in breadth, while one extensive bank (the Chagos bank) presents all the characteristics of an atoll, except that it does not reach the surface, but is completely submerged. The longer axis of this bank measures ninety miles, and the shorter as much as seventy; its central part is a level, muddy flat, between forty and fifty fathoms deep, surrounded on all sides by steep mounds, rising from twenty to thirty fathoms, with a breadth of from five to twelve miles, and the whole bank is bordered by a wall about a mile wide,

---

* Lyell, *ante cit.*, p. 506.

rising to within five or ten fathoms from the surface. At a distance of a mile outside this wall, the depth of the sea is 200 fathoms.

In addition to these atolls, coral reefs of a more continuous nature extend as barriers at some distance from the coast line of Australia, and other large islands. These are called barrier reefs, and resemble atolls in the depth of the sea outside their outer wall, and also in having a lagoon channel. These are also of enormous extent, extending on the west coast of New Caledonia for 400 miles, at a distance of eight leagues from the shore, and on the north-eastern part of Australia for 1000 miles, averaging from twenty to fifty miles from the shore.

In addition to these two kinds, there is a third kind of coral reef, not unusally found fringing volcanic islands in the Indian Ocean. These have no lagoon channels, they are narrow, often not more than fifty to a hundred yards wide, and they are less deep than those already described.

The cause that has given to atolls and barrier reefs their characteristic forms is supposed by Mr. Darwin to have been the gradual subsidence of portions of the bed of the ocean over large areas, and is partly deduced from the consideration of these two circumstances—namely, that reef-building corals flourish only at limited depths, and secondly, that vast areas are interspersed with coral reefs and coral islets, none of which rise to a greater height above the level of the sea than that attained by matter thrown up by the waves and winds. The foundation of each reef is assumed to have been rocky, but it cannot be thought probable that the broad summit of a mountain lies buried at the depth of a few fathoms beneath every atoll, with scarcely a point of rock projecting above the surface over so wide an extent as that in which these phenomena have been traced. Much other evidence in favour of the same view is adduced by Mr. Darwin, in his admirable work *On Coral Reefs*, which is accompanied also by a coloured chart of all such reefs and islands, one colour marking those districts in which barrier reefs and atolls occur, and another indicating the fringing reefs only.

It appears, then, as the general conclusion with regard to this subject, that when these two great types of structure—namely, barrier-reefs and atolls on the one hand, and fringing reefs on the other, are thus laid down in colours on map, a magnificent and harmonious picture of the movements which the crust of the Earth has within a late period undergone, is presented to us. We there see vast areas rising, with volcanic matter every now and then bursting forth through the vents or fissures with which they are traversed. We see other wide spaces slowly sinking without any volcanic outbursts; and we may feel sure, that this sinking must have been immense in amount, as well as in area, thus to have buried over the broad face of the ocean every one of those mountains, above which atolls now stand like monuments, marking the place of their former existence. Reflecting how powerful an agent, with respect to denudation, and consequently to the nature and thickness of the deposits in accumulation, the sea must ever be, when acting for prolonged periods on the land, during either its slow emergence or subsidence; reflecting, also, on the final effects of these movements in the interchange of land and ocean-water, on the climate of the Earth, and on the distribution of organic beings, it may be fairly assumed, that the conclusions derived from the study of coral formations are amongst the most important that can be presented to the consideration of the physical geographer.*

* Darwin *On Coral Reefs*, p. 148.

CHAPTER VIII.

STRUCTURAL PHENOMENA OF THE EARTH INDICATING IGNEOUS ACTION.

§ 105. Nature of igneous rocks in general. — 106. Extinct volcanic regions. — 107. Ancient lava currents and other products of extinct volcanoes. — 108. Other igneous rocks not volcanic. — 109. Metamorphism. — 110. Dykes and mineral veins.

NATURE *of Igneous Rocks in General.*—The igneous phenomena and their results, so far as we have yet considered them, are limited to the Earth's surface, and give little or no insight into the actual structure of any portion of that superficial crust which it is the object of geologists to understand and describe. Thus, we have seen that volcanoes, although of great interest and importance in the general economy of nature, are too few in number, and occupy too small an area, to affect the whole area of land to any considerable extent, and though, no doubt, those elevations and depressions that we have discussed, and which are connected with volcanic action, are of vast effect in their general result, when continued for a sufficient time, yet even these, in the short space of human history, must have been totally insignificant in modifying the general surface. But we must now carry our investigations somewhat farther, and we shall soon discover that while igneous action is not confined to one district or one period at present, but affects various points of very wide tracts, and lasts often in the same tract for an apparently indefinite period, there are many other parts of the Earth where, beneath the surface and in the rocks that are offered for investigation, proof may be obtained of igneous action, either directly or indirectly, and the usual results may therefore be looked for in the way of former elevation and depression, as well as additional results derived from the disturbance of material in a hardened state by violent mechanical force. In the present chapter we may consider with advantage these points, and thus obtain an insight into one very important department of geology, strictly so called—namely, that of mechanical rocks not left in their original condition of mechanical apposition, but altered by the action of heat or chemical forces; and of other rocks which offer no appearance whatever of mechanical origin, but, on the contrary, seem to have formed part of the original skeleton and framework of the globe, presenting themselves in the central axes of mountain chains, or in the long-exposed and weathered surface of granitic bosses, or rolled blocks broken from the parent rock and transported to a distance.

The various circumstances under which such rocks are presented—the evidence of igneous activity at very early periods of the Earth's history, as well as at more recent, but still distant times—the structural peculiarities of various igneous rocks, and the structural changes produced by them—these, together with the phenomena of segregation, and the collecting of various substances into veins and fissures, whence they may be extracted for the use of man, will, when explained, enable the student to comprehend something of the condition of a portion of the Earth, and form fit subject-matter for careful study.

106 *Extinct Volcanic Regions.*—As at present there are certain lines and small areas of volcanic activity, connected with which can be traced a considerable amount of elevation on the Earth's surface, so may we find in many places abundant proof of ancient volcanic agency in heaps of ashes, volcanic

cones and craters, and beds of lava, the burnt-out fires of former times, and the result of eruptions and attendant elevations of which little or no other record is preserved.

Appearances of this kind are not limited to such distinct marks of subterranean fires as we have mentioned, nor must we expect that eruptions that have been succeeded by the frequent denuding action of marine currents can be as manifest and as easily made out as where a vivid flame, a column of smoke, or a current of molten rock, speak to the senses in a language that cannot be questioned. But we need not feel less certain of the former existence of volcanic action in a spot because, at present, there are no eruptions, provided we can discover true erupted products, such as ashes and lava; and it is well known these are occasionally seen where there are absolutely no indications whatever of igneous disturbance at the surface, although, in other cases, the form of ancient volcanoes is partly preserved in the hills of the district in spite of the time that has elapsed since the period of activity. There may, however, be distinct conditions of igneous rocks where there is no evidence of volcanic disturbance, and it is necessary to consider the extent and value of the various phenomena in each case.

The principal and best known points at which volcanic eruptions have taken place on the continent of Europe, since the commencement of the tertiary period, from volcanoes which have now become totally extinct, are in the valley of the Rhine, between Bonn and Mayence; in the department of Puy de Dôme, in Central France; and on the north-east coast of Spain, at Olot, in Catalonia. All these have been perfectly quiet, and free from the disturbances of volcanic action, during, and probably long before, the existence of man upon the Earth, but all of them exhibit, with the utmost distinctness, series of volcanic phenomena exactly resembling those which are described as characterizing Etna and Vesuvius in modern times. One volcanic district of the Rhine extends for about twenty-four miles from east to west, and from six to ten miles from north to south. The volcanic cones have here been forced up through schistose and micaceous beds of the middle and older Palæozoic periods, and the trachytic lava and basalt have been poured out around the base of the hills, often extending to considerable distances, without much reference to the present configuration of the country. A number of ancient craters, some of which are now lakes, may be observed at different points on each bank of the Rhine, but the walls of these craters are usually made up of cinders and scoriæ, and the deep indentions and fractures of the walls often show the points whence a lava current must once have issued. On the whole, however, the lava seems to have been chiefly erupted through cracks and fissures in the subjacent rocks, and to have been spread evenly over the surface, often in very thin bands.

By far the most important feature of the volcanic district of the Rhine, though not that which presents itself most prominently to the passing visitor, is the great extent of the basaltic platform, partly in the Duchy of Nassau, and extending on the right bank of the Rhine, but reaching still further to the east, and forming the hills called the Vogels Gebirge. In the former district, indeed, the basalt is covered up in many places by a remarkable bed of lignite, or brown coal—but not less than 1000 square miles of country in the neighbourhood of the Rhine have been in former ages overwhelmed by a flood of lava, probably spread out beneath the waters of an inland lake long since dried up. The thickness of the bed is not generally considerable.

A district in Central France—in former times the seat of subterraneous disturbance—reposes, or, rather, rises out of a granitic platform: the Mont d'Or, the most conspicuous of the volcanic cones, rising suddenly to the height of several thousand feet, and being composed of layers of scoriæ, pumice-stones, and fine detritus, with interposed beds of basalt. A considerable number of minor volcanoes form an irregular ridge on the platform, and extend for about eighteen miles in length, and two in breadth. They are usually truncated at the summit, where the crater is often preserved entire, the lava having issued from the base of the hill; and the lavas may often be traced from the crater to the nearest valley, where they usurp the channel of the river, which in some cases has since excavated a deep ravine through the basalt. In Catalonia, the eruptions have burst entirely through secondary rocks, and the distinct cones and craters are about fourteen in number, but there are, besides, several points whence lava may have issued. The volcanoes are most of them very entire, and the largest has a crater 455 feet deep, and about a mile in circumference. The currents of lava are, as usual, of considerable depth in the narrow defiles, but spread out into thin sheets over the plains; the upper part is scoriaceous, further down it is less porous, and at the bottom it becomes prismatic basalt, about five feet thick, resting on the subjacent secondary rocks. In addition to these, many other parts of Europe, especially in Bohemia, Moravia, and Hungary, exhibit remarkable and extremely interesting examples of extinct volcanoes. Some of these are well known for the hot springs which rise out of the ground in the vicinity, or the hills of volcanic products which characterise the landscape, and of this kind are Carlsbad and Toplitz. Others are near existing volcanoes, but have still all the peculiarities of those which are extinct, and amongst this latter kind are numerous instances in the Greek Archipelago.

It appears from the investigations of various travellers that the western part of Asia and the peninsula of India exhibit the phenomena of recently extinct volcanic action on a scale far grander than is known in Europe, for in these countries the lava has been poured out over an area of many thousand square miles, and rests in flat tubular masses upon the country. The volcanoes of Asia Minor are still in a state of disquiet, and the elevation of the chain of the Caucasus has doubtless been continued to within a very recent period; while so closely does the past approach the present in this part of the world and in America, that it is often difficult to decide to which period many of the phenomena must be referred, and it has happened even in Europe, that volcanoes, supposed to be extinct, have once more burst forth, and apparently with tenfold violence, after a long period of repose.

The coast of Antrim, presenting the magnificent basaltic columns of the Giant's Causeway, and an important adjacent district in Scotland as well as Ireland, have long been celebrated as exhibiting very remarkable instances of the protrusion of large quantities of molten rock in former times. In the part of Ireland alluded to, there are many hundred square miles of country, extending from the neighbourhood of Belfast to Coleraine, in which a considerable series of rocks of the secondary period, terminating with the chalk, have been covered in this way. On the coast, especially towards the north, the basalt is seen capping the chalk, which is usually much altered and hardened into limestone, and the flints are reddened as if burnt near the contact. In other places, clayey or shaley beds are changed into hard siliceous rock, and sometimes indicate crystalline structure; while in others, again, as at Ben Evenagh and elsewhere, the basalt assumes a character of extreme grandeur, and successive stages of ponderous and shapeless masses rise to the base of the steep basaltic summit, and there break into pinnacles and precipitous cliffs. But in the interior of the country, the protruded rock, although present, sinks to a low level, and along the western shores of Lough Neagh and Lough Beg is so much concealed as to appear only in isolated lumps or small ridges, rising here and there above the surface. In many places, indeed, it is evident that the softer parts of the rock have been carried away, and that the whole of the detached portions were formerly continuous; and this is not to be wondered at, when we consider that the mineral composition and relative hardness is very variable, and that the whole district has been exposed to diluvial action, and to the denuding force of running water. It is not easy to account for the occurrence of these large masses of igneous rock in the north-east of Ireland, or to connect them with any focus or centre of eruption. They have probably been forced through wide cracks formed in the subjacent strata, and thus belong to the class of phenomena sometimes considered separately from the tabular basalt, and denominated trap veins and dykes. But however this may be, all the true characters of lava are apparent in the rock under consideration, and all the strata discovered in contact with the basalt have been altered by this foreign rock introduced among them. Phenomena almost exactly similar are seen in the Island of Staffa and in some others of the western islands of Scotland, and the picturesque beauty of Fingal's Cave and the Giant's Causeway has been too often described to render any account of them necessary in this place.*

107 *Ancient Lava-Currents.*—It has been proved by the experiments of Mr. Gregory Watts,† that the rock spoken of in the preceding page as *basalt*, is in point of fact, nothing more than lava of ancient date, and although in England basalt and basaltic rocks are confined to certain parts of the country, and to rocks of certain geological designation, they are found elsewhere more generally diffused.

Basalt occurs in the older rocks in two conditions, which may be separately considered—namely, 1st, in the condition of an overlying mass, or of beds alternating with the regular strata; and 2nd, as dykes, traversing stratified and other rocks, and filling up cracks and fissures. In this latter state it often forms the connecting link between the tabular masses and some great subterranean reservoir, although in other cases it does not rise above the surface of the rocks which it penetrates. Its mineral constituents are essentially the same as those of modern lava, but occasionally hornblende predominates, when, from the peculiar colour of that mineral, the name of greenstone is applied to the variety. The most usual characters of the basaltic rocks of England are—(1) their iron-grey colour, approaching to black; (2) their frequent tenacity and hardness (whence their value in making roads); and (3) a sharp and sometimes conchoidal fracture, and a granular aspect, indicating the commencement of crystalline structure. They are very liable to superficial decomposition, in which case the colour changes to a rusty brown, owing to the oxidation of the contained iron, and the decomposition sometimes penetrates a considerable depth into the mass of the rocks, exhibiting spheroidal masses less decomposable than the rest of the rock. There are several beds and overlying masses of trap among the carboniferous rocks of England, very many others which have only penetrated the Silurian rocks, and which, therefore, must have been erupted anterior to the decomposition of the Newer Palæozoic strata. It will be sufficient to allude shortly to the principal instances, in order to give a general idea of the nature of these rocks of intrusion in our own country. Basalt occurs in overlying masses in many parts of the north of England; eminences of this kind have often been chosen for the sites of feudal castles, and at Bamborough, where one of these castles was built, the thickness of the mass has been ascertained, by boring for water, to be seventy-five feet. A remarkable instance of overlying basalt may be observed forming a group of hills near the town of Dudley, in Staffordshire. The rock here has received the name of Rowley rag,‡ from the village of Rowley, situated on one of the highest of the basaltic hills. It is extremely hard and of coarse texture, and has been used for paving the streets of Birmingham; a similar rock is found at a distance, forming the upper part of the lofty hills of Titterstone Clee and Brown Clee, in Shropshire. The trap in these places distinctly reposes on the coal measures, and where it comes in contact with the coal has greatly injured its quality, and reduced it to a sooty state. The toadstone of Derbyshire is a well known rock, apparently interstratified with the rocks of the Carboniferous period in that county, and it offers a very striking example of bedded trap. This toadstone, which had generally been described as repeated in three distinct beds, has been supposed by Mr. Hopkins to be the effect of only one, or, at the most, two eruptions of melted

---

* Ansted's *Geology*, vol. ii. pp. 208—213. † *Trans. Roy. Soc.* for 1804, p. 279.

‡ It was a mass of this rock which formed the subject of Mr. G. Watts' experiments, already described.

rock, and he has endeavoured to show that the several beds, apparently distinct, merely consist of the original one repeated in different parts of the district by faults. The abundance and accuracy of the detailed information offered in support of this view render it difficult to doubt that the conclusion is correct. The determination of this point is of much importance in a country so valuable for its mineral resources, and the more so, because the identification of the limestones and associated lead veins depends on the position of the interstratified volcanic rock.*

Basaltic dykes of very considerable extent traverse the carboniferous limestone in many parts of the north of England, some of them being as much as from thirty to forty feet in width. These dykes are either vertical or very highly inclined, and the basalt of which they are formed is of a greenish-black colour and coarse texture. Sufficient evidence is supposed to exist of their igneous origin, and of the rock having been injected in a melted state, by the altered appearance of the wall of the dyke; for the adjacent coal, in one example, at Walker, in the Newcastle coal-field, is actually converted into coke, which, on one side, was found to be in some places thirteen feet thick, and on the opposite side upwards of nine feet.† But this fact of the coal being completely charred and turned into coke is common throughout the district, whenever a basaltic vein traverses coal-bearing strata.‡ The rocks of volcanic origin, which are most commonly associated with basalt, are those called *trachytic*, or *trachyte*, from their rough feel when rubbed between the fingers. Trachyte is sometimes considered to bear the same relation to granite that lava does to the ancient basalts, and is composed chiefly of felspar, combined frequently with a considerable proportion of silex. It abounds in the volcanic district of the Rhine, and there forms a kind of imperfect building stone, and it is also common in various forms in the Puy de Dôme, where it appears under very similar circumstances. Besides the ordinary form of trachyte as a volcanic rock, it appears yet more frequently in pulverulent masses of pumice, forming what is called *tuff* or *tufa*, which has been found in rocks of all ages, interstratified with fossiliferous beds, but itself rarely containing organic remains. The presence of this tufa invariably marks the vicinity of igneous and erupted rocks, and in this way it is often useful to the geologist, more especially in the older formations.§ It has frequently been attempted, more

---

* At Teesdale, in Yorkshire, and elsewhere in the north of England, there are instances of highly picturesque scenery owing to the presence of basaltic rocks in various crystalline conditions. In these cases, the associated limestones are usually altered and converted into marble.

† Conybeare and Phillips' *Geology of England and Wales*, p. 447. It may be observed here that this evidence, though very plausible, is by no means free from objection, and the change observed may possibly be independent of the heat of the basalt.

‡ A still more remarkable instance than that in the text, of the alteration effected in the neighbourhood of a trap-dyke, is related in the *Transactions of the Northumberland Natural History Society*, vol. ii. p. 343. An account is there given of the greenstone dyke on Cockfield Fell, and its effects on the coal strata in one of the collieries of the great north-eastern coal-field. In working the coal towards this dyke, the change was observable at a distance of fifty yards, the coal becoming dull, and losing its quality for producing flame. Nearer the dyke, it has the appearance of half-burnt cinder, and still nearer, consisted of sooty matter, caked together, while close to the dyke the bed was reduced in thickness from six feet to nine inches. This dyke is nearly vertical; it has been traced about seventy miles from south-east to north-west, and is in some places eighteen yards in width; and it is calculated to have spoiled as much as 100 yards of coal along all that part of the seam traversed by the dyke throughout Cockfield Fell. The observation made in the previous note will also apply here.

§ The pumice of commerce can hardly be regarded as a distinct mineral, as it is only a cellular and filamentous state which several volcanic rocks (chiefly trachytes) are capable of assuming. It is not met with in all volcanic districts, and seems to be erupted only under peculiar circumstances. Vast quantities have been quarried at the foot of Cotopaxi, one of the celebrated volcanoes of the Andes, and it there occurs in beds distinctly stratified, and is often associated with obsidian. The principal localities in Europe in which it abounds are the Lipari Islands, and some of the islands in the Grecian Archipelago, Iceland, and the extinct volcaic of the Rhine. It is also found in Teneriffe, and in some of the volcanic islands of the eastern Archipelago.

especially by the continental geologists, to class the various rocks of igneous origin with reference to their predominant minerals, but these arrangements have never attained any very general acceptance in our own country. There appear to be two series—those in which felspar or hornblende respectively abound—in rocks of each geological period, and these in their most characteristic forms of granite or trachyte, and basalt or lava, are sufficiently distinct, but they pass insensibly into one another by innumerable variations, which demonstrate the similarity of origin of all the unstratified rocks.

It may, therefore, be considered, on the whole, that the occurrence of trappean rocks is a geological event belonging to all successive periods, and affecting all rocks whether stratified or not, but it is also evident, that while no rocks bear more strictly the marks of igneous origin than those called basaltic, even they are sometimes so distinctly stratified as to have formed thin layers alternating with fossiliferous strata of aqueous origin and probably erupted from volcanic vents opening at the bottom of the ocean, as we have reason to believe still happens occasionally. There is, therefore, in these phenomena—which, it must be repeated, connect the rocks of known igneous origin, such as are still from time to time erupted, with the most ancient of those rocks supposed to be plutonic—a still farther and more interesting point rendered clear, the change being even indicated by which the regularly stratified fossiliferous rocks pass first of all into metamorphic, and then into distinctly igneous formations.

These facts with regard to ancient lava currents, erupted at various times and under various circumstances, afford ample proof that volcanic agency, or some very nearly allied force, has acted even during the formation of the lower, and therefore older, of those mechanically formed rocks met with in almost all parts of the Earth's surface. We must, however, now consider other appearances presented, in which igneous action appears clear, though not in the form exhibited in either modern or ancient volcanic vents.

108 *Other Igneous Rocks not Volcanic.*—A very large portion of the underlying rocks in many parts of the world, and almost all the highest peaks of the principal mountain ranges, are composed of rocks of which granite is the type, and which seem to have been upheaved from considerable depths, bearing with them in most cases masses of strata originally deposited horizontally upon them, but in the course of elevation cracked and broken, or otherwise altered, according to the nature of the elevating force and the mechanical condition of the beds themselves. These rocks are apparently igneous, but whether they were ever in actual fusion or not, their particles are now so arranged as to exhibit clearly the action of crystalline forces, and the rocks associated and lifted are not unfrequently penetrated by the granite or crystalline masses, or otherwise affected by them. The effects thus produced are not attributed to ordinary volcanic action, for they are on too large a scale, and too little identical, to bear strict comparison with any results of such action at present. They are, however, not unlike when fairly considered, and afford most useful material for such limited comparison as the case really warrants.

The granitic rocks are very widely spread over the earth, and in most cases they form the underlying portion, with reference to any sedimentary rocks that may appear. This might be proof either of their being the most ancient, or the newest formed rocks, for if the former, they must occupy as they do the lowest position, and if the latter, they may have existed in another form for an indefinite period, although only recently placed in a state to affect or upheave other rocks. It is, however, certain, that they really are of various periods, and although from their extensive range often regarded as the foundation and solid framework of the Earth, they are possibly in the very act of formation far beneath the surface, even at the present day.

Granitic rocks, although by no means always of the same general character, exhibit features which leave no doubt as to their nature, and may be found in several localities in each of the British Islands. Granite also occurs abundantly in other parts of Europe, as in the Scandinavian mountains, the Hartz, the range of mountains separating North Germany from Bavaria and Bohemia, the Alps both of Switzerland and the Tyrol, the Pyrenees and the Carpathians. In Asia it forms the centre of the Caucasus; it occupies a large part of the Himalayan, Uralian, and Altai mountains, and is found also in Siberia. In Africa it appears in Upper Egypt, in the Atlas mountains, and at the Cape of Good Hope: it may also be traced along the western part of the whole of the two Americas; and appears again in the islands of the South Pacific, and in Australia.

But granite is only one form of igneous rock, and many others, some having the same general porphyritic character (crystals embedded in a base), are found in various parts of the earth, either alone or in near association with true granite (quartz, felspar, and mica). Such rocks, under various names, have often been described in distinct groups as peculiar crystalline or chemical products, but many of the peculiarities they present, are probably rather owing to a difference in the rate of cooling of a large mass, than to any original characteristic. Thus, according to the rate of cooling, we might have a large or fine grained granite, or a nearly compact rock: or if the quantity of felspar was very great, and the cooling rightly proportioned, the mica and quartz might be crystallized in a compact earthy or glassy uncrystallized basis. In this way a felspar porphyry might be produced from the same ingredients as ordinary granite, and the various greenstone, hypersthenic, hornblendic, and other mixtures, do not require detailed descriptions in a general account of igneous rocks.

Of the granite and similar rocks presented in the British Islands, some portions in Scotland (Isle of Skye), Cornwall, Cumberland, and elsewhere, have not only forced up other rocks, but have also penetrated the fissures made in them during elevation. This seems to prove two important points—namely, that at least in these cases, the granite was more modern than the adjacent and overlying masses, and also was ejected in a soft or nearly fluid state. Granite veins or dykes, filling up crevices, are indeed by no means rare phenomena, although they had not till a recent period attracted full and complete attention.

The chief field for observation of igneous rocks within the British Islands is in Scotland, where almost every variety is represented. The Grampian and other mountain ranges are entirely composed of granite, and in the adjacent islands it is repeated in all its characteristic features. In Cumberland and North Wales, felspar porphyries take the place of granite to a great extent, and alternate with it. In Cornwall, granite re-appears in large quantity and throws off numerous veins. In the Malvern hills, and those of Charnwood Forest, in Leicestershire, Syenite prevails, while hypersthene rock frequently appears, and sometimes, as at Cuchullin and Carrock Fell, forms pinnacled mountains. The rock called claystone, and claystone porphyry, and various amygdaloidal rocks, also present themselves, varying and complicating the phenomena.

Thus do these igneous rocks present themselves at or near the general surface, in many important districts, and offer for the investigation of the naturalist many striking facts. The various rocks, abruptly rising and exposed at the surface, are often split by deep parallel fissures, sometimes formed into large flattened globes, which put on also a columnar appearance—and sometimes worn into mounds, scaling off in layers at the surface. The same rocks, different only by the circumstances of their formation, are elsewhere split into blocks, which might at first appear rolled or transported from a distance, but which are really only the results of a peculiar decomposition.

All these and many other appearances have been described as, at some times and in some places, characteristic of this group of rock masses, which have indeed little in common either in material or order of arrangement of the material. It is important also, to remark in conclusion, that the mineralogical and other peculiarities are wholly independent of age or position, for we find in opposite hemispheres in totally different climates, and under circumstances perfectly distinct, the same general aspect and the repetition even in minute detail of many common igneous rocks.

109 *Metamorphism.*—The erupted rocks, whether granitic or basaltic, not only act dynamically, shaking, elevating, inclining, and laterally displacing the superincumbent beds, but also modify the chemical combinations of their elements, and the nature of their internal structure; thus forming new rocks. These under the names of gneiss, mica slate, clay slate, granular limestone or marble, and quartz rock, are often very extensive, and are denominated *metamorphic*. The theory of metamorphism is now established with reference to a great variety of rocks, and the nature and amount of change are fully recognised.

Observations made with great care, and over considerable tracts of country, show that erupted rocks have acted in a regular and systematic manner. In parts of the globe most distant from each other, granite, basalt, and diorite are seen to have exerted, even in the minutest details, a perfectly similar metamorphic action on the argillaceous schists, the compact limestone, and the grains of quartz in sandstone. But whilst the same kind of erupted rock exercises almost everywhere the same kind of action, the different rocks belonging to this class present in this respect very different characters. The effects of intense heat are indeed apparent in all the phenomena; but the degree of fluidity has varied greatly in all of them, from the granite to the basalt; and at different geological epochs, eruptions of granite, basalt, greenstone, porphyry, and serpentine, have been accompanied by the issue of different substances in a state of vapour. According to the views of modern geology, the metamorphism of rocks is not confined to actual change effected at the contact of two kinds of rock; but it comprehends all the phenomena that have accompanied the issuing forth of a particular erupted mass; and even where there has been no immediate contact, the mere proximity of such a mass has frequently sufficed to produce modifications in the cohesion of the particles, in the texture of the rock, in the proportions of the silicious ingredients, and in the forms of crystallization of the pre-existing rocks.

All eruptive rocks penetrate as veins into sedimentary strata, or into other previously existing endogenous* masses; but there is an essential difference in this respect between plutonic rocks—granites, porphyries, and serpentines—and those called volcanic in the most restricted sense—trachytes, basalts, and lavas. The rocks produced by the still existing volcanic activity present themselves in narrow streams, and do not form beds of any considerable breadth, except where several meet together and unite in the samo basin. Where it has been possible to trace basaltic eruptions to great depths, they have always been found to terminate in slender threads, examples of which may be seen in three places in Germany,—near Marksuhl, eight miles from Eisenach,—near Eschwege, on the banks of the Werra,—and at the Druidical stone on the Hollert road (Siegen). In these cases, the basalt, injected through narrow orifices, has traversed the bunter sandstone and greywacke slate, and has spread itself out, in the form of a cup; sometimes forming groups of columns, and sometimes divided into thin laminæ. This, however, is not the case with granite, syenite, porphyritic quartz, serpentine, and the whole series of unstratified rocks, to which, by a predilection for mythological nomenclature, the term plutonic has been applied. With the exception of occasional veins, all these rocks have been forced up in a semi-fluid or pasty condition, through large fissures and wide gorges, instead of gushing in a

* This term has been used by Humboldt to designate all rocks formed or modified from within, and therefore, not owing their essential characteristics to mere mechanical action. It includes the igneous and metamorphic rocks of other authors.

liquid stream from small orifices; and they are never found in narrow streams like lava, but in extensive masses. Some groups of dolerites and trachytes show traces of a degree of fluidity resembling that of basalt; others, forming vast craterless domes, appear to have been elevated in a simply softened state; others again, like the trachytes of the Andes, in which Humboldt states that he has often remarked a striking analogy to the greenstone and syenitic porphyries (argentiferous without quartz) are found in beds like granite and quartzose porphyry.

Direct experiments on the alterations which the texture and chemical constitution of rocks undergo, from the action of heat, have shown that volcanic masses (diorite, augitic porphyry, basalt, and the lava of Etna) give different products according to the pressures under which they are melted, and the rate at which they are cooled; if the cooling has been rapid, they form a black glass, homogeneous in the fracture; if slow, a stony mass of granular and crystalline structure, and in this latter case crystals are formed in cavities, and even in the body of the mass in which they are imbedded. The same materials also yield products very dissimilar in appearance, a fact of the highest importance in the study of eruptive rocks, and the transformations which they occasion; since, for example, carbonate of lime, melted under high pressure, does not part with its carbonic acid, but becomes when cooler granular limestone or saccharoidal marble when the operation is performed by the dry method; while in the humid process, calcareous spar is produced with a less, and arragonite with a greater degree of heat. The mode of aggregation of the particles which unite in the act of crystallization, and consequently the form of the crystal itself, are also modified by differences of temperature; and even when the body has not been in a state of fluidity, the particles, under particular circumstances, may undergo a new arrangement manifested by different optical properties. The phenomena presented by devitrification,—by the production of steel by casting or cementation,—by the passage from the fibrous to the granular texture of iron, occasioned by increased temperature and possibly by the influence of the long-continued repetition of slight concussions,—may elucidate the geological study of metamorphism. Heat sometimes elicits opposite effects in crystalline bodies; for Mitscherlich's beautiful experiments have established the fact, that without altering its condition of aggregation, calcareous spar, under certain conditions of temperature, expands in one of its axial directions while it contracts in the other.

Passing from these general considerations to particular examples, we may mention the case of schist converted by the vicinity of plutonic rocks into roofing slate of a dark blue colour and glistening appearance; the planes of stratification are intersected by other divisional planes, often almost at right angles with those of stratification, indicating an action posterior to the alteration of the schist, the latter sometimes containing carbon, and then perhaps capable of producing galvanic phenomena.

Sometimes the contact and plutonic action of granite have rendered argillaceous schists granular, and transformed the rock into a mass resembling granite itself, consisting of a mixture of felspar and mica, in which laminæ of mica are found embedded. We are told by Leopold von Buch, that all the gneiss between the Icy Sea and the Gulf of Finland has been produced by metamorphic action of granite upon the silurian strata. In the Alps, near the St. Gothard, calcareous marl has been similarly changed by the influence of granite, first into mica slate, and subsequently into gneiss. Similar phenomena of gneiss and mica slate, formed under the influence of granite, present themselves in the oolitic group of the Tarantaise, in which belemnites are formed in rocks which have already in great measure assumed the character of mica slate.*

Remarkable instances of metamorphism have been pointed out in the

* Humboldt's *Cosmos*, Sabine, p. 245—250.

Tyrol, especially on the Italian side, where limestone is altered by means of fissures traversing it in every direction, the intervals and cavities being filled with crystals of magnesia, and the original stratification completely obliterated. Others, not less remarkable, are found also in the cliff on the coast of Cornwall, and in many of the western islands of Scotland.

110 *Dykes and Mineral Veins.*—One of the results of the intrusion of igneous rock, and the consequent change effected in the molecular condition of the rock, is the production of crevices and fissures, which may either have arisen from the absolute elevation and consequent disruption of the mass, or from contraction, owing to the drying or heating of the mass. Generally such crevices will be in two principal directions, the one identical with that of the axis of disturbance, and the other at right angles to that axis—tho former will be the longer and more uniform series, but will often include parallel fissures at intervals—the other will be shorter and more irregular, and perhaps chiefly observable at intervals where there seem to have been points of more abrupt violence. It may be considered also highly probable, that since we find two kinds of fissures, one of considerable width at and near the surface, but becoming narrower in descending, while the other continues of nearly equal width to considerable depths, these two kinds are not unfrequently due to different causes, the gaping cracks frequently identical with faults and dislocations of the strata resulting from upheaval, while the more even and regular crevices are connected with deeper-seated disturbances or the gradual contraction of very large masses.

It is convenient to have two names to apply to phenomena which often present themselves in such different manners. The broad cracks, subsequently filled up with matter thrown up from below, or overflowing and so running in, we may call *dykes;* while the narrower crevices, which, though also filled with various minerals, present them in a different way, are called *veins.* Examples of the former, filled with basalt or injected rock, have been mentioned in a preceding section, (see p. 288,) and we have now to consider the latter, which are of great practical importance, as containing not only crystalline earthy minerals, but a large proportion of the most valuable of those ores from which the metals are obtained.

The mineral substances contained in these veins are of two kinds; the one being generally either silex, fluor-spar, or carbonate of lime, all earthy minerals, and generally in a crystalline state, the other consisting of metallic oxides and salts, in greater or less abundance. The latter being the valuable produce of veins, are eagerly sought for and worked: but the others, not exhibiting any trace of metallic ore, possess little economic value. Two classes of veins therefore exist, which are found to differ from each other in various respects, and amongst the rest in compass-bearing and in their inclination to the horizon.

It appears at first, that nothing can be more variable and unaccountable than the relation of the metallic ores in a mineral vein to the circumstances of position of the vein, but in spite of this, there really exists a certain amount of order, and an approach to regularity. In all districts traversed by mineral veins, there are, for instance, what may be called systems of veins, each system being characterized by some peculiarities of position or contents, and each, so far as we can judge, referrible to a distinct period. In Cornwall, there have been described eight such systems, and the same number had been observed by Werner, at Freyberg. In the former district, three of the systems run east and west, and one north and south, while another ranges N.W. and S.E., or N.E. and S.W. Of these, the east and west veins are called *right-running*, because they include most of those which are productive for tin and copper, (the staple minerals of the district,) while the north and south are called *cross-courses*, crossing the first at right angles, and being also productive, but chiefly for lead and iron. The others are called contra lodes, and are few in numb r. The remaining three classes are also unimportant to the miner, and are usually filled with clay.

The systems of veins in the Freyberg districts are described by Werner, and offer a series of facts somewhat analogous to those observed in Cornwall; but the metals are different, and so also are the prevailing directions of the lodes. The first and most ancient are chiefly north and south, and include those veins from which the chief supplies of lead and silver have been obtained. The second system (contra lodes) are more argentiferous, but much thinner. Their direction is about north-east and south-west. The veins of the third are all north and south, and those of the fourth are at right angles to them, being what are called in Cornwall cross-courses. They both contain lead glance. The others are less important.

In the English lead districts, the systems of veins are much more simple than in Cornwall or Saxony; the direction of the productive veins is, almost without exception, east and west, and they are traversed by cross-courses, not productive, at right angles to them. The underlie is seldom considerable, and it is tolerably uniform throughout the district.

On the whole, and viewed with reference to the whole district, the direction of the productive veins in Cornwall must be regarded as strikingly uniform, and the mean of nearly three hundred observations, recorded by Mr. Henwood, gives 4° S. of W., while the actual direction, in nearly two-thirds of the number, differs but little from the average.*

Lastly, the fact of these veins being filled with various foreign substances, often placed one upon another, in regular order, and repeating nearly the same appearances, under similar circumstances, in the same mining district, is an important proof that they must be referred to some widely acting, if not universal, cause, if we wish to account for them in any rational manner. Electricity, especially in those two important forms, galvanism and magnetism, offers the best and the most satisfactory explanation of the greatest number of the phenomena. The constant action of a force so influential in re-arranging the ultimate elementary atoms of bodies, and causing them to enter into new combinations, cannot fail to produce great changes when acting under favourable circumstances and for a long time. No doubt, however, there have been many causes, proximate, if not direct and primary, which have all acted separately as well as jointly, and these may have operated at different periods, each tending to bring about results for which it was best adapted, and all together assisting in complicating the chain of phenomena now offered for investigation.

Mineral veins are very frequently faults or the result of the displacement of rocks, as well as simple crevices produced by contraction or separation in consequence of upheaval. In both cases they are sometimes filled with soft clay; sometimes the walls of the vein are lined with such clay, and sometimes the interior or contents of the vein are distinctly and at once separated from the walls without the intervention of any clay or other substance.

Veins vary exceedingly in dimensions, from less than an inch in breadth to many hundred yards, and from a length scarcely appreciable to many miles. They traverse all kinds of rocks, but are greatly affected by the kind of material through which they pass. They often cross each other, and are moved in position, the newer vein altering and heaving the older, and their contents are greatly modified by all the mechanical changes to which they are exposed.

The metalliferous ores contained in veins are very numerous, greatly varied, and highly important, as from them are derived the chief supplies of metals used in the arts. Many of the metals, as gold and platinum, are found only in a native state, or alloyed with other metals; others, as silver,

---

* See Ansted's *Geology*, vol. ii. p. 256. The actual number of observations tabulated was 295; of this number the direction in 182 instances was between west and south-west, and in 62 others between west and north-west. Dividing Cornwall into ten districts, the mean direction of the veins in seven of the districts is much more south of west than the general mean, as the other three districts chiefly contain the contra lodes.

copper, mercury, arsenic, bismuth, &c., are found occasionally pure or alloyed, and in the metallic state, but more frequently as metallic oxides, or mixed with other ingredients, and in an earthy state. Very common ores of copper, tin, iron and manganese, are the oxides of those metals; other ores, also very common, of copper, lead, silver, zinc, antimony, arsenic, &c., are combinations of the metals with sulphur (*sulphurets*), and others again with carbon and oxygen (*carbonates*); while some metals, such as cobalt, nickel, chromium, &c., are almost invariably found with other metals, such as arsenic and iron. With the common ores are mingled generally smaller quantities of other metallic salts and oxides, from which the numerous varieties presented in the mineral kingdom are derived.

The metalliferous districts of the British islands are chiefly confined to the western and northern parts of England and Scotland, and the eastern part of Ireland. Cornwall alone furnishes the whole of the tin and seven-eighths of the copper obtained, the rest of the copper being from Wales; large quantities of lead are obtained from Durham and Northumberland, Cumberland, Yorkshire, and Derbyshire, although Cornwall, Wales, and Scotland also contribute no unimportant quantity. Large quantities of zinc ore exist also in many of the lead districts of England, but are not now worked to advantage. The iron ores of England are chiefly bedded, and do not, therefore, admit of description in this place, but large quantities of rich oxides (*hæmatite*) are found in Cornwall, and in the northern part of Lancashire. The tin of Cornwall, chiefly in the form of oxide, supplies not only England, but a great part of Europe, a little being obtained from Saxony, and some small mines existing in Sweden and Austria. The island of Banca, in the Indian Archipelago, and the adjacent peninsula of Malacca, also yield a considerable quantity.

Russia is remarkable for numerous and rich supplies of gold, besides silver and lead; these, however, being chiefly important in the more distant easterly provinces of that vast empire. France is comparatively poor in metallic produce. Austria, chiefly in the Tyrol, and Hungary, yield gold, cobalt, iron, lead, silver, and mercury. Scandinavia is rich in iron and copper, while Spain yields mercury at Almaden, and lead and copper in other places. Prussia, with the exception of some parts of Silesia, is comparatively poor, while Saxony is remarkably rich in ores of silver, lead, tin, and cobalt. Various smaller districts in Germany also offer interesting spots to the miner, and amongst these the Hartz is perhaps the most remarkable.

While Europe and Northern Asia thus offer a multitude of places whence metallic riches may be obtained, other parts of Asia, especially India and the country adjacent the Malayan peninsula, together with Southern Australia, are amply provided with similar resources. Nor is America less favourably circumstanced, since Mexico, Columbia, Brazil, and, as has been lately shown, California, are rich in the precious metals, copper, and quicksilver, whilst elsewhere, as in the United States and Canada, the metalliferous minerals already discovered are numerous, extensively distributed, and of great value. Africa again appears to contain several metals, among which gold is not the least important, and many parts of Australia have already yielded large supplies of mineral wealth.

All these mineral districts offer the same general structure, and in most of them similar metalliferous veins are found in the same kind of metamorphic rock. Mountain-chains, or hill-tracts, presenting distinct axes of elevation, mark the line of greatest mineral riches in Great Britain and Scandinavia, the Ural Mountains, the Altai Mountains, the mining countries of the Hartz, of Hungary and Silesia, the Eastern Archipelago and Australia; while the gigantic Cordilleras of the Andes, in South, and the Rocky Mountains in North America, traceable throughout the whole length of the New World, are also remarkable for their metalliferous produce.

CHAPTER IX.

STRUCTURAL PHENOMENA CONNECTED WITH AQUEOUS ACTION.

§ 111. Stratification. — 112. Mechanical disturbance of beds. — 113. Order of superposition of European strata. — 114. Lower Palæozoic rocks. — 115. Middle Palæozoic rocks. — 116. Carboniferous system. — 117. Magnesian limestone, or Permian system. — 118. Upper New Red Sandstone, or Triassic system. — 119. Liassic group. — 120. Oolitic system. — 121. Wealden group. — 122. Cretaceous System. — 123. Older Tertiary rocks of England, France, and Belgium. — 124. Middle and Newer Tertiary formations of Europe. — 125. Tertiary deposits of Asia and America. — 126. Newest deposits of gravel and diluvium.

STRATIFICATION.—There are two classes of structural phenomena observable in aqueous rocks—the one including phenomena of deposition, the other of disturbance; the former presenting the result of many ages of uniform action, similar to that going on around us in every river and on every coast, while the latter marks the intervals of such regular action, and their interruption by upheaving and other forces from below, producing mechanical displacement, and often attended with the incursion of such rocks as we have been considering in the last chapter. As it is the object in the present chapter to study those structural phenomena which are connected with aqueous action, it is manifest that we have to deal with the former of the two classes of facts just referred to.

No one at all acquainted with the coast of our own island, or with the Earth's structure as exhibited in quarries, railway cuttings, coal mines, or other places where that structure is laid bare, can have failed to remark frequent evidence of mechanical deposition and arrangement in the various layers presented, and in the alternations of sand and clay, limestone and sandstone. As little can it have escaped the notice of any careful observer, that these layers are not, for the most part, horizontal, but tilted more or less, and sometimes very considerably, so that in travelling through a country we may, if our route lies in a certain direction, cross the edges of a number of beds in a comparatively short distance, or, on the contrary, may continue on one bed constantly, though that bed is manifestly of no great thickness. In other words, the various beds possess a certain definite direction or length, and a limited breadth, arising from and depending on their inclination to the horizon, rather than their absolute thickness. This is expressed in geological phraseology by the terms *strike* and *dip*, the former meaning the direction in which the edge of the lifted up bed is to be traced along the Earth's surface, and the latter the amount of its inclination to the horizon, which must necessarily be at right angles to the former direction, whatever that is. The geologist, taking advantage of this structure and position of the beds, (the result, no doubt, of the subterranean upheaving motion already described,) learns to connect together appearances in different countries, to extend his knowledge of different beds and multiply very greatly his observations on them, to discover the circumstances of their deposition, by looking at their present aspect, and arrange them in such order that he shall be able to recognise them when he desires to compare those found in distant places.

The materials, therefore, of the Earth's crust being to a great extent rranged in layers, beds, or strata, and appearing to have been deposited from suspension in water, the term 'stratification' includes a very large class of phenomena, and we may employ the expression 'stratified rock,' as a descriptive and distinctive name. The rocks described in the last chapter are, on the other hand, 'unstratified,' for they exhibit neither the appearance referred to, nor any marks of slow subsidence from water.

The general appearance of a stratified rock is that of numerous layers of material of the same kind—whether simple limestone, sandstone or clay, or any mixture of these—forming together a group to which the name of *bed* may be applied, and which differs from the separate leaf-like and irregular layers in presenting characters somewhat more marked at its junction with another such group or bed. Thus, a bed of clay may be of indefinite thickness, and may even form an almost homogeneous mass; but, provided it is separated from similar or dissimilar beds, it is considered distinct, even if resting on, or overlaid by other clay of the same kind; but minute differences of colour or tenacity are generally manifest, and afford sufficient proof of aqueous origin, by producing, in fact, these ordinary appearances of stratification. The word *stratum* (plural, *strata*) is very commonly used as synonymous with *bed*, as, on the other hand, *bedding* is synonymous with *stratification*. When, as frequently happens, several beds or strata rest upon one another, and are possessed of certain common characteristics, having been apparently deposited continuously, the whole together are distinguished as a *formation*, and in this way we speak of the chalk or the London clay as formations, meaning thus to express a higher step in generalization than when we speak of them merely as strata.

But the further investigation of nature shows that there are not only a great many of these *formations*, but that we may occasionally include several of them under more comprehensive titles. In this way, a number of formations together may be collected into a *system*, so that, for instance, the chalk and greensand formations, which have certain characters in common, are spoken of together under the name of the '*Cretaceous System*.' There is a yet higher division also, which is often adopted, and according to which the whole series of strata are collected into three great groups, and this, as its most striking feature, involves a total dissimilarity of fossil remains; and the lapse of a long period of time being supposed to have been the chief cause of this change, the group is sometimes denoted by the term *period*. The expression *series*, is also conveniently applied in some cases, and its use may occasionally be the means of avoiding difficulty or objection.

The whole number of strata thus grouped is exceedingly great, and their total thickness, if added together, would amount to many miles; but as there are no mines so deep, and no mountains so lofty, as to exhibit anything like the half of this thickness, it becomes necessary to inquire what are the means in the possession of the geologist, by which he can attain a knowledge which would thus seem necessarily shut out from him. The explanation of these means introduces another and most important branch of our science.

112 *Mechanical Disturbance of Beds.*—We have said that the beds are generally tilted or removed by some elevatory process from below into a more inclined position, with reference to the horizon, than that in which they were deposited. Now, since we find, on examination, that this elevatory process has acted very frequently during the deposit of the beds that form the series in such a country as England, it appears that the formation of regular strata has been accompanied from the very beginning by the action of forces, sufficiently powerful to elevate, break asunder, or alter the position of the whole mass of matter intervening between the point of application of the force and the surface of the solid matter of the globe at the time, and that these forces, although frequently shifting, were generally exerted in the same or nearly the same direction. It is clear also, that since the rocks have been very frequently consolidated and greatly altered, (partly, perhaps, by chemical and electrical causes, and partly by heat,) after they were deposited but before they were disturbed, and then after this have received the deposits of the next newer period—sufficient time must have

elapsed to allow of all this change, the greater part of which was, doubtless, effected by a process not merely gradual, but even slow.

Of the magnitude and mode of action of these forces, the observations which we are able to make on the rocks exhibited at and near the surface of the Earth, and which we have already considered, enable us to form a very real and useful notion, and although uniform in their nature, they have produced two distinct series of phenomena. From the examination of the first it appears, that the disturbances have often been such as to produce violent and sudden changes upon districts comparatively limited in extent, and that these changes have been accompanied by the eruption of heated or melted matter from beneath the surface. From the other appearances, we learn that tracts of land or of sea bottom of great extent have been the subject of slow and constant alterations of level, apparently without violent changes or marks of disturbance observable at the surface. To the action of the latter forces we must refer the general elevation of low and undulating, and often of mountain, districts, both island and continent, and their occasional depression; while all local disturbances, and the first formation of great mountain chains, belong to the other series, the forces acting at longer intervals and with greater violence over limited tracts.

The geological result of these forces has been, as we have said, to alter considerably the original horizontality of strata, to produce those phenomena which are respectively known as *dip* and *strike*, to cause the existence of *dykes* and *faults*, of *anticlinal* and *synclinal axes*, of *domes of elevation* or saddles, and *valleys of elevations*, while the position of many beds originally horizontal, but now seen lying on the upturned edges of the underlying beds, has introduced the necessity of employing such terms as *conformable and unconformable* stratification. These terms form a part of the technical vocabulary of the geologist, and their meaning requires to be fully understood before commencing any important geological investigations.

113 *Order of Superposition of European Strata.*—It is highly necessary to be acquainted generally with the whole series of mechanical deposits, and although it could hardly be expected that any one country could give a series so extensive, yet it so happens that most of the beds found in any part of Europe are met with also in the British islands.

The following table, though chiefly adapted for our own country, will also serve to give a general idea of the order of superposition of stratified rocks, and of the groups into which they have been collected. It will there be seen that we have a large number of rocks and collections of rocks to consider and compare, and that they have been arranged, as has been already intimated, into three principal divisions, called PERIODS, and in fourteen less comprehensive groups, called *series*, or *systems*. Of each of these we shall next proceed to give a brief outline, enumerating at least some of the more remarkable facts that have been determined with regard to the materials of which these groups have been made up, and the circumstances under which they are generally presented. It will be observed, however, that whilst in the table we have thought it best to give the order of succession in such a way that the eye would not be deceived in referring to it, it has been preferred, on the other hand, to commence the more detailed description with the rocks lowest in position, and therefore first formed. The reason for so doing will be very manifest when it is considered, that to give a true idea of the order of superposition in a table, the natural position must be observed, while to speak of the rocks themselves, which are derived from each other, the history is best given by commencing with the most ancient formations.

TABLE OF CLASSIFICATION OF ROCKS.

TERTIARY PERIOD.

British.	Foreign Equivalents, or Synonyms, and Chief Foreign Localities.
Modern Deposits.	
Raised beaches. Peat bogs. Submerged forests. Deposits in caverns. Shell marls.	Similar appearances in Northern Europe, Siberia, and America.
Newer Tertiary, or Pliocene Series.	
Upper gravel and sand. Till. Mammaliferous crag. Fresh water sand, and gravel.	These beds, or their equivalents, are known in various parts of Northern Europe and America. Other, but very different deposits, are the newer beds of Sicily. Others, again, are found occupying a large part of South America. Loess of the Rhine.
Red crag.	Subappenine beds. Brown coal (of Germany). Belgian tertiaries (Crag). The Sivalik beds (India) are supposed to belong partly to this period.
Middle Tertiary, or Miocene series.	
Coralline crag.	Touraine and Bordeaux beds. Part of the *Molasse* of Switzerland. Vienna basin. Certain European, Asiatic, North African, and North American beds.
Lower Tertiary, or Eocene series.	
Fluvio-marine beds. Barton clays. Bagshot & Bracklesham sands. London clay and Bognor beds. Plastic and mottled clays, sands, and shingles.	Paris basin. Central France. *Molasse* of Switzerland (lower beds). Belgian tertiaries. Various beds in Western Asia and India. Various beds in North and South America. Nummulitic beds.

SECONDARY PERIOD.

British.	Foreign Equivalents.
Cretaceous system.	
Upper. Upper chalk with flints. Chalk without flints. Lower chalk and chalk marl.	*Scaglia* limestone of the Mediterranean. Maestricht beds. *Senonian* division of D'Orbigny (Craie blanche). *Turonian* beds of D'Orbigny (Craie tufau). *Quadersandstein* of Germany.
Upper green sand. Gault.	*Albian* beds of D'Orbigny. *Planerkalk* of Germany.
Lower. Lower green sand. *a.* Kentish rag. *b.* Atherfield clay. ? Speeton clay.	*Neocomian* of Switzerland and France. *Hilsthon* of Germany. Pondicherry beds. Bogota beds, South America. ? *Aptian* beds of D'Orbigny. ? *Hils-conglomerat* of Germany.
Wealden system.	
Weald clay. Hastings sand. Purbeck beds.	Near Boulogne. North of Germany.

SECONDARY PERIOD—*continued.*

	British.	Foreign Equivalents, or Synonyms, and Chief Foreign Localities.
	Oolitic system.	*Jura limestone* is the usual continental synonym of our oolitic series.
Upper.	Portland stone.	Lithographic limestone of Blangy.
	a. Limestones with clay and cherty bands.	Honfleur clays.
		Solnhofen beds
	b. Siliceous sand.	Beds in South of Russia and in India.
	Kimmeridge beds.	
Middle.	Coral and calcareous grits.	*Nerinæan limestone.*
	Oxford clay.	*Argile de Dives.*
	a. Stiff clay.	
	b. Kelloway's rock.	
Lower.	Cornbrash.	*Etage Bathonien* is the name given by D'Orbigny to our lower Oolites.
	Forest marble.	*Calcaire à polypiers.*
	Bradford clay.	*Calcaire de Caen.*
	Great Oolite.	
	Stonesfield slate.	
	Fullers' earth.	
	Inferior Oolite.	
	Liassic system.	
	Alum shale.	
	Marlstone.	
	Lower lias.	*Calcaire à gryphites.*
	White lias.	
	Upper new red sandstone, or Triassic system.	
	Bone bed of Aust cliff.	
	Variegated marls, with salt and gypsum.	*Keuper marls,* or *Marnes irisées.*
		Muschelkalk.
	Variegated sandstones.	*Bunter Sandstein,* or *Grès bigarré.*

PALÆOZOIC PERIOD.

	British.	Foreign Equivalents, or Synonyms, and Chief Foreign Localities.
	Magnesian limestone, or Permian system.	
	Magnesian limestone.	*Zechstein.*
	Dolomitic conglomerate.	*Kupfer-schiefer* and other shales.
	Lower new red sandstone.	*Rothe-todte-liegende.*
	Carboniferous system.	
	Coal measures. *a.* Gritstones. *b.* True coal-measures. *c.* Freshwater limestone of Burdie House, near Edinburgh.	The coal-measures occupy an important place in various parts of the Continent, in Belgium, France, the Rhine, South Russia, and also in North America, in various parts of Asia, and in Australia. The foreign synonyms are, *Steinkohlengebirge, Terrain houillier, Terrain carbonifere,* and *Terrain anthraxifere.*
	Millstone grit. *a.* Coarse gritstones. *b.* Laminated shales.	The millstone grit is generally a bed of subordinate importance out of the British islands.
	Carboniferous limestone. *a.* Bands of fossiliferous limestone. *b.* Shales (*Calp, Culm*).	The *Kiesel-schiefer* of Germany is an equivalent of the carboniferous limestone. The Belgian limestone beds, and others in Northern Bavaria, are in the same part of the series.

PALÆOZOIC PERIOD—*continued.*

BRITISH.	FOREIGN EQUIVALENTS, OR SYNONYMS, AND CHIEF FOREIGN LOCALITIES.
Devonian, or old red sandstone system. Quartzose conglomerates (*Old red sandstone*) in South Wales and Scotland; represented by coarse red flagstones and slates in Devonshire and Cornwall. Cornstone and marl of the old red sandstone. Calcareous slate, limestone, sandy beds, and conglomerates of Devonshire and Cornwall.	Devonian beds are well known in Belgium, the Eifel, Westphalia, and North Bavaria. In Russia, the old red sandstone appears, and contains similar fossils to those found both in the corresponding beds in the British islands, and also in Devonshire and Herefordshire. The Palæozoic beds of Australia are supposed to be contemporaneous.
Upper Silurian series. Tilestone. Ludlow group. *a.* Upper Ludlow shales. *b* Aymestry limestone. *c.* Lower Ludlow shales. Wenlock group. *a.* Wenlock limestone. *b.* Wenlock limestone. *Lower Silurian series.* 50. Caradoc sandstone. 51. Llandeilo flags.	Silurian strata extend over much of northernmost Europe, and corresponding latitudes in America. They have been found in Brittany, in Westphalia, near Constantinople, and in Asia Minor. In South Africa, the southernmost parts of South America, Australia, and China, different contemporaneous rocks have been determined. In mineral character they are generally distinct from the English beds, but offer no marked characters uniformly present.

114 *The Lower Palæozoic Rocks.*—The rocks of the Palæozoic or older period are remarkable for possessing a certain striking uniformity of mineral character, in various very distant parts of the globe in which they have been examined. They either rest at once upon the granitic framework of the Earth, or pass by a series of insensible gradations from crystalline and altered rocks, which appear to have been originally formed by the decomposition of granite. These latter rocks also were either deposited before any living creature existed upon the Earth, or under circumstances which did not admit of their presence or preservation. The Palæozoic series consist of (1) the group of Lower Silurian rocks; (2) the Upper Silurian rocks; (3) the Devonian or Old Red sandstone system; (4) the Carboniferous system; and (5) the Magnesian limestone or Permian system.

1. *The Lower Silurian Rocks.*—These rocks are best known by the hard, dark-coloured, gritty beds abundantly met with near the town of Llandeilo, in Caermarthenshire, and thence called *Llandeilo flags*, and the sandstones with calcareous bands found on the flanks of Caer Caradoc in Shropshire, and denominated *Caradoc sandstones.* These, the original subdivisions of the Lower Silurian system, are, however, strictly local, and cannot be traced even throughout the northern part of Wales, although remarkably perfect in South Wales and Shropshire. The older Silurian strata thus determined, are found to be repeated under varying mineral conditions, throughout North Wales; they occur also very distinctly, although not to any great extent, in Cumberland and the Lake district; they appear to exist in Ireland; and they are met with in the south of Scotland, and the west of Cornwall. In most cases, the true age is somewhat doubtful, owing to the absence of any satisfactory evidence of condition or superposition.

On the Continent of Europe these rocks may be traced, though not without difficulty, in various parts of Westphalia and from point to point into

Bohemia, and they have been identified near Prague; they appear also in Silesia, and in this way seem connected with blue clays and other rocks, probably of the same age, in Russia, lying horizontally and undisturbed on the gneiss and other altered rocks of those districts. There is a much thicker series of rocks of the same age in Norway.

In Asia, the eastern flanks of the Ural chain seem to exhibit some specimens of the same ancient formations. In Southern Africa, similar rocks have been observed; many parts of North America exhibit them expanded to an enormous extent; and in South America, the frowning precipices of Tierra del Fuego and Cape Hoorn seem to be formed of contemporaneous deposits.

The thickness of the Lower Silurian beds, although extremely variable, is so frequently considerable, that whatever may have been the circumstances of deposition, we are justified in supposing that a very long period of time must have elapsed before the completion of the series. In our own country, this thickness amounts to several thousand feet.

The proportion of argillaceous matter and quartz, but chiefly the latter in its various forms, is, on the whole, much greater than in any newer rocks, and the mixture of calcareous matter less; while the presence of mica is clear proof of the preponderance of granite among those rocks to whose degradation the presence of these slates and sandstones was owing. In the British Islands and very generally in other countries, the group is represented by a greyish coloured sandy stone, often slaty and flaggy. In North Wales the slates have undergone an amount of mechanical pressure so considerable that they are often folded and twisted into the most extraordinary contortions. Such results are, however, merely local.

2. *The Upper Silurian Rocks.*—The country of the ancient 'Silures' in Wales and Shropshire, is the classic ground of these rocks in England, and exhibits the most remarkable and beautiful series of them anywhere discoverable. They are here distinctly a separate group from the Caradoc sandstone, and although their upper beds pass into the Old Red Sandstone of Herefordshire and the neighbouring counties, there can be little difficulty in at once perceiving that they form a great natural series, grouped into distinct formations.

The neighbourhood of Wenlock and Wenlock Edge, and the hill on which Dudley Castle is built, offer the best examples of the lower of these formations, and have given a name to them. They consist of limestone overlying shale, the latter—the *Wenlock shale*—generally of dirty, muddy appearance, and of grey or blackish colour, containing impure argillaceous and calcareous nodules. This is succeeded by an impure limestone, (containing a good deal of argillaceous matter,) the different layers of which are separated by clayey beds.

The uppermost group of the Silurian rocks is best seen at Ludlow and its vicinity, and comprises two beds of shale or mudstone (the Upper or Lower Ludlow shales) with an intervening bed of limestone (the Aymestry limestone) somewhat less argillaceous than that of Dudley. As might be expected, the limestone is sometimes absent, and, in that case, two beds of shale united represent the whole formation. The upper beds of the Ludlow shale pass upwards into sandy beds, and others which contain in incredible abundance the fragments of several small fishes.

These subdivisions of the Upper Silurian rocks are strictly local, and should not be looked for in other districts. In North Wales, the micaceous sandstones near Llangollen, the Denbigh flagstones, and a large series of rocks probably belong to the newer part of this period. In Cumberland, a great proportion of the mechanical rocks must also be referred to the same age; and in Ireland there are extensive similar and contemporaneous groups of strata. In the Border country and other parts of Scotland, there are rocks of this age of uniform character, and much altered from their original condition.

On the Continent of Europe a considerable proportion of the so-called *grauwacké* of Belgium, Rhineland, and Northern Westphalia, similar beds in

Brittany, others in Spain, and others in the Thracian Bosphorus, near Constantinople, have been shown to be of the Upper Silurian age. Other rocks in Northern Europe, in Russia, and Scandinavia, are yet more distinctly identifiable with our own Silurian strata; and in North America, South America, and the Polynesian Islands, there seems good evidence that groups of fossils more or less characteristic and identical with English Silurian species, mark a contemporaneous deposit of a very similar kind.

115 *The Middle Palæozoic Rocks.*—In the typical Silurian district the Upper Silurian rocks pass upwards into a sandy rock which is occasionally micaceous and becomes a flagstone. This rock, under the name of *tilestone,* is now ranked as part of the Silurian series. It appears most properly to belong to the latter; but the doubt that has been felt is a sufficient mark of the perfect passage between these two formations which, in most parts of England, differ completely in mineral structure. In fact, the so-called tilestones, which are often nothing more than hard and coarse sandstones alternating with red shales, pass into and are overlaid by a number of clayey and marly beds, which afford an excellent soil by decomposition, and are locally called *cornstones,* and these again are covered up by thick and extensive masses of conglomerate and coarse sandstone, the conglomerate consisting, for the most part, of quartzy pebbles imbedded in a red matrix, and known as the *quartzose conglomerate.*

The whole together make up the Old Red Sandstone Series of Herefordshire and Monmouthshire, and occupy a considerable district on the borders of South Wales, being there developed to a very great thickness.

The Old Red Sandstone does not, however, always retain the same character as that described above:—as we advance northwards in England, the thickness of the bed diminishes, and it loses many of its peculiar features; but it appears again as a thick irregular conglomerate in Westmoreland; and there, as in Herefordshire, the passage upwards from the Silurian rocks appears complete. But it is chiefly in Scotland that we find those huge masses of enormous thickness, from which the common notions of geologists concerning the Old Red Sandstone are derived, and the beds there extend at intervals for 120 miles, fringing the old rocks and attaining a thickness of many thousand feet. They are also continued round the coast, and are found in many of the Western Islands of Scotland.

Of this series there are said to be three subdivisions, and it is not unlikely that these are sufficiently well exhibited in various districts to allow of their being locally determinable. It is necessary, however, to look upon the whole as the result of causes acting during a long and unbroken period, probably corresponding to the middle and upper portion of the Old Red Sandstone of Herefordshire. In North Britain, the whole deposit rests on the gneiss; the lowest bed is a conglomerate of enormous but variable thickness, evidently made up of the broken fragments of the old granitic and porphyritic rocks, rolled and tossed about for ages in a troubled sea, the hardest stones being often rounded into bullet-shaped pebbles, by their long and incessant attrition against each other. These conglomerates, however, are not universal, being sometimes succeeded and sometimes replaced by a series of remarkable bituminous schists, which, in Orkney and Caithness, abound with the remains of fishes, and exhibit also some fragments of vegetables, the whole being overlaid by rocks of marly character, sometimes becoming a mere friable clay. The uppermost beds consist chiefly of quartzose sandstone.

The Old Red Sandstone was formerly supposed to be a local formation entirely confined to the British Islands, and its true importance, as representing a very well marked Geological epoch, has only lately been fully recognised. Although, however, it might well be supposed accidental that so large a series of coarse sandstones should be deposited as we find in Scotland and Herefordshire, a nearly similar series is found in Russia, covering a vast tract of country; and in the Western States of North America, a group has been described strikingly similar to the lower part of the Old Red of Scotland.

The beds, now called the DEVONIAN SERIES, which take the place of the Old Red Sandstone in the south-west of England, are for the most part calcareous slates, often sandy, and sometimes alternating with extensive sandy beds, and with imperfect limestones.

In Ireland, the Old Red Sandstone is represented by coarse conglomerates, and occasionally by arenaceous clayey beds.

On the Continent of Europe, although true Devonian strata exist and are abundant, they are so complicated, and the order of superposition is so difficult to make out, that they could hardly have been determined, had not this obscurity been first cleared away by investigations in our own country.

In Belgium, the Devonian limestones pass out of those belonging to the Silurian period without any break of continuity, and appear to include a perfect series, passing, also without any break, into the carboniferous rocks. On the right bank of the Rhine, near Cologne, where Silurian and Devonian beds appear, the whole series is inverted, the Devonian actually overlying the Silurian strata; and, farther to the south, in the north of Nassau, there are extreme contortions, marks of which may be seen at the fortress of Ehrenbreitstein on the banks of the Rhine, near Coblentz, and still more on the banks of the Lahn, going up towards Ems and Nassau. The Russian strata exhibit no such extreme confusion; but they include many rocks totally different in mineral composition from any that are known to be contemporaneous, although they also represent almost every form that the Devonian strata or Old Red Sandstones assume in other parts of the world.

116 *The Carboniferous System.*—The uppermost beds of the Old Red Sandstone and the Devonian series are often found to pass by a succession of shaly beds, or by an alteration of fine conglomerates and shales, into a black imperfect limestone, succeeded by other limestones, less argillaceous, and very soon covered up by extensive and thick limestones. The bottom beds of the series are commonly seen in Ireland, and they are found also in the Isle of Man, where they become flaggy limestones, and they are also probably represented in the carbonaceous rocks of Devonshire. Generally speaking, however, the overlying limestones do not pass into the Old Red Sandstone or Devonian shales by any passage of this kind, but cover them irregularly and often unconformably.

The distinguishing feature of the carboniferous rocks, wherever they have hitherto been found, consists in the very profuse distribution of carbon in various shapes through almost every member of the series. This is shown in the lower beds by the prevalence of carbonate of lime, in the middle ones by the occasional remains of vegetables, and in the upper by the existence of entire beds of carbonaceous matter, commonly used as fuel in this country, and well known as *coal*. None either of the older rocks or those of newer date, can be at all compared with these Palæozoic strata in respect to the abundance of carbon they contain.

Owing in many cases to subsequent movements of dislocation in the districts where these rocks appear, they are often broken up into fragments, and distributed into areas which have the character of basins or hollow depressions. In this way especially, the rocks which contain the largest quantity of vegetable carbon or the 'coal strata' are limited in range, but this is not the only reason for this limitation, since they must have been also greatly confined in the actual area over which such large contributions of organic matter could be accumulated.

The general order of superposition of the carboniferous series seems to have been (1) a widely-spread formation of limestone, for the most part the work of the coral animal; (2) a series of gritstones or coarse sandstones, called the *millstone grit*, alternating with, and sometimes replaced by shales; and (3) a great series of sandstones and shales, containing amongst them the various beds of coal, and also containing thin seams of iron ore, and generally spoken of as the *coal measures*.

The first of these beds is generally called the *Carboniferous* or *Mountain Limestone.* It occupies a prominent place in the Geology of England, and contributes much to the picturesque beauty of Yorkshire, Derbyshire, &c. In the north of Yorkshire, several thin beds of coal are met with in its lower part, although in other districts of England the vegetable remains are chiefly confined to the coal measures. It often abounds in caverns, some of which are of great extent; and, in Derbyshire and elsewhere, numerous mineral veins traverse it and yield a considerable quantity of lead and zinc ore.

The *Millstone Grit* is an important deposit in the north of England, where it occupies an extensive tract of country, and is extremely thick. In the middle and south of England, however, it fades away, and is almost lost, being feebly represented by a thin pebbly gritstone intervening between the true carboniferous limestone and the coal measures. In Ireland, it re-appears in great force in the mountains about Enniskillen.

The *Coal Measures* must be considered with reference to the various districts in which their vast value and importance are chiefly felt. The great North of England or Newcastle coal field is partly covered up by the Magnesian limestone in Durham, and is occasionally worked through this bed. It contains about eighteen workable seams of coal (whose total thickness is about eighty feet) alternating with shale and sandstone, and greatly disturbed by faults and dykes. The coal is the most bituminous and one of the best adapted for economical purposes of any yet known.

The Lancashire coal field occupies a considerable area, and is connected with that of Yorkshire. It includes perhaps the most perfect series of the rocks of the period anywhere existing, and consists as usual of sandy beds and shales, alternating with a large number of coal seams, seventy-five of which (whose total thickness is 150 feet) are described. In its upper part occurs a pale blue limestone of fresh-water origin, which is again met with in other coal fields nearly a hundred miles distant, and appears also at various intermediate points.

The South Staffordshire coal field is remarkable as the only representative of the Carboniferous rocks in that part of England, the Millstone grit and Carboniferous limestone being both absent. It exhibits a great preponderance of shale, and the number of its coal seams is only eleven, but the thickness of one of these is unusually great, amounting to upwards of thirty feet in some places.

The South Welsh coal field contains about ninety-five feet of coal distributed in about thirty workable seams, the most powerful of which is about nine feet thick. The associated shales and sandstones are of very unusual thickness, and they contain besides coal an abundant supply of ironstone ore. A considerable part of the coal in this district is non-bituminous, and distinguished by the name of *Anthracite.*

Besides these, there are numerous smaller deposits of coal in the middle and west of England, and in Wales, all of which possess local importance, but which we cannot now stop to describe.

The basin of the Clyde in Scotland, is no less interesting for its carboniferous deposits than important from their extent and value. In this district, the Old Red Sandstone is the general base of the coal strata, thick sandstones, occasionally containing coal, taking the place of the lower carboniferous limestone. Thin beds of limestone then succeed, and on these rest the great mass of the coal-bearing strata, which greatly resemble the similarly situated beds in England, but which include seams of ironstone ore yet more valuable. There appears, however, to be a freshwater limestone in this part of Scotland underlying the coal measures, and possibly contemporaneous with a bituminous shale in the North Staffordshire coal field.

The coal seams in the Clyde valley amount in number to eighty-four, but they are mostly thin; the coal, however, is good. The total thickness of the deposit is estimated at about 5000 feet.

The coal fields of Ireland are not unimportant, though they have hitherto been little worked. The principal one worked is that of Leinster, and as much as twenty or thirty feet of bituminous coal have been found in another small field near Tyrone. In Connaught there is also a supply of ironstone ore.

France and Belgium both contain a considerable number of coal fields, but they are mostly of small dimensions, and in the latter country are greatly disturbed, inclining at a considerable angle to the horizon, and worked like mineral veins. The French coal fields are all of very small size.

Russia is not without an extensive series of strata of the date of the Carboniferous rocks; and in the northern part of the empire there seems to be a prospect of workable coal, the lowest beds of the system containing (as in Yorkshire) a few seams of variable thickness, but of great value. In the south of Russia, very good bituminous and anthracitic coal is found in considerable abundance, but the beds are much disturbed by faults.

North America contains coal-bearing strata of great value, and of enormous extent, gigantic coal fields existing in the Western States and the British provinces. The coal measures here, as in Europe, form the uppermost part of the carboniferous series, and the number of seams hitherto known is about ten, having an aggregate thickness of fifty feet. There is one bed of thirty feet, worked like a quarry from the surface.

In Van Diemen's Land, and probably in several parts of Asia, there are strata of the Carboniferous period, greatly resembling those of our own island, and consisting of limestones overlaid by coal-bearing strata. Much yet remains to be done in making out satisfactorily the true position of these strata with reference to the well-known Carboniferous series of Europe.

117 *The Magnesian Limestone, or Permian System.*—The coal measures in the north of England usually terminate with, or rather pass into, a sandstone, differing from the ordinary coal grits in being discoloured with oxide of iron, giving it a red colour. This sandstone, which is frequently of coarse texture, and is very irregular in thickness, composition, and extent, is the *Lower new red sandstone* of English Geologists, and corresponds with a somewhat similar mass of contemporaneous origin in Germany, there called *Rothe-todte-liegende*, a name not unusually applied also in England. There is often an apparent break of continuity between the Lower new red and the next superior bed of *Magnesian Limestone*, but this is not universally the case; and marly beds, with thin bands of shelly limestone, unite and amalgamate the two formations. The Magnesian limestone is extensively developed in the north of England, and is there sometimes as much as five hundred feet thick. It receives its name from its mineral composition, which is a mixture of carbonate of magnesia with carbonate of lime. It is a very variable rock, sometimes hard and perfectly crystalline, forming an admirable building-stone, (in this state called *Dolomite*,) and sometimes in thin beds of loose texture—occasionally laminated—here and there oolitic, like the freestones of a later period—and on the coast of Durham possessing a singular concretionary structure, the cliffs appearing as if made up of piles of cannon balls. In this latter case the carbonate of lime would appear to have formed into nodules, and the magnesia is left in a powdery state, filling up the interstices. The Magnesian limestone in the north of England appears to be capped by gypseous marls of no great thickness, and these are often entirely absent; but further south, not only this capping, but the bed itself in its most characteristic form, is absent, and is replaced by a conglomerate, made up of fragments of carboniferous limestone, cemented together by a red or yellow magnesian paste. The Lower new red sandstone, without magnesian limestone, overlies the coal fields of Staffordshire and Shropshire, but is represented in a somewhat different form from that which it usually takes.

The beds intervening between the coal measures and the Upper new red sandstone are not extremely important in England, but are much more widely extended and more manifestly distinguished as a group in various parts of the Continent. In Germany and some parts of France these rocks are of considerable interest; one of the beds associated with the magnesian limestone containing a copper ore that has been much worked. The magnesian limestone series there forms two groups, the lower one argillaceous, and the upper calcareous, the latter being in all cases mixed with a certain proportion of magnesian earth. In Russia this system is developed yet more perfectly than in Germany; it occupies an enormous trough in the carboniferous limestone in the ancient kingdom of Permia, and consists of a great number of strata of very variable mineralogical character. It has been proposed by Sir R. Murchison to denominate the whole series, from its Russian type, the *Permian system.*

118 *The Upper New Red Sandstone, or Triassic System.*—This system of deposits is the lowest or oldest of the middle period, and is distinguished from the earlier formed beds partly by mechanical position, and also very strikingly in the nature of the organic contents. Like those of the Permian system just described, the rocks now under consideration are less perfectly developed in England than in some districts on the continent of Europe. They consist for the most part of an extensive series of yellow or red sandy beds, alternating with red, green, or blue marls, and containing large masses of rock-salt and gypsum, (sulphate of lime,) and although the beds thus characterized hardly admit of distinct subdivision in England, owing to their great similarity in mineral composition, they are elsewhere divided by a band of limestone, (the *Muschelkalk*,) and in that case the lower strata (*bunter sandstein* or *grès bigarré*,) are usually more sandy, and the upper (*keuper*) more marly. A similar difference in the character of the beds obtains also in some parts of England.

The Upper new red sandstone is generally seen spread evenly over the upturned edges of the underlying Palæozoic rocks, which have undergone much displacement before the deposit of this newer bed. The sandstones, generally of moderately fine texture—less coarse at any rate than the Lower new red sandstones—occupy in this way a large superficial area, and are seen in the extensive plains of the middle and west of England, and filling up all the valleys in the carboniferous limestone of the North. Their thickness is considerable, but not very easily calculated.

The continental beds of this period differ in some important points from those of England, but preserve a general analogical resemblance. The lower part, called *Bunter sandstein* by the Germans, and *Grès bigarré* by the French. is a fine grained, solid sandstone, passing upwards into an earthy clay. To this succeeds the *Muschelkalk*, a limestone of rather peculiar appearance, often argillaceous, and not unlike some of the Silurian limestones in mineral character, but sometimes very different, and even becoming extremely bituminous. The *keuper* or *marnes irisées*—coloured marls, often containing vegetable remains—cover up the muschelkalk, and terminate the series. The upper beds of the Upper new red series in England have been identified with the keuper, and are sometimes spoken of as 'variegated marls.'

119 *The Liassic Group.*—The beds of this formation, so called, it is supposed, from their frequent appearance in striped bands or *layers*, may be traced through England, from Lyme Regis in Dorsetshire, by way of Somersetshire, Gloucestershire, Worcestershire. Northamptonshire, Leicestershire. Rutland, and Lincolnshire, to the Humber, and then through the East and North Ridings of Yorkshire to the coast at Whitby. In all this tract the general features of the formation are the same, and from Gloucester northwards, there is an average and nearly uniform breadth of about six miles, the total thickness of the deposit being generally above 600 feet. The rock is little disturbed, and has a regular dip, being conformable to the underlying and overlying strata, except where it comes in contact with the mountain limestone in Glamorganshire and Somersetshire. The lias is generally subdivided into three parts, the lower portion reposing on a thin bed full of fishes' bones, and consisting of a lower limestone containing a large proportion of clayey matter alternating

with shales, often calcareous. These are overlaid by a bed called the marlstone, (a marly limestone of a very pale colour,) and above this there is another and a final bed of tough blue calcareous clay and shale, which passes into sandy beds, and so graduates into the oolites which next succeed. The uppermost bed is sometimes called the Alum shale, and is greatly developed at Whitby, where it is burnt for alum. The lower beds are exhibited best in Dorsetshire, and the marlstone in Gloucestershire.

On the Continent the Lias possesses nearly the same lithological character as in England, but the lower beds are more sandy, and the middle ones more calcareous. The upper marls are the most uniform of the continental liassic beds, and they most nearly resemble the contemporaneous English strata.

120 *The Oolitic System.*—This interesting group of formations is so admirably exhibited in England, and occupies so large a proportion of the surface of our country, that it has received even more than its due share of attention, and was somewhat too prominently put forward in all its numerous and interesting subdivisions, in the first determination of Geological series.

The beds called *Oolitic* (from the Greek words ὠὸν (*ōon*), an egg, and λίθος (*lithos*), a stone,) are usually subdivided into three well-marked groups, all of them characterized more or less by the presence of limestones; the peculiar structure of which (the rock being made up of innumerable small egg-shaped particles) has given its name to the formation. The general character of the Oolitic system in England may be described as consisting of three ridges running N.N.E. and S.S.W., with broad valleys or plains intervening. The ridges in this case represent the escarpments of the hard limestone beds of the Lower, Middle, and Upper group of Oolitic strata, and the plains, the less coherent or softer beds, interposed between them. In this way the series may be traced through England to the east of the Lias, and parallel to that formation; but in many places, more especially in the north of England, the upper series is wanting, and in the south the lower part is indifferently represented. Thus the order of the relative preponderance of different members of the series observable in the Lias is here reversed, the lower Oolitic beds being chiefly developed in the north, and the upper ones in the south.

The principal limestones of the lower series are the *Inferior* and the *Great Oolites*, and these are separated from one another by marly beds, used as fuller's earth, and by a thin flagstone remarkable for its fossils, and called the Stonesfield Slate. Under the Inferior Oolite there are sandy beds, which greatly preponderate in Yorkshire, and contain numerous vegetable fossils. The Inferior Oolite itself contains about forty or fifty feet of freestone; and the Great, or Bath Oolite, which is more important in economic value, presents a large series of excellent building stones, alternating with coarse shelly beds, but sometimes replaced by a thick clay, called '*Bradford Clay*,' At the top of the Lower Oolitic group is a bed called locally the *Cornbrash*, which decomposes into an excellent vegetable soil, and is chiefly made up of clays and sandstones with calcareous nodules.

The central portion of the Oolitic series consists, for the most part, of a thick bed of tough blue clay, called the '*Oxford Clay*,' very widely extended, not only in England, but on the Continent, and overlaid by beds of a more calcareous nature, sometimes taking the form of a true coralline limestone, and sometimes only containing a mixture of calcareous matter in sandy beds. In its most characteristic form, this upper bed (the *Coral rag*) is chiefly seen near Calne and Steeple Ashton, in Wiltshire, and at Malton, in Yorkshire.

The upper Oolites, like the middle ones, consist chiefly of a thick bed of tenacious clay, locally overlaid by limestone. In this case, the clay is called *Kimmeridge Clay*, from a village near Weymouth of that name, where it is well exhibited; and the bed may thence be traced northwards as far as Lincolnshire, and even into Yorkshire, resting on the Oxford Clay, sometimes without the intervention of the Coral rag, and forming the great fen district of Cambridgeshire. Over the Kimmeridge Clay there is in the south of

England a very extensive development of limestone in Portland Island, the quarries of which have been worked for many centuries, but this does not reach farther north than Buckinghamshire. Where best seen, the *Portland rock* includes several bands of coarse, earthy limestone, alternating with a considerable thickness of freestone, and covered up with a bed containing a substance like vegetable mould, in which the stumps and roots of trees are found. This singular stratum, the *Dirt-bed,* is met with over a somewhat extensive area.

North of Yorkshire, the secondary rocks are very rarely exhibited in the British islands, but in two or three valleys in Scotland, and especially at Brora, there has been described a series belonging to the Oolitic period. The beds are not oolitic in structure, and contain but little calcareous matter.

On the continent of Europe, there are many spots in which rocks contemporaneous with the English Oolites resemble them also in mineral character and general appearance. Near Caen the Great oolite and a considerable overlying series have been described by French geologists. Among the Jura Mountains, and even in the Alps, the three subdivisions are preserved as in England, and this is the case also in the north of Europe, while in Russia, the whole series is divided into two portions. the lower being very locally distributed, but the upper part calcareous and oolitic, and widely spread over the country. In the Caucasus the beds of this period are greatly altered, and have been described as primary.

In Asia, the north western part of the peninsula of India has afforded evidence of an interesting group, probably contemporaneous with the Oolites. The beds containing coal in Virginia, formerly described as carboniferous, belong also to the secondary period, and are of the same age as the lower Oolites of Yorkshire, which they resemble.

121 *The Wealden Group.*—Lying immediately on the top of the Oolites and passing out of them so gradually that the actual junction can hardly be determined, there is found in the south-east of England, a remarkable group of fresh-water beds, classed together under the name of 'Wealden,' and consisting of a very thick and varied series of arenaceous beds based on limestones of small extent and peculiar character, and covered by a bed of clay. This whole series may be described as a series of clays and sands with subordinate beds of limestone grit and shale, containing the remains of organic bodies whose condition manifestly shows that they have been subject to the action of river currents, but not to attrition from the waves of the ocean. The subdivisions are found only in some of the southern counties of England, and are not without some interest, the Purbeck, or lower beds, being remarkable for the presence of a shelly limestone taking a good polish, and known as Purbeck Marble, while the Hastings Sand, though of far greater thickness, hardly presents greater complexity. The Purbeck beds, including a fissile limestone. and as many as fifty-five beds of workable limestone, attain in all to the thickness of about 125 feet, and are much disturbed from their original position. The *Hastings Sand* consists at its base of friable sands such as those seen at the cliffs near Hastings, and upon them are found first an extensive series of arenaceous beds containing building stone, and then some bluish grey sandstones, or calcareous grits, of no great thickness, known as the Tilgate beds. The Purbeck strata are chiefly found in the western part of the Wealden district, and where the fractured chalk exposes the lower beds in the vale of Wardour and the other valleys of elevation in Dorsetshire and Wiltshire, while the Hastings sand is found not only in the vicinity of Hastings, where it is exposed on the sea cliff, but also throughout the whole Wealden district.

An upper band of clay, called the '*Weald clay,*' intervenes between the Hastings sand and the Cretaceous group, and is found along the line of the North and South Downs, near the base of the escarpment of the chalk, and again in the Isle of Wight in the same position. It occupies a tract, about six miles wide in the broadest part, between the Hastings sand and newer rocks, and consists of a tenacious argillaceous bed reposing on beds of sandstone and shelly limestone with layers of argillaceous ironstone.

There are in the Isle of Skye, and in one or two places on the coast of France, opposite the Weald of Kent, small patches of strata, nearly of the same age; and in the north west of Germany a considerable thickness of contemporaneous fresh-water beds has been also determined. With these exceptions, the transition from the Upper oolites to the Cretaceous rocks is abrupt, and there is reason to believe that a long interval must have elapsed between the deposit of the two series.

No marine beds are yet determined which can with safety and certainty be referred to the Wealden period. In other words, the period during which these beds were being deposited in England was either occupied by completing some of the Upper oolites in other seas, or else during that time there was a cessation of deposits over wide tracts, owing either to their being above the sea or the bottom of a deep ocean.

122 *The Cretaceous System.*—This group of strata has received its name from the almost universal presence in it of the white chalk (*creta*) which forms its upper division in most parts of Europe. The whole formation has generally been divided into three parts, (1) the Lower greensand, represented both in some parts of England and on the continent of Europe by very extensive and thick beds; (2) the Gault and Upper greensand; and (3) the Chalk; but the two latter groups seem to possess more analogies with one another than they do with the lower division.

The *Lower Greensand* of England is exhibited in a varied but characteristic form, in the cliffs between Folkstone and Hythe, and also near Maidstone, in the county of Kent, and at the back of the Isle of Wight, where it expands so as to occupy a very prominent place in the Geology of the district. Under the name of *Neacomian*, beds of nearly the same age have also been described from the vicinity of Neuchâtel in Switzerland, and from the south of France.

There are some places in the south-east of England where the passage upwards from the Wealden to the Lower Greensand is very difficult to trace, owing to the similarity of the clay beds in the two deposits. Near Hythe this is especially the case, and here also there is an admirable section of the whole Lower Greensand series. A similar, and equally interesting section may be seen in the Isle of Wight, between Atherfield and Black-gang Chine, but there is no passage there from the Weald clay into the Atherfield clay. In the more central counties of England, in Bedfordshire, Cambridgeshire, &c., where the Lower Greensand is still an extensive bed, it is remarkable for little more than its deep red colour, a phenomenon apparently due to the presence of a considerable quantity of the peroxide of iron.

The Lower Greensand of the south of France and of Switzerland consists of calcareous beds of considerable thickness, and in Germany the beds of the same age are represented sometimes by extensive beds of sand, and sometimes by clays. It is not easy to determine very distinctly the identity of date of the different beds of the cretaceous formation in the Pyrenees, the Carpathians, the Caucasus, and the south of Italy; but there can be little doubt that a very large proportion of the whole must be referred to the lower division.

The Gault and Upper Greensand are chiefly exhibited in the eastern and southern districts of England, and there form a well marked group, presenting distinct features.

The *Gault*, the lower member, is best seen near Folkstone, (to the east of the town,) where it appears from the cliff section to be about one hundred and twenty feet thick, and to rest on the Lower Greensand. It is a stiff blue clay, and is mixed with a small portion of iron pyrites. From Fo kstone the same clay may be traced, retaining its appearance and peculiar mineral character throughout the east of England, everywhere coming in between the Lower and Upper beds of Greensand. A little to the north of Cambridge it begins to thin out, and on the coast of Norfolk, where it comes out again to the sea, it is not more than fifteen feet thick.

The *Upper Greensand* is somewhat variable both in thickness and in general appearance. It often forms a kind of step at the foot of the chalk, having a small, but well marked, escarpment towards the Gault; but this is by no means always the case, and as it goes northward it loses the cherty character for which it is remarkable in Surrey and the Isle of Wight, and merely serves to separate the Gault from the Chalk. Both the Lower and Upper beds of Greensand have received their name from the prevalence throughout both of them of small green particles of silicate of iron.

The *Chalk* is a very well-marked and interesting formation, both on account of the peculiarity of its mineral composition, and its great uniformity in all respects throughout a very extensive area. It is also remarkable for the layers of flint distributed through it. Above the white chalk with flints there is found at Maestricht a yet newer bed, also of the Cretaceous period.

The lower part of the chalk is somewhat impure, owing to the presence of argillaceous matter and iron with grains of silex, but these disappear in the upper beds; and the silex, instead of being distributed in grains, is collected into distinct layers, each of which appears to have generally collected round some spongeous body as a centre. In this state the chalk is an almost pure carbonate of lime, with a very small per centage of iron.

In some districts on the Continent of Europe, the upper part of the cretaceous system bears a strong resemblance to the contemporaneous beds in England; and true white chalk has been traced not only in France, but in Denmark, Poland, Central Russia, and the Caucasus. Under another form, the beds of this period are found in the South of France and in Italy, there forming hard crystalline limestones and limestones made up of the fossil remains of foraminifera, and other beds; while, in the central plains of Asia Minor, semicrystalline rocks of the cretaceous epoch occupy a prominent place in the Geology of the district. Remarkable beds of the same age have also been described by Sir C. Lyell, and by American Geologists, as occurring in New Jersey and other parts of the United States; but these seem to rest immediately on the oldest Secondary rocks, without the intervention of the Oolites. It does not appear that any true chalk exists in America, but the formation is extremely calcareous, although perhaps chiefly arenaceous.

123 *The Older Tertiary Rocks of England, France, and Belgium*.—It is only of late years that the department of Geology professing to treat of strata newer than the chalk has assumed its due importance, and the reason of this it is not difficult to comprehend, for the Tertiary strata form a far less prominent group in northern Europe than the rocks of older date, and have for this reason been long considered as of inferior importance, and even as mere superficial deposits not worthy of being described as a distinct system. But this relative predominance of older over newer deposits is reversed in the south of Europe, in some parts of Asia, and in South America, where even the newest group of strata has undergone great change of position, and where thousands of square miles of comparatively modern deposits attest the vastness of recent operations.

It is worthy of remark with regard to these strata, that a large proportion of them bear marks of having been formed in the vicinity of extensive tracts of land, and that in this respect they are contrasted with the older rocks, which were for the most part formed at the bottom of deep seas studded here and there with islands, such as these we now find in the Eastern Archipelago. It is also clear that after the termination of the deposits of the secondary period, and probably during a long interval concerning which we have no records, land had arisen from the deep waters; and the bottom of the sea, previously the receptacle of chalky mud, assumed by degrees the outline of the continents now marked out by the mountain chains of Europe, Asia, and America. But, however this may be, the rocks of the Tertiary period in northern Europe are for the most part local deposits, and have been formed either in lakes, rivers, or estuaries, by matter conveyed along by fresh water, or else in narrow confined seas not far from land. Hence it arises that a variety of causes have come into operation, such as irregular depth, sudden and considerable alterations of depth, and others, sufficient to modify greatly the conditions of animal life.

The Tertiary strata of Europe having been thus formed in small areas, do not usually admit of general descriptions, but require the groups to be each separately described with reference to other contemporaneous deposits, but still more with regard to local circumstances.

The Tertiaries of Europe and Western Asia form a very variable series, consisting, in England and Belgium, of stiff clays, alternating with sand and resting on a coarse sand and gravel; and in Paris, of a number of limestones and marls alternating with gypsum and siliceous strata. They are deposited in valleys or depressions in the older rocks, and in England (in the Isle of Wight) some portion of them has been so greatly disturbed, that the beds are actually vertical. This, however, is an exception to their usual position, which is that of beds not much changed from their original horizontality.

The older Tertiaries of England are chiefly confined to three patches, which were originally, no doubt, connected and continuous, but are now detached and contained in trough-shaped hollows in the chalk. These are called, respectively, the London, the Hampshire, and the Isle of Wight basins, and the stiff clay which predominates in them, and which is very abundant near London, is known as the '*London Clay*.' The London clay often, but not always, rests on a series of sandy and gravelly beds, inclosing bands of potters' clay, and to these the name '*Plastic Clay*' has been given; but, in the Isle of Wight, a distinct group of sands forms the base. It is now certain that no mere mineralogical attempt at subdividing this group of strata will succeed; and Mr. Prestwich has shown that the great mass of clay in the lower part of the London series is strictly contemporaneous with the hard sandy beds at Bognor, from which the clays at Barton cliff are separated by no less than 700 feet of sands.

The strata which occupy the Paris basin differ exceedingly in point of mineral character from the beds just described. Over the chalk is usually found a fresh-water deposit of clay and lignite, and this is succeeded either by a coarse sandy limestone containing many fossil shells, or by a siliceous limestone of fresh-water origin, almost without fossils. Next, above these limestones, separated only by a bed of sandstone, is usually found a series of marls, containing amongst them a considerable quantity of gypsum, and in the quarries from which the gypsum has been extracted, (to make Plaster of Paris,) an immense number of the remains of land animals were found during the early part of the present century. Last of all, in the Paris series, there are two groups of marls and sands, one fresh-water and the other marine, developed to some extent, and separated from the gypsum by a thin bed of oyster shells.

The tertiary strata of Belgium are chiefly seen in the provinces of South Brabant and Limburg, and their general character is that of sandy beds containing oxide of iron, alternating with and overlying a series of badly developed marls and limestones. The whole sequence is rarely exhibited in the same locality, but the total thickness of the deposits is not great. At the base of the deposits in many localities, are argillaceous marls, found chiefly in the northern and western parts of the basin. These are of blue or black colour, tenacious, impervious to water, and containing beds of septaria.

In central France, and especially near Auvergne, is a group of sandstones, marls, and limestones, extending for a considerable distance from north to south, and having an average breadth of about twenty miles. Similar deposits, belonging to the older part of the tertiary period, are found near Le Puy, in Velay, and near Aurillac, in Cantal, the latter being, however, remarkable for containing a large proportion of silex, probably derived from hot springs. Many other small beds are met with in the same district.

On the south flanks of the Alps, near Vicenza, in Lombardy, a band of limestone occurs, and another at Monte Bolea, both of the older Tertiary period, and both remarkable for containing remains of organized beings, chiefly fishes. The beds here are marly limestones, interstratified with thick beds of compact limestone, and the whole series is overlaid by tabular basalt.

There is evidence showing that many parts of Greece and Asia Minor were the recipients of important deposits, apparently from some great fresh-water lake, not long after the termination of the chalk.

124 *Middle and Newer Tertiary Deposits of England and Europe.*—Overlying the older Tertiaries in England there is little more than a heap of gravelly strata, almost exclusively confined to the neighbourhood of the Eastern Coast. These accumulations are called 'the Crag formation,' and they appear to belong to a somewhat extended period, and to be divisible into three parts, the lower being the *Coralline Crag,* so called from the numerous remains of corals found throughout the bed; the next the *Red Crag,* distinguished by its deep ferruginous stain; and the uppermost, the *Mammaliferous* or *Norwich Crag,* which is of more recent origin than the Red Crag, and contains bones of large mammalia, and occasionally fresh-water shells. All these beds are of limited extent, the Coralline Crag ranging over an area of about twenty miles long, and three or four broad, its total thickness averaging not more than twenty feet, while the Red Crag, although extending to double that thickness, is still small in every respect. The Mammaliferous Crag appears to be an estuary deposit.

At various places in the valley of the Thames, and on the banks of the Stour and Medway, fresh-water deposits have been found, some of which appear to correspond in age with the newer portions of the crag, while others are still more modern. In the valley of the Clyde, near Glasgow, extensive beds. of comparatively modern date, have been described under the name of '*Till,*' chiefly consisting of unstratified clay mixed irregularly with gravel; similar or contemporaneous beds have been found at Bridlington, on the Yorkshire coast, and at various other localities, where evidence of recent change of level has been sometimes also seen in the raised beaches and sub-marine forests.

The middle tertiaries form a much more decided group in various river basins on the Continent than they do in our own country. They occupy a considerable portion of the west of France, filling up the basins of the Loire and the Garonne; they fill up also a great part of the valley of the middle Rhine; they alone are to be met with in the whole of the great valley of Switzerland, between the Alps and the Jura chain; and they proceed towards the north-east from Switzerland, following the course and partly occupying the valley of the Danube. From point to point they may be traced spreading out into extensive series near Vienna and in Styria, and occurring again in the plains of Hungary; they are also found in Poland and Russia; they appear both in northern and southern Italy, and on the shores and islands of the Mediterranean; and they are probably represented in the neighbourhood of Lisbon, and in the south of Spain. They thus form a most extensive group indicating, with much distinctness, that many portions of what is now Europe were submerged during the middle tertiary period.

The newer tertiary period is not less amply represented in Europe than the middle one: but it is chiefly in South Italy, in the Morea, and in the islands of the Eastern Archipelago, that the more extensive beds must be sought for, although the valley of the Lower Rhine, near Bonn, and a portion of central France, besides a large district in southern Russia, also present important contemporaneous beds.

The newer tertiaries are not all of the same age, and the beds so called must have been in the course of formation for a very long period. Those in Italy admit of being subdivided into two groups, the older of which is called Sub-Apennine, and attains a great thickness near Parma. These beds consist for the most part of greyish, brown, or blue marls, containing calcareous matter, and overlaid by thick sandy beds. The Sicilian beds are distinctly newer than these, and are equally extensive, since in the south of Sicily hills, 2000 feet high, are formed entirely of the uppermost of them. Marls, with occasional limestone, form the great mass of the materials of these strata.

Fresh-water beds of the newer period are found at Œningen, on the Lake of Constance, consisting chiefly of fetid marlstones and limestones, and occupying depressions in the molasse. These beds are of great thickness, but small extent.

The newer Tertiary deposits of the Rhine and Nassau are remarkable for the presence of very extensive beds of lignite, so thick as to be worth working, although the coal is too earthy and imperfectly bitumenized to be a valuable fuel.

Other deposits of the same age are found occupying an extensive region in southern Russia, and well exhibited in the cliffs on the Sea of Azof. They consist of beds of white and yellow limestone, covered by sands and siliceous grits. Similar beds occur in the Crimea, and the neighbourhood of Odessa.

125 *The Tertiary Deposits of Asia and America.*—Till within a very few years nothing was known of the great extent of these formations, and they are not even yet described in such detail that we can speak with certainty as to their geological age. The western part of Asia, generally, seems to exhibit a great variety of volcanic phenomena of recent date, accompanied by a considerable extent of modern Tertiary deposits, chiefly lacustrine, and consisting of calcareous marls, and white limestone containing chalk. Some of these have been already alluded to, from their vicinity and resemblance to European tertiaries, as for example, the beds at Smyrna, and others on the shores of the Caspian. There are, however, others further east, which now require consideration.

In the western part of India, near Bombay, thick beds of Tertiary limestone have been found, chiefly near Cutch, which are covered by argillaceous grits, and belong probably to the older part of the Tertiary period. Similar beds have been described as occurring in the more central province of Mewar, and also at Delhi. Beyond this the Tertiary beds of the Sewâlik range commence.

The formations composing the Sewâlik or Sub-Himalayan hills, consist of beds of boulders or shingle, of sands hardened to every degree of consistency, of marly conglomerate, and of an infinite variety of clays. The strata dip towards the north, at angles varying from 15° to 35°, and the breadth of the inclined beds is from six to eight miles.

In a part of the Sewâlik district, west of the Jumna, there is an interminable series of clays and sandstones, the former being most abundant, and in the upper part of the series, there occurs a sandstone rock, generally soft, but often in hardened masses, owing apparently to the presence of organic bodies, chiefly bones. A very large and remarkable group of organic remains has been obtained from fragments embedded in this way in sandstone.

The Tertiary strata of the Sewâlik hills appear to have extended along the whole of northern India, north of the Ganges, and they occur also near Bombay, on the one side, and in the Birman empire, in the upper part of the drainage of the great Irawaddi river.

There is a deposit, in various parts of India, called *Kunkur*, which is very generally distributed, and appears not to be confined to one period, although certainly not very ancient. This deposit is especially abundant in the country running up from Gujerat to the north-east, towards Delhi, and appears covering hills two or three thousand feet above the sea.

Little is known of the existence of Tertiary beds in the great plains of Siberia and northern Asia, and we are equally without information concerning China, Chinese Tartary, and Japan. There are not known to be any well marked tertiaries of older date in the islands of the Eastern Archipelago.

North America presents considerable tertiary beds in Virginia, the two Carolinas, Georgia, and Alabama, chiefly belonging to the older part of the period, and others of newer date in other districts. In Virginia there are greenish sands, replaced to the south by white limestones, of no great thickness, nearly contemporaneous with our London clay, and these, after being traceable for several miles, are lost under newer deposits, of considerable thickness, consisting of clay and loam, alternating with quartzose sand and beds of pure silicious rock, full of interstices.

Over the series of older strata thus described there is found, occupying a wide horizontal range, a deposit of clay of the middle Tertiary period, spread over immense plains, but little above the level of the Atlantic. These are replaced, in Massachusetts, by white and green sands and conglomerate, resting on lignite. Upwards of ten thousand square miles of country are occupied by these deposits, while others of somewhat newer date occur at the mouth of the Potomac river in Maryland, and consist chiefly of clay and sand.

In South America, the rocks of the Tertiary period are more extensive and important than in any other part of the world. extending in an unbroken line from the great plain of the Amazons to the Straits of Magelhan, a distance in all amounting to 2,500 miles, while in some places they are not less than 800 miles broad. Throughout this vast tract three principal groups have been determined—the lowest consisting of sandstones and marly limestones covered with gypseous clay, which retains water on its surface and produces marshes; the middle, or 'Patagonian series,' as it has been called, larger in extent and nearly the same in mineral character, and the highest or newest deposit, the 'Pampas clay,' is a single bed, probably one of the largest ever yet formed on the earth, covering a space of 180,000 square miles, and throughout chiefly argillaceous. It is partly covered up by alluvial sands.

126 *The Newest Deposits of Gravel and Diluvium.*—The regularly stratified deposits are often seen to be more or less covered up and hidden by a mass of heterogeneous material, generally unstratified and deposited in irregular heaps, but almost always bearing marks of having been transported from a distance. The fragments of transported rock which make up this mass are called 'boulders,' or 'erratic blocks,' when of large size and angular, and are in this case rarely far removed from the parent rock; but they are more commonly smaller and rounded, as if they had been long rolled against one another at the bottom of water, and in this state, and especially when mingled with fine sand, they are called 'gravel.' Such material has often been conveyed from great distances, amounting sometimes to many hundred miles from the place whence the rocks which compose it were derived. The whole deposit when of this nature is not unfrequently called *diluvium*, or diluvial drift, while *alluvium*, on the other hand, is a term used in contradistinction to diluvium, and signifies the ordinary effects of fluviatile action.

The origin of gravel and diluvial drift is a subject which has long attracted the attention of geologists, and which is not yet clearly made out. The direction of the drift, which can be traced by following up the gravel to its source, varies very considerably in different districts, but it generally seems to have travelled from some mountain chain, with the elevation of which the existence of these singular heaps seems to have been connected.

Among the more remarkable and instructive illustrations of the phenomena of gravel, must be ranked the gravel hills in the south of Scandinavia, and the isolated patches in the plains of Northern Europe—the *escars*, or gravel hills of Ireland—the detritus of England, as traced from the Cumberland hills to the north, south, and east—the diluvial phenomena of Switzerland and Italy—the gravel of North America, and that of some part of the southern extremity of the New World.

Connected with gravel phenomena, there must also be considered the rubbed, grooved, and polished condition of the rocks on which this material has been heaped, as these appearances have been the groundwork of theories suggested, and require to be accounted for in the explanation of the phenomena.

The tertiary deposits in many parts of South America near the banks of the great rivers are not, however, of this nature, as in most cases they appear to consist of nothing more than the mud deposited at various points and over wide areas, which some mouths of the gigantic rivers of that country once traversed. The shifting of the actual river course, and its replacement by thick mud, is, in the case of all rivers possessed of deltas or depositing much mud, an event so much a matter of necessity, that we need not here allude further to it.

With regard to the gravel beds and erratic blocks of North Europe, they are chiefly grouped in elliptical areas, with the longer axis pointing to some part of the Scandinavian mountains. The larger blocks are generally near the surface. The blocks consist principally of granite, Syenite, porphyry, and hard limestone, and have been found in Poland and Russia as well as North Germany, reaching from the Ems and Weser to the Dwina, and even the Neva. In Scania they are however much more abundant, and the quantity of material greater, though the blocks are not larger.

The dispersion of blocks from the Cumberland hills is also remarkable, as the rocks themselves of which these mountains are composed are very distinct and peculiar, and very easily recognised. The granite of Ravenglass, on the western border of the region, has been drifted to the south across the sea, along the flat or hollow of Lancashire, west of the Penine chain, and over the plains of Cheshire and Shropshire towards the valley of the Severn. In this long course the quantity of pebbles and boulders is very considerable, and it is evident that the currents, whatever they were, which carried the boulders, respected the present levels of the country, for they have not once crossed the Penine chain to the eastward, nor penetrated far into the principality or the border districts, where the gravelly deposits have been derived from the neighbouring hills. From the eastern side of the Cumbrian mountains, the granites of Shap Fell and Carrock Fell have been transported northwards to Carlisle, southwards by Kendal and Kirkby Lonsdale to beyond Lancaster, eastwards over the vale of Eden, and up the Penine escarpment at Stain Moor above Brough. Having here mounted the summit, the boulders diverge to the east-by-north, east and south-east, cross many lower ridges, and sweep over the oolitic moors and the chalk wolds to the sea-side at Scarborough and Flamborough Head, a distance of 110 miles. In this course three ridges and two vales were crossed, but the present configuration of the ground has manifestly undergone no change, as the passage of the Penine chain is at only one point, and that the lowest, opening directly to the west.*

The phenomena of rubbed surfaces of rock beneath accumulations of gravel, and in the track of large blocks and considerable masses of diluvial material, are important as pointing to the probable origin of the accumulations themselves. The appearance is sometimes exactly that produced now by the action of a glacier moving along slowly, loaded with a heavy weight of transported matter, or else appears due in a similar way to the action of ice, which must in that case have drifted on the spot where we now find the gravel, when the level of the surrounding land was much below its present position. There can be little doubt that the transporting power of floating and drifted ice, as affording a ready means of removing large heaps of rock—as accounting for the deposit of these in one spot, far removed from the mountains whence they were derived, and as explaining the marks of mechanical pressure and rubbing met with in the vicinity of isolated large blocks, or considerable quantities of smaller ones—is a probable and satisfactory explanation of the phenomena of gravel.

Many of the limestones of various geological periods are remarkable for containing caverns, originally, perhaps, mere cracks in the strata, but since then worked into holes by the passage of water, or by other mechanical means. These have often served as the dens of wild animals; and, when afterwards silted up, and their floor covered with stalagmitic incrusta-

---

* Phillips's *Treatise on Geology*, (Edinburgh, 1838,) p. 209.

tion, whatever remains these animals left have been accurately preserved, and may often be obtained for investigation. We learn in this way, that large hyænas and bears once roamed over the waste expanse of our own island and of Europe, and that these fierce carnivora were accompanied by a singular race of ruminants and pachyderms; among the former being large animals of the deer tribe and a gigantic ox, while the latter included the elephant, and a nearly allied genus, whose habits appear to have required the vicinity of extensive marshes.

It is, however, almost exclusively the remains of carnivora that are found in the caverns, which must in many cases have been the resort of successive generations of wild animals for a long series of years. The species of bear and hyæna, whose remains are chiefly abundant, were much larger and more powerful than any of those now living, and there are indications also of a very large feline animal (a tiger) existing contemporaneously with them.

The gravel in various parts both of England and elsewhere contains numerous fragments of the bones of the larger quadrupeds, once the inhabitants of this region. Among them may be enumerated the elephant, the rhinoceros, a hippopotamus, several large cervine animals, one of them remarkable for the enormous spread of its horns, and some large species of the *Bos*. All these were contemporaries, and living also at the same time were the wolf, the fox, the badger, the otter, and a number of species still remaining. Concerning the nature of the revolution which, extending over the whole of Northern Europe, destroyed entirely all vestiges of the larger mammalia as indigenous species, allowing the smaller ones to remain, it is not easy to decide in the present state of our knowledge.

In other countries, as in Asia, America, New Holland, and New Zealand, there are similar proofs of the former existence of gigantic animals of analogous species to those which compose the existing faunas, and we everywhere find marks of extensive changes produced on the surface indicated by the presence of numerous fragments of rock, transported from a great distance, and more or less evenly spread over the face of the country.

The only ultimate cause that can be assumed, with any degree of probability, as accounting for these phenomena, is the slow and successive elevation of large tracts of land at certain intervals. It is not unlikely that such elevation, even if in some places permanent, might be accompanied by a partial sinking, and there is evidence of recent elevation and also of depression to a very great extent over most parts of the whole world. Such evidence is seen in ancient sea beaches, and in deposits once formed quietly at the bottom of the sea near coast lines, but now raised many feet, and sometimes many hundred feet above the existing sea level; while not far off the presence of decayed forests running out towards the sea at levels below that of high water, affords not less satisfactory proof of partial depression.

Thus we have seen that the structure of the Earth's crust, considered simply in a mechanical sense, offers a vast variety of facts, which it is not easy at once to explain; that, however, all these facts point to some regular plan and system in the elaboration of the existing surface; and that the successive deposits which may be traced have been altered and disturbed by frequent upheavals. These general results of the investigations of geologists require, however, to be considered and compared with reference to the organized beings which also greatly modify the Earth's surface, and whose conditions of existence we next proceed to discuss.

PART III.

ORGANIZATION.

CHAPTER X.

THE DISTRIBUTION OF VEGETABLES IN SPACE.

§ 127 The meaning and nature of organization, and especially of vegetable life. — 128. Natural arrangement and classification of plants. — 129. Influence of climate on vegetation — 130. Influence of soil on vegetation. — 131. General range of plants in various countries at moderate elevations. — 132. The botanical regions. — 133. Distribution of plants in vertical space. — 134. Range of cultivated plants. — 135. General considerations of the distribution of plants in distant botanical centres.

THE Meaning and Nature of Organization, and especially of Vegetable Life.—The vegetable world presents us with some of the most readily understood of those forms of matter which are endowed with vitality, being provided with organs enabling them to form new and peculiar combinations of various elementary substances. In other words, we have in this department of natural science a new force introduced, modifying the action and altering the results of other forces—a body not only capable of selecting and separating the various material elements, and bringing them into new combinations, but also of reproducing another body, which, though at first different in many respects, will, after passing through certain transformations and metamorphoses, repeat the individual and continue the race.

The basis of structure of all the various and dissimilar vegetables is, however, the same—it is a little closed vesicle composed of a membrane, usually transparent and colourless. The cell-wall consists of carbon, hydrogen, and oxygen, while a semi-fluid investing substance contains also nitrogen. These elementary substances, in various proportions, make up the mass of all vegetation; and the cells in the course of their development becoming crowded closely together, form into three principal tissues, according to the shapes of the cells, and their importance to the life of the plant. We may indeed regard the cell as a little independent organized body living for itself alone. It imbibes fluid nutriment from the surrounding parts, out of which, by chemical processes, which are constantly in action in the interior of the cell, it forms new substances, which are partly applied to the nutrition and growth of its walls, partly laid up in store for future acquirements, partly again expelled as useless, and to make room for the entrance of new matters. In this constant play of absorption and excretion, of chemical formation, transformation, and decomposition of substances, especially consists the life of the cell, and—since the plant is nothing but a sum of many cells united into a definite shape—also the life of the whole plant.*

Since, then, every plant in its course of formation, and every undeveloped part of a plant, consists of these cells, which in their growth, and by pressure against each other, become six-sided, radiated, cylindrical, spindle-shaped, or

---

* Schleiden's *Plant*, translated by Henfrey, p. 45.

even filamentary, and which sometimes multiply so rapidly, that in one fungus, (*Bovista gigantea*,) 20,000 new cells are formed every minute, we may well understand the necessity of making out something of their structure, mode of growth, and natural relations. By one modification of the cells is formed the external layer of the plant or epidermis, a membrane which appears continuous, and which, as *bark*, is known to every one. Another modification produces tubular channels, which appear to the naked eye as fibres, but which allow of the passage of the fluid contents or sap circulating through the plant, or else serve as air vessels; while a third continues the development of these vascular bundles, and at length produces what is called *wood*. Those plants, and parts of plants, which consist neither of bark nor wood, exhibit the cells either in their simple state or as vascular bundles, so that these three conditions may be considered as the fundamental ones, and as involving all that need be at first regarded.

The contents of the cells of plants are, however, also very important, and may be divided into two groups—those soluble and insoluble in water. The former include albumen, gum, sugar, and the agreeable acids of fruits, such as malic and citric acids. The latter are chiefly the fat oils, such as are found in the kernel of the almond and the fruit of the olive, and the aromatic oils which characterise many plants. Of all these various contents, however, the starch found in the cells, under certain circumstances, and composing a large portion of the nutrient matter of plants, is the most important. It occurs in every part of every plant, but only the roots, tubers, seeds, fruits, and more rarely (as in the sago palm) the pith, afford sufficient to serve as food, or repay the trouble of separating it.

Such being the general condition of the matter of which plants are made up, it is still only when endowed with vitality that they exhibit the properties peculiar to organization. The cell-formation, the first result of life, changes that which was merely a mineral into an organized body, and then all the different plants are distinguished from one another by the shape or plan according to which the cells are united together. The form, therefore, and modifications of form, as they develop the system in plants, are matters without a strict knowledge of which the idea of the vegetable kingdom cannot be conceived, and in order to assist in this conception, it is well to describe the language of naturalists in this department of science with reference to a single plant.

A plant, then, may be said to consist of the following parts, although it must be remembered that some of them are absent, and others greatly modified in particular natural groups. There is a continuous principal trunk or *stem*, with various lateral appendages, of which three kinds may be traced, namely, the *root*, the *leaves*, and the *buds;* but the latter being, in fact, repetitions of the whole plant, except that they are not free at the lower extremity, and the roots agreeing perfectly, in all their characters, with the free extremity of the plant, we have the plant really made up of a stem or axis, terminating downwards in roots and rootlets, which attach it to some solid support, and upwards in a *seed-bud*, whence the original plant is repeated, and leaves, which vary greatly in their form and nature, since amongst them, and belonging to them, must be ranked all the beautiful flowers and delicious fruits presented by the vegetable kingdom. Different in external appearance as these are, their true character no longer admits of a doubt, and the change that takes place belongs to development, according to well marked and invariable laws. According to the kind and degree of development that is natural to plants is their ultimate and characteristic form, and specific definition.

128 *Natural Arrangement or Classification of Plants.*—The first beginnings of vegetation are seen when a green film covers old damp walls, or is deposited on the sides of a glass, in which soft water has stood for several days in summer. These consist of the simple cell, vegetating as an independent plant, and are succeeded in organization by the confervæ or mould, where the cells are arranged in lines and filaments. Then come those long,

thin, and lettuce-like leaves, sometimes green, sometimes red, often found on the coast, and afterwards the vast tribe of *Lichens* and *Fungi*, which with the sea weeds (*Algæ*), form the three groups composing one large class of plants. In the first mentioned tribes there are no definite organs, but in these latter there are cells separated from the rest, and destined to the production of reproductive cells; but it is important to remember that, in all plants, the same organ may serve the most different vital offices in different plants, and the same vital process may belong to the leaf in one plant, to the stem in the other—except, indeed, the organs of reproduction, which are not applied to any other use.

In the higher sea-weeds and lichens, the forms which in the Fungi (and also in those lichens covering walls, stones, and palings, with a whitish-grey or yellow scurf) are very indeterminate, put on a more definite and regular character, exhibiting constant shapes, which resemble stems and leaves, though they have not the same uses, nor the same relation to their detailed structure. All these plants, however, present this one great peculiarity, that in none of them is there, properly speaking, either stem or leaf, and they are consequently flowerless, and have no visible organs of fructification, in the usual meaning of the term. They thus form a separate natural group, which is associated by very close natural resemblances with another group, of which the Mosses, Ferns, and Club Mosses, are well known examples. In all these, there can be distinguished a distinct stem, with leaves, but a peculiar series of gradations is presented in the formation of the reproductive cells, which first come into more intimate connexion with the leaf, and at last assert so strongly their claim to definite foliaceous organs, that they lose all resemblance to the other leaves. Thus, in the Mosses and Ferns, there is a peculiar approximation in form to the structure of the reproductive organs of more highly organized plants, while in the Club Mosses, the resemblance is even greater, and the analogies are more real. All the various natural groups above referred to are described by botanists under the general name of CRYPTOGAMIA, and the second group are also called *Acotyledons*, owing to the plant not growing from a seed, which contains nourishment for the young individual during the earliest stage of its existence, although in some respects resembling plants of higher and more complicated organization. In all other plants the stem and leaf are the elementary organs, but definite leaves are transformed so as to form reproductive cells, and these are therefore sometimes called *sexual plants*, to distinguish them from the Cryptogamous tribe.

The sexual plants are again subdivided, one group exhibiting a very simple inflorescence—indeed, no flower in the ordinary sense—and presenting the seed naked and undefended. The whole fir tribe, the misletoe, and a family of tropical plants (the *Cycadaceæ*) are of this kind, and offer a striking contrast to the other plants where the inflorescence is remarkable and characteristic. The phanerogamous plants are therefore either *Gymnosperms* (naked-seeded) or *Angiosperms* (covered-seeded); and the latter are either developed from a bulb or single-lobed seed, as the palms and grasses, and are called *Monocotyledons* (single seed-lobed), or from a double seed, like the bean, thence called *Dicotyledons* (double seed-lobed). The plants of the two series not only differ essentially in their apparently unimportant characters, but in all the rest of their organization; and are so strikingly distinct in their external appearance, that a little practice enables the eye to recognise them at a glance. Thus the first or monocotyledons generally have the fibre-like wood-bundles scattered throughout the stem, as in the maize, while the second has a closed firm circle of wood, like the willow; in the leaves of the first the veins are usually parallel, as in the grasses, but in the others they ramify like the branches of a tree, and form an elegant net work on the surface of the leaf, as in the lime; and finally the number three prevails in the floral arrangements of the first, as in the tulip, while the number five is that found characterizing the other, as in the primrose. The two series proceed parallel with each other in respect of inflorescence, from the simple to the more complicated forms, so that in the highest stage, where a number of separate flowers are united into one definite whole, arranged according to a marked type and defined with circlets of leaves, we find on the one side the grasses and on the other the so called *Compositæ*, of which the daisy, dandelion, thistle, &c., are well known examples, holding side by side the highest station in existing vegetation.

Thus, then, we find all the plants brought within range of description, by referring to these important, because natural, characteristics, and it may be worth while here to recal the principal points, and express in a tabular form the outline of the classification as a matter to which we shall frequently have occasion to refer.

CRYPTOGAMIA.

1. THALLOPHYTES. (*Confervæ, Fungi, Lichenes, Algæ.*) Stemless, and often without leaves or roots, growing in a centrifugal manner, and capable of undergoing modifications in the individual cells.
2. ACOTYLEDONS. (*Liver-worts, Mosses, Ferns, Equisetaceæ, Club-mosses, and Rhizocarps.*) Having stems, vascular bundles, all developed at the same time, embryo a simple cell or congeries of cells, growth simultaneously upwards and downwards from the central axis or stem, no visible floral development.

3. ANGIOSPERMS. (*Coniferæ, Cycadeaceæ, Loranthaceæ.*) Inflorescence very simple, not presenting a true flower, seed-bud and seed naked.

PHANEROGAMIA.

4. MONOCOTYLEDONS, also called ENDOGENS. Having one seed-lobe, which forms one small leaf in the embryo state, the fresh leaves springing from the centre, and the footstalks of the old leaves forming the outside of the stem; the vascular bundles definite, and converging towards the interior; not having true wood; illustrated by the palms and grasses—all the arrangements having reference to the number three and its multiples.
5. DICOTYLEDONS, also called EXOGENS. Increasing by successive coats from without, the growth of each year forming a concentric circle of wood round the central pith; having two lobes in the seed, symmetrically arranged, and appearing as two small leaves above the ground when the plant first grows; vascular bundles indefinite; the floral and other arrangements governed by the number five. Most of the common forest-trees of temperate climates, as the oak, beech, &c., are examples of this group.

129 *Influence of Climate on Vegetation.*—Plants being thus very variously constituted, and offering so many varieties of structure, are greatly influenced by various causes, of which climate and soil are the most direct and important. Thus in tropical climates monocotyledonous plants abound, and in temperate regions dicotyledonous, while in polar or extremely cold countries, the vegetation is chiefly cryptogamic. On the other hand, certain tribes of plants are strictly confined to particular local conditions, which, at least to some extent, are connected with the soil, directly as well as indirectly.

We have already, in speaking of the distribution of temperature on the globe, explained those causes on which climate depends, and the vast difference in climate that may exist in places having the same latitude, but different longitude; in others, having the same mean annual temperature, but different summer and winter heats; and in others, having the same extreme limits of temperature, but not on the same isothermal. Vegetation is greatly influenced by almost every distinct change of climate, although individual plants will adapt themselves permanently to considerable ranges of heat and cold.

With regard to the extreme limits of temperature at which vegetable organization can exist, we may say, that although seeds will not germinate at a temperature below the freezing point of water, (according to Göppert's recent observations, 39° Fah. is the limit,) still even the extreme cold required to freeze quicksilver does not destroy their vitality. So also, on the other hand, no seed will germinate in water whose temperature is 122° F., and at the heat of 144° in vapour, and 167° in dry air the vitality of corn is destroyed. It is indeed probable that a long continuance at much less extreme temperature would be absolutely destructive, since in the case of grain an exposure to 95° F. for three days has been effectual in preventing subsequent growth.

It has been observed generally that the mean temperatures of different seasons and single months form the best guides for purposes of botanical geography, since, if the isothermal lines only are attended to, the most extreme dissimilarity may exist in real climate. In those places which have the same isotheral lines, (equal mean summer temperature,) and in which the maxima of heat for certain limited periods are nearly the same, there is a sufficient resemblance to allow of the growth of similar plants, although in the one place the winter may be mild, and in the other very severe.

It is well known that the leaves and flowers of the same plant are unfolded at different periods of the year; earlier in the warmer regions, later in the colder. M. G. de. St. Hilaire once observed the peach trees at Brest without leaves or blossoms on 1st of April; on the 8th he found them in full bloom at Lisbon; on the 25th, at Madeira, the fruit had set; and on the 29th he got ripe peaches at Teneriffe. Numerous other examples might be quoted, the general result being that for each degree that the station of a plant is nearer the pole, the time of flowering is delayed almost four days, but there are many causes which greatly modify this law, and it may be otherwise and more accurately expressed by saying, that vegetation is retarded, on an average, three days if the temperature be diminished one degree of Fahrenheit, although, after all, such calculations have no very sound basis. It requires light and the action of the chemical rays of the sun to stimulate plants to activity, and perhaps heat may be a much less important element than has often been supposed.

Climate alters and is combined with a change in the condition and pressure of the atmosphere as we ascend from plains towards table-land and the higher portions of mountain-chains. This is seen equally well in whatever part of the world the investigation is made, and modifies very greatly both the present and past distribution of vegetables on the Earth. Thus, at the foot of a mountain, the plants of the plain appear, but they gradually disappear as we ascend, and a traveller familiar with the vegetation, or *flora*, of an arctic or temperate climate, will find, in ascending high mountains within the tropics, that he sees first one and then another group of familiar forms prevailing over the tropical forms of vegetation that he has left in the plains. After a time, even the trees cease to grow to their full height, bushes being the largest plants, and, at length, as he approaches the limit of perpetual snow, the bushes give place to herbs, these to lichens, and but a few of the forms of plants of the arctic zone are missing, while even the same species re-appear after having been lost throughout the whole space between the arctic regions and the summits of these mountains.

There is, therefore, a certain parallelism between the distribution of vegetation from the level of the sea to the limit of perpetual snow, and that from the equator to the poles, although the gradual change of vegetation takes place much more slowly towards the poles than with increasing altitude. With our present knowledge it is now no longer difficult to perceive that this parallelism exactly agrees with that which we find between the gradual decrease of heat from the equator to the poles, and that from the plain to the limit of perpetual snow.*

It is extremely difficult even to imagine any hypothesis which shall explain the true influence of climate on vegetation, for we often find plants capable of undergoing great changes in temperature and even in all other constituents of climate without injury, and yet naturally limited in extent within very narrow bounds. On the other hand, however, we find forest trees and natural tribes of well known plants altering their external character and form to a very great extent when exposed to a change of climate, either

* Meyen's *Botanical Geography.* Translation published by the Ray Society, p. 23.

by removal to a different latitude, or by being transplanted to more or less considerable elevations above the sea level.

As an example of another kind we may take the case of barley, which is cultivated from the extreme limits of culture in Lapland to the heights immediately beneath the equator, although it is only within a very narrow zone that it apparently flourishes under natural conditions. It has been found by some curious experiments that in several places under latitudes varying as much as forty degrees, the actual number of days between planting and reaping multiplied by the mean temperature is nearly the same, so that to define accurately the conditions of temperature required to maintain any plant in a flourishing condition we must state within what limits its period of vegetation may vary, and what quantity of heat it requires.

The great importance of considering the extremes of temperature in speaking of climate is, however, best illustrated in the case of the vine, which will indeed grow, and, in some seasons, produce eatable fruit in many districts beyond certain well defined limits within which drinkable wines are grown to profit. For this latter purpose a mean annual temperature of more than 49° Fah. is sufficient, provided the mean winter temperature is above 32°.8 Fah., and the mean summer temperature at least 64°.4. Thus, at Bordeaux, (latitude 44° 50′,) the mean temperature of the year is 56°.8, of winter 43°.2, and of summer 71°. On the Baltic, (latitude 52½°) at a spot somewhat beyond the extreme verge of the wine-drinking countries, the corresponding figures are 47°.5, 30°.8, and 63°.7 respectively, and here wine is produced, but can hardly be called drinkable. On the east coast of Ireland, in latitude 55°, the myrtle flourishes as luxuriantly as in Portugal, but the summer temperature being low, the vine will very rarely ripen its fruit in the open air, for the mean temperature for the month of August being only 60°.8 Fah., the proper summer average is not approached, and the mildness of winter, which raises the isothermal, cannot make the required difference. Thus, the culture of the vine and the profitable limits of other plants useful to man, depend more on the isotheral than the isothermal line, and are little affected by great cold occurring in winter.

130 *Influence of Soil on Vegetation.*—Plants are generally attached to the earth mechanically, and derive very important inorganic substances from the soil in which they grow. Many, however, can exist permanently in water, while some few seem to require nothing more than they can obtain directly from the air, and others derive support only indirectly from the soil, being attached as parasites to other plants.

Almost all soils, even fine quartzose sands, the most barren of all, contain some soluble matter which plants can avail themselves of, and if we remove any plant to matter perfectly insoluble and water it with distilled water, it can never attain to perfect development, although with carbonic acid gas and water it will continue to live. Water is thus absolutely essential, and carbonic acid not less so, to the existence and reproduction of all vegetable matter, but much more than this is generally required, and it becomes important to know how far the presence or absence of particular minerals, the nature of the materials of which a soil is principally made up, or the mechanical condition of such materials affect the capacity of the soil for receiving and nourishing certain plants or natural groups of plants.

From the different habits already alluded to it will readily be seen that a division into aquatic, land, and parasitic plants, includes almost all the various kinds we are likely to meet with.

The first class includes many groups, and with them may be properly associated shore plants, amphibious and inundated plants, and some others; while the third or last class includes those only which are limited, so far as their habitat is concerned, to other trees and vegetables. But it is with the second class that we have now to deal, and these also are much subdivided, as we have sand plants, limestone plants, clay plants, gypsum plants, turf plants, bog plants, and marsh plants. We may also consider in reference to this subject the mechanical condition of the soil and subsoil, some plants growing on hard rock; others on fragmentary or broken rock, boulders, or gravel; others on material in finer subdivision or sand; and others again on tough argillaceous rock; while, again, there are whole tribes of plants which seem to have especial reference to cultivation, becoming so far modified by artificial culture that their true habits are rarely now to be recognised. It will be convenient to follow the arrangement of Dr. Meyen (see *Geography of Plants* before quoted) in this part of our subject.*

Sand plants, or flint plants, are of peculiar character in all parts of the Earth, and the greatest number of them are probably grasses. Amongst them are a Carex (*C. arenaria*), an Arundo (*A. arenaria*), several species of Tussilago and Potentilla, and several other plants usually found in sandy plains, while one (*Elymus arenarius*) grows naturally and freely in shifting sand hills on the sea coast, and is often used with great advantage to bind loose sand, and prevent its being drifted by the wind when no mechanical contrivance will serve and no other plant will grow upon it. Besides these there are some plants confined to river sand.

There are plants which are found almost exclusively in rocks, and others again are more common on loose stones, amongst the former of which a great number of Cacti and other succulent plants in the tropics may be mentioned, together with the greater number of ferns, lichens, and mosses. These are found indifferently on quartz and calcareous rock, but particular species are limited more closely in geological position.

Gravel plants have been considered as chiefly growing on the detritus of mountains, such as *Saxifraga rivularis, Ranuncula alpestris*, and *R. glacialis*, and some species of *Sida* have been described, of remarkable beauty, growing on a white trachytic sand on extensive tracts in the plateaux of Peru, at an elevation of from fourteen to sixteen thousand feet.

Plants growing on calcareous rocks, whether chalk or limestone, form another group, of which the family *Orchideæ* presents many species. Calcareous mountains exhibit many peculiarities in their vegetation, having for the most part few woods, but generally rather a shrubby and bushy vegetation, and, therefore, they possess a number of small plants which grow in the shade of these bushes. The chalk of our own island is well known as growing a short but sweet herbage, and on the ridges of the hills the yew and some few other coniferous trees grow to large size. In addition to the plants growing on the calcareous rocks, some are found also where gypsum forms the subsoil, but this is by no means a common condition in nature. The presence of magnesia in rocks is generally unfavourable to the growth of plants, and the rocks that are very hard and not readily decomposed or disintegrated by atmospheric influence are also usually barren.

Mixtures of soils are often found to be most favourable for the growth of those classes of plants that naturally abound on the mineral that preponderates, but it must not be forgotten that even those plants which peculiarly belong to a soil, appear also very frequently elsewhere; and it has even been observed, that some which have undoubted preference for a soil of a particular nature have a much wider circle of distribution than others which grow in common mould.

Other mixtures, such as those which result in the formation of bog-earth and turf, have a peculiar vegetation, seen in those countries where turf-moors, bogs, and marshes are frequent and extensive. The species which grow on turf are distinguished by growing socially and by an excessive development of root. The *Sphagna* is an example of this, and is a plant which rarely allows any others to appear where it has taken up its abode. Bog plants grow on very wet soil, and as bogs are very frequent in northern

---

* Meyen's *Botanical Geography, ante cit.*, p. 46 *et passim.*

countries and in the higher parts of mountains, such plants are found on the Alps, the Harz mountains, the mountains of Silesia, the plateaux of the Andes, and in Ireland. These, however, and turf plants are often mixed, as, in fact, a small addition of moisture turns a turf moor into a bog, and a still further addition to a marsh, but as marshes often contain sheets of water besides being permanently softer than bogs, they include also some aquatic plants and some peculiar to themselves. It is evident in all these cases that the qualities of the soil have in many important respects a decided influence on the presence of certain plants and on their abundant increase.

It is a singular fact, that a large number of plants seem to have attached themselves to civilized man, since they follow his footsteps as he advances, and thus appear to exhibit a kind of domestication. The higher and more stimulating quality of the soils used for the cultivation of the food plants is no doubt often the reason of this, but there are also others, and a number of species have been grouped by Schouw, one of the most eminent botanists in reference to the geography of plants, into wall-plants, ruin-plants, roof-plants, flank-plants, and rubbish-plants. These possess habits which are at once understood by their names, and in most cases show a decided preference for artificial over natural conditions of existence.

Certain species also appear in fixed and singularly remarkable situations, as for instance, there is an extremely pretty fungus, which is found on and appears absolutely limited to wine casks. There is also one (a Conferva) which grows on window panes, and another on paper. These habitats are remarkable as being purely artificial, and not presenting any very analogous substance in nature.

131 *General Range of Plants in various Countries at moderate Elevations.* —However clear it may appear that plants are greatly affected by soil, situation, and culture, so that while some have naturally a wide range, others are limited in this respect, from causes easily understood, it is yet equally clear, that there are other natural limits of distribution which it now becomes necessary to treat of. There are in this matter two very different classes of facts to be considered. The Heath plants, for example, *occur* on dry, sunny, sandy plains; they *extend* from the Cape of Good Hope through Africa, Europe, and Northern Asia, to the extreme limits of vegetation in Scandinavia and Siberia; these plants are *distributed* in this great region in such a manner that South Africa has a vast number of distinct species, of which, however, never more than a few individuals grow side by side, while, towards the north, the number of species suddenly diminishes in an important degree, the number of individuals increasing, till at last in the north of Europe a single species (the common Heather) overspreads whole countries in millions of single individuals. The range of distribution, or the area of a plant, includes all those localities in which plants freely grow, the expression 'natural habitat' denoting the particular station or stations to which it has been appointed by nature.

There are three ways in which we may speak of this area—namely, in latitude or distance from the equator towards the poles—in longitude or distance on a line parallel to the equator—and in vertical distance from the sea level. The two former may be called 'distribution in horizontal space'—and the latter 'distribution in vertical space.' There is also another distribution determined by the examination of the fossil remains of vegetables in various rocks, which as it appears to present something like analogous conditions, is now known as 'distribution in time.' In the present section we have to treat of distribution in horizontal space.

The distribution of plants is chiefly regulated by that of heat on various parts of the Earth's surface; and as this, again, has a certain relation to the parallels of latitude, it follows that the distribution is according to latitude principally, the longitudinal extent of the area being much less important.

The area of a plant, with reference to its extent in latitude, is called its 'zone of latitude,' or more simply 'zone,' and it is called the 'region,' when vertical range is referred to. The term zone of longitude is applied, though more rarely, to the horizontal range of plants in districts within similar limits of longitude.

The zone of every plant has a polar and equatorial limit beyond which the plant does not appear, but those plants whose polar limits extend to extreme latitudes are exceptions to this, as well as those which cross the equator, and enter the opposite hemisphere. The former are generally called polar or arctic plants, and the latter tropical plants, but this is not quite accurate, as an arctic plant may appear within the arctic zone without ascending to the highest latitudes. Similar examples might be given of tropical plants which do not reach the equator.

There are many conditions, some of which we have already adverted to, which modify and interrupt the range of particular species of plants. Thus, for example, if a plant require a certain degree of heat, and its presence chiefly depends on this, it may appear in all those places which have the same mean annual temperature, and thus exhibit a greatly interrupted range, especially when we combine vertical with horizontal distribution. The primroses, the anemones, and the gentians, of the plains of northern Europe, re-appear in this way at a certain elevation in the Swiss Alps, while *Salsola kali*, having an extraordinary and peculiar relation to the sea coast, has an almost uninterrupted range on the shores of most parts of the world.

It is clear, also, that there is an artificial, as well as a natural, range of plants, for man is enabled to transplant many, as, for instance, the cereals and the vine, so as to have corn in almost every country, while the grape, indigenous only within narrow limits, is now introduced and is cultivated to advantage in South Africa, Australia, the islands of the Eastern Achipelago, and many parts of America, on the Pacific as well as the Atlantic side. Many plants seem to grow with much more than natural luxuriance when introduced into new countries.

Generally it is found that plants with a naturally wide range may be extended much farther artificially, while plants of limited area are generally spread with difficulty, and we may lay it down as a rule, that the range of plants is wider the lower the degree of their development. Thus, the Cryptogamiæ—especially the lichens and mosses,—and probably the Algæ, are distributed uninterruptedly from one end of the Earth to the other, and of one hundred and sixty-seven plants, common to Europe and Australia, as many as one hundred and twenty-two are Acotyledons, thirty only being Monocotyledons, and fifteen Dicotyledons. On the other hand, some plants have a range as remarkably limited, being confined to an island or a mountain.

Plants vary so much in the extent of their range, that general rules can scarcely be laid down concerning them, but it has been supposed by Schouw, that in the temperate zone of the northern hemisphere, a distance of 10°—15° is the most common breadth of the area of a plant, while the extremes do not extend more than five degrees as a minimum and thirty as a maximum.

The longitudinal extent of a zone is often much greater, since there are some plants which range as a belt round the globe. There are, however, cases of very limited range in this direction, generally caused by the existence of some natural obstacle, as a broad expanse of water, or a lofty mountain ridge.

The subject of the distribution of plants may be divided into two perfectly distinct branches, one of which treats of the distribution of the forms which point out the groups of plants, while the other does not inquire concerning the absolute predominance of any particular group or type, but considers the relative proportions founded on actual numbers, which any given group, by its number of species, bears either to the whole mass of known plants, or to the number of species of other groups. The former gives what may be called the Physiognomy of plants, since in it the general aspect is regarded, while the other presents the true Statistics of plants. As an example, it is well known that a particular group of plants, such as the ferns, may determine the natural character or floral physiognomy of a country without therefore being predominant by the number of its species, because, although in the same country, some other plants, such as the *Compositæ*, may exceed the ferns in the actual proportion they bear to the sum of all the phœnogamous plants, yet a single species of fern may cover ten times more ground than all the Compositæ together. The ferns here preponderate by the mass of individuals, not by the number of species.

It is at any rate a fact, and a very important one, that plants are distributed over the Earth's surface according to certain laws, but of the true nature of these we are not perfectly acquainted, for although we know some of the external causes which place the more developed and nobler forms of vegetation in the hot zones, we know of no cause why the same species of plants are not always produced under similar conditions of climate. Thus, the singular group of the *Cactaceæ* is properly peculiar to the torrid and subtropical zones of America, two species only having been met with in Asia, and none in Africa. But the form of Cactus has its representative in the Old World, for we have on both sides *Euphorbiæ*, which we should certainly consider Cacti, if we were ignorant of their organs of fructification. It is equally inexplicable why the Old World should possess abundance of heaths (*Ericæ*), while only a representative form (not a true heath) comes in their place in America; but these and other remarkable facts agree in showing that the greater number of families of plants are distributed over the whole globe, individual representatives of the groups appearing wherever a fertile soil is exposed to light and air.

In the distribution of plants, it has also been observed, that the species of genera, as well as the genera of families, proceed sometimes from a point, and range themselves round it in concentric circles, or spread from it like rays in various directions, while in other and more common cases, they are arranged in belts. Occasionally these methods are modified by the social or isolated habit of the plant, which is a very important circumstance in its distribution.

Genera, as well as families, attain their maximum in some one place on the Earth, and when in addition to this the number of individuals in which the genus or family grow is sufficient to influence the physiognomy of the flora, it has been found convenient to give a special name, generally formed from that of the country or zone. The Palms and others are thus almost exclusively confined to the torrid zone, and are regarded there as characteristic, although species extend far to the north and south of the two tropics.

When a family of plants predominates in any zone, either by a number of individuals or species, and in another zone there are only a few or single forms of it, the family is said to be represented by the few species, and these are then called the representatives of the family. Thus, the Heaths of the Old World have their maximum in South Africa, but the beautiful shrubby forms abundant at the Cape of Good Hope are represented in the south of Europe by one species (*E. arborea*.) So the Acaciæ characterise New Holland, but one species (*A. heterophylla*) is the representative of the family in the Sandwich Islands, and in the form and growth of its leaves seems even to connect in the northern hemisphere two forms of prevalent vegetation in Australia.

If we consider the general features of the vegetation spread over the globe, or the different impressions which, at different places, it makes upon us, we shall soon remark certain principal groups, which are more or less clearly separated from the surrounding plants. These groups, which are distinguished by their peculiar physiognomy, sometimes agree also in artificial characters, and form certain genera and families, but sometimes it is the whole vegetation of the district which has received a peculiar character from the arrangement or grouping of the different forms of its plants. If we were to classify the whole mass of vegetation according to the peculiarities in physiognomy which it presents, the classification must be twofold, both geographical and botanical. When the geographical principle is taken, we may divide the vegetation according to the countries, or larger tracts, in which it is found, and call such divisions 'Floras,' which are further designated by the names of the countries, but such divisions may also be called 'regions,' or phyto-geographical kingdoms. The whole surface of the globe has been mapped out into such divisions, which we now proceed to enumerate.

132 *The Botanical Regions.*—Two eminent authors have suggested divisions of this kind. The first is that of M. de Candolle, with reference to natural stations, and the other by Professor Schouw, who has taken the most remarkable features of the vegetation of geographically marked districts. We quote the tables as given by Professor Balfour, in his *Manual of Botany*, not long since published:—

PLANTS AS GROUPED ACCORDING TO THEIR NATURAL STATIONS.

A. *Plants growing in Water, whether Salt or Fresh.*

1. Marine plants, such as Sea-weeds, Lavers, &c., which are either buried in the ocean, or float on its surface; also such plants as *Ruppia* and *Zostera*. In the Sargasso Sea there are floating meadows of *Sargassum bacciferum*, gulf weed. This sea extends from 22° to 36° north latitude, and from 25° to 45° west longitude from Greenwich, an area of 40,000 square miles.

2. Maritime or saline plants. These are plants which grow on the border of the sea or of salt lakes, and require salt for nourishment, as *Salicornia*, glasswort, *Salsola*, salt wort, *Anabasis*. Such plants are often called Halophytes (sea plants). Under this head may be included littoral and shore plants, such as *Armeria*, sea pink, *Glaux*, and *Samolus*.

3. Aquatic plants, growing in fresh water, either stagnant or running; as *Sagittaria*, arrow head, *Nymphæa*, water lily, *Potamogeton*, pondweed, *Subularia*, awlwort, *Utricularia*, bladderwort, *Stratiotes*, water-soldier, *Lemna*, duck weed, *Pistia*, *Confervæ*, *Oscillatoriæ*, and *Ranunculus fluviatilis*. Some of these root in the soil, and appear above the surface of the water; others root in the soil and remain submerged; while a few swim freely on the surface without rooting below.

4. Amphibious plants, living in ground which is generally submerged, but occasionally dry, as *Ranunculus aquatilis* and *sceleratus*, *Polygonum amphibium*, *Nasturtium amphibium*. The form of the plants varies according to the degree of moisture. Some of these, as *Limosella aquatica* grow in places which are inundated at certain periods of the year; others, such as *Rhizophoras* (mangroves) and *Avicennias*, form forests at the mouths of muddy rivers in tropical countries.

B. *Land Plants which root in the Earth and grow in the Atmosphere.*

5. Sand plants; as *Carex arenaria*, *Ammophila arenaria*, *Elymus arenarius*, and *Calamagrostis arenaria*, which tend to fix the loose sand, *Plantago arenaria*, *Herniaria glabra*, *Sedum acre*.

6. Chalk plants; plants growing in calcareous soils, as some species of *Ophrys*, *Orchis*, and *Cypripedium*.

7. Meadow and pasture plants; as some species of *Lotus*, bird's-foot trefoil, a great number of grasses and trefoils, the daisy, dandelion, and butter-cups.

8. Plants found in cultivated ground. In this division are included many plants which have been introduced by man along with grain, as *Centaurea cyanus*, corn blue-bottle, *Sinapis arvensis*, common wild mustard, *Agrostemma*, corn-cockle, several species of *Veronica* and *Euphorbia*, *Lolium temulentum*, *Convolvulus arvensis*, *Cichorium intybus*, also plants growing in fallow ground, as *Rumex acetosella*, *Carduus nutans*, *Echium vulgare*, *Artemisia campestris*, and *Androsace septentrionalis*. In this division, garden weeds are included, such as groundsel, chickweed, *Lamium amplexicaule*, *Chenopodium vulgare*, and *viride*.

9. Rock or wall plants; Saxifrages, Wall flower, *Linaria cymbalaria*, *Draba muralis*, species of *Sisymbrium* and *Sedum*, *Asplenium*, *Ruta muraria*, and some lichens and mosses.

10. Plants found on rubbish heaps, especially connected with old buildings. Some

of these seem to select the habitations of man and animals on account of certain nitrogenous and inorganic matters, which enter into their composition. Among them may be noticed, Nettles, Pellitory, Docks, Borage, Henbane, *Xanthium*. Here, also, have been placed some plants immediately connected with the habitation of man, such as *Racodium cellare*, a fungus found on wine casks, *Conferva fenestralis*, an alga produced on window panes, and *Conferva dendrita*, one developed on paper. Some plants, as *Sempervivum tectorum*, select the roofs of houses.

11. Plants growing in vegetable mould; such as bog-plants, or those growing on wet soil, so soft that it yields to the foot but rises again, and marsh plants growing in wet soil, which sinks under the foot and does not rise. To the former class belong such plants as *Pinguicula alpina*, and *Primula farinosa;* to the latter, such as *Menyanthes, Comarum, Bidens cernua.*

12. Forest plants, including trees which live in society, as the Oak, the Beech, Firs, &c., and the plants which grow under their shelter, as the greater part of the European Orchises, some species of *Carex* and *Orobanche.* Some plants especially grow in pine and fir-woods, as *Linnæa borealis,* and some Pyrolas.

13. Plants of sterile places, found in barren tracts by road sides. This is a heterogeneous class, and contains many plants of uncertain characters. Under it are included the plants of uncultivated grounds, as those found on moors, where *Calluna vulgaris,* common heather, and various Heaths, Juniper, *Andromeda,* and some species of Polytrichum occur.

14. Plants of the thickets or hedges, comprehending the small shrubs which constitute the hedge or thicket, as the Hawthorn and Sweet-briar; and the herbaceous plants which grow at the foot of these shrubs, as *Adoxa,* Wood sorrel, Violets; and those which climb among their numerous branches, as Bryony, Black Bryony, Honeysuckle, Travellers' joy, and some species of *Lathyrus.*

15. Plants of the mountains, which De Candolle proposes to divide into two sections:—1. Those which grow on alpine mountains, the summits of which are covered with perpetual snow, and where, during the heat of summer, there is a continued and abundant flow of moisture, as numerous Saxifrages, Gentians, Primroses, and Rhododendrons. 2. Those inhabiting mountains, on which the snow disappears during summer, as several species of snap-dragon, among others the Alpine snapdragon, Umbelliferous plants, chiefly belonging to the genus *Seseli,* meadow Saxifrage, Labiate plants, &c.

C. *Plants growing in Special Localities.*

16. Parasitic plants, which derive their nourishment from other vegetables, and which consequently may be found in all the preceding situations, as the Mistletoe, species of *Orobanche, Cuscuta,* (Dodder,) *Loranthus, Rafflesia,* and numerous fungi.

17. Pseudo-parasitic plants or Epiphytes, which live upon dead vegetables, as Lichens, Mosses, &c., or upon the bark of living vegetables, but do not derive much nourishment from them; as *Epidendrum, Aerides,* and other Orchids, as well as *Tillandsia, Bromelia, Pothos,* and other air plants.

18. Subterranean plants, or those which live under ground, or in mines and caves, almost entirely excluded from the light; as *Byssus,* Truffles, and some other cryptogamic plants.

19. Plants which vegetate in hot springs, the temperature of which ranges from 80° to 150° of Fahrenheit's thermometer, as *Vitex agnus-castus,* and several cryptogamous plants, as *Ulva thermalis,* the hot-spring laver.

20. Plants which are developed in artificial infusions, or liquors, as various kinds of *Mucor,* causing mouldiness.

21. Plants growing on living animals; as species of *Sphæria* and *Sarcinula* and various other Fungi and Algæ.

22. Plants growing on certain kinds of decaying animal matter, such as species of *Onygena,* found on the hoofs of horses, feathers of birds, &c., some species of Fungi, which grow only on the dung of animals, and certain species of *Splachnum.*

Of these groups of plants a large number were recognised by De Candolle, the others being added by Bory St. Vincent. We next give the more generally recognised and more geographical divisions of Schouw, which are based on various observations made in many parts of the world, and agree with the conclusions arrived at by Humboldt and others, who have carefully studied this important department of Physical Geography:—

PLANTS GROUPED IN GEOGRAPHICAL REGIONS.

I. *The region of Saxifrages and Mosses,* or *the Alpine Arctic Flora.*—This region is characterised by the abundance of mosses and lichens, the presence of the saxifrages, gentians, the chickweed-tribe, sedges and willows; the total absence of tropical families; a notable decrease of the forms peculiar to the temperate zone; by forests of firs and birches, and an absence of other forest trees; the small number of annual plants, and the prevalence of perennial species; and finally a greater liveliness in their simple colours. This region is divided into two provinces. 1. The province of the *Carices,* or the Arctic Flora, which comprehends all the countries within the polar circle, with some parts of America, Kamtschatka, New Britain, Canada, Labrador, Greenland, and the mountains of Scotland and Scandinavia. 2. The province of primroses and rampions, or the Alpine Flora of the South of Europe, which embraces the flora of the Pyrenees, Switzerland, the Tyrol, Savoy, &c., the mountains of Greece, the Apennines, and probably the mountains of Spain.

II. *The region of the Umbelliferous and Cruciferous Plants,* (to which the hemlock, parsley, wallflower, cresses, &c., belong.)—These tribes are here in much greater number than in any other region; roses, crowfoots, mushrooms, amentaceous and coniferous plants are also very numerous; the abundance of *Carices* and the fall of the leaves of almost all the trees during winter form also the chief features of this division. It may be separated into two distinct provinces. 1. The province of the Cichoraceæ (including the sow-thistle, dandelion, lettuce, &c.), which embraces all the north of Europe, not comprehended in the preceding region—namely, Britain, the north of France, the Netherlands, Germany, Denmark, Poland, Hungary, and the greater part of European Russia. 1. The province of the *Astragali* and *Cynarocephalæ* (to which the milkvetch, burdock, thistle, &c., belong),which includes a part of Asiatic Russia and the countries about Mount Caucasus. The cultivated plants include those most useful and important in the temperate zones.

III. *The region of the Labiatæ and Caryophyllæ,* (to which the pink, catchfly, sandworts, &c., belong), or the Mediterranean Flora.—It is distinguished by the abundance of the plants belonging to these two orders. Some tropical families are also met with, such as palms, laurels, arums, plants yielding balsam and turpentine, grasses belonging to the genus *Panicum,* or millet, and the true *Cryperaceæ,* or sedges. The forests are composed chiefly of the amentaceous and coniferous tribes, as birches, oaks, &c., the copses of *Ericaceæ,* or heath tribe, and *Terebinthaceæ,* as the mastich, &c. We meet here with a great number of evergreen trees. Vegetation never ceases entirely, but verdant meadows are more rare. Schouw divides this region into five provinces. 1. The province of the cistuses, including Spain and Portugal. 2. The province of the sage and scabious, the south of France, Italy and Sicily. 3. The province of the shrubby *Labiatæ,* the Levant, Greece, Asia Minor, and the southern part of the Caucasian countries. 4. The Atlantic province, the north of Africa, of which he does not yet know any distinctive character. 5. The province of the houseleeks, the Canary Isles, and probably also the Azores, Madeira, and the north-west coast of Africa. Many houseleeks and some spurges with naked and spring stems particularly characterise this province.

IV. *The region of the Rhamni and Caprifoliaceæ,* (to which the buckthorn and honeysuckle belong,) or the Japanese region.—This region is as yet too little known to enable us to determine accurately its characteristic features. It embraces the eastern temperate part of the old continent, namely, Japan, the north of China, and Chinese Tartary. Its vegetation appears to occupy a middle place between that of Europe and that of North America, approaching more to the tropical than to the European.

V. *The region of Asters and Solidagos,* (Michaelmas daisies and golden-rods.)—This is marked by the great number of species belonging to these two genera, by the great variety of oaks and firs, the small number of *cruciferous* and *umbelliferous* plants, the total absence of the heath, and the presence of more numerous species of whortleberry than are to be met with in Europe. It comprehends the whole of the eastern part of North America, with the exception of what belongs to the first region. It has been divided into two provinces. 1. That of the south, which embraces the Floridas, Alabama, Mississippi, Louisiania, Georgia, and the Carolinas. 2. That of the north, which includes the other states of North America, such as Virginia, Pennsylvania, New York, &c.

VI. *The region of Magnolias,* comprising the most southern parts of North America. —The tropical forms which show themselves more frequently than on a similar parallel of the old continent, are the chief feature in the vegetation.

VII. *The region of Cactuses, Peppers, and Melastomas.*—These families are here predominant, both as regards the number of the species and of the individual plants. It is divided into three provinces. 1. The province of the ferns and orchises, comprehending the West Indian Islands. 2 The province of the palms, the lower parts of Mexico, New Granada, Guiana, and Peru. 3. Brazil also seems to form a province, and may perhaps constitute a region of itself.

VIII. *The region of Cinchonæ,* or Medicinal Barks, which comprises a part of the elevated regions of South America included in the torrid zone. The *Cinchonæ* belongs exclusively to this region and forms its principal feature.

IX. *The region of Escallonias, Whortleberries, and Winter's Barks.*—It embraces the highest parts of South America. We also meet with Alpine plants, as saxifrages, whitlow-grass, sandworts, sedges, and gentians. Perhaps also the mountains of Mexico belong to this region, although they may form a separate province, that of the oaks and firs.

X. *The Chilian region.*—The Flora of Chili differs essentially from those of New Holland, the Cape of Good Hope, and New Zealand, although an approach to them is observable in the genera *Goodenia, Araucaria,* (Chilian pine,) *Protea, Gunnera,* and *Ancistrum.*

XI. *The region of Arborescent Compositæ,* (or arborescent plants, with flowers like the dandelion, daisy, &c.)—The great number of syngenesious plants, more particularly of the family of Boopideæ, forms the chief feature of this flora, which approaches in a remarkable manner to that of Europe, whilst it differs entirely from those of Chili, the Cape, and New Holland. This region comprehends the lower part of the basin of La Plata, and the plains which extend to the west of Buenos Ayres.

XII. *The Antarctic region,* formed by the countries near the Straits of Magellan.—There is a considerable affinity between the vegetation here and what is seen in the north temperate zone. Polar forms, however, display themselves in the species of saxifrage, gentian, arbutus, and primrose. There is also a resemblance between the flora of this region and those of the mountains of South America, of Chili, the Cape, and New Holland.

XIII. *The region of New Zealand.*—This flora, besides the plants peculiar to New Zealand, comprehends several others which belong to the extremities of America, Africa, and Australia, or New Holland.

XIV. *The region of Epacrides and Eucalypti.*—It comprehends the temperate parts of New Holland and Van Diemen's Land. Besides the two families whence it receives its name, it is characterised by the presence of a great number of *Proteaceæ,* myrtles, *Stylideæ, Restiaceæ, Diosmeæ, Acacias, &c.*

XV. *The region of Mesembryanthema, or Fig Marigolds and Stapelias.*—These two genera, as well as the heaths, are very abundant here. The latter is found in greater quantity here than anywhere else. The region embraces the southern extremity of Africa.

XVI. *The region of Western Africa.*—We are only acquainted with Guinea and Congo, the vegetation of which is a mixture of the Floras of Asia and America, though most resembling the former. This region is characterized by a considerable number of grasses and sedges, and the peculiar genus *Adansonia,* the baobab, (the largest known tree in the world.)

XVII. *The region of Eastern Africa.*—In regard to the eastern coast of Africa, our knowledge is very imperfect. The region is chiefly distinguished by the genera *Danais, Ambora, Dombeya,* and *Senacia.*

XVIII. *The region of the Scitamineæ* (of the turmeric, cardamom, Indian shot, &c.), or the Indian Flora. The *Scitamineæ* here are much more numerous than in America, as well as the *leguminosæ,* such as pease, broom, &c., *cucurbitaceæ* or the cucumber tribe, and *tiliaceæ,* or the lime-tree tribe, although in a less degree. In consequence of the imperfect state of the science, we cannot subdivide this region into provinces. It comprehends India, east and west of the Ganges, the islands of Madagascar, Bourbon, and Mauritius, those between India and New Holland, and perhaps the tropical part of this last continent.

XIX. *The mountains of India* ought to form one or two regions, the vegetation of which differs from that of the plains. These countries, perhaps, constitute one region with the whole of central Asia.

XX. *The Floras of Cochin China, Tonquin, and the north of China,* notwithstanding their resemblance to that of India, present a sufficient number of peculiar indigenous plants to constitute a distinct region.

XXI. *The Flora of Arabia and Persia,* differing from that of India and the Mediterranean, forms a particular botanical region, characterised by the numerous species of *cassia* and *mimosa*, (to which senna, the sensitive plant, &c., belong,) which are found in it. It appears probable that Nubia and a part of central Asia belong to it. Abyssinia, the elevated parts of which possess such a different climate, may perhaps form one of the great subdivisions, or even a totally distinct region.

XXII. *The Islands of the South Sea* which lie within the tropics form undoubtedly a separate region, though with but a slender degree of peculiarity. Among 214 genera, 173 are found in India, and most of the remainder are in common with America. The bread-fruit tree is among the characteristics of these islands, although it is not confined to this region.

Marine plants are also confined to particular regions, from causes analogous to those which limit or favour the extension ot terrestrial plants. Thus, the Northern Ocean from the pole to the fortieth degree, the Sea of the Antilles, the eastern coasts of South America, those of New Holland, the Indian Archipelago, the Mediterranean, the Red Sea, &c., present so many large marine regions, each of which possesses a peculiar marine vegetation and often characteristic plants.

133 *Distribution of Plants in Vertical Space.*—Just as the mean annual temperature of any part of the Earth is found to diminish as we advance from the equator towards the poles, although greatly modified in different districts from local circumstances, so does it decrease regularly and rapidly as we ascend from the plains into the higher regions of the atmosphere, so that starting from the burning heat of central America, at or near the sea level, we pass quickly through all changes of temperature, till in a few hours' travelling we reach the icy region where perpetual snow and ice prevent all vegetation. The most striking exemplification of the mere change of temperature is recognised in rising rapidly in a balloon; but when one ascends a high mountain, a similar but more gradual decrease of temperature is observed to correspond with striking differences in the vegetation. At the foot of the mountain the plants of the plain appear; these gradually vanish as we continue to mount—trees are found up to a certain height, but no further—then bushes prevail; after which, towards the extreme elevations, the bushes give place first to herbs, and at length to only a few lichens.

The traveller who has visited the countries to the north will, when ascending high mountains in southern latitudes, very soon enter regions amongst whose vegetation he will recognise northern plants. At the limit of permanent snow on these mountains he will miss but a few forms of the plants of the arctic zone, and even will find identical species which do not once appear in the plains in the whole space between the arctic regions and the summit of those mountains.

There is therefore a certain parallelism between the distribution of vegetation from the level of the sea to the limits of perpetual snow, and that from the equator to the poles, although the gradual change is far more rapid in the former than in the latter case. This parallelism also exactly agrees with that which we find between the gradual decrease of heat from the equator to the poles, and that from the plain to the limit of perpetual snow.

In ascending from the level of the ocean in the temperate and frigid zones, we find as we rise upon the slopes of the mountains that plants decrease both in the size of the individuals and also in their numerical development, while in the tropics the mass of vegetation is more limited in the plains than in the lower mountain regions. This is also the case with the greater variety of species which in common with these decrease in an upward direction, and the remark is applicable especially to the temperate zones, since in the cold zones the plants of higher regions cannot differ much from those of the plains, because the snow limits have but little absolute elevation. The distance of the limits of trees and shrubs from the snow line is also greater in the torrid than in the temperate and frigid zones.

In central and southern Europe the following difference is observed between the flora of the plains and that of mountains of 4000 feet elevation. The proportion of monocotyledons to dicotyledons, which in the plains is as one to four, decreases with the elevation (but only on dry mountain slopes), till at the height of 8526 feet it is as one to seven, and in particular cases even as one to nine. Moist mountain slopes, on the contrary, favour the growth of monocotyledons, as here the proportion becomes one to three.

The tropical families which have representatives in the plains disappear altogether in the mountain flora, and this is also the case with those families which have their maximum number of species in the torrid zone. Examples of the first are found in the palms, and of the second in the laurels. Other families which have their maximum in the torrid and diminish in the temperate zone, exhibit this decrease still more on the slopes of mountains, as exemplified in the *Leguminosæ* and *Euphorbiaceæ*.

Among the families which have their maximum in the temperate zone, there are many that undergo but little change with increased elevation, as the well known families *Compositæ*, *Cruciferæ*, *Umbelliferæ*, *Rosaceæ*, and others; while some families decrease both towards the poles and the snow line in vertical space (e.g. *Liliaceæ*, *Labiatæ*, *&c.*); and others, again, appear as subordinate groups, which have their maximum in the higher regions.

In some cases the proportion becomes greater with increased elevation, as seen especially with the saxifrages, mosses, and lichens.

In the European Alps the *Compositæ*, from the number of species, are the prevailing family; after these follow, in nearly equal number, the *Cyperaceæ*, *Alsineæ*, *Gramineæ*, *Cruciferæ*, *Leguminosæ*, *Rosaceæ*, *Saxifrageæ*, and *Umbelliferæ;* but the mass of vegetation is formed by the Catkin-bearing plants (*Amentaceæ*), the grasses, and the genus *Rhododendron.* As characteristic marks of the Alpine flora may be noticed, first, that the number of annuals is very small; second, that the flowers are of great size in proportion to the whole plant; and third, that the colour of the flowers, and indeed of the entire plants, is brighter and purer than in the plains.

Alpine plants afford more nourishment to cattle than those grown on plains, and plants with thorns or very hairy plants are seldom found in the Alpine regions.

On ascending a mountain in the torrid zone, as in the Cordillera of the Andes, the tropical families disappear altogether at the height of about 7000 feet, or at least become represented by single species; the number of species gradually decreasing, and those of families which attain their maximum in temperate zones replacing them and increasing with the height. Thus of 327 genera, to which the plants on the declivity of the Andes at a height of 7800 feet and upwards belong, as many as 180, or more than one-half, are common to the temperate zone.

As, therefore, the physiognomy of the vegetable kingdom is characterised by certain plants in the different latitudinal zones from the equator to the poles, so is it also in the vertical direction in the mountain regions which correspond with the zones; and proceeding from the vegetation of the equatorial zone, we follow the series of vegetable regions in ascending lines one after the other, and may compare them with the different zones as follows:—

1. Region of palms and bananas . .	Equatorial zone.
2. Tree ferns and figs	Tropical zone.
3. Myrtles and laurels	Sub-tropical zone.
4. Evergreen trees	Warm temperate zone.
5. European trees.	Cold temperate zone.
6. Pines	Sub-arctic zone.
7. Rhododendrons	Arctic zone.
8. Alpine plants	Polar zone.

This table shows that each of the zones of higher latitudes possesses a region less than that which precedes it, but it must also be understood that many modifications occur in nature in particular localities. Thus the limit of trees in the equatorial zone, in the Andes of Quito, is marked by an *Escallonia* (not a Conifer), while in the temperate zone, in the Himalayans, the oak is the last tree at 11,500 feet above the sea on the south side, and the birch the last on the north side at 14,000 feet. Similar exceptions occur with regard to the limit of shrubs.*

134 *Range of Cultivated Plants.*—Several natural families and many genera and species of plants bear so directly on the habits and even existence of man in the country where they abound, that the subject of cultivated plants becomes of great interest in a treatise on Physical Geography. The plants of this kind resolve themselves into about five groups, which we will now consider separately. They are (1) the cereals, (2) the tuberous roots, (3) the trees bearing food, (4) the plants used in the preparation of luxuries, and (5) the plants used in the manufacture of various articles of clothing.

The CEREALS include a number of cultivated grasses bearing grain, of which wheat, barley, rye, oats, rice, maize, millet, buckwheat, &c., are in various countries the chief food of man. Of these the first four are generally used in Europe, rice in Asia, maize in America, and millet in Africa.

The culture of *Wheat* is carried on in every quarter of the globe, from latitude 60° to 64° in Europe to the torrid zone, and even at the equator at an altitude of about 3000 feet. Its vertical limits in South America are between 3600 and 10,000 feet, the grain being extremely productive at moderate altitudes in hot countries.

In the middle of the temperate zone, as in France, its cultivation is not successful above 5400 feet. The productiveness in cold countries with indifferent cultivation is not more than five or six fold; but in Hungary, Croatia, and Sclavonia, it is from eight to ten fold; in La Plata twelve fold; in the north of Mexico seventeen fold, and in the equatorial parts of the same country twenty-four, and even in favourable seasons thirty-five fold. As instances of extraordinary productiveness, Humboldt mentions an instance in Mexico of wheat plants sending up forty, sixty, and even seventy stalks, the ears of which were almost equally well filled, and contained from 100 to 120 grains each.

The other grains of Europe, barley, rye, and oats, are only cultivated as bread corns in the northern and colder countries. In Scandinavia, barley extends to 70° north, rye to 67°, oats to 65°, wheat not being cultivated with profit above 62°. So also these other cereals are grown at higher elevations than wheat, barley being cultivated in Peru for fodder, at the very extreme elevation of 13,800 feet above the sea.

There is much doubt as to the native country of the cereals. It has been supposed that wheat grows wild in Asia Minor and Persia, and barley in the north of Africa—perhaps Egypt. Oats do not appear to have been used by the ancients, but though they have been recently introduced as cultivated grain, their native habitat is extremely doubtful.

Rice probably supports a larger number of persons on the Earth than any other single article of human food, as its use is universal in eastern and southern Asia, and it is common in the north of Africa and the south of Europe, besides being now extensively cultivated in North America. There are two varieties of this vegetable, one growing on mountain slopes, and the other in swamps; and of these, the latter, the most common, and also the most productive, yielding one hundred or one hundred and twenty fold, and in some places even four hundred fold; while the mountain rice does not produce more than forty fold when grown continually on the same ground, or eighty fold on newly prepared spots. This kind, however, though less rapidly increased, is more esteemed and more valuable, inasmuch as it may be kept longer without spoiling.

Maize is indigenous only in America, and thrives best in the hottest and dampest tropical climates, yielding in some cases as much as eight hundred fold, and in less fertile lands three hundred or four hundred fold; while one hundred fold is regarded as a poor crop in tropical countries,

---

* Johnston's *Physical Atlas*, 'The Geographical Distribution of Plants.'

though in the temperate zone, as in California, it does not produce more than seventy fold, and in still colder countries the yield is still smaller.

Maize has been introduced into Asia, and its growth had spread over India, China, and Japan very many centuries ago. It is not, however, so favourite a food as rice. In America, the vertical limits of its growth are very high, as it has been actually cultivated artificially at an elevation of 12,800 feet, and Humboldt describes vast maize fields on the plateau of Mexico 8680 feet above the sea.

Turkey millet or *Negro-corn* is also a grain of hot countries, much grown in the East Indies, and ranging to very considerable heights. Its limits in other respects are not accurately determined.

THE TUBEROUS ROOTS.—Of these, the *potato* is beyond doubt the best known, and most widely spread in temperate climates. It was introduced about 260 years ago from America, (where it appears to be indigenous in the cold regions, at considerable heights on the Andes,) and within a very short space of time its cultivation has extended over the whole of Europe, up to latitude seventy-one degrees north, and has reached the lower plains of India, China, and Japan, the South Sea Islands, Australia, and New Zealand. The true native country and natural limits of this useful food plant are not accurately known; but it is supposed *not* to be indigenous in North America, whence it was first brought to Europe. It is to this day chiefly and most carefully cultivated in South America.

The *Arum* or *Taro*, as it is called in the Sandwich Islands, is an extremely important tuberous root, cultivated with extraordinary care in the hottest part of the torrid zone, and ranging now in the East Indies and China, in the West Indies, in Africa, and at several points in the continent of America. The tube of this plant, which requires almost more than any other the intense heat of a vertical sun to ripen it properly, attains the size of a child's head, and is very delicate in flavour. It requires much moisture. and is limited in vertical distribution to about 1000 feet above the sea.

The *Manioc*, from which is made Cassava bread, is another important tropical food plant, cultivated in America, where it is probably indigenous, and also in Guinea. Tapioca is made from this plant.

The *Batata*, the *Yam*, and some other tuberous roots, are very extensively used for food in all parts of the torrid zone. Yams have been recorded to weigh as much as 474 pounds, being nine and a half feet in circumference, but the usual dimensions and weight are very much smaller.

THE FOOD-BEARING FRUIT TREES.—Of these, the *Bread-fruit* is one of the most important, but is confined to the torrid zone, and chiefly abounds in the islands of the Indian Archipelago and the South Sea. It has never been observed in the wild state.

It is the fruit of this tree that furnishes food, and the fruits are very abundant during eight or nine months of the year, the dried and prepared bread made from them lasting during the rest of the year. Each fruit is round, and often of considerable size; it is generally plucked when unripe, and is peeled, wrapped in leaves, and baked.

The *Plantain* or *Banana* yields another exceedingly common and most nutritious food to the inhabitants of tropical countries. Several species of the genus *Musa* produce, however, fruits that receive this name, and all of them are occasionally cultivated, the process of culture being exceedingly simple, and merely consisting of the removal of the old trunks after they have borne fruit.

The plantain ranges very wide, and it is doubtful whether its native country is in the Old or New World, or whether some species are not indigenous in both. In the plains it can be cultivated as far as thirty degrees, or even thirty-five degrees of latitude, and on the mountains some species reach nearly 3000 feet above the sea. According to Humboldt, the banana yields in a given extent of ground forty-four times as much nutritive matter as the potato, and 133 times as much as wheat.

The *Cocoa palm* is an inhabitant of the coast, and is incredibly abundant in the South Sea Islands, and those of the Indian Archipelago, nearly three millions of the nuts having been exported in one year from Ceylon alone, where, indeed, there is a forest of cocoa palms several leagues broad, stretching along the coast for twenty-six miles, and containing eleven millions of full-grown trees. Each tree will bear from 200 to 300 nuts in the year, and will live for nearly a century. The limits of growth of this palm are about twenty-eight degrees of latitude, and a height of about 2000 feet.

The *Date palm* is another tree belonging to the same family, and its fruit is also extensively used as food. It is indigenous in the north of Africa, in Asia Minor, and Arabia, and has been transported as far east as Batavia. It will grow in Italy, in latitude forty-four degrees, and in Sicily to the height of 1700 feet, but is not there fruitful. In Arabia and Egypt, it affords the chief food of the inhabitants.

The *Sago palms,* of which there are several, are confined to the Eastern Archipelago, and the palm which supplies the large quantity of palm oil used in commerce to the coast of Guinea. Other palms are useful for various purposes of luxury, but not as principal articles of food.

The *Olive* is a most valuable plant, growing in South Europe, between the limits of forty-four and a half degrees, and thirty-six degrees north latitude; but it cannot endure severe winters, and thus cannot be generally grown at considerable elevations. In warmer climates than those of Europe, it appears to grow more luxuriantly, and has been introduced with success into America. It is also grown in many parts of Mexico.

The *Ches'nut* spreads over the whole south of Europe, but finds its true home in the warmer part of the temperate zone. It reaches eastwards to China, and thus crosses the Old World from Spain to the Pacific. By art the chestnut has been induced also to grow north of the Alps, and is now found in northern Germany and England. Many other trees supply fruits occasionally used as the food of man, but they do not form a supply on which he can safely and constantly depend.

Food-Plants used as Luxuries.—Of these the *Sugar cane* is, perhaps, the most important. Indigenous in the Old World and cultivated in China and the eastern islands before the historical era, this valuable plant was introduced into America by the Spaniards about the year 1520, and since then has been greatly cultivated in the tropical islands of the West Indies, and also on the mainland.

The tract within which it can be cultivated stretches far beyond the tropics, reaching even to the latitude of South Europe, and in Mexico and Columbia it may be grown at the height of 6000 feet on the warm mountain slopes. It is understood to succeed best with a mean temperature of 76° or 77°, but will grow with advantage when the temperature is not below 67° or 68°. The total amount of sugar produced was calculated in 1833 to exceed 600,000 tons. There are several varieties of the sugar-cane, and the raw cane when ripe is much used as food.

The *Tea plant* is another of those shrubs which have become highly important, but this is owing to the presence of a stimulant rather than any nutritive quality. China is the native country of this plant, and it there extends as far north as 40°, growing also in the mountain districts to the south, particularly on those mountains which separate China from the Birman empire. The British territory in North India, especially Assam, has also been found favourable to the growth of tea, and indeed it seems to flourish throughout the sub-tropical zone in the eastern part of the Old World. *Coffee,* a very important substitute for tea in various countries, is more tropical in its habits than tea, but admits of great range artificially, while *mate,* or Paraguay tea, serves as the substitute in Brazil and many parts of South America.

The *Vine* is a plant which has been employed by man in the manufacture of a spirituous liquor from the very earliest period, and has been so long cultivated and so widely transported artificially, that its native station is not certainly known, nor can it be distinctly made out, whether all the varieties now used (as many as 200 might be enumerated) have been derived originally from one or several distinct species.

We have already had occasion to speak of the limits of culture of the vine, which is regulated much less by mean temperature than by summer heat, but it is chiefly the duration of the summer that influences the ripening of the fruit. Excellent wine is made with a mean temperature 60° Fah. and it is probable, that if damp and too much moisture are avoided, every greater heat will also succeed. Although the Old World is the natural habitat of this plant, it has been introduced into America, and flourishes on both sides of that Continent, and in both the northern and southern hemisphere, wherever the limits of temperature and dryness are obtained. Its polar limits may be considered to be between 49° and 55° in the northern, and about 40° in the southern hemisphere.

Tobacco, the *Betel nut,* and *Opium* are all very important and very widely spread vegetable productions, used in various parts of the world for their stimulating and soothing properties. The former seems to have been known in China long before its introduction into Europe from America, and several species are determined ranging even as far as 55° N. lat. and grown very extensively in various parts of central Europe, while a large quantity is also cultivated in New Zealand. The largest quantity and best kinds of this plant are grown in hot countries, especially in the tropical parts of America and the West Indian Islands. The *betel nut,* obtained from the Areca palm, and used with what is called the betel pepper, is employed in the same manner on the shores of eastern Asia, and in the various islands of the Indian Archipelago. *Opium,* again, is very largely used for similar purposes by the Turks, Malays, and Chinese. Some idea may be formed of the extent to which it is grown, from the fact that in fourteen years, from 1818 to 1831, above fourteen millions of pounds weight were conveyed into China through Canton alone, besides an enormous quantity consumed by the Malays, the inhabitants of Cochin China and Siam, as well as India and Persia.

Plants used in Clothing.—Besides the food plants there are others also greatly modified by civilization, and conveyed by man to distant parts of the Earth, but only because from them he is enabled to derive a portion of the clothing which he requires to shelter him from cold, and enable him to withstand the rigours of winter in most parts of the Earth. The *Cotton plant* and *Hemp* are the plants most important in this respect—the former, however, being the most widely spread, and perhaps the most useful, is that which deserves chief attention. Not only is the cotton plant cultivated in the tropical parts of every land of the Old and New World, but it extends far beyond the tropics even to countries whose mean temperature is not more than 62°, reaching thus the most southerly parts of Europe. The number of species of the tree is, however, large, and no doubt various species are indigenous in different localities. As to the quantity supplied, some idea may be formed from the statement that England is estimated to consume annually three hundred millions of pounds.

The *hemp* is also a plant of vast importance, and although its growth is greatly extended by culture, there can be little doubt that it is capable of much farther increase, if it were not that other plants in different countries supply the same material. Thus, in New Zealand a large and handsome reed (*Phormium tenax*) yields fibres capable of being spun into fine thread, and also made into the stoutest cables.

135 *General Considerations of the Representation of Plants in distant Botanical Centres.*—The general laws of nature as derived from the observation of a vast multitude of facts connected with the distribution of vegetables seem to be—*first,* that certain districts originate distinct groups of plants which are capable of a wide range, although the actual extent of the range, both in space and time, is dependent on various external circumstances.

Such places are technically called 'specific centres.' *Secondly*, that in similar climates, whether in the same hemisphere at the same level or otherwise, there are either individuals of the same species, if circumstances have been favourable for their transport, or else that the species resemble each other so manifestly, as to be in a proper and simple sense 'representatives.' *Thirdly*, that in places not separated in latitude by any distinct natural barrier, such as a lofty mountain chain or a broad tract of sea, and situated in very different climates, and in different latitudes, there is a graduated transition from the flora of one district to that of another, generic forms lingering much longer than specific, and whole families being rarely obliterated till after a long series of changes. For places situated at very different levels the same observation is true, and the same law holds good, as is illustrated in the existence of palms and other tropical forms of vegetation far north and south of the tropics, on the one hand, and far above the ordinary limits we might have anticipated (judging only by temperature), on the other. *Fourthly*, that in spite of the usual absence of identical species in districts removed by a lofty chain of mountains, a broad tract of ocean, or a complete zone of temperature, there are some species which cannot at all be distinguished from each other in the floras of the arctic and antarctic zone—in those of New South Wales and north Europe, and in those of tropical Africa, Asia, and America. The rarity of such instances is not to be taken as any explanation or solution of the difficulty, for, if possible, it adds to it, nor has anything yet been suggested which really and importantly bears on the true question at issue. The cases of exception to the general rule also are of a nature which rather increase the puzzle, since in large intermediate areas certainly capable of supporting a particular kind of vegetation, the expected plants are not found, notwithstanding that at the two extremities some common species appear. It is perhaps only when we study carefully the distribution in time, that these apparent anomalies cease, and resolve themselves into the working out of one far more general and important law, according to which the succession of races as well as any single race is arranged, and the peopling of the world with an infinite but harmonious variety, which shall exhibit mutual relations throughout all time, is fully provided for.

We have chiefly directed attention in these observations to the physiognomy of plants, but the study of their statistics would lead to the same or nearly the same conclusion, though perhaps by a different path. In whatever way vegetation is considered, it is found to be distributed according to these or similar laws, and tending to bring out analogous results.*

---

* Of somewhat more than 20,000 species of plants catalogued in De Candolle's *Prodromus*, it appears that 3210 are European; 5004, Asiatic; 3731, African; 2111, North American; 5742, South American; and 922, Australian. The island vegetation in each case is included in the list for the adjoining mainland.

CHAPTER XI.

THE DISTRIBUTION OF ANIMALS IN SPACE.

§ 136. Organization of animals. — 137. Classification of animals. — 138. Statistics of animals. — 139. Nature and degrees of resemblance amongst animals, and comparison of their structure. — 140. Natural grouping of animals in a FAUNA. — 141. Distribution of the Faunas. — 142. Arctic Fauna. — 143. Temperate Faunas. — 144. Tropical Faunas. — 145. Special distribution of *Quadrumana.* — 146. Distribution of *Carnivora.* — 147. Distribution of *Rodentia.* — 148. Distribution of *Ruminantia.* — 149. Distribution of *Pachydermata.* — 150. Distribution of the *Edentata* and *Marsupialia.* — 151. Distribution of *Birds.* — 152. Distribution of *Reptiles.* — 153. Distribution of the *Marine Vertebrata.* —154. Distribution of the *Articulata.* — 155. Distribution of the *Mollusca* and *Radiata.*

ORGANIZATION of Animals.—Animal life presents many points altogether peculiar, and exhibits forms of organization not less different from those afforded by plants than are seen in the latter when they are compared with inorganic substances. It will, therefore, be advisable briefly to consider the more essential of these before proceeding to the subject of the distribution of animals in space, and it is desirable to determine, as far as possible, the simplest forms of animal life, and their relations with organic matter of greater complexity, and with inorganic bodies.

The greater part of the structure of animals consists of tissues, of which fibre is the elementary form. There are two kinds of fibre, muscular and nervous, the one forming the flesh, and the other the brain, the spinal chord, and the nerves; and in the more highly organized forms several others occur, serving for various important purposes. In animals of less complicated structure, as in some of those called 'polypi,' and in infusorial animalcules, there are, however, myriads of individuals made up of nothing but cells in contact with each other.

The structure of animals is, in all the higher groups, so manifestly different from that of vegetables, that it would seem superfluous to allude to the points of distinction. The old definition, that minerals increase only by mechanical additions, while vegetables live, and animals live and move, is not, indeed, sufficiently accurate, since plants are sometimes endowed with a kind of instinct, and an appearance at least of voluntary motion, and animals, on the contrary, are sometimes almost without either instinct or the power of moving at will. In proportion as we descend to the lower forms of each, and compare them together, we find the differences less marked, so that it becomes at length difficult to pronounce whether an object before us is animal or plant. Thus, the sponges have so great a resemblance to some of the polypi, that they have generally been classed with animals.

Animals and plants differ in the relative predominance of the elements, oxygen, carbon, hydrogen, and nitrogen, of which they are composed. In vegetables hardly a trace of nitrogen is found, except in seeds and some special products, but it enters largely into the composition of animal tissues.

Another peculiarity of animals is the presence of limited cavities for the reception of certain important organs, such as the skull and chest in higher animals, and the abdomen in almost all. The possession of a digestive cavity involves marked differences between the two grand divisions of organic nature, for in plants the fluids absorbed by the roots are conveyed to the whole plant, by means of the trunk and branches, before they can reach the leaves, where they are to undergo a process analogous to digestion; while, on the contrary, the food of all animals passes at once into the digestive cavity, and is there elaborated into fluids, which being afterwards circulated through the body, are in a condition to be at once separated by the proper organs, and applied to the required purposes of renovation or increase.

Plants commence their existence usually from a seed, but admit also of increase by various means of mechanical division, having reference in all cases to the original nature of leaves as individuals of compound bodies.

Animals are developed from an egg, the animal germ being the result of successive transformations of the yolk, while nothing similar takes place in plants. The subsequent development of individuals is also different in the two kingdoms, as to method, form, and dimensions; the two latter varying during the whole life of the plant, but attaining a limit in the case of each species of animal, especially in those of complicated organization.

In the effects they produce on the air there is also an important difference, since animals consume oxygen and give off carbonic acid gas, while plants reverse the process, absorbing carbonic acid gas and giving off oxygen. If an animal, therefore, be confined in a small portion of air, or if of aquatic habits, in water containing air, this soon becomes so vitiated by respiration as to be unfit to sustain life; but if living plants are confined with the animal at the same time, the air is kept pure, and no difficulty is experienced. This, at least, is the case by day, and the practical effect of the compensation is very important, vegetation restoring to the atmosphere what is consumed by animal respiration.

Lastly, all animals have, more or less distinctly, voluntary motion and sensation, while plants, although endowed with a certain sensibility, appear to have neither true sensation nor actual volition. Life in animals is manifested by two functions instead of only one, as in vegetables, and the organs of animal life which involve the possession of a certain amount of intelligence, relation, and selection, which enable us to approach at will our fellow-creatures, to perceive their existence and act accordingly, are quite distinct from those which merely affect the functions of vegetable life, such as nutrition and reproduction.

To understand the development of animals and the facts of chief importance in their structure and mutual relations, we must consider a little their different organs and functions, and as the possession of a nervous system is at once the characteristic of all animals, and the function which, when present in its highest form, is the main cause of the vast difference of intellectual and reasoning power traceable between species and families, this must first be discussed.

There appear to be in nature four principal types within which may be included all the varieties presented of this most important and essential characteristic of animal organization. These are—*first*, that in which the nervous system is grouped into two principal masses, the brain and the spinal marrow; *secondly*, where it is collected into a series of small ganglia, knots, or small brains of nervous matter, placed at intervals beneath the alimentary canal and connected by threads, and a somewhat larger ganglion placed above the œsophagus; *thirdly*, where the nervous matter is collected in a single ganglionic circle, the principal swellings of which are placed symmetrically above and below the œsophagus, and whence the filaments which supply the organs in different directions take their origin; and *fourthly*, where the nervous matter is distributed in a single ring encircling the mouth, disposed in a horizontal position and in a starlike form. The first type includes all animals called *vertebrated*, or having a back-bone; the second, the insects, crustaceans, and other animals, whose body is made up of rings or portions nearly detached; the third, all animals such as those inhabiting univalve and bivalve shells, (the mollusks, or soft animals, as they are called;) and the fourth, the star fishes and other radiated animals.

The nerves, thus important in communicating to the animal all impressions from without, are usually so arranged as to render particular organs acutely perceptive to what are called the senses, which are recognised as five in number, under the names, sight, hearing, smell, taste, and touch. The impressions communicated in this way produce voluntary or involuntary results, chiefly acting on the other functions of the body, of which the organs of locomotion, or prehension, and of mastication and digestion, are the most prominent.

Nutrition is a function absolutely essential to the continuance of life, and involves a continual interchange of substances between the animal body and the external world. 'In early life, during the period of growth, the amount of substances received is greater than that which is lost. At a later period, when the growth is completed, an equilibrium is established between the matters received and those rejected; while at a still later period, the equilibrium is again disturbed; more is rejected than retained; decrepitude begins, and at last the organism becomes exhausted, the functions cease, and death ensues.'*

The reproduction of animals is not less necessary for the continuance of the race than nutrition is for that of the individual. It is effected in plants, as we have seen, by the modifications of what appears to be part of a simple body, but is really an individual member of a highly complicated one. In animals it is almost universally accomplished by the association of individuals of two kinds, *males* and *females*, each characterised by peculiarities of structure and external appearance, and both necessary for the production and proper fertilization of the germ of the future individual.

All animals are produced from eggs, and when enveloped in this way are called *embryos*—the period passed in this condition being called the *embryonic period*. Eggs are usually oval or spherical in shape, and are contained in the body of the female in sacs called *ovaries*, being at that time of very minute size, and merely consisting of little cells containing what is called *yolk* or yolk-substance, with other similar cells, namely, the germinative vesicle and the germinating dot.

The number of eggs is large in proportion as the animal is of lower organization; thus the ovary of a herring contains more than 25,000 eggs, while that of birds does not contain more than one or two hundred, and the higher mammalia produce only one at a birth.

At a certain period the eggs leave the ovary, and being fertilized are either discharged by the animal (*laid*), or else remain within the body till the young is fully developed. Animals in which the former habit is usual are called *oviparous*, while those which produce living young are said to be *viviparous*, or in some cases *ovo-viviparous*.

The formation and development of the young animal within the egg is a most mysterious phenomenon, and the changes undergone differ materially in the various natural groups of animals. In some animals, there are intermediate conditions between the embryonic and perfect state, but generally, and indeed invariably in the more highly organized groups, the young as it emerges from the egg, or is born, possesses the external form and habits of the species. The metamorphoses in the exceptional cases are sometimes extremely curious, and their cause very difficult to comprehend.

137 *Classification of Animals.*—In considering the arrangements of the nervous system we have seen that four important distinctions can be drawn amongst animals, and these point to a natural division into four departments, which are generally called, respectively, I. VERTEBRATA; II. ARTICULATA; III. MOLLUSCA; IV. RADIATA.

Of these the vertebrata are conveniently grouped into four classes, which all have an internal skeleton with a back-bone for its axis. The classes are 1. *Mammals* (animals which suckle their young); 2. *Birds*; 3. *Reptiles*; and 4. *Fishes*. These divisions are all so well known and so natural that they

* *Principles of Zoology*, by Agassiz and Gould, (Boston, 1848,) p. 72.

require no special description, but their subdivisions are also important. The most convenient arrangement is perhaps the following :—

CLASS MAMMALIA, (QUADRUPEDS AND BIPEDS.)

ORDER.	EXAMPLE.
I. BIMANA (*two-handed*)	Man.
II. QUADRUMANA (*four-handed*)	Monkeys.
III. CHIROPTERA (*finger-winged*)	Bats.
IV. INSECTIVORA (*insect-eating*)	Hedgehog.
V. PLANTIGRADE CARNIVORA	Bear, Badger.
VI. DIGITIGRADE CARNIVORA	Cat, Lion.
VII. AMPHIBIA (*aquatic mammals*)	Whale, Porpoise, Seal.
VIII. RODENTIA (*gnawing*)	Rat, Hare, Squirrel.
IX. RUMINANTIA (*ruminating*)	Ox, Sheep, Deer.
X. PACHYDERMATA (*thick-skinned*)	Elephant, Rhinoceros, Pig, Horse.
XI. EDENTATA (*toothless*)	Sloth, Ant-eater, Armadillo.
XII. MARSUPIATA (*pouched*)	Opossum, Kangaroo.

CLASS AVES, (BIRDS.)

I. RAPTORES (*birds of prey*)	Vultures, Hawks, Owls.
II. SCANSORES (*climbers*)	Cuckoos, Woodpeckers, Goatsuckers.
III. OSCINES (*songsters*)	Sparrows, Linnets, Crows.
IV. GALLINACEÆ (*gallinaceous birds*)	Pheasants, Fowls, Pigeons.
V. GRALLATORES (*waders*)	Herons, Bitterns, Plovers.
VI. NATATORES (*swimmers*)	Geese, Divers, Gulls.

CLASS REPTILIA, (REPTILES.)

I. *DINOSAURIA**	*Megalosaurus, Iguanodon.*
II. *ENALIOSAURIA**	*Ichthyosaurus, Plesiosaurus.*
III. CROCODILIA	Crocodiles.
IV. LACERTILIA	Lizards.
V. *PTEROSAURIA**	*Pterodactyl.*
VI. CHELONIA	Tortoises, Turtles.
VII. OPHIDIA	Serpents.
VIII. BATRACHIA	Frogs.

CLASS PISCES, (FISHES.)

I. GANOID (*scales splendent*)	Sturgeon.
II. PLACOID (*scales plated*)	Sharks and Rays.
III. CTENOID (*scales comb-shaped*)	Perch.
IV. CYCLOID (*scales circular*)	Cod, Herring.

The ARTICULATA are divided conveniently into three classes—1. *Insects;* 2. *Crustaceans;* and 3. *Worms.* The MOLLUSCA also into three—1. *Cephalopoda* (having locomotive and prehensile organs ranged round the mouth); 2. *Gasteropoda* (creeping on a flattened disc or foot); 3. *Acephala* (having no distinct head, and enclosed in a bivalve shell). The RADIATA again are divided into three classes — 1. *Echinoderms* (bearing spines on the external surface, like the sea-urchins); 2. *Acalephe* (jelly-fish, often stinging like nettles, as the medusæ); 3. *Polyps* (fixed like plants, and with a series of flexible arms round the mouth—often compound). The further subdivisions it is not necessary here to discuss.

The technical or natural history names of animals, as of plants, are composed of two terms, one generic, including a considerable variety of structure united by some marked and important characteristics, and the other specific or trivial, forming an adjective or qualifying addition to the generic designation. Several genera combined together (possessing some characters in common) are called a *family*—families are combined to form

* Those orders and genera of which the names are printed in italics, are not now represented on the Earth by any existing species.

orders, and orders form *classes;* the various divisions corresponding to which names we have already enumerated in the preceding page.

Since the specific name is the ultimate point to which we arrive in classifying, it is important that every one should have a clear idea on this subject. A *Genus* is generally founded on some distinct peculiarities of anatomical structure; such as (in the case of a Vertebrate) the number, disposition, and proportions of the teeth, claws, fins, &c.; while a *Species* depends on characters which are sometimes external, sometimes apparently trivial, but which are always supposed to be sufficiently real to prevent accidental admixture of race. There is also recognised another and a lower distinction, that of *Variety*, which, unlike *Species*, includes apparent and possible mixtures of race. It has been usual to consider that nature has set a broad and marked barrier between species, not allowing of any infraction, but this appears to be in reality a somewhat arbitrary assumption, although there is no doubt that the production of varieties from what are generally regarded as distinct species is rarely effected, except under the influence of extraordinary external circumstances.*

The real difficulty in the case of animals, as in plants, arises from an occasional interference with what appears at first to be an universal law, that of the production of similar types in parts of the Earth widely removed, but of similar climate. We shall have occasion to revert to this part of the subject.

We quote the following from the introduction to a work already referred to (Agassiz and Gould's *Principles of Zoology*) as fitly concluding this section, by stating what is most required of the elements of Zoology for the purposes of Physical Geography:—

'For each of these groups, whether larger or smaller, we involuntarily picture in our minds an image made up of the traits which characterise the group. This ideal image is called a TYPE, a term which there is frequent occasion to employ in speaking of the Animal Kingdom. This image may correspond to some one member of the group, but it is rare that any one species embodies all our ideas of the class, family, or genus to which it belongs. Thus we have a general idea of a bird, but this idea does not correspond to any particular bird, or any particular character of a bird. It is not precisely an ostrich, an owl, a hen, or a sparrow; it is not because it has wings, or feathers, or two legs; or because it has the power of flight, or builds nests. Any or all these characters would not fully represent our idea of a bird, and yet every one has a distinct ideal notion of a bird, a fish, a quadruped, &c. It is common, however, to speak of the animal which embodies most fully the characters of a group as the type of that group. Thus we might, perhaps, regard an eagle as the type of a bird, the duck as the type of a swimming-bird, and the mallard as the type of a duck.'

138 *Statistics of Animals.*—It is not possible to appreciate the importance of the subject we are now considering, either with reference to the grand features of general Zoology, or the details concerning the distribution of animals, without some reference to actual statistics. It is not enough to regard nature generally with admiration, or even to study carefully some detached points—we must also become acquainted with the extent of material for observation and learn the true spirit that animates the whole. 'We must acquire a proper conception of the varied affinities which combine beings together, so as to make of them that vast picture in which each animal, each group, each class has its place, and from which nothing could be removed without destroying the proper meaning of the whole.'

It is only within a short time that Zoology has so far extended itself as to become fairly beyond the grasp of any single individual. A century ago, the number of known animals did not exceed 8000, and thus fewer species were known in the whole Animal Kingdom than are now contained in many private collections of certain families of insects merely.

---

* This subject will be found considered in further detail in paragraph 166 in the chapter on Ethnology.

The number of vertebrate animals may now be estimated at 20,000. Of these there are about 1500 species of mammals pretty precisely known, and the number may probably extend to 2000.

There are about 4000 or 5000 species of birds well known, and the probable number is 6000.

The number of reptiles is about the same as that of mammals—namely, about 1500 described species, and 2000 in all.

The fishes are more numerous. The number in the museums of Europe are about 5000 to 6000 species, but the total number may extend to 10,000.

The invertebrata are much more numerous. Of Mollusca there are probably from 8000 to 10,000 species in collections. There are collections of marine shells, bivalve and univalve, which amount to 5000 or 6000, and collections of land and freshwater shells extending to 2000 species. The total number of mollusks may probably exceed 15,000 species.

Among the Articulata it is difficult to estimate the number of species. There are collections of coleopterous insects which number from 20,000 to 25,000 species, and it is quite probable that by uniting the principal collections 60,000 or 80,000 species might now be counted. For the whole department of Articulata, comprising the crustacea, cirrhipeda insects, red-blooded worms, intestinal worms, and infusoria, so far as they belong to the department, the number would already amount to 100,000, and may be safely estimated as reaching double that sum.

The Radiata, including the echini, starfishes, medusæ, and polyps, cannot be estimated at less than 10,000 species. We may thus present the following tabular view.

	Known.	Estimated.	Known number of species.	Estimated number of species.
Mammals	1,500	2,000		
Birds	5,000	6,000		
Reptiles	1,500	2,000		
Fishes	6,000	10,000		
Total Vertebrata			14,000	20,000
Mollusca			10,000	15,000
Articulata			100,000	200,000
Radiata			10,000	10,000
Grand total			134,000	250,000

This large number of species of animals must be still further increased, and perhaps even doubled, if we include also those no longer represented, but whose remains are preserved to us in the strata of the Earth's crust. These will, however, require separate consideration.

139 *Nature and Degrees of Resemblance amongst Animals, and Comparison of their Structure.*—There is no subject more important to the general student of natural history, and there is none which has more worthily occupied the attention of the best and most philosophic naturalists, than the true nature of those resemblances which are presented everywhere in nature, which evidently have important meaning, but which, when made use of, are so likely to lead their pursuer into error, that they are the very points on which the greatest and most mischievous mistakes have been made. We must endeavour here to make the reader acquainted with some of the simpler meanings of homology, analogy, and affinity, as they are required to be understood in considering the distribution of animals.

Analogy and homology are relations of simple resemblance in portions of the living framework without reference to identity of race, while affinity is a relation obtaining between the corresponding parts of animals of the same race—and thus, at the outset, there are important and real distinctions to be recognised. But there is more than this, and there are also important distinctions to be drawn between the former terms. An *analogue* has been defined to be 'a part or organ in one animal which has the same function, or does the same work as another part or organ in a different animal;' while a *homologue* is 'the same organ in different animals under every variety of form and function.' It will not be difficult to understand, from these definitions, something of the true meaning of the words on which so much stress has been laid, but a few examples will render their use still more clear.

In a very general way we may show this, by considering the nature of the wings by which various animals fly, the legs or arms which others use for walking and running, and the fins by means of which fishes swim—in a word, of the organs of locomotion. There is analogy between the wing of a butterfly and that of a bird, for both of them serve for flight, but they are not homologous, since a different organ is employed. On the other hand, the fore leg of a quadruped is homologous to the wing of a bird, but not strictly analogous, for the same organ is employed, but the same purpose is not attained. Thus, also, the fin of a porpoise is homologous to the fin of a fish, being at the same time analogous, since both are employed in swimming, and both are modifications of the same organ.

Affinities are different, and indicate closer relations. Thus, there is affinity between the leg and foot of a man and the paddle of a seal, for both are constructed on the same plan, and the affinity in this case is far more important than the analogy and homology that exist between seals and fishes, in their structure and habits. Affinities, rather than analogies and homologies, are therefore most useful in guiding us in the arrangement of animals.

Resemblances are traced not only in the parts of the individual or species, but in general external character, with regard to genera and larger groups. Usually we may consider, that in any natural arrangement, such as we have endeavoured to give, there will be resemblances of affinity between all species collected together in any group, whether large or small—that, in other words, all animals in the first place—all vertebrata in the next—all mammals in the third—all monkeys in the fourth—and all baboons in the fifth place, have different degrees of affinity, gradually becoming closer as the number of species included is smaller. On the other hand, there will be analogy between some vertebrata and some mollusca or articulata, between carnivorous quadrupeds and birds of prey, between different tribes of carnivora and so on; and thus each natural group of organic beings will present resemblances of different kinds, which must be estimated, each according to its true value, in any general view of the whole Animal Kingdom.

It is important also to remember, that investigations concerning the true nature and relations of animals should not be limited to the adult, but extend over the whole course of development. If this is not done, some peculiarities of structure which are predominant at one period of life, will be exaggerated in importance, and others neglected. Thus, the organs of respiration, which appear to be most essential characters for classification, if we regard only the full-grown animal, are found, on examining and comparing their various states in the same individual, to be quite subservient to the nervous system. The comparative study of development is also not less valuable, as a means of estimating the relative position of animals. Thus, the caterpillar, in becoming a butterfly, passes from a lower to a higher development, and therefore, those animals, such as worms, which resemble the caterpillar, must occupy a lower rank than those approaching the butterfly.

All animals undergo changes, or *metamorphoses*, during the earlier period of their existence, although in many cases, especially in those of highest grade, these take place before birth, and during the embryonic period. It is only by connecting the two kinds of transformation—namely, those that take place before and those after birth, that we are furnished with means of ascertaining the relative perfection of animals; so that, in fact, such transformations become a natural key to the gradation of types. No one can properly appreciate the structure of animals and the difference of races, or comprehend, even in a very inferior degree, the law that governs the placing of groups in certain districts, adapts them a certain climate and certain food, and enables them to resist certain changes, without knowing something of the nature of analogy and affinity, and the changes of structure that take place in the individual and the species, in passing through all the various forms of its existence, as an organized being.

140 *Natural Grouping of Animals in a* 'FAUNA.'—The collection of animals inhabiting any particular region, including all the species, both aquatic and terrestrial, is called its *Fauna*, just as the plants of a country combine to form its Flora. It is not necessary that every species should be peculiar, only there must be some special distribution of families, genera, and species, and a preponderance of certain types, sufficiently important and prominent to impress upon the group well-marked features. Thus, the fauna of New Holland is characterised by the existence there of tribes of quadrupeds of the *Marsupial* order, that of South America by *Edentata*. The polar bear and reindeer are characteristic of the arctic regions of the Earth, and certain peculiarities of structure in monkeys at once distinguish the faunas of Asia and America, in those parts where monkeys appear.

As animals feed either on other animals, or on vegetables, it is evident that, ultimately, the distribution of animals will depend on vegetable life. Thus, there arises a relation between the fauna of a locality, its climate, and its flora; but although this is certainly very important, it must not be forgotten that while plants chiefly inhabit land, animals range far more widely, and exist to such an extent in water, that it has been even said, that the ocean is the true home of the Animal Kingdom, and this is certainly the case in those extreme latitudes where vegetable life entirely ceases, and where the sea teems with animals of all classes and all dimensions. The chief influence of extreme cold seems to be to render more uniform the distribution of species, so that many of the large quadrupeds, for example, are common to Europe, Asia, and America, within certain high latitudes, while the faunas of tropical Asia are totally distinct from those either of tropical Africa, or tropical America. A wide tract of deep sea, and the existence of broad desert tracts, lofty mountains, and distinct zones of climate on land, limit Faunas very strikingly, as we find on comparing the productions of the Cape of Good Hope with those of Cape Horn, and this is even the case when latitude and climate are very nearly similar. The depths of the ocean are, indeed, quite as impassable for marine species as high mountains are for terrestrial animals, and it would be as difficult for a fish or a mollusk to cross from the coast of Europe to that of America, as it would be for a reindeer to pass from the arctic to the antarctic regions across the torrid zone. It is probable that the deepest parts of the ocean are absolutely untenanted, for there seem there no means of subsistence, and few animals are organized so as to resist the pressure of a column of water many thousand fathoms in height.

The animal inhabitants of the sea are, therefore, as strictly limited to districts as those of the land; and as by far the larger proportion depend on the adjacent shores more or less for their means of existence and their shelter from natural enemies, no doubt the limits of the marine are less easily defined than those of terrestrial Faunas, but still marked differences are discernible, while freshwater species vary, not only in different zones, but even in the rivers and lakes of the same district.

The range of species does not depend on powers of locomotion, but on the contrary, animals which move slowly and with difficulty, generally have a wide range, while those which are active are often very narrowly limited. Thus, the common oyster extends on the American coast from Cape Cod to the Carolinas, and is, as we know, also common over a long line of coast on this side of the Atlantic, so that its range is absolutely very great; and when compared to that of some fleet animal, as the moose, appears enormous. It is indeed possible that the very want of power to travel really contributes to the diffusion of this and some other species, since when once removed they cannot return, and their eggs being left to the mercy of marine currents, may be drifted very far, while fishes depositing their spawn in sheltered bays and inlets, are secured from wide dispersion.

The nature of their food has an important bearing upon the grouping of animals, and upon the extent of their distribution. Carnivorous animals are generally less confined in their range than herbivorous ones, because their food is almost everywhere to be found. The herbivora, on the other hand, are restricted to the more limited regions corresponding to the different zones of vegetation. The same remark may be made with respect to birds. Birds of prey, like the eagle and vulture, have a much wider range than the granivorous and gallinaceous birds. Still, notwithstanding the facilities they have for change of place, even the birds that wander widest recognise limits which they do not overpass. The condor of the Cordilleras does not descend into the temperate regions of the United States ; and yet it is not that he fears the cold, since he is frequently known to ascend even above the highest summits of the Andes, and disappears from view where the cold is most intense. Nor can it be from lack of prey.

Finally, to obtain a true picture of the zoological distribution of animals, not the terrestrial types alone, but the marine species, must also be included. Notwithstanding the uniform nature of the watery element, the animals which dwell in it are not dispersed at random, and though the limits of the marine may be less easily defined than those of the terrestrial fauna, still marked differences of the animals in the great basins are not less observable. Properly to apprehend how marine animals may be distributed into local faunas, it must be remembered that their residence is not in the high sea, but along the coasts of continents and on soundings. It is on the banks of Newfoundland, and not in the deep sea, that the great cod fishery is carried on ; and it is well known that when fishes migrate, they take care to run along the shores. The range of marine species being therefore confined to the vicinity of the shores, their distribution must be subjected to laws similar to those which regulate the terrestrial faunas. As to the fresh-water fishes, not only do the species vary in the different zones, but even the different rivers of the same region have species peculiar to them, and not found in neighbouring streams.

A very influential cause in the distribution of aquatic animals is the depth of the water. The mollusks, and even the fishes found near the surface between high and low water, differ, in general, from those living at the depth of twenty or thirty feet, and these again are found to be different from those which are met with at a greater depth. Their colouring in particular varies according to the quantity of light they receive, as has also been shown to be the case with the marine plants.

It is sometimes the case that one or more animals are found upon a certain chain of mountains and not elsewhere ; as for instance, the mountain sheep upon the Rocky Mountains, or the chamois and the ibex upon the Alps. The same is also the case on some of the wide plains or prairies. This, however, does not entitle such regions to be considered as having an independent fauna, any more than a lake is to be regarded as having a peculiar fauna exclusive of the animals of the surrounding country, merely because some of the species found in the lake may not ascend the rivers emptying into it. It is only when the whole group of animals inhabiting a region has such peculiarities as to give it a distinct character, when contrasted with animals found in surrounding regions, that it is to be regarded as a separate fauna. Such, for example, is the fauna of the great steppe or plain of Gobi, in Asia, and such also that of the chain of the Rocky Mountains may prove to be when the animals inhabiting them are better known.

The migration of animals might at first seem to present a serious difficulty in determining the character or the limits of a fauna ; but this difficulty ceases, if we regard the country of an animal to be the place where it makes its habitual abode. As to birds, which of all animals wander the farthest, it may be laid down as a rule that they belong to the zone in which they breed. Thus the gulls, many of the ducks, mergansers, and divers, belonging to the boreal regions, though they pass a portion of the year with us. On the other hand, the swallows and martins, and many of the gallinaceous birds, belong to the temperate faunas, notwithstanding that they migrate during winter to the confines of the torrid zone. This rule does not apply to the fishes who annually leave their proper home and migrate to a distant region, merely for the purpose of spawning. The salmon, for example, comes down from the north to spawn on the coasts of Maine and Nova Scotia.

Few of the mammals, and these mostly of the tribe of Rodents, make extensive migrations. Among the most remarkable of these are the Kamtschatka rats. In spring they direct their course westward in immense troops, and after a very long journey, return again in autumn to their quarters, when their approach is anxiously awaited by the hunters, on account of the fine furs to be obtained from the numerous carnivora which always follow in their train. The migrations of the lemmings are marked by the devastations they commit along their course, as they come down from the borders of the Frozen Ocean to the valleys of Lapland and Norway; but their migrations are not periodical.

141 *Distribution of the Faunas.*—We have stated that all the faunas of the globe may be divided into three departments, corresponding to as many great climatal divisions—namely, the glacial or arctic, the temperate, and the tropical faunas. These three divisions appertain to both hemispheres, as we recede from the equator towards the north or south poles. It will hereafter be shown that the tropical and temperate faunas may be again divided into several zoological provinces, depending on longitude or on the peculiar configuration of the continents.

No continent is better calculated to give a correct idea of distribution into faunas as determined by climate than the continent of America, extending as it does across both hemispheres, and embracing all latitudes, so that all climates are represented upon it.

Let a traveller embark at Iceland, which is situated on the borders of the polar circle, with a view to observe, in a zoological aspect, the principal points along the eastern shore of America. The result of his observation will be very much as follows. Along the coast of Greenland and Iceland, and also along Baffin's Bay, he will meet with an unvaried fauna composed of animals which are, for the most part, identical with those of the arctic shores of Europe. It will be nearly the same along the Labrador coast.

As he approaches Newfoundland, he will see the landscape, and with it the fauna, assuming a somewhat more varied aspect. To the wide and naked, or turfy plains of the boreal regions succeed forests in which he will find various animals which dwell only in forests. Here the temperate fauna commences; still the number of species is not yet very considerable; but as he advances southwards along the coasts of Nova Scotia and New England, he finds these species gradually increasing, while those of the cold regions diminish, and at length entirely disappear, some few accidental or periodical visitors excepted, who wander during winter as far south as the Carolinas.

But it is after having passed the boundaries of the United States, among the Antilles, and more especially on the southern continent along the shores of the Orinoco and the Amazon, that our traveller will be forcibly struck with the astonishing variety of the animals which people the forests, the prairies, the rivers and the sea shores, most of which he will also find to be different from those of the northern continent. By this extraordinary richness of new forms he will become sensible that he is now in the domain of the tropical fauna.

Let him still travel on beyond the equator towards the tropic of Capricorn, and he will again find the scene change as he enters the regions where the sun casts his rays more obliquely, and where the contrast of the seasons is more marked. The vegetation will be less luxuriant, the palms will have disappeared to make place for other trees, the animals will be less varied, and the whole picture will recal to him, in some measure, what he witnessed in the United States. He will again find himself in the temperate regions, and this he will trace on, till he arrives at the extremity of the continent, the fauna and the flora becoming more and more impoverished as he approaches Cape Horn.

Finally, we know that there is a continent around the South Pole. Although we have as yet but very imperfect notions respecting the animals of this inhospitable clime, still the few which have already been observed there, all present a close analogy to those of the arctic region. It is another glacial fauna—namely, the antarctic. Having thus sketched the general distribution of the fauna, it remains to point out the principal features of each of them.

142 *Arctic Fauna.*—The predominant feature of the arctic fauna is its uniformity. The species are few in number, but, on the other hand, the number of individuals is immense; we need only refer to the clouds of birds which hover upon the islands and shores of the north:—the shoals of fishes—the salmon among others, which throng the coasts of Greenland, Iceland, and Hudson's Bay. The same uniformity appears in the form and colour of the animals. There is not a single bird of brilliant plumage, and not a fish with varied hues. Their forms are regular, and their tints as dusky as the northern heavens. The most conspicuous animals are the white bear, the moose, the rein-deer, the musk ox, the white fox, the polar hare, the lemming, and various seals, but the most important are the whales, which it is to be remarked rank lowest among the mammals. Among the birds may be enumerated some sea-eagles and a few waders, with an immense number of other aquatic species, such as gulls, cormorants, divers, petrels, ducks, geese, &c., all belonging to the lowest order of birds. Reptiles are altogether wanting. The Articulata are represented by numerous marine worms, and by minute crustaceans of the orders Isopoda and Amphipoda. Insects are rare and of inferior types. Of the type of Mollusks, there are Acephala, particularly Tunicata, fewer Gasteropods, and very few Cephalopods. Among the Radiata are a great number of jelly-fishes, particularly the Beröe; and to conclude with the Echinoderms, there are several star-fishes and Echini, but few Holothuriæ. The class of Polypi is very scantily represented, and those producing stony corals are entirely wanting.

This assemblage of animals is evidently inferior to the other faunas, especially to those of the tropics. Not that there is a deficiency of animal life; for if the species are less numerous, there is a compensation in the multitude of individuals, and also in this other very significant fact, that the largest of all animals, the whales, belong to this fauna.

It has already been said that the arctic fauna of the three continents is the same; its southern limit, however, is not a regular line. It does not correspond precisely with the polar circle, but rather to the isothermal zero, that is, the line where the average temperature of the year is at 32° of Fahrenheit. The course of this line presents numerous undulations. In general, it may be said to coincide with the appearance of trees, so that it passes where forest vegetation succeeds the vast arid plains, the barrens of North America, or the tundras of the Samoyedes. The uniformity of these plains involves a corresponding uniformity of plants and animals. On the North American continent, it extends much farther southward on the eastern shore than on the western. From the peninsula of Alashka it bends northwards towards the Mackenzie, then descends again towards the Bear Lake, and comes down to near the northern shore of Newfoundland.

143 *Temperate Faunas.*—The faunas of the temperate regions of the northern hemisphere are much more varied than that of the arctic zone. At its northern margin, the leaves, excepting those of the pines and spruces, fall

on the approach of the cold season, and vegetation is arrested for a longer or shorter period. Insects retire, and the animals which live upon them no longer find nourishment, and are obliged to migrate to warmer regions, on the borders of the tropics, where on the ever verdant vegetation they find the means of subsistence.

Some of the herbivorous Mammals, the bats, and the reptiles which feed on insects, pass the winter in a state of torpor, from which they awake in spring. Others retire into dens, and live on the provisions they have stored up during the warm season. The Carnivora, the Ruminants, and the most active portion of the Rodents, are the only animals that do not change either their abode or their habits. The fauna of the temperate zone thus presents an ever-changing picture, which may be considered as one of its most important features, since these changes recur with equal constancy in the Old and the New World.

Taking the contrast of the vegetation as a basis, and the consequent changes of habit imposed upon the denizens of the forests, the temperate fauna has been divided into two regions, a northern one, where the trees, except the pines, drop their leaves in winter, and a southern one, where they are evergreen. Now as the limit of the former, that of the deciduous trees, coincides, in general, with the limit of the pines, it may be said that the cold region of the temperate fauna extends as far as the pines. In the United States this coincidence is not so marked as in other regions, inasmuch as the pines extend into Florida, while they do not prevail in the western states; but we may reckon as belonging to the southern portion of the temperate region, that part of the country south of the latitude where the Palmetto or Cabbage tree (*Chamærops*) commences, nearly all the states to the south of North Carolina; while the states to the north of this limit belong to the northern portion of the temperate region.

This division into two zones is supported by observations made on the maritime faunas of the Atlantic coast. The line of separation between them, however, being influenced by the Gulf Stream, is considerably farther to the north;—namely, at Cape Cod. It has been ascertained, that of one hundred and ninety-seven Mollusks inhabiting the coast of New England, fifty do not pass to the north of Cape Cod, and eighty-three do not pass to the south of it; only sixty-four being common to both sides of the Cape. A similar limitation of the range of fishes has been noticed by Dr. Storer, and Dr. Holbrook has found the fishes of South Carolina to be different from those of Florida and the West Indies. In Europe, the northern part of the temperate region extends to the Pyrenees and the Alps; and its southern portion consists of the basin of the Mediterranean, together with the northern part of Africa, as far as the desert of Sahara.

A peculiar characteristic of the faunas of the temperate regions in the northern hemisphere, when contrasted with those of the southern, is the great similarity of the prevailing types on both continents. Notwithstanding the immense extent of country embraced, the same stamp is everywhere exhibited. Generally the same families, frequently the same genera represented by different species, are found. There are even a few species of terrestrial animals regarded as identical on the continents of Europe and America, but their supposed number is constantly diminished, as more accurate observations are made. The predominant types among the Mammals are the bison, deer, ox, horse, hog, numerous Rodents, especially squirrels and hares, nearly all the Insectivora, weasels, martins, wolves, foxes, wild cats, &c. On the other hand, there are no Edentata, and no Quadrumana, with the exception of some monkeys on the two slopes of the Atlas. Among birds there is a multitude of climbers, passerine, gallinaceous, and rapacious birds. Of reptiles there are lizards and tortoises, of small or medium size, serpents, and many batrachians, but no crocodiles. Of fishes there is the trout family, the cyprinoids (carps), the sturgeons, the pikes, the cod family, and especially the great family of herrings and scomberiods, to which latter belong the mackerel and the tunny. All classes of the Mollusks are represented; though the Cephalopods are less numerous than in the torrid zone. There is an infinite number of Articulata of every type as well as numerous Polyps, though the true corals do not appear abundantly.

On each of the two continents of Europe and America, there is a certain number of species which extend from one extreme of the temperate zone to the other. Such, for example, are the deer, the bison, the cougar, the flying squirrel, numerous birds of prey, several tortoises, and the rattlesnake in America; and in Europe the brown bear, wolf, swallow, and many birds of prey. Some species have a still wider range, like the ermine, which is found from Bhering's Straits to the Himalayan Mountains, that is to say, from the coldest regions of the arctic zone, to the southern confines of the temperate zone. It is the same with the musk-rat, which is found from the mouth of Mackenzie's River to Florida. The field mouse has an equal range in Europe. Other species, on the contrary, are limited to one region. The Canadian elk is confined to the northern portion; and, on the other hand, the prairie wolf, the fox-squirrel, the bassaris, and numerous birds, never leave the southern portion.*

In America, as in the Old World, the temperate fauna is further subdivided into several districts, which may be regarded as so many zoological provinces, in each of which there is a certain number of animals differing from those in the others, though very closely allied. Temperate America presents us with a striking example in this respect. We have, on the one hand—

I. The fauna of the United States, properly so called, on this side of the Rocky Mountains.

II. The fauna of Oregon and California, beyond those mountains.

Though there are some animals which traverse the chain of the Rocky Mountains, and are found in the prairies of the Missouri, as well as on the banks of the Columbia, as for example, the Rocky Mountain deer (*Antilope furcifer,*) yet if we regard the whole assemblage of animals, they are found to differ entirely. Thus, the rodents, part of the ruminants, the insects, and all the mollusks, belong to distinct species.

The faunas or zoological provinces of the Old World which correspond to these are—

I. The fauna of Europe, which is very closely related to that of the United States proper.

II. The fauna of Siberia, separated from the fauna of Europe by the Ural Mountains.

III. The fauna of the great Asiatic table-land, which, from what is as yet known of it, appears to be quite distinct.

IV. The fauna of China and Japan, which is analogous to that of Europe in the birds, and to that of the United States in the reptiles, as it is also in the flora.

Lastly, it is in the temperate zone of the northern hemisphere that we meet with the most striking examples of those local faunas which have been mentioned above. Such, for example, are the faunas of the Caspian Sea, of the Steppes of Tartary, and of the Western Prairies.

The faunas of the southern temperate regions differ from those of the tropics as much as the northern temperate faunas do; and like them, also, may be distinguished into two provinces, the colder of which embraces Patagonia. But, besides differing from the tropical faunas, they are also quite dissimilar to each other on the different continents. Instead of that

* The types which are peculiar to temperate America, and are not found in Europe, are, the opossum, several genera of insectivora, among them the shrew-mole, (Scalops aquaticus,) and the star-nose mole, (Condylura cristata.) which replace the mygale of the Old World; several genera of rodents, especially the musk-rat. Among the types characteristic of America must also be reckoned the snapping-turtle among the tortoises; the menobranchus and menopoma among the salamanders; the garpike and amia among the fishes; and, finally, among the crustacea, the limulus. Among the types which are wanting in temperate America, and which are found in Europe, may be cited the horse, the wild boar, and the true mouse. All the species of domestic mice which live in America have been brought from the Old World.

general resemblance which we have noticed between all the faunas of the temperate zone of the northern hemisphere, we find here the most complete contrasts. Each of the three continental peninsulas which jut out southerly into the ocean represents, in some sense, a separate world. The animals of South America, beyond the tropic of Capricorn, are in all respects different from those at the southern extremity of Africa. The hyenas, wild boars, and rhinoceroses of the Cape of Good Hope have no analogues on the American continent; and the difference is equally great between the birds, reptiles, and fishes, insects and mollusks. Among the most characteristic animals of the southern extremity of America are peculiar species of seals, and especially, among aquatic birds, the penguins.

New Holland, with its marsupial mammals, with which are associated insects and mollusks no less singular, furnishes a fauna still more peculiar, and which does not approach those of any of the adjacent countries. In the seas of that continent where everything is so strange, we find the curious shark, with paved teeth and spines on the back (Cestracion Philippi), the only living representative of a family so numerous in former zoological ages. But a most remarkable feature of this fauna is, that the same types prevail over the whole continent, in its temperate as well as its tropical portions, the species only being different at different localities.

144 *Tropical Faunas.*—The tropical faunas are distinguished on all the continents by the immense variety of animals which they comprise, not less than by the brilliancy of their coverings. All the principal types of animals are represented, and all contain numerous genera and species. We need only refer to the tribe of humming-birds, which numbers not less than 300 species. But what is very important is, that here are concentrated the most perfect and also the oddest types of all the classes of the Animal Kingdom. The tropical region is the only one occupied by the quadrumana, the herbivorous bats, the great pachydermata, such as the elephant, the hippopotamus, and the tapir, and the whole family of edentata. Here, also, are found the largest of the cat tribe, the lion and tiger. Among the birds we may mention the parrots and toucans, as essentially tropical; among the reptiles, the largest crocodiles and gigantic tortoises: and finally, among the articulated animals, an immense variety of the most beautiful insects. The marine animals as a whole are equally superior to those of other regions; the seas teem with crustaceans and numerous cephalopods, together with an infinite variety of gasteropods and acephela. The echinoderms there attain a magnitude and variety elsewhere unknown; and lastly, the polyps there display an activity of which the other zones present no example; whole groups of islands are covered with coral reefs formed by those little animals.

The variety of the tropical fauna is further enriched by the circumstance that each continent furnishes new and peculiar forms. Sometimes whole types are limited to one continent, as the sloth, the toucans, and the humming-birds to America; the giraffe and hippopotamus to Africa; and again, animals of the same group have different characteristics, according as they are found on different continents. Thus the monkeys of America have flat and widely separated nostrils, thirty-six teeth, and generally a long prehensile tail. The monkeys of the Old World, on the contrary, have nostrils close together, only thirty-two teeth, and not one of them has a prehensile tail.

But these differences, however important they may appear at first glance, are subordinate to more important characters, which establish a certain general affinity between all the faunas of the tropics. Such, for example, is the fact, that the quadrumana are limited on all the continents to the warmest regions; and never, or but rarely, penetrate into the temperate zone. This distribution is a natural consequence of the distribution of the palms; for as these trees, which constitute the ruling feature of the flora of the tropics, furnish to a great extent the food of the monkeys on the two continents, we have only to trace the limits of the extent of the palms, to have a pretty accurate indication of the tropical faunas on all three continents.

The tropical fauna of Asia, comprising the two peninsulas of India and the isles of Sunda, is well marked. It is the country of the gibbons, the red ourang, the royal tiger, the gavial, and a multitude of peculiar birds. Among the fishes the family of Chetodons is most numerously represented. Here also are found those curious spiny fishes, whose intricate gills suggested the name (*Labyrinthici*) by which they are known. Fishes with tufted gills are more numerous here than in other seas. The insects and mollusks are no less strongly characterized. Among others is the nautilus, the only living representative of the great family of large chambered shells, which prevailed so extensively over other types in former geological ages.

The tropical zone of Africa is distinguished by a striking uniformity in the distribution of the animals, which corresponds to the uniformity of the structure and contour of that continent. Its most characteristic species are spread over the whole extent of the tropics; thus the giraffe is met with from Upper Egypt to the Cape of Good Hope. The hippopotamus is found at the same time in the Nile, the Niger, and Orange River. This wide range is the more significant as it also relates to herbivorous animals, and thus supposes conditions of vegetation very similar over wide countries. Some forms are nevertheless circumscribed within narrow districts, and there are marked differences between the animals of the eastern and western shores. Among the remarkable species of the African torrid region are the baboons, the African elephant, the crocodile of the Nile, a vast number of antelopes, and especially two species of ourang-outang, the chimpanzée and another large and remarkable animal of the same kind, recently described by Drs. Savage and Wyman. The fishes of the Nile have a tropical character as well as the animals of Arabia, which are more allied to those of Africa than to those of Asia.

The large island of Madagascar has its peculiar fauna, characterized by its makis and its curious rodents. It is also the habitat of the aya-aya. Polynesia, exclusive of New Holland, furnishes a number of very curious animals, which are not found on the Asiatic continent. Such are the herbivorous bats and the galeopithecus, or flying maki.*

Several well marked faunas may be distinguished in the tropical part of the American continent—namely,

I. The fauna of Brazil, characterized by its gigantic reptiles, its monkeys, its Edentata, its tapir, its humming-birds, and its astonishing variety of insects.

II. The fauna of the western slope of the Andes, comprising Chili and Peru; and distinguished by its llamas, vicunas, and birds, which differ from those of the basin of the Amazon, as also do the insects and mollusks.

III. The fauna of the Antilles and the Gulf of Mexico. This is especially characterized by its marine animals, among which the manatée is particularly remarkable; an infinite variety of singular fishes, embracing a large number of Plectognaths; also Mollusks, and Radiata of peculiar species. It is in this zone that the *Pentacrinus caput-medusæ* is found, the only representative in the existing creation of a family so numerous in ancient epochs, the Crinoidea with a jointed stem.

The limits of the fauna of Central America cannot yet be well defined, from want of sufficient knowledge of the animals which inhabit those regions.

145 *Special Distribution of* QUADRUMANA.—In addition to the facts already given with regard to the various faunas in different parts of the

* For the whole of this account of the distribution of the faunas, the author is indebted to an excellent abstract given by Prof. Agassiz, in his *Principles of Zoology*, recently published in America. The above five sections are adopted with little change from that work, chapter xiii.

world, it is desirable that we should consider also the special distribution of various races and natural tribes of animals. Of those which are calculated to give useful information of this kind, the great division of Vertebrata includes by far the larger number, and we now proceed to explain in what manner the class of Quadrumana is constituted with reference to climate and position.

Of the Quadrumana there are two subdivisions, the *Simiæ*, or monkeys, and the *Prosimiæ*, or makis. Of the former there are two families, the one having oblique and wide set nostrils and a human-like system of teeth, and characteristic of the Old World; and the other having nostrils placed at the side and wide asunder, with three false grinders on each side of both jaws, found only in America. There are in all one hundred and seventy described species, of which seventy-nine belong to the former and ninety-one to the latter country. There are thirty-two species of makis, making in all two hundred and two described Quadrumana.

With regard to the distribution of these two hundred and two species, we find that the apes are concentrated in countries under the equator, and there have their maximum. Of the three equatorial regions of Asia, Africa, and America, that of America (Brazil) has by far the greatest number of species, the amount being nearly double that of the continents of the Old World. Probably the greatest number of species of apes occur in the Silvas, on the banks of the Amazon, whence they extend to the eastern declivity of the Andes; they do not, however, cross the chain, since, on the whole western side of the Cordilleras, from Panama to Chili, only one or two species of the spider-monkey (*Ateles*) occur, and these are confined to Peru. Not only is the maximum of all the apes of the New World found in Brazil, but the maximum of each single genus also occurs there.

Of nine genera of monkeys found in the Old World, five are common to Asia and Africa. Four of these (the baboons, magots, macacos, and long-tailed monkeys, *Cercopithecus*) belong to the group of tailed monkeys, and the other (the Orangs) to the tailless monkeys. Of the other four genera the tailed gibbons are found only in Sumatra, and the solemn apes (*Semnopithecus*) occur pretty widely distributed in the islands of the Indian Archipelago, and are met with also in India and China, but nowhere in Western Asia or Africa. The whole group of the gibbons corresponds pretty nearly in distribution with that of the solemn apes, and the two groups are similarly limited, while thumbless apes (*Colobus*) are strictly limited to Africa, and chiefly confined to about sixteen degrees on each side of the equator.

The Baboons (*Cynocephalus*) are large, ferocious, and dangerous apes, attaining the size of a wolf, and remarkable for their canine physiognomy, whence their name has been derived, (κυνη, *cynè*, dog, κεφαλη, *cephalè*, head.) There are two groups of them—viz., the baboons proper and the mandrills. One species of the former is nearly confined to the Cape of Good Hope, another to the vicinity of the Red Sea, another to Northern and Central Africa, and another to Asia (East Indian Islands). The mandrills are exclusively met with in Central Africa.

The Magots are represented in North Africa and Europe by the Barbary ape, and in Sumatra by another species. The Barbary ape is not indigenous in Europe, but has migrated from Ceuta to Gibraltar, the only European locality in which it occurs.

There are two divisions of macacos—the long-tailed and short-tailed. They are both widely spread, but the second division occurs only in Asia, inhabiting Hindustan, Ceylon, Java, and Sumatra. The species of the former abound in the East Indian Islands and occur also in Africa.

The Thumbless apes (*Colobus*) form a peculiar African group of the Asiatic genus *Semnopithecus*, (Solemn apes). The latter are long-tailed and have a slender body; they are mild, intelligent, and slow. They abound in India, Ceylon, and the South-eastern Archipelago, and one species extends into China, Cochin China, and the Malay peninsula, where its flesh is highly prized as an article of food. The African thumbless apes have a singular head of hair, and there are several (eight) species of them.

The Long-tailed monkeys (*Cercopithecus*) are chiefly African, where they are described as being singularly abundant. The proper habitat of the genus is Western Africa, but six species occur in Asia, one of which is common to the two continents. One species reaches far south in Africa, and another inhabits the island of Mauritius.

The Tailless monkeys are of two groups, the long-armed apes (gibbons) and the orangs. The former inhabit only the most secluded parts of India and the Eastern Archipelago; the latter are found both in Asia and Africa, but are limited to about thirteen degrees latitude on each side of the equator, and occur chiefly in the interior of the country.

The Monkeys of the New World differ remarkably from those of the Old, especially in their smaller size and less ferocious manners, in the possession of naked callosities, and in the want of cheek pouches. They form two groups, and include, as we have already said, a very large number of species. The monkeys of the first group all possess prehensile tails; they include the *howlers*, (nine species,) the *spider monkeys*, (two,) the *gluttonous monkeys*, (two,) and the *weepers*, (twenty-three.) The species of the first genus are of large size and have the widest circle of distribution, being found as far north as Panama, and extending also to the south polar limit of the whole race. The spider monkeys inhabit chiefly Brazil and Guiana; they are generally mild, timid, melancholy, and inactive. The gluttonous monkeys are strictly confined to the tropical countries in the interior of South America, and the weepers, although found in greatest numbers in Guiana, extend southwards to the tropic of Capricorn; they are mild, quick and lively in their movements, and excellent climbers. The second group of American monkeys are chiefly Brazilian, and they generally have large tails and bushy hair.

The *Makis* include thirty-two species, of which fourteen are *Lemurs*, and six *Loris*. The Lemurs are exclusively confined to Madagascar and the adjacent islands, and so are also another group (*Lichanotus*), the largest of the tribe, attaining the size of a baboon. The Lorises are distributed through Asia, and are remarkable for their nocturnal habits, and large sparkling eyes.

Among the Monkeys of the Old World, one of the solemn apes (*Semnopithecus entellus*) ascends to the greatest height attained by the Quadrumana, and where there is wood, individuals are found on the slopes of the Himalayan Mountains, 13,000 feet above the sea. In Africa the *Macacus montanus* is found in Abyssinia, to the height of 8000 feet, and one of the howling monkeys of America occurs on the eastern side of the Andes, at more than 11,000 feet elevation.

146 *Distribution of* CARNIVORA.—The Carnivora are so important, as well by their number as in their distribution, that they require to be considered in some detail. The families of Carnivora are five—four of them terrestrial, and the fifth marine. They are divided into sixty-six genera, and about five hundred and twenty-six species; of these the first family, or bats (CHIROPTERA), includes two hundred and twenty-four species; the insect-eaters (INSECTIVORA), sixty-one; the PLANTIGRADA, thirty-four; and the DIGITIGRADA, one hundred and ninety-five; the remainder are AMPHIBIA.

The distribution of the Bats is most considerable within the tropics, where there are seventy-two species in Asia, forty-one in Africa, and fifty-five in America, without including the species in New Guinea and the islands of the Pacific, which number twenty-five species. The most extensive genus (that including the common bats of Europe) is also the most widely distributed, ranging from the Arctic circle to the extremity of Australia, and also into South America.

The *Insectivora* are pretty generally distributed throughout the great continents, but are entirely absent in the islands of the Pacific Ocean, including Australia, and in South America, below the tropics. The greatest number of species (twenty-five) occur in tropical Africa, but there are fifteen in tropical Asia, and four in tropical America. The shrews are found throughout, and the hedge-hogs almost so; the moles are pretty general in north, temperate, and arctic climates, but are almost entirely absent in the tropics. Generally, the Insectivora are remarkable in not following the general law with regard to Carnivora, that of increasing and attaining all their maxima in tropical climates.

The *Plantigrades*, like the Insectivores, are absent in the islands of the Pacific, in Australia, and temperate South America, but differ remarkably in their tropical distribution, only two species occurring in Central Africa, while twelve tropical species are American, and eleven Asiatic. The bears are the more generally distributed, and are found throughout; the gluttons present the same number of species within the tropics and in the Arctic circle, but are, with one North American exception, entirely absent in the temperate climates.

The *Digitigrades* are met with everywhere, the dogs being the most widely distributed; the cats are next in importance in this respect (being absent in Australia and the Pacific Islands), and then the martins and otters must be mentioned. This family, although not so numerous as that of the bats, is the most important, since it contains the fiercest and strongest of all the Carnivora. The most interesting groups among them are—*Canis* (dog), and *Felis* (cat)—the former of which, in some form or other, has representatives in every country from the Arctic Sea to the southernmost islands in the Pacific, and in the Old as well as in the New World. Some particular species are also very widely spread, the wolf occupying both continents, from the Arctic Circle to the north coast of Africa and the Isthmus of Panama, extending eastwards into India, and westwards to the western shores of America. The fox ranges over the greater part of Europe, and almost the whole of northern Asia; the jackal, the representative species in Africa, extends from the Senegal to India, and from Abyssinia to southern Russia. The whole tribe is, however, remarkably poor in species in India beyond the Ganges, and also in the Indian Archipelago, which, in other respects is rich in Carnivora.

The genus Felis is found in all parts of the world, except in the islands of the Pacific, Japan, and the Philippines, and the vast expanse of Australia. The species inhabiting America differ greatly in appearance from those of the Old World, and are generally smaller in size. They are also confined to the eastern side of the Andes. The lion is spread over almost the whole of Africa, from the Cape of Good Hope to Barbary, but is confined in Asia to a much smaller region, not extending beyond lat. 32° north, and chiefly met with in the jungle countries of India, and the borders of the Euphrates. The puma, the lion of America, has a far wider range, extending from Patagonia, in lat. 54° South, to California on the one side, and the Canadian lakes on the other, in lat. 50° north, a distance of 7000 miles. The tiger, more active than the lion, and nearly equal in strength, is very differently distributed, ranging through almost the whole of India, Siam, and China, extending northwards far into Central Asia, and southwards into Sumatra and Java. The jaguar, or American tiger, has its principal habitat in Brazil and Paraguay, but reaches southwards only to the latitude of Chiloe, and does not extend northwards beyond the borders of Mexico.

The vertical distribution of the Carnivora is, of course, very different in different zones of latitude. In Europe, in the Alps, the bats range to about 8250 feet, several species occurring at that elevation. The hedge-hog, amongst Insectivora, is met with at the same height, but the shrews a little lower. The black and brown bear are found in the Alps, between 5000 and 8000 feet, and the Pyrenean bear at nearly 9000 feet. The stoat (ermine), amongst Digitigrades, has been met with at the height of 9600 feet. The martin, the wolf, the otter, the wild cat, and the lynx ascend in the Alps to about 8000 feet, and in the Pyrenees a little higher. In Northern Europe, the glutton and the wolf ascend the highest of the Scandinavian Alps, from which the latter animal frequently descends to the plains, when the mountains are covered with snow.

In tropical Asia, one species of bat ascends to the height of 9600 feet; a species of weasel occupies a height of 8000 feet; the tiger ranges, in Java and Sumatra, from the sea-shore to nearly 4000 feet above it, and on the continent of India pursues its prey to an elevation of 9600 feet, where vegetation loses its tropical character. This animal, as well as the leopard and panther, frequent the naked, woodless, table-lands of Thibet, at a height equivalent to that of Mont Blanc. In tropical Africa, the lion of the Cape dwells on table-lands, at an average height of nearly 5000 feet above the sea; and, at the same elevation, one of the hyenas (*H. venatica*) pursues not only the antelopes, but even the lion and panther, attacking them in herds, and overpowering them by numbers. In tropical America, the bear lives at 16,000 feet above the sea, on the confines of the snow-line; the puma ranges in the Cordilleras of Chili, to the height of 11,000 feet (also close to the snow), whilst, in Peru, the jaguar scarcely attains the height of 3000 feet, although the ocelot is met with at double that elevation.

The *Amphibia*, being marine animals, obey laws of distribution very distinct from those to which the land quadrupeds are subject, and may be more conveniently considered afterwards.

147 *Distribution of* RODENTIA.—There are in all six hundred and four species of Rodents recognised and described, which are grouped into ninety-five genera, and these again into four principal families—namely, the squirrel family (including also the beaver), the rat family, the porcupine family, and the hare family. In all these, the species of the same group generally have a wide range in the same zones of climate, except when they are inhabitants of high ridges of mountains, in which case they follow the course of the mountains, even when, as in the Andes, these run from north to south. There are also examples of groups, for the most part confined to high latitudes, but re-appearing in low latitudes at considerable elevations. It is also worthy of remark, that the great mass of the South American Rodents belong to a group, naturally distinct from and of lower organization than the mass of the species in the Old World, and the northern parts of the New.

Of the squirrel family, (153 Species,) as many as ninety species are true squirrels, of which thirty-two are East Indian, twenty-four North American, twelve from Asia, (excluding the East Indies,) eleven Central and South American, and only two European. Of the genus *Pteromys*, (flying squirrels,) almost all the species are confined to Eastern Asia and the Indian Islands, and the rest are North American. Africa is remarkably poor in all kinds of squirrels, having only eighteen species, sixteen of which are true squirrels, and two referred to a genus which has no other representatives. The Beaver, the only other well-known and interesting rodent of this family, except the marmot, presents two species, the European and the North American beaver. The former is found in the rivers of temperate and Northern Europe and Asia, between latitude thirty-six degrees and sixty-seven degrees; the latter ranges on both sides of the continent of North America, but chiefly on the eastern side, between the northern limits of tree vegetation, and the confluence of the Ohio with the Mississippi river. The Marmots are confined to high mountain localities, or nearly so, and are found in the Alps, in Poland, and Russia, in Europe; in the hilly region of Nepaul and Thibet, and also in the valley of Cashmere, in Asia; and in America, from the sixtieth parallel of latitude, on the Rocky Mountains as far as Texas.

The Rat family contains 306 acknowledged species, 195 occurring in the Old World, and 114 in the New. Of all the genera, the common rat is at once the most numerous and the most widely distributed; its seventy-five species being distributed in pretty equal proportions through every zoological region on the globe; one of them, the common brown rat, occurring in all parts of the world; others, such as the black rat, the field mouse, and the harvest mouse, extend through Europe; the Barbary mouse, and another species, through North Africa; several others occur in South Africa, and others in various parts of Asia. The species peculiar to Central and South America are, however, very few, even these being doubtfully ascribed to the genus.

Of the other genera of this family, the common dormouse (*Myoxus*) occur throughout the southern and western parts of temperate Europe, and other species in Africa and Asia Minor. The *Jerboa* has a range extending from North Africa into Eastern Europe, and Western Asia. The *Hamster* is another animal limited in pretty much the same way, but not extending to Africa. Besides the recognised animals of this group, there are a number of species found in South America, which have been doubtfully ascribed to it, and require further examination. The group of Voles (*Arvicola*) are also interesting, and widely spread. The water vole, or water rat of England, is found throughout Europe and Northern Asia, extending eastwards as far as the river Lena, in Siberia, and northwards to the Arctic Ocean. Other species are found in most of the countries of Europe and Northern and Western Asia, and there is also a considerable number peculiar to North America. The *Lemming* is a curious genus, confined to the polar regions of both hemispheres, and the countries immediately adjacent.

The third family of Rodents includes the common Porcupine of Europe, and some other genera spoken of under the same name, such as the Canada porcupine, and the prehensile porcupine. The first named is indigenous in Southern Europe, Asia Minor, and Northern India, but it occurs also in Barbary, and re-appears at the Cape of Good Hope. The Canada porcupine is a widely spread North American representative, and the prehensile porcupine extends from the north coast of South America, as far south as Bolivia. Belonging to the same family, we have also the *Agouti*, a well known Brazilian genus, and the spotted cavy, found throughout the whole of South America, as far down as Paraguay. The *Chinchilla*, the *Biscacha*, the Guinea pig, the *Capybara*, and many other animals are also referred to it; and, indeed, in the New World, we have as many as seventy-seven species, instead of the six found in the Old World. This important fact in the distribution of the Rodents is well worthy of observation.

The fourth and last family of Rodents presents only two genera, the Hare and the *Lagomys*. The varieties of the common hare and rabbit, and the species of the same genus most nearly allied, may be said to inhabit the north temperate portions of the eastern hemisphere generally, some being confined to the warmer parts, but others ranging quite up to the Arctic Circle. Some species occur also in India, others in North Africa and Egypt, others in Asia Minor, Syria, and Arabia, and others again at the Cape of Good Hope. There are in all twenty-two species distributed in this way, and fourteen in various parts of North America, from the Arctic Circle to Texas. One species only is met with in South America, and this ranges throughout Brazil, and extends to Peru, Bolivia, and Paraguay. The genus Lagomys, is, with one exception, confined to the Old World, and chiefly to the northern extremity of it, although an American species is found on the Rocky Mountains, between the forty-second and sixtieth parallels.

148 *Distribution of* RUMINANTIA.—The animals of this order, which is one of the most natural and best defined of all the primary groups of quadrupeds, are distinguished from all others by the existence of four stomachs, arranged for the act of ruminating or 'chewing the cud.' They are all essentially herbivorous; they have cloven feet; and it is only amongst them that species are met with whose foreheads are armed with true horns.* There are in all nine genera, represented by the *Camel*, the *Llama*, the *Musk-deer*,

* The horn of the rhinoceros consists of parallel horny fibres, scarcely indicated on the skull, and belonging only to the skin.

the *Deer*, the *Giraffe*, the *Goat*, the *Sheep*, and the *Ox*, respectively: they are most numerous near the equator, but are distributed over all latitudes in the northern hemisphere, as far as the Arctic Circle. They are, however, totally absent in Australia, New Guinea, the South Sea Islands, and Madagascar.

The greatest number of species of Ruminants occur in Asia and Africa, each of these countries possessing more than one-third of all the species, so that, on the whole, the Old World possesses as many as 128 species, while in the two Americas there are only twenty-three species.

Of the particular genera, the Camel is a native of Asia, and now extends over Arabia, Syria, and Asia Minor, to the foot of the Caucasus, the south of Tartary, and India. It extends also in Africa, from the Mediterranean to the Senegal, and from Egypt and Abyssinia to Algiers and Morocco, and it abounds in the Canary Islands. The Bactrian camel, distinguished by its two humps, its rougher and shaggier hair, and stronger and more muscular frame, is almost unknown in South-western Asia, but abounds in the countries north of the Taurus and the Himalayan Mountains, extending, it is said, to the borders of China. The Llamas, the camels of the New World, present three species, differing from the true camels, by being much smaller, and having no hump on the back. They are chiefly distributed on the western side of the Andes, extending from Venezuela and New Granada, through Peru, Bolivia, and Chile, into Patagonia, and even to the wooded islands of Tierra del Fuego.

The Musk-deers, of which there are seven species, are distributed in various parts of Asia, chiefly south of the Himalayans, but two species are found in Africa. The whole group is distinguished by the absence of true horns. The true deers have solid horns or antlers; they include on the whole thirty-eight species, twenty-eight of them being found in the Old World, and of these, twenty-one in the East Indies. The largest of the genus, the elk or moose deer of America, inhabits the colder regions both of the Old and New World; the European elk, a distinct species, is found in the forest regions of Scandinavia, Eastern Prussia, Poland, Lithuania, and Russia, extending eastwards into Asiatic Tartary, and southwards to the Caucasus; the reindeer has its southernmost limit in America, in latitude fifty degrees north, but is most abundant between 63° and 66° north latitude. In Asia it traverses Siberia and Kamschatka, and in Europe is found in Iceland, Spitzbergen, Scandinavia, and Northern Russia, but chiefly in Finmark and Lapland.

The Fallow-deer inhabits central Europe, as far as fifty-three degrees north latitude, but extends also to the north of Persia and China, and is found in the northern part of Africa, as far south as Abyssinia. The common stag or red-deer is also a native of the temperate countries of Europe, but ranges ten degrees further north than the fallow-deer, and has not been found south of the Caucasus. It occurs in Siberia, from the Altai Mountains to the Lena River. The roebuck is also widely distributed in Europe, as far as fifty-eight degrees north latitude, and in Asia, eastwards to the River Lena, and southwards to Peru; it is common in the north of England, and in the north of Scotland, but is unknown in Ireland. In North America there are six species, and in Central and South America eight, one species being common to the two Americas. The most remarkable is the Virginian deer, which ranges from Canada, as far south as Louisiana.

The Giraffe is an isolated genus exclusively confined to Africa. There are two species, one inhabiting Nubia, Abyssinia, and the countries near Lake Tchad, the other a southern species, found in south lat. 29°, near the Orange and Lion Rivers. Africa is also the head-quarters of the Antelopes, containing thirty-four species, while Asia has only ten, Europe two, and America one. The European antelope, the *Chamois*, inhabits the alpine districts of Europe and Western Asia, being found in the Alps, Pyrenees, the Tatra, the mountains of Greece, the Caucasus, and the Taurus. The Goats, like the European antelopes, inhabit alpine countries, and of these the *Ibex* is well known, and ranges even to a greater height than the chamois, being found occasionally even above the snow line. The greatest number of species of the goat family are Asiatic, and only two are met with in the New World.

The Sheep are considered to have inhabited originally Western Asia. There are in all twenty-one species, thirteen of them Asiatic (excluding the East Indies), and five East Indian, there are also two in the Rocky Mountains of North America. In a domesticated state they have been introduced into most parts of the civilized world. The Bovine tribe (oxen), of which there are thirteen species, comprise the largest of ruminating animals, and are widely distributed over most countries of the globe. The Buffalo, long known as a domesticated animal in India, has spread westwards to the western extremity of Europe, and eastwards to the islands in the Pacific Ocean. The Cape Buffalo is a much more ferocious animal, wandering in large herds over extensive districts in South Africa. The two American species, the bison and the musk ox, are both confined to North America, the former extending from New Mexico and California to about 64° north latitude, while the latter is peculiar to the frozen regions of the continent, its southern range commencing where the bison terminates, and extending thence over the barren regions of the Polar districts to Melville Island, thus attaining with the rein-deer the highest latitude of any known species of ruminant.

The vertical distribution of ruminants is not uninteresting, the Chamois and Ibex reaching in the Alps to the snow line (8900 feet), while oxen graze and sheep pasture within a thousand feet of this elevation. The common stag in the same parts of the country reaches only to 7000 feet, and the fallow-deer to 6000. In the table-lands of Central Asia, the goats and sheep not only reach the height of from 10,000 to 16,000 feet, but one species is described as bounding lightly over the encrusted snows of the higher ridges of the Himalayan Mountains, where its human pursuers find it difficult to breathe. Another species, the *Yak*, seems actually limited to districts where the temperature is below that of the freezing point of water, and even the Bactrian camel attains in the table-lands of Central Asia a height at from 3000 to 5000 feet above the sea. In South America, the Llama inhabits the bleak and rocky precipices of the Andes and regions bordering on the limit of perpetual snow. In the cold climate of Patagonia these animals approach the vicinity of the sea, but further north large herds attain (as on Chimborazo) a height of 15,800 feet, and on the Bolivian Andes an elevation of 18,000 feet.

149 *Distribution of the* PACHYDERMATA.—Of this family there are nine genera containing thirty-nine species. Only one species (*Sus*—the swine) is indigenous in Europe, while nineteen are Asiatic, twenty African, and seven American. Besides the Swine, the Asiatic genera includes the Elephant, Rhinoceros, Tapir, and Horse, and to these in Africa are added the Hippopotamus, Hyrax, and Phascochœrus, while in America we have only the Peccaries and Tapirs. The animals of this order are not only few in number, but much smaller in size in the New World than in the Old. In North America they are totally absent, and so also are they in Australia. On the other hand, in Africa they are singularly abundant, and highly characteristic.

If we refer to the particular genera, we find the Elephant inhabiting the whole of the peninsula of India, the Birman Empire, and Siam, extending also to Cochin China. It ascends the Himalayan Mountains to the height of 6000 feet, and reaches southwards to the extremity of Sumatra, although it has never yet been proved indigenous in Java or Borneo. The African species reaches from the Mountains of the Moon nearly to the Cape of Good Hope, thus ranging in the western part of the Old World from 31° south latitude to 13° north, and in the eastern part from 6° south latitude to about 30° north. The Hippopotamus at present extends from the Orange River, near the Cape of Good Hope, to the upper Nile in Dongola, and occasionally still farther north. The Rhinoceros is more subdivided into species than the elephant or hippopotamus, there being four African and three Asiatic; it is confined to nearly the same limits as the elephant, but extends a little farther north into China, and also into Java. The common or one-horned African species, and the corresponding one-horned species in India, are the most widely distributed, the others are smaller and chiefly found in the interior of the country. The genus *Sus* (or swine) is distributed into three groups, the European-Asiatic, the Indian, and the South African. The first contains only the common swine, which ranges from the shores of the Atlantic to the Pacific, extending westwards from the borders of the Sahara to the Baltic provinces of Russia, and eastwards from the Gulf of Tonquin to Lake Baikal in Siberia. The other species are far more narrowly distributed, one of them forming a passage to the Tapirs, and another nearly confined to South Africa, and extending into Madagascar, where it is the sole representative of the whole tribe.

The *Hyrax* (daman) is a singular and interesting genus of pachyderms, approaching the rodents in some respects, and at present only known in South Africa, in the countries bordering the Nile, and in Syria. The *Phascochærus* (warthog) is also exclusively African, inhabiting the country between Abyssinia and the northern extremity of the Cape Colony, and rare even within these limits. The other Pachydermatous group of the Old World is that which includes the Horse, the Ass, and the Zebra. It is not possible now to determine the original limits of the true horse, though it appears to be a distinctly Asiatic species. The ass seems characteristic of Central Asia, and the zebra is peculiar to Africa, where there are several species ranging southwards as far as the Cape of Good Hope.

The only remaining Pachyderms are the *Peccaries* and *Tapirs*, the former absolutely confined to South America, the latter chiefly characteristic of that continent, but not uncommon in the islands of the Asiatic Archipelago. The Peccaries inhabit dense forests, and extend from the peninsula of Yucatan in Central America to Paraguay, climbing the eastern slopes of the Andes to the height of six thousand feet. The common American tapir is met with from Nicaragua (latitude 14° north) to the Pampas of La Plata, in latitude 40° south, and ascends the Andes to as great a height as the peccaries. Another species inhabits chiefly the most elevated parts of the Andes of New Granada.

150 *Distribution of the Edentata and Marsupialia.*—Of the former of these remarkable groups there are six recognised genera, four of them confined to the New World, one occurring only in Africa, and one (*Manis*) reaching into Asia. South America contains three times as many species as all the remaining countries of the World, and is in every respect the metropolis of the order. We shall see also in a future chapter that this distribution has long obtained.

The principal genera of the Edentates are the *Sloths*, the *Armadillos*, and the *Ant-eaters*. The former ranges from the southern limits of Mexico as far south as Rio Janeiro; and from the eastern coast to the slope of the Andes there are four species, all inhabiting the trees of the gigantic and primeval forests of those countries. The armadillos, of which there are eleven species, range in like manner through Central and Southern America, they vary in their habits, living in the plains as well as on the table-lands, and extending into the lower regions of the Andes to the height of about 3000 feet. There is one remarkable and closely allied genus (*Chlamyphorus*) inhabiting Chili and La Plata, and interesting from the enormous strength exhibited in so small a frame. The American ant-eaters, the largest of the Edentata, are less widely distributed than the sloths and armadillos, both in vertical and horizontal space.

The Edentates of the Old World number only five species in all. The African genus includes one ant-eater (*Orycteropus*) very different from the American species, and extending from the Cape Colony to Congo. The *Pangolin*, or scaly ant-eater (*Manis*), has four species, and ranges from the

Senegal in Africa, in a narrow band southwards to the equator, occurring also in North-eastern India, and thence castward to Formosa, and in the islands of Sumatra, Java, Borneo, and the Celebes.

As South America is the country of the Edentates, so on the continent of Australia and its adjacent islands we find the great majority of the Marsupial tribe, although of these also a few representative forms have been found in America. The whole order has been divided into eight families, which present a remarkable diversity of structure, and consequently of habit, some species amongst them being herbivorous, some carnivorous, and others insectivorous. All, however, present the striking peculiarity of the order—namely, the premature birth of the young, and the existence of a kind of bag or pouch, situated beneath the belly of the female to receive them at this period, and retain them for a considerable time even after they have grown to a large size.

The *Ornithorhynchus* and *Echidna,* two of the most remarkable animals known, form one group of the marsupials, and are almost confined to South-eastern Australia and Van Diemen's land. The *Kangaroo* family, which numbers not fewer than forty species, are very widely distributed in Australia and New Guinea, and have been said to occur in Java. The *Wombats,* of which there are two species, are found chiefly in the southern and eastern part of Australia and Van Diemen's land. The *Phalangers* are widely distributed not only in Australia but in New Guinea, and many of the Asiatic islands, extending even to the Celebes. The *Dasyuridæ* (including the *Thylacinus,* or Australian dog) are limited to New South Wales and Van Diemen's land, while the *Opossums* are an exclusively American family, extending from the southern limits of Canada to the thirty-sixth parallel of south latitude. They are nearly confined to the eastern side of the continent, and one, a Brazilian species, lives in the water. The whole number of species of marsupials may be estimated at not less than 126; and the group found in Australia is the more important from the absence in that country of other mammals, and the number of representative forms of various tribes which it includes.

151 *Distribution of* BIRDS.—Birds, like other Vertebrates, exhibit the greatest number of species in the tropical climates, with the partial exception, however, of the continent of Europe, which contains 490 species, while, although tropical America has 624, tropical Asia presents only 450, and Africa only 211. North temperate America affords in all 178 species, and the north frigid zone in America as many as 103. There are, also, other apparent anomalies when we examine the different orders in detail; as, for example, there are 186 European species of *Oscines* (singing-birds) and 112 of *Natatores* (swimmers), while in tropical America there are 319 of the former and only 26 of the latter group. Europe and tropical America possess the greatest number of birds of prey, and the climbers and songsters are most abundant in the latter country. Tropical Asia presents the greatest number of *Gallinaceæ,* and Europe the greatest number of waders and swimmers.

If we take the particular genera, we find amongst the birds of prey the Vulture tribe the most remarkable, and the largest of all flying birds. The habitat of the *Condor,* of which individuals have been found in the Andes of Quito measuring fifteen feet from tip to tip of the wings, is exclusively confined to the vicinity of the Andes, and breeds at an elevation of from 10,000 to 15,000 feet above the sea. Humboldt, on one occasion, saw this enormous bird floating over the summit of Chimborazo at an elevation of upwards of 22,000 feet. The species ranges from the Strait of Magalhaens to 7° north latitude. Of the other vultures several are American, and there are also species dispersed through Africa and India. The birds of prey of Europe include five vultures, thirty-four hawks, and fifteen owls, many of them extending into North Africa and Asia. The greater number of species occur in the south of Europe, and as many as twelve range through various parts of the Alps. These include one vulture, two eagles, five hawks, and four owls.

The order of climbing birds, including the parrots, cuckoos, king-fishers, and others, are chiefly confined to the tropical zone; but they also occur abundantly in the southern hemisphere, where they extend to very high latitudes, reaching even beyond New Zealand as far as Macquarie in latitude 56° south. In the northern hemisphere they attain in the United States the latitude of 42° north. Forty species are found in the tropical regions of South America, while only three inhabit the opposite coast of Africa. The Birds of Paradise, a small but very remarkable group, are limited to a few islands in the neighbourhood of New Guinea, migrating according to the monsoons. The Toucans, and some other groups, are also confined within very narrow limits. Of European climbers there are twenty-three species, some of them, as the Woodpecker and Hoopoe, ranging throughout the whole continent, but others more local. Eight of them inhabit or traverse the higher parts of the Alps.

Of the order of songsters (*Oscines*), the Humming-birds, the smallest and most brilliant of the whole tribe, are all natives of America, and chiefly of the tropical portions of that country, but they range to the height of 10,000 feet on the Andes, and have been met with breeding in the Island of Juan Fernandez ($33\frac{1}{2}$° S. latitude), and as far north as latitude 61° on the shores of Behring's Straits. Of the 186 species of this order found in Europe, as many as 100 belong to the typical genus from which the order has received its name, and which are all of them song-birds. Forty-three of these extend into Africa, and ten reach to tropical Asia; there are also ten European species of Larks; forty-three of Finches, of which one, the common Sparrow, extends over most parts of the known world; twenty-eight Nut-hatchers, including amongst them six species of *Corvus* (crow), and five species of Swallow. These are all of them pretty generally distributed throughout the country, and range also into the adjoining continents.

The gallinaceous birds are far more numerous in the Old World than the New, the greatest number of species (72) being found in tropical Asia, and some of these being now domesticated in almost every country. The Pheasant thus extends, in its natural distribution, from the Caucasus through Central Asia to China, and southwards as far as Java; the Peacock is a native of India; the Pigeons (of which six species are European) extend into the two great continents; and the Turkey is peculiar to the New World, its proper limits appearing to be from the Isthmus of Panama to the north-western extremity of the United States. It does not appear to be indigenous on the western side of the Rocky Mountains, or in South America. Only twenty-eight species of the order are found in Europe, and many of these are not natives; but the grouse, the pheasant, the common fowl, the pea-fowl, the partridge, and many others are of this kind, and are too well known to require further allusion. Two species of pigeon, four of grouse, and two of partridge, have been found amongst the higher passes of the Alps.

The order *Grallatores*, or waders, is most abundant in the north temperate zone, but by far the most remarkable species occur in tropical and southern countries—thus, the African and South-American *Ostrich*, and the Australian *Emu*, as well as the *Cassowary*, are amongst the most extraordinary, as they are the most gigantic of birds. The former (the ostrich) has a tolerably wide range, and has been met with to the height of 7000 feet, on the high plateau of the Uspallata Mountains, in South America. One South American species extends to 54° south latitude, and the African species ranges from the Cape of Good Hope to Barbary, and has extended as far as the southern declivity of the Caucasus, and the shores of the Black Sea. The most numerous European genus is that which includes the Snipes, of which there are thirty-eight species, sixteen of them extending into North Africa, and twenty-five into Siberia. The Ibis and the Flamingo are recognised species in Europe, but belong to Africa and Asia.

The *Natatores*, or swimming birds, including the ducks, pelicans, penguins, gulls, and many others, are, like the waders, more abundant in European than tropical latitudes. There are one hundred and twelve

European species, of which forty-four belong to the duck genus, and thirty-three to the gulls, of each of these more than half extending into Asia. The Eider-duck is an interesting and important species, chiefly inhabiting the shores of the Arctic Ocean, and the land immediately adjacent, extending in Europe to the Orkney Islands, and even into Germany, and in America to the latitude of New York.

The migration of birds is a fact in their natural history which fully accounts for the wide extent of country over which many species are found. Some proceed to very distant spots in search of food, or at the breeding season, and many of the sea-fowl are found over many thousand miles of ocean, and are rarely seen to rest, while other birds, although not naturally migratory, proceed from one spot to another on the occasional failure of food in their natural district. The habits of birds in migrating are very different, some going singly, some in small groups, others in flocks of many thousands. When in great multitudes, they generally have a leader, as in the case of the swallows and martins; but when the groups are smaller, the birds often fly in very regular order—wild geese, for example, in the form of a wedge. The swift, a remarkable bird in its power of sustaining rapid and long-continued flight, is said to proceed at the rate of one hundred miles per hour, and the wild duck and wild pigeon four or five hundred miles in a day. Migrating birds generally return to the same spot, within a few days of the same time of the year, and often occupy the same nest for successive years.

152 *Distribution of* REPTILES.—Of the existing orders of reptiles, the *Sauria*, including crocodiles and lizards, number two hundred and three species; the *Chelonia*, or tortoises, sixty-nine species; the *Serpents* two hundred and sixty-five species, and the *Batrachians* (frogs), one hundred and twenty species—making in all six hundred and fifty-seven. Of this number more than twice as many are found in the countries of the torrid zone than appear in temperate climates. The *Chelonia* are most numerous in the United States, where there are nineteen, in Brazil (fifteen), and in the Indian islands (thirty-three). In Africa (Barbary) there are six species, and in Europe, except in Italy and Turkey, only three in all. The *Sauria* include thirteen species of Crocodiles, nine of them American, and four Asiatic and African. The remaining Sauria are far more widely distributed in Africa and South America than in the rest of the world, Brazil being the richest in species, and containing in all as many as forty-two. *Serpents* are far the most abundant in the East Indies and in Central and South America, and most of all in the Island of Java, where no less than fifty-six species have been determined, while in the adjacent Island of Borneo there is not at present a single one known. The *Batrachians* are most numerous in Central and South America, but thirty-nine species are North-American, and twenty-three European. Asia, Africa, and Australia show a remarkable absence of the animals of this order. Generally, reptiles may be regarded as more limited to warm climates than any other animals, and better able from their structure, and the slowness of their circulation, to bear the extreme rigour of an excessive climate than the absence of hot summers that characterizes island countries.

Of the *Chelonians*, the common marsh tortoise of Europe attains the highest latitude, extending in Prussia to lat. 52° north, while a corresponding species in North America reaches to 50° north. Some of the sea-turtles have been met with in the northern hemisphere, even so far north as the Shetland islands (lat. 60° 30′), but the individual in question may probably have been drifted thither by storms, its usual range being only to the shores of France, to about the fiftieth parallel of latitude. The species thus observed (the hawk's-bill turtle), furnishes the horny plates usually known in commerce as tortoise-shell, but the principal fishery of these animals is in the Moluccas, and other islands of the Indian Archipelago, and the islands of the West Indies; the former, however, being the most important, since the shell is the most valuable. The green turtle, used for food, is a species inhabiting the tropical parts of the Atlantic Ocean, and attains a large size, often weighing six or seven hundredweight. The fresh-water tortoise is very abundant in North America, where there are fifteen species determined; the land tortoises, on the contrary, are chiefly African, although there are several European species.

The *Crocodiles* are divided into three groups—named respectively, *Alligators* or *Caymans*, true crocodiles, and *Garials* or *Gavials*. The first group are exclusively American, and have a wide range of distribution, extending from the United States, in lat. 32° 30″ north, through Central America, and southwards into Brazil and Paraguay, in lat. 31° south. They are amphibious, chiefly inhabiting the estuaries of great rivers, and rarely leaving the fresh water. They are very fierce, but chiefly prey in the night, and the South American species are considered less dangerous than those of the Mississippi. The African crocodiles extend from Congo to Senegambia on the west, and Egypt on the east, the common crocodile of the Nile being distributed over nearly the whole river district, and throughout Nubia and Abyssinia. The Asiatic crocodile, or Gavial, extends from the north-western coast of Australia, through the Indian Archipelago to Hindustan, where it is exceedingly abundant in the Ganges and other great rivers. The *Lizards* (including the monitors, iguanas, chameleons, blind-worms, and true lizards) range somewhat more widely than the former group, and many of them, as the chameleons and monitors, are absent in America. The Chameleons form an interesting African and Asiatic group, extending over many parts of the south of Europe. The Geckos and Iguanas are greatly multiplied in Brazil, but range also in other countries. The Monitors are chiefly Asiatic; and one, sometimes called the land crocodile, chiefly inhabits Africa and the Indian Archipelago. A nearly allied genus is found in Guiana, where it attains the length of six feet. The Skinks are distributed like the Iguanas, being chiefly abundant in Africa and South America; but there are ten species inhabiting Europe.

The *Serpents* are totally absent from the islands of the Pacific, and most widely distributed in the adjacent islands of the Indian Archipelago—a very remarkable fact in the general distribution of animals. It is also well worthy of careful attention, that although many species of the order are widely dispersed in various parts of temperate Asia and Europe, no species is common to Asia and America. Australia is almost without representatives, (there being only eleven species in all, and these peculiar,) and Japan has six species, also peculiar. America and Asia, between the tropics, present by far the largest number of species, and Africa is remarkably poor in species, although the few that there are seem very widely spread. Of the two divisions of serpents, the harmless and the venomous, the number of species of the former is three and a-half times as great as the latter, but with the exception of western Europe and Madagascar, scarcely any country is without some species of both.

The *Frogs* extend further than any other reptiles towards the polar regions, reaching in Finland nearly to the limit of perpetual ground-frost. In the New World, however, some of them extend even beyond this line in Greenland and British America, existing on the banks of the Mackenzie River, up to the sixty-seventh degree of north latitude, where the mean temperature is not more than seven or eight degrees Fahrenheit, and where the cold in winter is so excessive, that the thermometer sometimes sinks to more than 90° below the freezing point of water. In the southern hemisphere a frog was found by Mr. Darwin in latitude 50° south, on the banks of the river Santa Cruz.

Within the tropics Crocodiles and Boas are found on the Andes of Quito, at an elevation of 3000 feet; and a remarkable reptile, the *Axolotl*, occurs in Mexico at the height of 8000 feet. In the Alps there is a frog living in the vicinity of the snow-line, and various other reptiles of the same order between 4500 and 6000 feet. In the Pyrenees, the common frog is found at 8000 feet.

If we take the distribution of individuals we shall find by far the most abundant locality to be the Island of Java, after which Brazil, the southern States of North America, the Island of Sumatra, the Celebes, Egypt, South-western Europe, and North-eastern India may be mentioned as the places where reptiles chiefly abound.

153 *Distribution of the* MARINE VERTEBRATA.—This group includes the whale tribe, the seals, and a single genus of reptiles, in addition to the vast and important class of true fishes. The whales form two groups, the herbivorous whales (the *Lamantin* and *Dugong*) and the ordinary whales, including the *Dolphin*, the *Porpoise*, the *Narwahl*, the *Cachalot*, and the *Balæna*, or Whalebone whale. All these suckle their young. The lamantin, or sea-cow, is chiefly limited to the mouths of rivers in the hottest parts of the Atlantic Ocean, the American species being distinct from the African, but both occasionally attaining the length of fifteen feet and upwards. The dugong inhabits the Indian Ocean, and there is also an allied genus found in the Pacific. The spouting whales are very widely spread through the various parts of the great ocean, but there is no family of mammalia more difficult to observe, in spite of their frequently gigantic size. Amongst them the dolphin is seen in almost every latitude, and the porpoise is almost as widely spread, but particular species appear to be, and probably are, very much more limited. The Grampus is the largest species of this group, and abounds both in the Atlantic and Pacific Ocean. The Cachalot and Balæna are, however, much larger, attaining the length of from sixty to seventy feet, and the Rorqual (a whalebone whale) has been met with having a total length of as much as one hundred feet. The former appears to range from the limits of the Arctic nearly to the Antarctic Ocean, but their chief resort is in the deepest parts of the warmer seas near the tropics. The whalebone whales are chiefly found in the colder seas, but appear to travel to warmer latitudes in search of food.

The Seal tribe present a number of species of which the common seal and the morse are the best known; they are both chiefly confined to the polar seas and desert islands in high latitudes, but some of them have a very wide range, especially in the southern hemisphere.

The distribution of the true fishes, like that of the marine mammalia, is chiefly known as far only as regards the species used by man. Thus, the cod, the herring, the salmon, the pilchard, &c., have naturally attracted attention, and their habits of migration and the nature of the spots they select for feeding ground, are tolerably well known, but of the vast multitude that herd on the various shores of the different countries in the world, or that dwell concealed from observation in the deeper parts of the open ocean, it is scarcely possible to determine at present their true geographical or climatal limits, or the law of their distribution.

Of the various natural tribes of these animals, some are certainly migratory and some constantly confined to narrow limits, but the greater number have a wide, although by no means indefinite range. The former pass from one ichthyological province to another, according to the season and the abundance of food, or the necessities of breeding; but these provinces, although indicated, have been only partially determined. The most extensive includes about forty degrees of latitude on both sides of the equator, in the Pacific, and this is flanked by the northern and southern portions of the great ocean. The Atlantic presents a similar division, and there are many local and peculiar marine faunas in the great bays and gulfs near the mouths of great rivers, in the principal inland seas, and in the various rivers themselves.

Somewhat more than eight hundred and fifty species of fishes have been described from European seas, rivers, lakes, and coasts, of which two hundred and ten inhabit fresh water, and of the whole number two hundred and sixteen are British, and as many as four hundred and forty-four of the marine species are Mediterranean. Comparatively few of this number extend to America, still fewer are found in the Red Sea, and scarcely any reach to the Indian seas. It is remarkable, also, that the Black Sea, which communicates directly with the Mediterranean has a distinct fauna, and the Caspian another, also peculiar to itself. The great lakes of Central Asia and of North America, most of the great tropical rivers in both continents, and many other smaller areas of water, appear to be more or less isolated.

Although, in number of species, the southern seas of Europe and the warmer parts of the Atlantic are richer than the more northern districts, this is by no means the case with regard to individuals, or even the tribes most useful to man; and, indeed, in this matter, there seems a certain balance struck between the cold and warm regions; for while Italy and the south supply fruits and vegetables in enormous abundance, the northern shores and banks are eagerly watched for countless myriads of fish, which are dried and exported as food for the inhabitants of warm countries. Thus the banks of Newfoundland, and the Dogger Bank, in the North Sea, where there is shoal water and shelter, are crowded with cod in the month of February to such an extent, that in the latter locality as many as sixteen millions of fish have been caught in one place within a few weeks, and in the former, the produce of the fishery for a single season has amounted to forty thousand tons weight. The pilchard, in point of numbers, is still more remarkable, as it has been estimated that, on one occasion, twenty-five millions of fish (ten thousand hogsheads) have been taken on one shore in one port on a single day.

It is by no means the case, however, with these and many other fishes which migrate from one sea or part of a sea to another, that they can readily transport themselves to great distances. The contrary is rather the fact, as the pilchard and the herring are really limited to very narrow areas of sea, although appearing only at particular seasons, when impelled by instinct to the shores for the purpose of spawning; and so with others, where the migration is rather in vertical than horizontal space.

The limits of distribution of fish in vertical space seem to be very strictly defined. Some swim always near the surface, and, like the flying-fish, appear to rejoice in exposing themselves to the air, while others are still more nearly amphibious, and, like eels and an Indian species of perch, can transport themselves for some distance on land, or attach themselves to the shelter afforded by particular trees growing near water. Others, again, are littoral, inhabiting shores in moderate depth of water; but others, although found near shore, are, like the plaice and many flat fish, always buried in the mud or moving at the bottom. Many others, again, rarely or never approach the shores, but remain constantly in deep water; amongst these are the sharks. Mr. Yarrell has remarked, 'that those fish which swim near the surface of the water have a high standard of respiration, a low degree of muscular irritability, great necessity for oxygen, die soon—almost immediately when taken out of the water—and have flesh prone to rapid decomposition. Mackerel, salmon, trout, and herrings are examples. On the contrary, those fish that live near the bottom of the water have a low standard of respiration, a high degree of muscular irritability, and less necessity for oxygen; they sustain life long after they are taken out of the water, and their flesh remains good for several days. Carp, tench, eels, the different sorts of skate, and all flat fish may be quoted.'*

With tenacity of life is connected the extraordinary power observed in some fishes of enduring extremes of temperature, and thus the gold fish, a native of China, not only lives, but thrives to excess, in water whose temperature is constantly as high as eighty degrees Fahrenheit. Other species have been found in hot springs in various countries whose temperature ranges between 110° and 130° Fah., and Humboldt and Bonpland perceived

* Yarrell's *British Fishes*, 1st edition, Introduction, p. xiii.

fishes thrown up alive from the bottom of a volcano, in South America, along with water and heated vapour, the thermometer showing a temperature within two degrees of the boiling point of water. The enduring power of fishes with regard to cold is, perhaps, still more remarkable, for Mr. Jesse speaks of a gold fish frozen with the water, in a marble basin, into one solid mass of ice, and yet, within a few hours of the ice having been thawed, the fish recovered, and was soon as lively as usual. The carp also, to which the gold fish is nearly allied, is well known to have remarkable power in this respect; and perch, as well as other fishes, are well able to sustain the congelation of the water surrounding them, without permanent injury.

154 *Distribution of the* INVERTEBRATA *and* ARTICULATA.—The *Invertebrate* animals are not less remarkable in their peculiarities of habit, and the limitation of their natural range, than the more highly organized groups already considered; and though some of them, as the *Sepias*, or cuttle fish, range freely in all parts of the ocean, or like the butterflies, flit about in the air and proceed like birds to distant countries, others are far more limited, and exhibit few capabilities of extensive or distant range. Thus, whether we consider the flying species, those which inhabit the surface or soil of the land, or the enormously larger and more important group, the marine invertebrata, we everywhere find natural limits of range, both in horizontal and vertical space, the increase of depth in the sea answering to greater elevation on land.

The *Articulata*, including insects, crustaceans (crabs and lobsters), and worms, are distributed in comparatively narrow and limited areas, so that a vast number of species have been determined, often differing very slightly from each other. In high latitudes, insects are very few, both in species and individuals, except during the short summer period, when certain tribes, as mosquitoes, fleas, and others, multiply with enormous rapidity, and prey upon all larger animals. In North Europe, and, indeed, in Europe generally, the number of species is much larger, and the variety far greater, and this increases as we advance towards the equator, but diminishes again in tropical Africa, while South Africa, the African and the Indian islands, are all richly supplied with these animals, although by no means to such an extent as Central America, which perhaps in some parts may be regarded as the true metropolis of the class. Beetles, however, generally, are much more abundant in temperate than in tropical climates, and this is especially the case in the northern hemisphere.

The causes that seem chiefly to affect the distribution and range of insects are—first, food; secondly, temperature; thirdly, prevailing winds; and fourthly, elevation above the sea. With regard to the first, as some insects feed upon living vegetables, these are necessarily limited to the range of such plants, and usually become introduced by man into those distant countries into which the plants are conveyed. More than two-thirds of the whole number of species are considered to be thus dependent directly on the vegetable kingdom. Temperature also acts indirectly by modifying the nature and amount of food, and in this way, as well as by immediate action on the animals themselves, produces a considerable change. It is, however, pretty certain that extremes of temperature have chiefly to be regarded in considering the direct action of climate, as where there is considerable summer heat many of these creatures will easily withstand the action of the greatest reduction of temperature, even in the polar regions. The common mosquito, the flea, and the common fly, are examples of this.

Mountain chains form natural barriers to the passage of most kinds of insects. As an example of the extent to which insects are sometimes multiplied, and, therefore, of the way in which they may be said to affect the aspect of any fauna, we need only refer to the following account of the condition of some of the great rivers of tropical America, and the swamps near their mouth. According to Humboldt, 'there is no rest in these spots at any hour of the day or night, or at any season of the year, so that whole districts are absolutely left desert from the impossibility of enduring life under such torture. New species follow one another with such precision, that the time of day or night may be known accurately from their humming noise, and from the different sensations of pain which the different poisons produce. The only respite is the interval of a few minutes between the departure of one gang and the arrival of their successors, for the species do not mix. On some parts of the Orinoco, the air is one dense cloud of poisonous insects to the height of twenty feet. It is singular that they do not infest rivers that have black water, and each white stream is peopled with its own kinds; though ravenous for blood, they can live without it, as they are found where no animals exist.'

In Brazil, the quantity of insects is so great in the woods, that their noise may be heard in a ship at anchor some distance from the shore. The torrid zone not only produces the most noisy, but the most brilliant and the most powerful insects. Amongst the former are the butterflies of Africa, the East Indies, China, and America, which rival the lustre of metals in their colours; and here also the forests, peopled with millions of fire-flies of various kinds, present to the eye an appearance almost like that of an immense conflagration. The Termes, or white ants of Africa, build solid hillocks, and in the course of an incredibly short time can remove every particle of flesh even from the carcass of an elephant; they are so destructive in South America, that there is said to be not a manuscript in that country a century old. Spiders also, although there are more species in Europe than elsewhere, attain a gigantic size only in hot countries, where, as in Guiana, a species is found large enough to catch and devour birds.

The migration of insects, like that of birds, is necessarily obscure to a certain extent, but tribes of Locusts are known occasionally to transport themselves from one country to another, in a mass so dense and so large as to form a visible cloud in the air, darkening the sun's light, and making with the beating of their wings a sound which is said to resemble the distant murmur of the sea.* The main body when thus compacted, sometimes proceed to great distances, crossing the Mozambique Channel from Africa to Madagascar (a distance of 120 miles), and proceeding occasionally from Barbary into Italy. Many other insects are remarkable also for the great distances of their flight, and the vast multitudes collected together for this purpose.

The *Crustaceans*, which are also Articulata, include a number of marine species, chiefly littoral, besides many from the fresh water, and some that are terrestrial. In the Polar seas they are found in great abundance, though the number of species is very limited; and in the equatorial regions, while they are no less numerous, they present a greater diversity of form, attain a larger size, and exhibit in the highest perfection those peculiarities of structure by which the several groups are characterised. The Land-crabs are chiefly remarkable in the table-lands (Ghâts) of the peninsula of India, and in the West Indies. In the former country they are troublesome, and indeed dangerous, by their extensive burrowings, but in the Antilles are eaten as food.

The *Annelids*, like the Crustaceans, include inhabitants of the land, of fresh water, and of both shallow and deep ocean. Some also, as the Earthworms, live permanently beneath the surface of the Earth. They occur in all climates, but are not able generally to wander far from the specific centre to which they belong. The marine species are chiefly littoral.

155 *Distribution of the* Mollusca *and* Radiata.—The Mollusca are regarded as, on the whole, of lower organization than the Articulata, although they include amongst them one group (*Cephalopoda*) which approaches the

* 'A fire devoureth before them; and behind them a flame burneth: the land is as the garden of Eden before them, and behind them a desolate wilderness; yea, and nothing shall escape them. . . . Like the noise of chariots on the tops of mountains shall they leap, like the noise of a flame of fire that devoureth the stubble, as a strong people set in battle array.'—*Joel*, ii. 3—5

Vertebrata very closely. They are chiefly marine, although there are many fresh-water and terrestrial species. The aquatic species are found in all seas from the poles to the equator, but generally at moderate depth, some burying themselves in sand or mud, others in indurated clay, and some burrowing into limestone rocks. Many species delight in quiet sunny nooks on the margin of fresh-water pools, others in rapid and mighty rivers, and others, again, in the depths of the ocean, but all are exceedingly dependent on local condition. We cannot better give an idea of the nature of the distribution of these and other lower animals, than by quoting the following summary from the admirable memoir by Professor Edward Forbes on the Ægean Invertebrata.* Professor E. Forbes divides the portion of sea to which his observations were chiefly confined into eight regions of depth, each characterised by its peculiar fauna; 'certain species in each are found in no other, several are found in one region which do not range into the next above, whilst they extend to that below, or *vice versâ*. Certain species have their maximum of development in each zone, being most prolific in individuals in that zone in which is their maximum, and of which they may be regarded as especially characteristic. Mingled with the true natives of every zone are stragglers, owing their presence to the action of the secondary influences which modify distribution. Every zone has also a more or less general mineral character, the sea bottom not being equally variable in each, and becoming more and more uniform as we descend. The deeper zones are greatest in extent, the first or littoral zone extending only to two fathoms, the second from two to ten, the third from ten to twenty, the fourth from twenty to thirty-five, the fifth thence to fifty-five, the sixth to seventy-nine, the seventh to one hundred and five, and the eighth to two hundred and thirty fathoms; below this, at a depth of about three hundred fathoms, there are supposed to be no living animals.' It must not be imagined that exactly similar regions are to be met with in every sea, that there are always the same number, or that the limits of animal life are invariably the same as in the Ægean Sea. We take this as the best example that has been hitherto worked out, and there is no doubt of there being some determinable order of distribution in most other seas, whether confined or open.

The indications as to climate or distribution which may be drawn from the examination of the Testacea will be found to vary, not only according to depth, but also from the nature of the ground. A comparison of the various animals of the lowest zones with those of the higher, exhibits also a great distinction in the hues of the species; those from great depths being generally white or colourless, while those from the higher regions exhibit more usually brilliant combinations of colour. The chief cause of this is no doubt the increased amount of light above a certain depth, but the nature of the feeding-ground and the food must also exert a modifying influence.

Every species has two *maxima* of development in space, one in depth, and another in horizontal area; and in each we find a species at first represented by a few individuals, which become more and more numerous till they reach a certain point, after which they gradually diminish, and at length altogether disappear. Sometimes the genus to which the species belongs, ceases with its disappearance, but not unfrequently a succession of similar species is kept up, representative, as it were, of each other. When there is such a representation, the minimum of one species usually commences before that of which it is the representative has attained its corresponding minimum. Forms of representative species are similar, and often only to be distinguished by critical examination. When a genus includes several groups of forms or sub-genera, we may have a double or triple series of representations, in which case they are generally parallel.

* *Reports of the British Association for the Advancement of Science*, Cork, 1843, pp. 151 & 172.

'The consideration of the representation in space forms an important element in our comparisons between the faunas of distinct seas in the same or representative parallels. The analogies between species in the northern and southern, the eastern and western hemispheres, are instances. But there is another application of it, which I would make here. The preceding tables and list afford indications of a very interesting law of marine distribution, probable *à priori*, but hitherto unproved. The assemblage of cosmopolitan species at the water's-edge, the abundance of peculiar climatal forms in the highest zone where Celtic species are scarce, the increase in the number of the latter as we descend, and when they again diminish, the representation of northern forms in the lower regions, and the abundance of remains of Pteropoda in the lowest, with the general aspect of the associations of species in all, are facts which fairly lead to an inference, *that parallels in latitude are equivalent to regions in depth*, correspondent to that law in terrestrial distribution which holds *that parallels in latitude are representative of regions of elevation*. In each case the analogy is maintained, not by identical species only, but mainly by representative forms; and, accordingly, although we find fewer northern species in the faunas of the lower zones, the number of forms representative of northern species is so great as to give them a much more boreal or sub-boreal character than is presented by those regions where identical forms are more abundant.'*

The laws of distribution of Mollusca and Radiata are not yet so distinctly made out as those affecting the Vertebrata generally, but they appear, from what has been said above, to be of very similar nature. Certain seas present innumerable multitudes of some species, which do not extend beyond certain well-marked, if not narrow limits; other seas are equally remarkable for a mixture of groups, and an absence of definite character. These points at first seem to present difficulties almost insuperable to the proper working out of the various laws, for the exceptions are both numerous and unexpected. It is only when we include the element of *time*, and consider the laws of succession as well as distribution, that we find the explanation of such apparent anomalies; and that the apparent disorder and confusion result in order, and a more distinct apprehension of the unity of plan and system throughout nature. We now proceed to examine briefly the evidence of such succession and representation in time, and thus connect the present history of the Earth with that past history, which, in the case of organized beings, is now recognised as a distinct science under the name of Palæontology.

---

* Professor E. Forbes, *ante cit.*

CHAPTER XII.

DISTRIBUTION OF ORGANIC BEINGS IN TIME.

§ 156. Nature of organic remains, and proof of the existence in the Earth's crust of fragments of Plants and Animals belonging to Species now extinct. — 157. Distribution of extinct Mammalia in time. — 158. Distribution of extinct Birds. — 159. Distribution of extinct Reptiles. — 160. Distribution of extinct Fishes. — 161. Distribution of extinct Mollusca. — 162. Distribution of extinct Articulata. — 163. Distribution of extinct Radiata. — 164. Distribution of extinct Plants.

NATURE of Organic Remains, and Proof of the Existence in the Earth's Crust of fragments of Plants and Animals belonging to Species now extinct.—Most of the numerous deposits met with in different parts of the Earth are, as we have already intimated, loaded with the remains of plants and animals of various kinds, but chiefly those of the sea, accumulated contemporaneously with the inorganic materials of the beds themselves, and therefore in most cases strictly indications of the actual condition of the sea bottom within a given area, and during a limited period. These remains, therefore, afford materials for a history of the past condition of life on the globe, and they afford indeed the most distinct information concerning this history. They are called *fossils;* and the use of this word is now limited to such organic remains, as being of all things that are dug out of the Earth those of greatest interest to man in his efforts to penetrate into the past.

The fossils that have been found appear to be distinct in all the essential characteristics of species from the recent animals and vegetables of the same district; and this is the case, whether we regard the living representatives, or those lately embedded in superficial deposits, or whether we look into those deeper and more metamorphosed beds, which from their position beneath a vast mass of fossiliferous strata, are manifestly of great age when compared with the existing creation.

Every particular group of deposits in all parts of the world is more or less distinctly characterised, not only by its peculiar mineral character, but also, and far more distinctly, by the groups of species which together make up its fossil fauna and flora. These usually differ much less in any two adjacent conformable beds than in others which are separated by intermediate bands, whether such intervening masses contain organic remains or are destitute of them; and they are also more alike then than when the beds are not parallel to, or have immediately succeeded each other, but have been disturbed between the completion of the lower and the commencement of the upper series.

Generally it may be regarded as a law deduced from observation, that the species of animals characterising any one geological period have either originated during this epoch, or have then attained their maximum development in number. It also appears that species were on the whole more widely distributed at the time when the older rocks were being deposited than they are now; that the departure from a given type or form is greater the farther back, or older, the formations that we refer to; and lastly, that the remains of animals found in the older rocks exhibit by degrees, as we retrograde in order of time, a larger preponderance in number of invertebrated over that of vertebrated species, till at length we reach formations in which no remains are found higher in organization than the mollusca.

The first of these laws—that which involves the statement that '*fossils are characteristic of formations,*' is one which is of great importance, as it involves two very distinct and startling assumptions—that the fossil remains found are those of animals and plants, of which not only the individual but the species is now dead, or extinct from the Earth, and that there has been not one only, but a long succession of creations of species to supply the place of those that have from time to time thus become lost. The former assumption has been so fully proved in every work on Geology and Palæontology; is so clearly illustrated by the absence now of species once common, and their replacement by others; and agrees so well with the probabilities of the case, that we must here take it for granted. The occasional loss of species, genera, and even families, from their place in creation is now recognised by every naturalist, and we only refer to the subject to complete the line of argument. The successive creation of groups of species to repeople the Earth when old ones have departed seems, however, far more questionable, and it is more reasonable and more consistent with the facts that are known on the subject, that we should assume the introduction to have been very gradual, species after species, as occasion seemed to require. As in the different countenances of various individuals of our own race, there is a distinct expression in each individual, which identifies him, although all are of one species and possess innumerable points in common, so in the representative species of some important genus, we see the same kind of resemblance and difference; and so also in the group of species of a certain epoch, we may recognise a physiognomical character, which yet admits of these species being replaced in other groups by individuals resembling them, but not at all to be mistaken. The true meaning of the law seems, therefore, to be, that taking each formation as including a group of deposits, formed under similar or very slowly changing circumstances for a certain duration of time, and represented in different parts of the world at that time by other species having similar resemblances and differences to those which are found to affect a fauna or flora now in different geographical areas, we may perceive by careful study that amount of unity of character which will enable us to recognise the group of species and distinguish it from that found in other beds that are contemporaneous, even when there exists no other evidence of their contemporaneity. The actual limitation of a group of species to a particular group of beds has not, we believe, been at all satisfactorily proved with regard to any one case.

The second law, 'that species belonging to more ancient periods had a wider geographical distribution than those now living,'* is also to be understood as true only in a general sense, and with many limitations and apparent exceptions. We shall, indeed, find in particular cases, that species of manifest importance are spread much more widely in older rocks than their representatives are now, or have been since; and as this is the case with large groups of those species which must themselves be regarded as highly characteristic, in particular instances the law may so far be regarded as established. It has been mentioned as a deduction from the operations of this law observed in various ways, that the temperature of the Earth's surface has undergone change, and this, indeed, may have well happened from those numerous alterations that we know to have taken place with regard to the relative level of land and water, and the absolute quantity of land above the water. We believe the weight of evidence in this question does not preponderate in favour of the views of those who believe the Earth to have cooled down from an incandescent state since organic beings were introduced on its surface.

The third law enunciated is, that the more ancient the formation, the more widely do its fossil contents depart from the existing type; and this is really the simple expression of facts, made out by numerous long continued and careful observations in various parts of the world, and may, therefore, be fully relied on.

The fourth and last of these laws asserts, that the faunas of the most

* See Pictet's *Paléontologie*, vol. i. p. 73.

ancient formations are, *cæteris paribus*, numerically richer in animals of low organization, and chiefly in Mollusca, than those of more recent deposits; but this—although in one sense the mere statement of a fact which cannot now be questioned, since all observations up to the present time have tended to confirm it—is yet not to be received without some qualification. It may be said, indeed, as an answer to any theory of development, or of the existence of a scale of beings gradually approaching perfection, that although it is true in the ancient epoch, that only the remains of fishes are found amongst invertebrata, and that even these at length disappear, yet the faunas even of the earliest periods are by no means imperfect, and we ought not to be hasty in assuming the absence of the more perfect types in the older rocks, merely because we have not yet discovered any remains of them. This is well exemplified in the case of many parts of the world at present; for putting aside the presence of man, we find the fauna of Asia apparently superior to that of Europe, if we regard merely the extreme point of organization, since in the former continent we have the Orang-otang, and in the latter scarcely a single ape, and few carnivores of large size. According to this rule, indeed, the fauna of New Holland would indicate a condition of the Earth greatly less developed than that of any other country, since the only mammals are didelphine; but it is clear, that a very false notion of the general condition of the Earth's surface at the present time would be obtained by the most careful consideration of the organic remains found in the islands of the Indian Archipelago, and the Pacific Ocean.

In point of fact, neither the Radiata, the Articulata, the Crustacea, the Mollusca, nor fishes, were at all imperfectly represented or developed in ancient times, and ever since their first appearance, the members of these classes of animals have possessed the same degree of perfection as their modern representatives. It is a mistake to suppose that the early faunas, generally, were composed of animals less perfect than the recent ones, although no doubt the highest point to which organization has reached, has risen during successive geological periods, so that while cephalopods, or fishes, first formed the superior limit of organization, these were afterwards surpassed by reptiles, and these also, after an interval, by mammals.

Two courses are open to us in this attempt to communicate a true notion of the distribution of animals in time. We might either take the various periods, or the natural groups of species, as the means of representing the absolute facts determined. Although, however, a correct idea would be best obtained by a combination of the two methods, we propose here to give only an outline of the various tribes of animals as they are represented in the faunas of different periods, leaving the other division of the subject to be studied in works devoted expressly to Palæontology.*

157 *Distribution of extinct* MAMMALIA *in time.*—Organic bodies generally are only preserved in strata, so far as they present hard and comparatively indestructible portions in their skeletons, and since most of the mammals, birds and reptiles, are land animals, while the greater number of deposits are of marine origin, the distribution of these is also limited to such deposits as have originated either near land or near the mouths of great rivers. Amongst Quadrupeds, the teeth offer at once the hardest and the most distinctive characters, and these can rarely be mistaken, and are seldom injured materially by long exposure to decay.

Amongst all the mammalian and bird remains that have occurred, but few belong to those rocks which are called secondary, and none at all to the Palæozoic group. With a very remarkable exception, occurring in the Stonesfield Slate (one of the beds of the lower Oolites of England), no true quadrupedal remains so old as the chalk have yet been obtained.

The remains of mammals are, therefore, almost confined to the rocks of

---

* See *The Ancient World*, by the author of this treatise, where an attempt has been made to give a popular and connected view of the Earth's organic history.

the tertiary period, but are there very abundant. They include species of all the natural orders, with the exception of man, and no fossils that have been found require the formation of new orders.

Of *Quadrumana*, the number of remains that have been found is small, but they offer matter of great interest for the comparative anatomist. Several species have been determined from India (lat. 30° N.) from the tertiary rocks of the Sewâlik hills, one of them of gigantic size, and at least as large as an Orang-otang. In Europe, also, the order is represented, one species having been found in France (at Sansans, in 43° N. lat.), which is described as intermediate between the gibbons and solemn apes; and two species in England, in the older tertiary beds of the London Clay, which appear to belong to the group of Macacques (*macacus*). Remains of Monkeys, of gigantic size compared with the existing species of that continent, have been found also in Brazil.

The remains of Bats (*Chiroptera*), have been found scarcely more abundant than monkeys, and they are confined hitherto to the insectivorous group. Of these one species is mentioned by Professor Owen, from the older tertiary sands of Kyson (Suffolk), where the monkeys' remains occurred, and another is known (also older tertiary) from the Paris Basin. A single species is described from Œningen, in newer tertiary schists, and fragments of several species, some of them not extinct, have been found in caverns in England, Belgium, and elsewhere. A few species have been determined from the cavern remains of Brazil.

The *Insectivora* present some extinct and some recent species in a fossil state, but considering the almost universal distribution of some tribes at present, and the aquatic habits of many of the species, it is perhaps remarkable that the extinct forms should be so very few, and so exceedingly rare as we find them to be. One species of Hedgehog, one of Shrew, and one of *Mygale*, have been found at Sansans, and an extinct genus nearly allied to the mole, but as large as the hedgehog, was associated with the gravel animals whose remains are found at Bacton, on the Norfolk coast of England.

One of the most interesting of all the mammalian fossils found in the Oolitic beds of Stonesfield, and already alluded to as affording evidence of the great antiquity of mammals on the Earth, has been referred by Professor Owen to this order of Insectivora, under the name of *Amphitherium*. For the evidence on this subject we must refer to Professor Owen's beautiful work on the *British Fossil Mammals*, p. 29.

There are many more species of Carnivora found fossil than of those orders yet referred to. Of the *Plantigrade* group, a considerable number of species, and, indeed, several new genera, have been described from remains found in caverns and other superficial deposits. Of the most remarkable and interesting is the great Cavern bear (*U. Spelæus*), whose bones abound in many large caverns in Germany, and are met with also in England. Other species are known from Central France, Algiers, Brazil, and the Sewâlik hills, all, however, of the tertiary, and many of the gravel period. Species of Badger, Weasel, Glutton, and Coati, have also been found fossil.

The Digitigrade Carnivora are represented by fossils from most of the tertiary deposits. In the Paris Basin and other older tertiaries, we have the Dog (*Canis*) represented by two or three extinct species, while the Genette and the Otter exhibit one, and the cat tribe (*Felis*) several.

The middle tertiaries, however (chiefly in France and the Rhine Valley), contain more both of species and individual remains than the older, and the newer many more than both together, far the most remarkable and most interesting of the group belonging, in fact, to the gravel, except those which have been met with in India, and of these the age is somewhat doubtful.

Of gravel fossils obtained from England, and belonging to this group, we may enumerate the *Felis spelæa*, or cavern tiger; the *Machairodus*, a gigantic carnivore of the most ferocious habits and of great strength; a Wild cat, the Cavern hyæna, the Wolf, Fox, and some others of existing or closely allied species. Besides the cavern hyæna, other species occur in deposits of the same age in India and Brazil, and this is the case also with the genus *Felis*, of which no less than six species have been described by Lund from the Brazilian caverns, varying in size from that of the jaguar to dimensions something less considerable than those of the domestic cat, and presenting some curious anomalies. The *Amphibia* are only at present known in a fossil state by two or three species of Seal, one found at Angers, one in the tertiary marls of Osnaburgh, and others on the shores of the Mediterranean. Fragments of a fossil Morse (*Trichechus*) have also been described, and various bones of Whales, both in this country and North America.

The tribe of *Rodents*, although represented in a fossil state by many species, has not been very much studied. They have been found in the gypsum beds of Montmartre, in the middle tertiary beds of Auvergne, or in the diluvial deposits of caverns and osseous breccia. Asia and America, as well as Europe, have yielded such remains, and many of those in more recent beds are with difficulty distinguished from existing species. Of the various tribes of these animals we find Squirrels and a species of *Myoxus* in the older tertiaries, and an *Arvicola*, a *Hamster*, and others, in Auvergne and at Eppelsheim. The Beaver, and an extinct and nearly allied, but gigantic species (? genus) (*Trogontherium*) are found in the newer tertiary, and many others occur in the gravel, among which, in Europe, may be reckoned representatives of most of the chief existing European genera, and in America a multitude of new species closely allied to the forms at present existing in that continent.

The *Ruminants*, infinitely important to man, and now extremely abundant in individuals, varieties, species, and genera, did not present the same preponderance during the later tertiary periods, and were, it would seem, exceedingly rare during the earlier part of this last portion of our Earth's history. Many species, very nearly allied to the group and distinctly representative of it, are referred to the order of *Pachydermata*, and those that remain are confined to the gravel or newest part of the period, except, indeed, that the deposits of India prove their existence in that country at a much earlier period. The Indian species include two Camels, and a third occurs in Siberia. One or two species of *Moschus* (musk-deer), species of *Antilope*, *Cervus*, *Bos*, *Bubalus*, and others, are found in the same locality. In addition to these, there has been found another and very remarkable genus (*Sivatherium*), now quite extinct, in which the head is not only provided with horns, like other true ruminants, but no less than two pair appear (including both those now characteristic of principal natural groups of the order), and with these are associated peculiarities of the skeleton, apparently indicating a very close approach to the pachyderms, and especially the elephant.

The ruminants of the diluvial period in England, and of the caverns of Brazil, and other parts of the world, include numerous species, very nearly allied to those now indigenous in the same districts, but others as remarkably distinct. Thus, the gigantic Irish elk and several species of Cervus (deer) afford admirable examples of the former, and the existence of remains of a Giraffe in Central France not less striking evidence of the latter condition.

The distribution of the *Pachydermata* during the tertiary period is especially interesting, as it is chiefly from this order that the most striking and characteristic, and even representative forms, seem to have been obtained during the earliest part of the tertiary period. The extinct species are also interesting, since, in many cases, they fill up gaps now existing in the order, and connect this with the not very similar groups of Ruminantia, Rodentia, Carnivora, Cetacea, and Marsupialia. The lacunæ thus filled up show how complete the scheme of nature is, and they show also, that during one part, at least, of the Earth's history, and over an extensive portion of the surface, one group of quadrupeds preponderated, and included animals having all varieties of habit, just as, at the present time, the marsupial tribe is developed in Australia, almost to the exclusion of other races.

The most ancient forms of Pachyderms are those described by Cuvier under the name *Palæotherium*, *Anoplotherium*, *Anthracotherium*, *Hyracotherium*, *Lophiodon*, &c. These gave place to *Dinotherium*, *Rhinoceros*, &c.; and these again to *Mastodon*, *Elephant*, other species of *Rhinoceros*, *Hippopotamus*, &c., in the Old World, accompanied (not replaced) by *Macrauchenia*, *Toxodon*, and others, in South America. In India, there were besides these a number of very curious species, forming an exceedingly rich fauna, to which the order Pachydermata furnished the greatest number of species, and appears most to affect the physiognomy. We need not here describe the peculiarities of these singular animals, as they will more properly come under consideration in the next chapter. In England, of about twenty mammals distinctly made out from the older tertiary beds, more than twelve are Pachyderms; but from the deposits of more modern date, although the number of mammals is very much more considerable, there are but seven from the gravel beds, seven from caverns, and three from the alluvium, and this relative preponderance in the older rocks of the period seems universally observable, although it is most strikingly the case in the beds found near Paris and those of the London Basin. It is worthy of remark, that the physiognomy of the fauna is very greatly affected by this order in the older tertiaries, not only because there are so many representative forms of the other, and more recently developed natural orders of quadrupeds, but because the multitude of individuals as well as species, and the largest and most important of the quadrupeds, were of this kind.

The *Edentata* are now almost confined to South America, only a few representative forms extending to Asia and Africa. Their distribution in ancient times was apparently not very different so far as geographical area is concerned, as the fossil remains have hitherto been found only in the present metropolis of the order. The extinct species are, however, extremely different in form and magnitude from the existing ones, presenting some of the most extravagant departures from existing types yet met with, so that though the number of species is not large, their investigation becomes a subject of great interest. The remains of the gigantic representations of the Sloth and Armadillo range, however, more widely than the species now characteristic, at least one genus (*Megalonyx*) having reached as far north as Virginia, U.S., while others extended far down into Patagonia. There are two principal groups, one represented by the *Megatherium*, *Mylodon*, *Megalonyx*, *Scelidotherium*, *Cœlodon*, and *Sphenodon*, the corresponding existing genus being the Sloth. The other group contains *Glyptodon*, *Hoplophorus*, *Pachytherium*, *Chlamydotherium*, and two others, which all, more or less, resembled the Armadillo. One or two fragments of bones from the Plata have been doubtfully assigned to animals of which the Ant-eater is the modern type. Most of the genera above-named are confined to a single species, and they are all of the very recent tertiary period.

As the Edentata are chiefly found fossil in America, where the existing forms appear, so the order *Marsupiata*, at present characteristic of Australia, is that to which the greatest number of mammalian remains of the same country must be referred, and few occur elsewhere. There is, however, one remarkable exception in the Stonesfield Slate, where a Didelphine species has been discovered accompanying the Insectivorous mammal before described. With this exception, and a couple of species in the older Tertiaries of London and Paris, all the extinct forms are Australian, and include Kangaroos, some of them of gigantic dimensions, and a Wombat. They occur in caverns, chiefly in Wellington Valley, about 200 miles north-west of Sydney, New South Wales.

158 *Distribution of extinct* BIRDS.—The remains of birds occur but rarely, and are usually very imperfect. Footmarks, however, have been found which it is difficult not to refer to animals of this kind, in rocks of very ancient date, and thus the class of birds may be referred back much further in date than the mammals. Impressions of birds' feet occur in the red sandstone of

Connecticut, United States, and in beds of similar mineral composition, and belonging to the oldest portion of the secondary series in England and Germany. The former have been generally described as carboniferous; the latter are certainly from the newer red sandstone, above the magnesian limestone. The evidence on which the correctness of their reference to birds may be considered to rest, arises from the shape, which requires that the animal that made them should have been a biped—that the feet should have been tridactyl or three-toed, the middle toe much the longest, and each terminated with claws, and that sometimes there was a fourth short toe behind. It cannot be regarded as impossible that reptiles may have been so constructed as to leave impressions of this kind, and as few remains of birds' bones have been found in other rocks of the secondary period,* but little evidence concerning these animals is obtained till we examine the older tertiary beds of the Paris Basin. There, however, and in the London Basin, and again in numerous other tertiary rocks where circumstances were favourable for their preservation, such indications are found as leave no doubt that Birds accompanied the Pachyderms, Carnivores, and other representatives of the class Mammalia, in tolerable abundance. The older tertiary species include a Vulture from the London Clay, a species referred doubtfully to the King-fisher tribe (*Halcyonidæ*), and a small wading bird from beds of the same age, besides several related more or less closely to the Pelican, Sea-lark, Curlew, Woodcock, Owl, Buzzard, and Quail, from the Paris Basin. The newer tertiary beds have also supplied several species; and in the gravel, or in caverns, there have been found remains of species of Raven, Lark, Pigeon, Duck, and Snipe.

In South America, and especially in Brazil, where caverns have been so effectually searched for fossil remains by M. Lund, there have been found fragments of several birds, amongst which may be mentioned two Ostriches much larger than existing American species; while in New Zealand other remains have been found in great abundance, distinctly referable to an extinct and gigantic race of wingless birds—the prototypes of the small Apteryx, at present characteristic of the same island. Many species of these have been described, and various genera named to include them.

159 *Distribution of extinct* REPTILES.—The distribution of reptiles in time is a matter of great importance to the Geologist, inasmuch as these animals seem really to have been the chief inhabitants of the Earth during the middle period of its existence, and their remains are not only more abundant, but more perfect, and also more distinct from the existing representative species—at least so far as the continent of Europe is concerned—than any of those hitherto considered. It is here first that new orders require to be defined, to include species far removed in habit and structure from known forms, and some of these are so strange that description can hardly exaggerate the singular departure from all we are in the habit of considering.

If the reader refer to the list of orders of *Reptilia* in a previous page, he will find three mentioned as not existing now in a recent state, and known only by organic remains, found in rocks chiefly of ancient date. In addition to these three, however, all the existing orders have some fossil representatives, and some of them a considerable number, contained in genera which can no longer be recognised as including recent forms. We proceed to consider briefly the distribution of the different species of fossil reptiles in time.

The most ancient reptilian remains are those which accompany the supposed birds' footprints in the Carboniferous (?) sandstone of Connecticut. We find also various footprints in these rocks which have been referred

---

* One specimen was found by M. Von Meyer in the cretaceous slates of Glaris, having the form and general characters of passerine birds. Another specimen, from the Wealden beds of Kent, is referred very doubtfully to albatross, and a large wading bird has been determined from Tilgate Forest, (also Wealden.)

chiefly to Chelonia (turtles and tortoises), and similar markings have sometimes been described as fossil footsteps in the sandstones of ancient date in our own island.

The most ancient actual bones of reptiles hitherto discovered occur in the magnesian limestone beds of the neighbourhood of Bristol, but it may be permitted to doubt whether these are not rather of the secondary than the Palæozoic period. In the middle beds of New Red Sandstone in Cheshire and Warwickshire, many very interesting fragments of bones have been met with besides footprints, all tending to prove that at that period many reptiles existed, varied in form and dimensions, and belonging probably either to the Batrachian or the Lacertian order. Beds near the Cape of Good Hope (South Africa) have yielded also fossils which partly from independent geological evidence, but chiefly from the character of these remains themselves, are regarded as older secondary. Numerous footprints in the New Red Sandstone seem beyond a doubt reptilian.

The rocks of the secondary period form a perfect necropolis of the reptilian tribe, and in the Lias, which succeeds the New Red Sandstone, we find a multitude of remains of the *Ichthyosaurus* and *Plesiosaurus*, the chief representatives of the order *Enaliosauria*. These remarkable animals, which were apparently strictly marine in their habits, and even more thoroughly adapted for aquatic existence than the cetacean mammals, were singularly abundant in the argillaceous bed already alluded to, but continued, not only by the preservation of the genus, but in some cases by identical species, through the whole oolitic series into the chalk, receiving an additional genus during the deposit of the newer oolitic rocks. In the lower Oolites (Stonesfield Slate, already more than once referred to for its fossils) the order *Dinosauria* also appears, and is represented by the carnivorous and gigantic *Megalosaurus*, which appears to have continued where circumstances admitted, and in the newest part of the Oolitic period (Wealden) was accompanied by the *Iguanodon* (a herbivorous genus, also gigantic), and the *Hylæosaurus*. Not only, however, were these two remarkable orders of marine and land saurians first presented during the middle part of the secondary period, but they were accompanied by the *Pterosauria* or Flying saurians, a race yet more unlike existing forms and the inhabitants of the air. The only genus yet described by these animals (*Pterodactyl*) appears first in the Lias, but was continued like the marine tribe into the Chalk, and presents, like the others, a considerable number of species. It is chiefly in England and Western Europe that these remains have been found, since there the oolites are chiefly developed, and seem to have been accumulated under the most favourable conditions.

The order of *Crocodilia*, or mailed saurians, was richly represented in the secondary period. Of the three divisions (those of which the vertebra are bi-concave, convexo-concave, and concavo-convex, respectively), the first contains the *Teleosaurus*, a kind of gavial, extending from the Lias into the Middle Oolites, and another genus, also oolitic, besides two generic forms (*Suchosaurus* and *Goniopholis*), both Wealden. The second (convexo-concave) contains several species, the older ones occurring in the Lower Oolites, and the newest in the Wealden; while the third (concavo-convex) includes all the existing crocodiles: one doubtful cretaceous species, several of the tertiary period, from the London and Paris Basins, and some of the middle tertiary deposits of Central France.

We have already referred to the *Lacertians*, as containing the most ancient representative forms of the great Reptilian class. Besides those already mentioned, there is another New Red Sandstone species, referred to a distinct genus (*Cladyodon*), whilst the *Geosaurus* is found in the Solenhofen (Upper Oolitic) beds, besides two or three genera met with in the chalk, of which that called *Mosasaurus* is the best known. The *Leiodon* is nearly allied.

The *Chelonians*, recognised by numerous foot-prints in the older rocks and New Red Sandstones, are distinctly exhibited, by fragments, in a fossil state, in the oolitic beds, but they are almost confined to the Stonesfield slate in England, though on the continent of Europe some of the other oolitic rocks have yielded similar indications. In the Wealden rocks more numerous and characteristic fossils of this kind appear, and, like the others, they belong to the emydian tribe, inhabiting marshy and swampy places. The true fresh-water turtles are found in the triassic rocks and lias, and in several tertiary deposits. True marine turtles (Chelonians) have been found in the Portland and Purbeck rocks, and in various tertiary strata, especially of the older part of the period.

The fossil remains of Serpents (OPHIDIA) have not been found in rocks older than the London Clay, and only a few species have been described from that locality. These animals appear to have had gigantic representatives during the older tertiary period in Great Britain, but since then have disappeared from these parts of the world, or at least have left only a few species of comparatively small size. The BATRACHIANS, also, once presenting very remarkable forms, approximating them to the Crocodilians, have not of late exhibited any aberrant forms. Fragments of frogs and salamanders are found, occasionally, in tertiary rocks, but few striking deviations have been seen amongst the more recently deposited fossils from the most ordinary existing types.

160 *Distribution of extinct* FISHES.—Most of the deposits containing fossils having been formed under water, it is not astonishing that a very large proportion of the organic remains preserved should have belonged to marine animals; and thus it follows, that although rarely so characteristic, or in themselves so valuable for determination, the remains of marine animals afford, from their number and preponderance, the principal means of becoming acquainted with the ancient conditions of life on the globe. Fishes, as the most highly organized of marine animals (except, indeed, Cetaceans, whose remains are rare and comparatively unimportant) thus assume an importance in Palæontology, which they do not possess in general Zoology.

We have spoken above of the division of fishes into four orders, according to the structure of their scales. Of these four orders, two are absolutely confined to the rocks of the Cretaceous and Tertiary periods and existing seas. The other two are also still represented, but by comparatively few species, and these, with the exception of the Squaloid, or Shark family, not the most important ones. It thus happens that the termination of the Oolitic (including the Wealden) period, exhibits the most perfect break in the whole series, so far as this class of animals gives evidence, and two families of fishes (the Sturgeons and Rays) also take their rise at the commencement of the secondary period, while the Hybodonts disappear at its termination. It is worthy of note, that not only are the fishes of the Palæozoic period limited to two of four of the natural orders, but they are confined to one group of these, characterised by the continuation of the vertebral column into the upper lobe of the caudal fin, producing a much more considerable development of that part, and thence called *Heterocercal.* These, which were abundant during the Palæozoic or Older fossiliferous period, then became very rare; the rocks of the secondary series chiefly present *homocercal* fishes, or those which have the caudal fin equally developed, and proceeding entirely from the extremity of the vertebral column, or at least have very few that are of the other kind.

Of the different groups of Fishes, the *Acanthodians* and *Dipterians* (two families of Ganoids, nearly allied to the *Lepidoids*), and the *Cestracionts* (Placoids), were first introduced, and have been found together in the Old Red Sandstone (Devonian) rocks, and the latter also, though very rarely, in Silurian rocks. The number of species in the older rocks is not considerable, but gradually increases towards the newer beds, and becomes rather numerous in the Carboniferous rocks, several complete genera being introduced and lost during the interval. Amongst these are the singularly formed *Cephalaspids*, the *Pterichthys*, the *Coccosteus*, and others among the Lepidoid group, and also several Sauroid fishes, as *Diplopterus*, *Megalicthys*, and others, while in the Magnesian Limestone, where the Palæozoic rocks terminate, and the Heterocercal fish cease to be exclusively present, the *Pygopterus*, *Acrolepis*, and some other genera of Sauroids, with the *Palæoniscus* (Lepidoid), make their appearance, but are not continued into the secondary rocks.

Taking the different families of fishes, and commencing with the LEPIDOID ganoids, we find that the heterocercal genera, of which there are six (not including the Acanthodians and Dipterians), include four absolutely confined to rocks not newer than the Carboniferous, and two (*Palæoniscus* and *Platysomus*) only just extending into the trias. There are still remaining the whole tribe of homocercals, including ten genera and many species, which are exceedingly common, and highly characteristic of the lias and some newer oolitic beds, extending in one instance (*Lepidotus*) into the chalk. The lias may, however, be regarded as the metropolis of this group; at least thirty-two species being known in the English beds alone, and many others occurring in the lias on the Continent. Of the different genera, *Gyrolepis* is carboniferous and triassic; *Dapedius* and *Tetragonolepis* almost exclusively liassic; *Lepidotus* widely distributed throughout the secondary period; and *Pholidoporus* chiefly Wealden.

The SAUROID, like the Lepidoid family, is widely spread among fossiliferous rocks, and the CŒLACANTHS, in some respect analogous, may be considered as having a similar distribution in time. The heterocercal genera range between the Old Red Sandstone and the Trias; one genus (*Saurichthys*) being triassic exclusively, and others confined to the old red and carboniferous rocks. Of the Cœlacanths there are also several carboniferous and older genera, *Megalicthys* being the most remarkable.

The homocercal Sauroids are chiefly oolitic, where the number of species is exceedingly large. The family of PYCNODONTS are almost all oolitic, but may be considered to range from the trias to chalk. The SCLERODERMS, another family, is found in cretaceous rocks, but extends and is chiefly common in the older tertiaries. The ACCIPENSERIDES (Sturgeons) include one supposed lias genus, and one from the London Clay, besides the existing Sturgeons.

The order of PLACOIDS, divided into seven families, is represented in a fossil state by genera referred to every family but one (*Cyclostoma*). Of these, the most important among existing fishes are those least abundant in a fossil state, and the converse is also true, the *Cestracionts* having only a few living species, while the Rays and Saw-fish are rare among extinct forms.

The oldest placoid fishes are Cestracionts, but the greatest development of the family seems to have taken place about the close of the carboniferous, and commencement of the secondary period, and they are now represented by a single species. The *Hybodonts* commenced in the carboniferous period, and extended only to the cretaceous rocks; but like the Cestracionts, the chief species are triassic and oolitic. Of sharks (*Squaloids*), there are representative forms from the commencement of the carboniferous to the existing period, the cretaceous rocks generally containing perhaps the greatest number, although many teeth are found, and some of gigantic size, in the middle tertiary series. The rays and saw-fish have been found only in tertiary rocks, but the *Chimeroids* appear to have extended over a much wider range, remains having being found occasionally in the carboniferous limestone.

The CTENOID and CYCLOID orders of Agassiz, include a very large proportion of all existing fishes, but not a single species older than the chalk. The Perch family amongst the former, and the Scomber and other families, of which the carp, the pike, and the herring are now well known genera, are those chiefly represented in the ancient seas. It is remarkable, however, that the fossil species are usually of distinct generic character, and not unfrequently form into a group or sub-family, showing some more or less striking peculiarity. Thus, there is a distinct group of perch-like fishes in the cretaceous rocks, having more than seven rays to the branchiostegous ray, and differing absolutely in this point of structure from the existing species. So also the Sparoid fish (Dentex, &c.) are found only fossil in the Monte Bolca (older tertiary) beds. Most of the other Ctenoid, as well as the Cycloid fishes, are represented either by a few species of known genera, or by genera now altogether extinct. Many more are found in the tertiary than the cretaceous rocks, and the beds of Monte Bolca are especially rich in individuals as well as species. The following tabular statement of the distribution of fossil British species determined by M. Agassiz some years ago, will, if not quite accurate, give at least a useful idea of the subject. It must be observed, that the number of British tertiary species is exceedingly small, compared with that from other countries.

TABLE I.—*Grouping of the Species of British Fossil Fishes.*

	Genera.	Species.
CYCLOIDS		86
CTENOIDS		31
PLACOIDS—		
Cestracionts	13	83
Hybodonts	5	48
Sharks	11	26
Rays	7	24
Chimeroids	9	43
		341

	Genera.	Species.
Brought forward		341
GANOIDS—		
Lepidoids	27	116
Sauroids	25	74
Cœlacanths	10	27
Pycnodonts		84
Sclerodeims		6
Sturgeons		2
Total species		650

TABLE II.—*Distribution of British Fossil Fishes in the Principal Groups of Formations.*

TOTAL SPECIES.	Doubtful,* or Ichthyodorulites.	Cestracionts.	Hybodonts.	Sharks.	Rays.	Chimeroids.	Total PLACOIDS.	Lepidoids.	Sauroids.	Cœlacanths.	Picnodonts.	Scleroderms.	Sturgeons.	Total GANOIDS.	CTENOIDS.	CYCLOIDS.
PALÆOZOIC.																
7 Silurian	7	..	..	..	..	..	7	..	..	..	..	..	..	..	..	..
69 Devonian	7	3	..	..	..	..	10	34	13	12	..	..	..	59	..	..
170 Carboniferous	34	63	10	1	..	..	108	34	14	14	..	..	..	62	..	..
49 Permian	1	10	..	..	..	..	11	24	10	3	1	..	..	38	..	..
SECONDARY.																
63 Triassic series	6	7	11	..	..	16	40	5	8	1	9	..	..	23	..	..
128 Lias	11	5	5	2	2	..	25	59	41	1	1	..	1	103	..	..
202 Oolitic series	19	10	5	5	2	16	57	37	56	3	49	..	..	145	..	..
24 Wealden series	7	1	4	1	..	..	13	7	..	..	4	..	..	11	..	..
155 Cretaceous series	..	16	1	29	5	..	51	5	3	2	20	6	..	36	19	49
TERTIARY.																
92 Older Tertiary (London clay)	..	..	..	10	19	3	32	..	..	..	10	..	1	11	12	37

161 *Distribution of extinct* MOLLUSCA.—Of the various natural groups of mollusca, or shell-bearing animals, which have left behind them distinct indications of a former state of existence, the *Cephalopoda* are among the most remarkable and abundant, especially in the older and middle series of

* The species of Placoids thus designated, are determined only from Ichthyodorulites, except in some cases, (especially on the Silurian list,) where they have not yet been referred with certainty to any natural family, and may be either Placoids or Ganoids.

rocks. The *Gasteropoda*, of which the limpets and whelk are examples, and which now include the large tribe of univalve shells, are also well indicated by a vast number of species, while the *Conchifera* (the bivalved-shell animals) are presented in a number of different forms, gradually approximating those of existing species as they approach our own times, but affording in the older rocks generally a singular preponderance of the group called BRACHIOPODA, represented now by the *Terebratula*.

Beginning with those of highest organization, we find the remains of Cephalopoda of simple and long extinct forms in the most ancient of fossiliferous rocks. The genus *Orthoceras*, and others nearly allied, (*Gomphoceras*, *Cyrtoceras*, *Phragmoceras*,) are thus enormously developed in the Silurian and Devonian rocks, while *Nautilus*, *Clymenia*, and afterwards *Goniatites*, present numerous Devonian and Carboniferous species, and a singular preponderance of individuals greatly affecting the physiognomy of the fauna. The nautilus, retaining its general form and structure, was in the secondary period accompanied by the numerous members of the genus *Ammonites*, which, attaining a maximum of development in time towards the latter part of the period, entirely died out before its close. Peculiar forms of the shells of these animals are to a very remarkable degree characteristic of particular beds or groups of beds, and thus in the chalk, the form which at first was a comparatively simple spiral, became greatly varied, and often exceedingly different from the normal type. The genus *Belemnites*, although rather less widely diffused, contains some of the most doubtful and least recognisable of shells, partly from the great simplicity in the external surface and form, and partly from the varieties of growth and accident to which it was subject. No less than twenty-five genera of ancient Cephalopoda have been determined, of which only two are now living, (*Sepia* and *Nautilus*,) and but three additional ones can be found in all tertiary deposits hitherto known. There are nine genera Palæozoic, (seven of them from the lower rocks,) fifteen are lower secondary, and six upper secondary. Of all the genera, *Ammonites* is that most abundantly represented; and it has been found convenient and useful to separate its very numerous species into no less than twenty-one groups, forming seven divisions of the genus, characterized chiefly by the shape of the back of the shell. This division is considered to be natural and gives proof of marked modifications of form, having reference to epochs of time. It was introduced by Von Buch, and has since been slightly modified by M. A. D'Orbigny.

The species of Gasteropodous Mollusks, found in the oldest or Silurian rocks, are comparatively few, and are difficult to determine accurately, although many have been referred to existing genera. The well-known genus *Natica*, the patelliform *Capulus*, and the *Chiton*, are considered to be truly represented in these ancient rocks, but with these there are a number of others, more or less resembling *Littorina*, *Nerita*, *Patella*, *Trochus*, *Turbo*, and *Turitella*. There are many others to be added to the list.

Taking, however, a wider range, we find amongst the principal genera of these univalve mollusks, only ten acknowledged, and five doubtful ones, in the whole lower Palæozoic group of rocks, and only sixteen admitted, and ten doubtful in the upper Palæozoic series, most of the genera in the older being also included in the newer rocks. Of these, all without exception are marine, some being littoral or inhabit shallows, but most of them occurring in deep water. In the lower secondary rocks we have sometimes thirty-six genera, and in the upper secondary forty-six, while throughout the tertiary rocks the order is represented in 108 genera, including a number of terrestrial and fresh-water species.

The CONCHIFERA, or bivalve mollusks, are very scarce in a fossil state in the oldest fossiliferous rocks, and exhibit some singular and long extinct forms. The *Avicula* and *Pecten* are the first known genera distinctly recognisable, but with them are associated several others, that have been doubty, and in many cases wrongly, referred to such groups as those which now include the cockle, the mya, the muscle, &c. It is in the carboniferous limestone that shells of this kind first become common, and Ireland is especially rich in specimens. The species of *Arcaceæ* are especially characteristic of this among the ancient formations, and in the still newer deposits of the Oolitic period, where fossil shells of all kinds are unusually abundant, this family is nearly approximated to the existing divisions. Besides these, we have also in the Oolites species of *Corbula*, *Porina*, the *Mytilaceæ*, the *Veneridæ*, the *Lucinæ*, *Astarte*, *Lima*, and *Crenatula*. 'The genera most developed in British strata are, *Pholadomya*, of which nineteen species are enumerated, *Modiola* (17), *Arca* (23), *Nucula* (11), *Trigonia* (13), *Astarte* (22), *Cardinia* (12), *Cardium* (12), *Isocardia* (11), *Pecten* (31), *Lima* (23), *Gervillia* (10), and *Ostrea* including *Gryphæa* (33). Some genera, of which there are few species, are also highly characteristic, as *Perna* (2), *Pholas* (2), *Panopæa* (several), *Opis* (2), *Myoconcha* (1), *Lysianassa* (4), *Hippopodium* (1), and *Corbis* (3). In the fresh-water beds of the Wealden numerous well-marked species of *Unio* occur, with *Cyclas* and *Dreissena*. The British cretaceous fossils of this family have considerable relations with Oolitic forms, and in some few instances (as *Gervillia aviculoides*) appear to be identical. The greater number occur in the Greensand, or Lower cretaceous series, and indicate the formation of these beds to have been in shallower water than that in which the chalk was deposited. The genera greatly developed are, *Arca* (12), *Nucula* (11), *Trigonia* (12), *Venus* (17), *Inoceramus* (17), *Ostrea* with *Gryphæa* (20), *Lima* (12), *Pecten* (14). The presence of true species of *Crassatella*, *Cyprina*, *Cardita*, *Solen* and *Spondylus*, is worthy of note. *Pholadomya*, *Panopœa*, *Corbis*, *Corbula*, *Isocardia*, *Anomia*, *Avicula*, *Gervillia*, *Plicatula* and *Pecten*, have well-marked representations among British crestaceous fossils. *Thetis* is a remarkable genus of this period."*

The Eocene or older tertiaries contain a vast number of species referable to known genera, but all, or almost all of them are now extinct. In the upper tertiaries, a larger proportion of existing species is met with, and the prevailing and characteristic forms assume a much closer resemblance to those found in the vicinity of the spot containing such groups. There are also many generic forms of these shells in foreign beds, not known in our own country, and there appears to be a grouping which gradually resembles that now observable. Many species found fossil on our own shores and belonging to newer tertiary deposits, have also been met with under other circumstances and in distant spots, still living.†

The general character of the bivalves of the middle part of the tertiary series in England is Mediterranean, or rather Lusitanian, and of the newer part, mixed Mediterranean and northern, while still newer beds occur which are essentially northern, and even arctic.‡

The remarkable shell-bearing animals called BRACHIOPODA, although somewhat rarely represented in existing seas, must at one time have played a most important part in the animal economy, and even greatly affected the physiognomy of many ancient and now extinct faunas. They seem to have been the earliest introduced of all mollusca, some species of *Lingula* being the oldest fossils known. They soon and greatly increased, and the typical forms of genera, and more important groups, were at once amongst the most abundant, and the most remarkable of the forms of organic life of which any remains are left.

Of these animals more than 100 species have been determined from British Silurian beds alone, the genus *Orthis* (50 species) being most

---

* See the descriptive letter-press attached to the Palæontological Map, by Prof. E. Forbes, in Johnston's *Physical Atlas*.

† This is the case also with the univalves, as a remarkable *Fusus*, (*F. contrarius*,) long supposed to be confined to the fossil beds on the east coast of England, has lately been found occupying a definite position as a recent species on the coast of Spain.

‡ E. Forbes, *ante cit.*

remarkable. *Leptæna* (20 species) is also characteristic, and *Pentamerus* is confined to this group of rocks. *Spirifer*, *Terebratula* and *Atrypa*, *Orbicula* and *Crania*, and a few *Producti* have also been described. In the Devonian period Spirifer increases, *Strigocephalus* replaces *Pentamerus*, *Productus* increases, *Orthis* decreases greatly, *Leptæna* continues, and *Calceola* (a new genus) is added, and is exclusively of this period. In the carboniferous rocks, *Spirifer* and *Productus*, and *Chonetes* with *Terebratula*, include almost the whole number of Brachiopods, which, however, are enormously preponderant in number of individuals in many districts. In the Permian rocks the whole group has fallen back into a few unimportant representatives, thirty-seven species only being known.

The genus *Terebratula* is in a high degree characteristic of the whole secondary period, and only a few *Spirifers*, with *Crania*, *Lingula*, *Orbicula*, *Magas*, and others, interfere with its presence. In the tertiaries, the shells of Brachiopods are almost as rare as in existing seas. A remarkable and anomalous extinct group, which under the name *Rudistes* have attracted much attention, but have not been satisfactorily explained, are peculiar to the rocks of the newer secondary period.

162 *Distribution of extinct* Articulata.—Of this great and important class, now represented by so many thousand species of insects, Cirrhipeds, Annelids, and Crustaceans, but few remains, comparatively speaking, have been found in a fossil state. Some of the few, however, exhibit great interest.

Of Crustaceans, the family of *Trilobites*, now totally absent, seems to have been eminently characteristic of Palæozoic formations. There are several groups, chiefly from the Silurian or lower part of the Palæozoic series, and the species that occur in the Devonian and Carboniferous rocks, are for the most part few in number, and not remarkable for any full representation of individuals, or any marked peculiarity of form, with the exception, indeed, of the genera *Brontes* and *Harpes* (Devonian), and *Griffithides* (Carboniferous). Many other Crustaceans appear in the carboniferous rocks, but they have not been found in sufficient abundance to affect the general character of the group of fossils.

The Oolitic rocks, and indeed all the rocks of the secondary epoch, from the Lias to the Chalk, present numerous and interesting Crustacean remains, many of them peculiar, but all approximating much more to the existing forms than the Trilobites do. The Lias contains several species resembling the lobster and prawn, and these as well as species of crabs, &c., are continued and multiplied in the oolites of England, and the upper oolitic beds from which the celebrated lithographic slate of Solnhofen, in Bavaria, is obtained. Other Crustaceans, both crabs and lobsters, or rather representatives of these tribes, are found occasionally in the lower cretaceous beds. The London Clay, and other tertiary beds, both in England and elsewhere, contain remains of various specific forms still more nearly allied to the inhabitants of the adjacent seas. Some species of small Crustaceans of lower organization, (*Cypris*, &c.), have been met with abundantly in various parts of the newer palæozoic, the secondary, and tertiary series.

Insects have left remains in various rocks, but they are generally too ill preserved to enable us to distinguish any very important characters. In the coal measures the body of a scorpion, the remains of wings of flies, and the wing-cases of some beetles have been described, and in the Lias and lower Oolites numerous fragments, generally imperfect, have been the objects of careful examination by Mr. Westwood.* The newer Oolitic and the Wealden deposits present other examples, but it is difficult to refer to fragments so imperfect by very distinct specific characters. In tertiary deposits the remains of such animals become much more abundant, but are chiefly confined to a few localities. The tertiary beds of Aix, in Provence, and of Œningen, the lignites of the neighbourhood of Bonn, and the amber-bearing deposits on the

* See Brodie's *History of Fossil Insects in the Secondary Rocks of England.*

shores of the Baltic, are the most remarkable and prolific, and have yielded results of some importance to the Entomologist. The following eight principal orders of insects are represented in a fossil state—*Coleoptera* (beetles), *Orthoptera* (locusts), *Neuroptera* (dragon-fly), *Hymenoptera* (Ichneumon-fly), *Hemiptera* (lady-bird), *Lepidoptera* (butterfly), *Diptera* (fly), *Thysanoura* (Podura).

Remains of ANNELIDA are not wanting in a fossil state, but the animals of this tribe being soft, only a few and imperfect indications are usually preserved. In the oldest Silurian rocks, marks have been found which have been referred to worms, and it is not unlikely that similar indications might be found in rocks of almost all ages.

Many worms incase themselves in stone, and thus the shelly tubes in which the animal once lived are very permanent. Since, however, at present, very different species are found to inhabit tubes not to be distinguished from one another, it is clear that not much stress can be laid on evidence derived only from data so little important. The genera *Serpula* and *Ditrupa* are of almost universal occurrence, and probably include a large number of extinct species in all parts of the world and of almost all geological dates.

163 *Distribution of extinct* RADIATA.—Of these animals, the *Echinodermata* and the *Zoophyta* form the two most important groups, and we have in addition to these, the *Amorphozoa*, containing the sponges, of which many are found in a fossil state. Many well marked and peculiar forms occur in a fossil state in rocks of all periods, and many natural families, once enormously abundant, have either entirely disappeared or dwindled down to the most insignificant dimensions.

Of the Echinoderms the most ancient group is that of the *Cystideæ*, closely allied to another group, the *Crinoideæ*, which, as well as the former, is abundantly presented in a fossil state, but very rarely by any existing species. The Cystideans include a number of genera all (with one doubtful exception) Silurian, but the Crinoids are more widely diffused, although these also appear to have commenced their existence at the very earliest introduction of life, and attained their maximum of development during the Carboniferous period. A new and peculiar group (*Pentacrinus*) replaces the older forms in the Lias, and by various species continues into the Chalk. Other, but not numerous, species are also found, the free-swimming forms commencing, and gradually displacing the attached Crinoids. In addition to the Crinoids, the orders of *Ophiuridæ* and *Asteriadæ* (star-fishes) commenced in the oldest period, but appear to have obtained their chief development much later. Star-fishes and true Ophiuræ, as well as Crinoids, have thus a wide range of distribution in time among the large and not unimportant group of animals to which they belong, and in the newer part of the Palæozoic period they began to be accompanied by Echinidæ (sea eggs). The remaining groups of Echinodermata present no hard parts by which their form can be preserved to future ages, and there is thus no evidence of their existence in a fossil state.

The ZOOPHYTA, amongst which are included corals and a multitude of small animals having calcareous skeletons, besides many others which have no solid framework, afford abundant indications of their former existence in rocks of all ages. It appears from the result of observations on these, that 'little if any change has been made in the plan of zoophytic organization since the beginning of geological time; that whilst some genera have passed away and new ones have taken their places, the earliest forms were as perfect as their successors, indeed, among the very earliest, the most perfect forms of zoophytes play as important a part as the most rudimentary. Most of the genera are remarkable for their great duration in time, and this applies also to a great many species both during Palæozoic and Tertiary epochs.'*

There are two divisions of Zoophytes building solid habitations, one of which, the *Bryozoa*, does not really belong to the class, but on account of the

* E. Forbes, in *Physical Atlas, ante cit.*

extreme similarity of the stony frameworks constructed by its members, they cannot be dissociated from the true polyps constructing corals. Of this division as of the other (the *Polyps*), there are examples in Silurian rocks where the genera *Eschara, Flustra,* and others are found. In the same rocks are *Favosites* and *Chætetes, Petraia, Catenipora,* and *Aulopora.* These, with *Strombodes* and *Syringopora,* give a marked character to the oldest fossiliferous limestones of the Silurian period. Many of the Silurian species extend into Devonian rocks, although many others disappear and are replaced by new forms, and *Astræa,* already introduced, becomes there more abundant. *Cyathophyllum, Lithodendron,* and *Lithostrotion* occupy an important place, and with *Gorgonia* attain a maximum in the subsequent or Carboniferous rocks, which are remarkable for the large proportion of coralline limestone of which the lower division is made up.

The Palæozoic zoophytes are quite distinct as a group from the species found in rocks of the secondary period, and some forms, as *Graptolites,* are altogether peculiar to the older epoch. In the lower and middle Oolites, a considerable number of corals occur, *Astræa* being especially rich in species and individuals, though *Turbinolia* is almost equally remarkable. In the cretaceous rocks there are many small corals, most of them Bryozoa, which have not been much examined, and in tertiary formations the number of species is very large, but the condition of the seas in which they lived appears to have greatly differed from that of more ancient periods.

The fossil *Amorphozoa* include chiefly sponges and spongiform bodies, the lowest in organization of all that have been determined. There are a few Silurian and some Devonian species, while others have been observed also in carboniferous rocks, but some of the German localities of Oolitic rocks are far more remarkable than older beds for the presence of such remains. A large number of forms have been described both there and in the newer or cretaceous rocks, the most remarkable genus among the latter being *Ventriculites,* which occurs abundantly among the chalk flints. Tertiary sponges have been described by Michelin and others.

There still remain to be mentioned the two large and doubtful, but not uninteresting, groups, the *Foraminifera* and *Infusoria,* which must be referred to the ZOOPHYTA, and which, although no doubt introduced very early and occurring fossil in Devonian rocks, begin to be important in the newer part of the palæozoic period, especially in Russia. Other species have been found in the lias and oolites, a large number in cretaceous rocks, and an almost infinite multitude in rocks which are perhaps intermediate in age between the secondary and tertiary, as well as in the older tertiary rocks of various parts of Europe and North America. Most of the fossil infusorial animalcules of which remains have been found are in tertiary rocks of comparatively modern date.

164 *Distribution of extinct* PLANTS.—The remains of plants are, as might be expected from the character of most of the deposits, either entirely absent, or confined to a few spots, and only in rocks far removed in point of time. Thus we find such remains chiefly in the rocks of the carboniferous period, but also in the older oolitic rocks in the Wealden and in tertiary deposits. The oldest forms of vegetation are very distinct from those since introduced, and show a remarkable preponderance of ferns, both arborescent and others—at least, this is the case with the carboniferous fossils: and although some species have been referred to Devonian rocks, and fucoids are found occasionally in Silurian limestones and schists, the really important groups are only known in beds associated with coal. With the ferns of this period are dicotyledonous trees allied to pines, and these in the newer beds are accompanied by *Cycadeæ* and true *Coniferæ,* which ranged plentifully during the secondary period in England and Europe. The fossil plants of the London Clay are closely allied to some groups now confined to the East Indian Islands, and probably indicate a warmer climate than at present, and a very different distribution of land.

CHAPTER XIII.

ETHNOLOGY.

GENERAL *Nature and Meaning of the Science of Ethnology.*—No account of the Earth, its inhabitants, and its history—professing to explain the modifications of its surface, and record the revolutions and changes it has undergone—would be in any sense complete without including some notice of the human race and its distribution in various countries, and at various times. The study of this department of Natural History has been designated Ethnology, and the object in the present chapter is to give an outline of the science so named. We must, however, neglect many points of interest, especially those which are connected with the personal and social qualities of the human race, for these in no way affect that natural-history view which solely belongs to Physical Geography.

Considered as a race introduced upon the Earth at a certain period of its history, the human family presents to the careful and philosophic observer an infinite variety of problems, difficult and complicated in the highest degree. Hitherto these problems have received but little attention compared with their real importance, and the growing interest felt in reference to them within the last half century has hardly yet spread to the mass of society, who are apt to shelter themselves under doubtful histories, and the general but vague ideas derived from very imperfect knowledge. The most that we can here attempt, however, will be to state a few of the problems, and point to the various attempts made for their solution or illustration.

The subjects that offer themselves for consideration in the strictly natural-history study of the human race, are chiefly those connected with colour and other external peculiarities, internal structure, language, and intellectual development. These all involve to some extent positive facts, and hence we may, with some satisfaction, discover by their means the degree of affinity that may exist amongst the principal divisions of men; but the real importance and relative value, even of these facts themselves, can only be appreciated by careful study.

It may perhaps be considered, that the inquiries of chief importance, and those which, when answered, promise the greatest results, have reference to (1) the specific identity of those various races of men which differ most from each other, and which being found inhabiting districts naturally distinct, may be regarded to some extent as typical races—(2) the degree to which mixtures of these races can produce other and permanent varieties—(3) the extent to which such mixtures as have been already produced can be traced back—(4) the absolute period during which the human race has been actually present, not only on the globe in general, but in particular countries—and (5) the true amount of influence that man, in an uncivilized or civilized state, has upon the distribution of other families of his own kind, and upon other organic beings. These are points fairly within the inquiry of the naturalist, and demand therefore notice in this place.

166 *Specific Character.*—In considering such points we are forced to pay some attention to another question that has long been a source of dispute—namely, what is to be understood by the term *species,* and how far varieties may extend without reaching to specific difference. In man, as in other animals of high and complex organization, capable of adapting themselves to great changes of temperature and climate, living at one time under the burning rays of a tropical sun, and at others enduring a three or four months perpetual night and frost near the poles, there must occur many modifications of habit at least, if not of structure, which manifestly involve no departure from the normal type. But because this is the case, we are by no means justified in assuming that such differences of habit can involve real and permanent modification of structure, for such a conclusion could only with propriety be admitted, if it were supported by many analogies derived from other natural-history facts, directly bearing upon the point. Too little attention has often been paid to natural-history and common-sense views on this subject, and to the laws of analogy and affinity of distribution and limitation of species of other animals, in deciding on the probable origin of the human race, and the date of this event.

It has, indeed, been usual to assume, as the definition of species, that 'the faculty of procreating a fertile offspring constitutes identity of species, and that all differences of structure and external appearance compatible therewith, are solely the effects resulting from variety of climate, food, or accident, consequently are forms of mere varieties, or of races of one common species.'* It may, however, be safely asserted, that any argument concerning the origin of the human race derived from this definition is vicious, for the whole point in question is assumed, and there seems no doubt that several of those groups of other animals best determined, and most universally allowed to be distinct, may naturally breed together, and do produce hybrids capable of continuing a race, and exhibiting some peculiarities of each of the tribes from which they are derived. Thus, various tribes of wild *felidæ* breed with each other; goats breed with sheep; common cattle with the Zebu, and other well marked species; and the common hare with the rabbit, and also with the hares of other countries, exhibiting examples of no slight importance, where fertile hybrids have been produced by mixtures of well marked species, although new races have not been established. In all these cases, as, indeed, in any single family of any animal, a certain amount of mixture of blood is required to keep up a healthy race, and it may even be necessary to revert to the original stock for such purpose, but this does not interfere with the important conclusion that such mixtures of species are, to a certain extent, natural and are essentially prolific.

In spite of this, notwithstanding such occasional exceptions to the usual sterility of hybrids, it is still, however, very clear, that there must be some provision in the constitution of organized beings tending, under ordinary circumstances, to keep breeds distinct, and prevent the amalgamation of really natural groups. In other words, though species may not be strictly determinable by the test of unfertile hybrids, there still are true specific distinctions preserved unbroken and unmixed with singular tenacity. It is of the highest importance for naturalists to determine, if possible, the nature of these distinctions, and how far any of them are universally applicable; but we are bound to admit that those who pursue the higher departments of Philosophical Zoology, have as yet failed in assisting the progress of natural history by the discovery of any such characteristics.†

---

* Hamilton Smith, *Natural History of the Human Species,* p. 114.

† We quote from a very recent work by Alexander Von Humboldt the following additional evidence on this subject of the fertility of hybrids:—'The Canadian bison can be trained to agricultural labour. It breeds with the European cattle, but it was long uncertain whether the hybrid was fruitful. Albert Gallatin, who, before he came forward in Europe as a distinguished diplomatist, had obtained, by personal inspection, great knowledge of the uncultivated

167 *Divisions and Mode of Treatment of the Subject.*—Ethnology, therefore, or the physical history of the human race, cannot obta n from general natural history a decisive answer, even to those inquiries which properly and necessarily belong to that science; and it therefore calls for assistance from many other departments of knowledge. In the present outline, we may with advantage consider, first, that portion of the physical view of the human species which is more directly connected with zoology, comparative anatomy, and comparative physiology. When in this way some idea is communicated of the more elementary facts, we may proceed to consider very generally those points of comparative philology, and afterwards of general human history, which bear upon the questions we have to discuss. Having thus determined the natural-history facts of our race, it will be useful to consider the influence of the human species on inorganic and organic nature, and conversely the influence of external nature on the human family under various circumstances of temperature, climate, and civilization. It is true that in this sketch many details of great importance may be omitted, while, on the other hand, opportunities will be afforded for lamenting the almost total absence of great classes of facts; but perhaps also this may be useful in directing attention to the present state of knowledge on so important a subject.

168 *External Structural Peculiarities of the Human Race.*—Those marked peculiarities of men that are continued from generation to generation without change, and seem at length to be absolutely unchangeable, relate chiefly to colour, hair, and external form, but also include some striking anatomical characters of great importance. Thus, permanent varieties in stature, in the proportions of the limbs, in the form of the pelvis, and in the form and proportions of the cranium, are so numerous and distinct as to separate at once the different families of men into several groups.

The earliest recorded accounts that have survived the destruction of written documents and oral tradition, seem to point to the existence of races of men attaining in former times more gigantic dimensions than at present; and however exaggerated and distorted the accounts may be, they yet seem sufficient to justify a conclusion, that the early conquerors in Asia Minor, and Southern as well as Northern Europe, may have exceeded the original races in respect of height, as much as they certainly did in vigour of character and physical energy. The only race, however, that can now be referred to as showing any distinct evidence on the subject is that which has been described in Patagonia, and which, like others, must soon give way to the encroachment of the white man; but still showing superiority of form when compared, not merely with the stunted and ill-developed Fuegians about them, but even when placed side by side with Europeans of full vigour and ample proportions. This is stated by all travellers of credit, and must certainly be admitted. Many instances, however, are on record of individuals in all countries attaining even a more considerable stature; and amongst them we may mention the case of a Swede, one of Frederick the Great's gigantic guards, described by Haller as being eight and a half feet high, while several Irishmen have been known to attain the height of seven to eight feet; and one, whose skeleton is now in the Museum of the College of Surgeons, and who died, aged twenty-two, in 1783, measured eight feet four inches.

Notwithstanding these exceptions of individuals and races, there is certainly no evidence of any great deviation from the average standard that

---

parts of the United States, assures us that 'the mixed breed was quite common fifty years ago in some of the north-western counties of Virginia; and the cows, the issues of that mixture, propagated like all others.' 'I do not remember,' he adds, 'the grown bison being tamed, but sometimes young bison calves were caught by dogs, and were brought up and driven out with the European cows.' At Monongahela, all the cattle were for a long time of this mixed breed, but complaints were made that they gave very little milk.' We believe no one ever questioned the specific distinctions between the European breed of cattle and the bison.

cannot well be referred to local circumstances, but as little doubt can there be that various races do present different average stature. Thus, the Patagonians, inhabiting the southern extremity of South America, are beyond all question an eminently tall race, while the Bosjesmans of the Cape of Good Hope, and the neighbouring country, are as strikingly below the average stature. Nor is intellectual cultivation by any means concerned in this matter, since the native Australians, the nearest in point of low intellectual powers to the South African dwarfish tribes, are, on the contrary, a tall race; while the stunted Fuegians, the race nearest in position to the lofty Patagonians, and the Caffres, inhabiting the country near the Bosjesmans, differ but little in civilization from their dwarf neighbours.

Although it is certain that great differences in stature are capable, under favourable circumstances, of producing permanent varieties without reference to climate, yet it has been considered that this latter also may have some effect. The point is one of some little importance, especially in considering the average height of races taken fairly from a sufficient number of observations; but facts are wanting to found any certain argument with reference to this subject.

If there is difficulty in judging of unity of race by the average stature, it will readily be understood that other dimensions are still less useful in this respect. A considerable difference, however, may be traced in the development of various races, though insufficient to justify important generalizations.

Other external characters of the human race are found in the form of particular parts, some tribes having the head flattened in a remarkable manner, others having the bones of the extremities more or less developed, some possessing thick lips, others small ears, others high cheek bones, while a vast variety of less important differences characterise particular groups, according to some temporary or local circumstances. Many of these depend directly on internal structure, while others, such as colour, are exclusively superficial, although sufficiently important to require careful and minute attention. The nature and condition of the hair afford other external characteristics of singular value, and thus hair and colour are usually considered as the most direct and ready means of grouping the different varieties of the human race into large natural families.

The peculiarities of colour presented in man are chiefly four—white, yellow, red, and black, but each of these admits of a vast variety of shades. The white is often varied with delicate shades of pink, and passes also into tawny and olive coloured. The yellow passes into copper coloured on the one hand, and black on the other. The copper colour also admits of many varieties, and even black is often presented of different shades in the various members of the same great natural family. All these colours are liable to what are called *albino* varieties.

Of the whole population of the world, a very large proportion, including almost all the inhabitants of tropical countries, exhibit tints of colour approximating them more or less closely to black. These have generally black hair and dark eyes, the hue of the skin being less decided than that of the hair and iris. Where the black is combined with red, as in the indigenous copper coloured races of America, the hair does not cover any part of the face, and in some parts of Africa the hair is not only black, but is crisp, woolly, and short, presenting very marked and permanent characteristics.

The white and yellow varieties of men generally present a fair complexion, assuming a red or tawny tint on exposure to sunlight, and accompanied by hair of light brown, auburn, yellow, or red colour, and eyes either grey, azure blue, brown, or some shade of yellowish or greenish brown, or greenish yellow. These colours of the eye are often found in individuals not presenting the true characteristics of skin and hair, but in great masses of men not exhibiting recent mixture of race one prevailing tint may generally be recognised.

The term albino is applied to individual cases occurring from time to time in all countries, although chiefly noticeable among Negroes, owing to the marked contrast then presented to the ordinary condition. The characteristic of this variety is, that the hair and skin are perfectly white, without a tinge of colour, and the iris of the eye red. Races of albinos have been described in some parts of the interior of Africa, but they probably do not extend to more than a few families in particular villages. The persons thus characterized are frequently the offspring of parents whose other children do not present the same peculiarities.

Before concluding this account of external structure, it is necessary to refer to varieties of form presented by the face, and especially the lips and nose, which are amongst the more distinctly marked characteristics in the Negro race, the Chinese, the Malays, and some of the Americans. The form and position of the ears is also a point worthy of remark.

169 *Internal Structural Peculiarities.*—The form and proportions of the human cranium exhibit differences so marked, and so greatly affecting the intellectual development and capacity for civilization of the inhabitants of different countries, that the assistance of anatomy in this matter is of the highest importance to the progress of Ethnology, and lately also it has been found that peculiarities of structure corresponding to these are to be met with in the figure and proportions of the pelvis. It is necessary, therefore, to consider the facts that are most important in each case.

The cranium is a hollow bone peculiar to vertebrated animals, and forms the protective investment of the brain, on which it is moulded, and the form of which, in warm-blooded animals, it represents. It contains in its walls the organs of hearing, and contributes to form the orbits of the eye, the nostrils, and the face. It is built up of eight bones which are not firmly connected till some time after birth, so that there is a certain amount of flexibility, admitting of great change of general form and proportions by continued artificial pressure.

The first attempt to point out distinctive characters in skulls was that of the anatomist Camper, who based his conclusions on the shape of the skull and the measurement of the angle (called the facial angle) included between two lines, one drawn from the passage of the ear to the base of the nose, and the other slanting from the forehead to the most prominent part of the upper jaw-bone. This angle was thought to afford a measure of the capacity of the fore part of the skull and of the size of the corresponding portion of the brain, and in this way the skull of Europeans when measured gave an angle of 80°, that of a Kalmuk 75°, and that of a Negro only 70°. He also observed that there are forms of the head in which the angle appeared to be greater than it is in the European, and others in which it is less than in the Negro, the former being the ideal heroic heads of the ancient Grecian deities, and the latter being animals of inferior organization, the ape having the greatest angle, but not exceeding 64°. It must, however, be remarked, that in this measurement the apparent gradation from the Negro to the ape is not real, as if the skulls are taken from animals of full age in which the dentition is complete and the jaws completely developed, the angle is not more in the orang or satyr than 30°, and in the troglodyte only reaches 35. In the comparison of skulls, one important point has also sometimes been overlooked—namely, the form of the base of the skull, on which depends much of the general measurement of the angles.

Besides the facial angle, there are other points of difference seen in comparing the skulls of different races; for while some skulls are round and symmetrical, with a broad smooth forehead, others, again, are square, or nearly so, others pyramidal, others narrow and laterally compressed; while ll these varieties naturally induce very marked external peculiarities corresponding to them. Almost all the anomalous and even monstrous divergencies from the normal type in man are capable of being transmitted to posterity, and thus the races amongst whom flatness of the head or any other deformity is regarded as a beauty, exhibit the corresponding form in the heads of very young infants, even when no mechanical pressure has been induced.

One of the most important varieties in the structure of different races consists in a peculiar conformation of the pelvis, and this has recently been the subject of careful investigation by Dr. Vrolik, of Amsterdam, who has examined and described minutely the details observable in skeletons of Europeans, Negroes, and Javanese of both sexes, a female of the Bosjesmans race, and a person of mixed breed.

The important result of these investigations seems to be, that, although the proportions of the bones in this region in Europeans are very different in the two sexes, the difference is much greater between the male and female Negro, the former exhibiting remarkable strength and density, while the latter, in the same race, combines lightness of substance and delicacy of form and structure. The Javanese of both sexes appear to possess a pelvis of peculiar lightness of substance and smallness of size, while the female Bosjesman exhibits, in a most exaggerated form, the narrowness and elongation remarkable in the Negress, and apparently approaches to the structure of the chimpanzee and the orang.

Other observations on the pelvis, by Professor Weber, would tend to show that all varieties of form in the pelvis may be described as belonging to one of four kinds—the oval, the round, the square, and the wedge-shaped, of each of which examples are found in most countries. The form that is most usual among Europeans is the oval, that of the Americans the round, that of the Mongols the square, and that of the different races of Negroes the oblong.

Other structural peculiarities are seen in the bones of the extremities, which in the Negro and some uncivilized races are comparatively elongated and straggling, crooked and badly formed. Thus the tibia and fibula in the Negro are more convex in front than in Europeans, the calves of the legs very high, the feet and hands flat, the heel-bone flat and continued nearly in a straight line with the other bones of the foot, and the foot itself remarkably broad. The fore arm is also much longer in proportion to the body than in other races, and the head is placed further backward on the vertebral column.

170 *The Principal Varieties of the Human Race and their Arrangement into Distinct Groups.*—Although the peculiarities mentioned in the preceding section are none of them strictly confined to special races, still they are so far characteristic that by their means we can with some degree of reason speak of the white, black, copper-coloured, and other races, without fear of being misunderstood, and we may also subdivide these into woolly-haired, black-haired, beardless, and others. But when connecting these so far natural groups with those which, according to the records of human history, have dwelt in, or emigrated from, special countries, there are immediately introduced various elements of confusion, preventing any possibility of subdivision into tribes without the assumption of so much, that fiction soon takes the place of fact. It is evident that the space devoted to the subject of Ethnology in these chapters will by no means admit of the discussion of any views, and we can only put before the reader, as a conclusion, the arrangement that has seemed most convenient and most useful.

Among the various points of difference that might be assumed to assist in the arrangement of the tribes of men, the form of the skull, combined with the colour of the skin and hair, the texture of the hair, and the form and proportions of the pelvis, agree for the most part in marking at least three groups possessed of the extremes of difference in these respects, and not ill supported by historic testimony. It has, indeed, been usual to admit of five principal or typical stocks of this kind, but, perhaps, two of these are more properly considered as sub-typical, at least in the present condition of our knowledge. The three groups thus suggested may be called the CAUCASIAN, or bearded type; the MONGOLIC, or beardless type; and the woolly-haired, or NEGRO type. The Europeans generally may be considered as representing the former; the Tartars, Chinese, and other inhabitants of Central Asia, the native tribes of America, and the inhabitants of Australia, the second; and the Africans the third.

The characteristics of the three principal types may be thus described :—

1. The Caucasian Type.—This typical group has received its name from the idea of its having originated in the mountains of the Caucasus, whence it has spread in Europe and Asia. All the civilized nations of the West belong to it, and it has generally obtained absolute domination when families have migrated to distant countries. It admits of many and very important subdivisions.

The races thus designated are for the most part white, but include tribes of almost every shade towards absolute blackness. The hair is abundant on the head, varying from the deepest brown, and even black, to auburn, yellow, and fiery red, and becoming grey with age. In all the races, the males have decided beard, often spreading over the upper lip and fringing the sides of the face, being, in such case, crisp, curly, or undulating, and not lank. The hair usually harmonizes with the complexion, and that of the head and face have nearly the same colour.

The skull of the Caucasian tribes is larger in proportion than in the others —it is oblong and rounded, and the facial angle rises from 75° to nearly 90°. Its volume amounts to from 75 to 109 cubic inches. The mouth is small, the teeth vertical, the lips graceful and not tumid, the cheek bones not projecting, the chin full and round. The shoulders are ample, the chest broad, the ribs firm, and the loins well turned ; the thighs and the calves of the legs symmetrical, and the whole frame constructed for the endurance of toil, and with physical powers equal to the intellectual organization, combining more than any other race strength of limb with activity, and enduring with ease the greatest vicissitudes of climate and temperature.

The people thus characterized include the inhabitants of the great river-valleys of Southern and Western Asia, and all the inhabitants of Europe, except the Laplanders, the Finns, the Magyars, and some other eastern tribes. A large part of North America and many portions of South America are also now peopled with the descendants of the Western Europeans who have migrated in a civilized state.

2. The Mongolic Type.—The races that belong to this class differ both from the Caucasian and Negro stock in many highly important physical and intellectual qualities. The skull is small, the facial angle 70°—80°, the contents of the cerebral chamber 69 to 83 cubic inches ; the face is flat, the cheek bones projecting laterally, the eyes small and obliquely placed ; the hair coarse, lank, and black ; the beard scanty, not curly, and not covering much beyond the chin. The nose is small and pointed, and the mouth well formed. The colour of the skin yellow of all shades, rarely passing into white, on the one hand, or black, on the other. The typical races are square of body, low in stature, having the trunk long, the extremities comparatively short, and the wrists and ankles weak.

The people chiefly exhibiting these peculiarities of structure are the Central and Northern Asiatics, the Finns and Laplanders in North Europe, and the Magyars of Hungary. The Chinese and Japanese, and the various Tahtar tribes are the most numerous and characteristic of these races at present. The Esquimaux also belong to them.

The Indian tribes inhabiting North America approach the true Mongols, and may be regarded as subtypical, presenting some points of resemblance to the aberrant tribes of Caucasians. In these, however, the colour is more deeply red or copper-coloured, the cheek bones more rounded and not projecting laterally, the face broader, the forehead low, and the skull less pyramidal.

Another remarkable and very large natural group, the Malays, may be also considered as forming a connecting link between the Mongol and Caucasian types. The Malay tribes have generally a small head, measuring from 64 to 89 cubic inches—the forehead is low, the face flat and broad, the nose short, the mouth wide, and the upper jaws projecting. The hair is generally coarse, the skin varying in colour from clear brown to dark clove, the beard scanty, and the frame slight, except when a mixture with Caucasian blood can be traced. As a people, they are apt to be treacherous, implacable, and ferocious, and they are chiefly confined to the coast, and some of the islands of the Indian Archipelago, excluding parts of Papua and some parts of Australia.

3. The NEGRO Type.—The woolly-haired stock properly designated by this name predominate in Africa. They present many marked peculiarities, amongst which may be mentioned a small facial angle, varying from 65° to 70°, a small head laterally compressed, a narrow depressed forehead, a broad crushed nose, a protruding lower jaw, a wide mouth with thick lips, and large solid teeth, with the incisors placed, not vertical, but obliquely forwards. Besides these characteristics, we find the hair frizzled, coarse, and though not really wool, simulating the appearance of it. The body is often extremely muscular, and exhibits perfect physical development, but the humerus is shorter, and the fore arm proportionably longer than in Caucasian skeletons. The legs and feet are inelegant, the wrists and ankles robust, and the hands coarse. The skin is generally dark-coloured, but very often jet black. Intellectually, they do not occupy a high position among the races of men, thought being habitually dormant, and there being in most cases an almost peurile love for musical sounds. An important and highly interesting branch of this variety occurs in Western Asia, in what is sometimes called the *Semitic race*, including the Assyrians and Babylonians, now almost extinct, the Jews, the Arabs, and the Ethiopians.

All these well marked varieties of the human race, and a large number of others less distinctly characterised, have certainly been in existence on the Earth for a very long period, since in paintings and sculptures made by the Egyptians more than three thousand years ago they were as strongly indicated as at this day. It is certain, too, that the differences are not entirely caused by climate, if, indeed, they are at all dependent on that as an agent, but we are not at present in a condition to explain the real origin of the peculiarities of structure observed, or refer them to any reasonable and probable source.

171 *Natural Geographical Limits of Distribution.*—The various tribes of men, in different countries, appear in most cases to have had definite limits, corresponding to those of certain groups of animals, and although individuals and hordes have wandered to distant countries, and settling there, have exposed themselves to the influence of different climates and habits, they have yet retained their peculiarities of structure. It is therefore important to consider, as far as possible, the chief groups in relation to the country where they now exist, or whence they have migrated.

The Arabs and the Egyptians are two examples of contiguous races belonging to the same family, but exhibiting marked differences, the former occurring in Asia, and the latter in Africa; the former adjacent to the civilized countries of the East, among whom the Hindoos, the Persians, the Armenians, and others, are well known examples; while the latter border on the Negro tribes. Dr. Prichard has remarked, that 'though inhabiting, from time immemorial, regions in juxtaposition and almost contiguous to each other, no two races of men can be more strongly contrasted than were the ancient Egyptian and the Syro-Arabian races: one nation full of energy, of restless activity, changing many times their manner of existence, —sometimes nomadic, feeding their flocks in desert places, now settled and cultivating the Earth, and filling their land with populous villages, and towns, and fenced cities,—then spreading themselves, impelled by the love of glory and zeal of proselytism, over distant countries; the other reposing ever in luxurious ease and wealth, on the rich soil watered by their slimy river, never quitting it for a foreign clime, or displaying, unless forced, the least change in their position or habits of life.'* The differences thus indicated

* Prichard's *Natural History of Man*, 3rd edition, p. 150.

were carried out also in detail, and nearly correspond to the conditions of the two countries in all respects of Physical Geography, and thus it is, that the natural configuration of a district may and does exercise an important influence on the growth and development of the human race therein.

It has been customary to consider the different races of men as proceeding originally from certain lofty mountain chains as their original habitat, and in this way the Caucasians and the Mongols have been so named, because the one race was supposed to be derived from the lofty mountain chain of the Caucasus, between the Black Sea and the Caspian, and the other from the loftier chain of the Altai, peopled in its higher plains by the Mongols. So also the Negroes have been supposed to be derived from the southern face of the Atlas mountains. This view, however, is not supported by facts, at least so far as history can adduce them. It is more probable that the principal races have flourished and obtained their peculiarities in great river valleys, as that of the Euphrates, the Indus, the Ganges, the Nile, the rivers of China, and others in the Old World, or in great fertile plains, or extensive tracts of country, abounding in herds of deer and cattle; while others have adapted themselves to circumstances in smaller areas, and formed fishing tribes, hunting tribes, or mountaineers of various degrees of interest and importance.

To trace the geographical range and limits of each race now recognised as aboriginal, would occupy too much space, and we must refer the reader for such information to the work of Dr. Prichard, already quoted, and to that of Colonel Hamilton Smith, recently published, *On the Natural History of the Human Species.* It will be useful to illustrate the subject by a few examples, drawn from the distribution of races in Europe, and especially in those countries in which we, as Englishmen, must feel the greatest interest.*

It is now almost universally admitted, that the European nations are a series of colonies of what is called the Arian† race, but under what circumstances, and by what path they originally passed into Europe, can only be a matter of conjecture. It has been considered probable that the northern nations of Europe took their way through the regions which lie to the northward of the Caspian, reaching in this manner the mouth of the Danube, and spreading then towards the north. The Italian, Hellenic, and Illyrian races, on the other hand, probably arrived by a different route—namely, through Asia Minor and across the Bosphorus.

Of the different European nations, which may be regarded as derived from branches of one original stock, we must look upon those which were driven most to the west as the oldest, and thus begin with the Celtic nations, including two branches, one represented by the Irish, Scotch, and Manx, and the other by the Welsh and Bretons, and the early inhabitants of Spain. Next in order comes the Germanic family, consisting of the Northmen, ancestors of the Icelanders, Norwegians, Swedes, and Danes; and the Teutonic stock, in its three subdivisions of Saxon, German, and Gothic. Next are tribes inhabiting Lithuania; and then the Slavonic race, of which there are two branches, the Western or Proper Slavic, including the Poles, Bohemians, and tribes near the Baltic, and the Eastern branch, comprehending the Russians, Servians, and other allied families.

South Europe seems to have modified the migrating races in a different way, and presents the old Italians, the Tuscans, the Thracians, the Arnaouts and Albanians, and the ancient Hellenic race.

---

* While these sheets were passing through the press, a work has been published by Dr. Latham, (*The Natural History of the Varieties of Man*, 1 vol. 8vo,) which may safely be recommended to the student as the soundest and clearest enunciation of the most advanced and scientific views of Ethnologists.

† The name 'Aryas' is the ancient national designation both of the Persian and Indian branch of the great Asiatic source of the races that now overspread Europe and Southern Asia, and the derived races have thence been called 'Arian.' The name was adopted by the Medes, and has been handed down by the Greeks.

It still, however, remains doubtful whether these races, whose history can be to a certain extent traced, and which present distinctly their relations to each other, and to the original stock, were really the earliest tenants of these countries. The more probable hypothesis is, that there were still earlier tribes, and in the case of our own country there is not wanting distinct evidence in proof of its having been the habitation of man very long before the earliest introduction of that tribe of Celts who have often been regarded as the first settlers.

If we look to the evidence that exists concerning the actual distribution of these races, we shall find them greatly but not entirely limited by mountains and rivers; each tribe seems to have had a nucleus in the newly discovered, or newly conquered tract, while from this nucleus they at first diverged to occupy a certain area, and finally migrated in part to carry the advance that had been made in civilization to a fresh spot, where the highest advance that had been made in the mother country served as the starting point for the young hordes. Thus it is, that in mountainous countries we still find kingdoms and portions of highly civilized countries, presenting in their population the most marked differences, and even contrasts, while over other far larger but level tracts, a perfect uniformity and monotony of national character prevails, often exceedingly unfavourable to the progress of civilization.

It has already been stated, that the Caucasian tribes occupy all Europe, with the exception of Finmark, Lapland, and part of Hungary. They also now occupy part of North Africa, Persia, the whole of India, the United States and British possessions of North America, a very large part of South America, and many portions of Australia. A part of South Africa, and a multitude of islands in the Pacific Ocean, have also been colonized by them in recent times, and thus the Western Caucasian varieties are now spread over the globe, and have in many cases almost driven out the original races.

When we regard the whole Earth, and consider what is known of the physical geography and climate in every country, there will often appear some distinct natural reason for the spread of particular races in the directions we may trace them. Thus, the Caucasians occupy, and have occupied for a very long period, the great fertile valleys and plains of the temperate zone, and the more habitable countries in the torrid zone, at least so far as the Old World is concerned; while the Negroes have been chiefly confined to the waste and unfertile deserts and other lands of tropical and Southern Africa; and the Mongols to the table-lands, mountains, and valleys of Northern Asia, America, and Australia. The greatest popula ions are generally found on the banks and mouths of rivers, on the shores of gulfs and great inland seas, and thence the races have generally extended up the country, following the course of the streams, and strictly limited by great and rapid rivers, which have thus proved effectual natural barriers. Men, indeed, in a natural state, are subjected to laws of distribution like other animals—they spread where means of subsistence and shelter offer themselves, they multiply in the most favourable spots, they stop where there is no longer any inducement to go on; but this is not the case when races become able by mechanical ingenuity to overcome natural difficulties; and thus the spread of civilized nations, and their limits of distribution, offer no parallel, and are bounded by no such checks as those which, up to a certain point in cultivation, have proved absolute. Still, early impressions have never yet been effaced. Penetrating through the surface on the smallest occasion of extraordinary excitement, we are able to perceive the marked national characteristics in almost every people, whether we look at races derived from a multitude of sources like our own, or those compounded only of two or three—whether we regard the half-breeds between the Negro and Caucasian, or the Caucasian and Mongolic, or look at the nearly pure descents of the higher castes of the Hindoo. Government has no power of uniting races whose blood is different—language may conceal for a time, but cannot obliterate these permanent characters; and for at least thirty centuries there have been as well marked and important distinctions between the bearded and the beardless man, the red man and the white, and the true Ethiopian and the Negro, as there are at this day, while the essential points of distinction are as clear now as they were at that distant period.

172 *Language.* — Of all characteristics presented by the different races of men, and depending on the higher or intellectual part of his nature, none is more useful in determining disputed points as to the origin of particular tribes than the careful study and comparison of the words and grammatical construction employed to express the wants and feelings of our nature. The study of language must, therefore, go hand in hand with that of physical peculiarities and human history, and though, as we shall see, not absolutely to be depended on or trusted, when it affords only negative results, or to be taken without hesitation even when resemblances can be traced, still it must always have great weight in the mind of any unprejudiced person.

It is generally agreed, that the most extensive relations between languages, and those least likely to be effaced by time and foreign intercourse, are the fundamental laws of construction, both in words and sentences. Construction, indeed, or the rules which govern the relations of words in sentences, seems especially enduring and constant, since similarity in this respect prevails through whole classes of languages which now have few words in common, though they appear originally to have had more. But beyond this, there is a cognate character in words themselves, which sometimes pervades the entire vocabulary of a whole family of languages, the words being formed in the same manner and according to the same artificial rule. This is illustrated in the monosyllabic structure of the Chinese and Indo-Chinese languages, while a remarkable instance of grammatical analogy is to be found in each of the two systems of the Indo-European languages, of which the Greek and English are respectively examples.

It has, indeed, been doubted whether analogy of structure alone is sufficient to prove community of origin of different languages, when unsupported by similar words, as it would seem that languages really descended from the same stock must exhibit their origin in both ways. It is, however, certain that such words may be very few in number, as will be seen if we compare the Welsh and Russian tongues, which are singularly unlike in this respect; while, on the other hand, a large number of words being introduced does not prove the languages to be of cognate origin. The evidence to be deduced from verbal analogies depends, however, much on the classes of words in which such analogy is to be traced, and the words that resemble each other in languages derived from the same stock are very different from those borrowed after the two languages are formed. There is, for example, a kind of domestic vocabulary in the first case, which includes the simplest family relations, 'father,' 'mother,' &c., together with the names of various parts of the body, of the most essential and manifest material and visible objects, and of domestic animals, besides some verbs expressive of universal bodily acts, many personal pronouns, and the numerals, at least to a certain small extent.

On the other hand, there are words belonging to a certain degree of civilization, and connected with the simple arts (*e. g.* to plough, to weave, to sew, &c., and the names of weapons, tools, and dress), which are often common to nations whose domestic vocabularies are different, and different when the domestic vocabulary is nearly the same. It will also be evident that many words indicative of intellectual improvement, moral cultivation, religion, and other matters, will be occasionally borrowed by a nation during its progress in civilization, and often from people who from any accident have influence, although they may belong to a different stock. Thus, the New Zealanders will acquire a multitude of English words, although no relation may be traceable between the roots of their languages and the English, nor its earlier and domestic vocabulary.

The various languages of the Earth have been grouped into four:—
1. The Indo-European languages. 2. The Turanian, or languages of High

Asia, and other regions to be pointed out. 3. The Chinese and Indo-Chinese, a monosyllabic and uninflected language. 4. The Syro-Arabian, or Semitic.

The Indo-European languages are the national idioms of all those races who at the time of Cyrus became, and have ever since continued to be, the dominant nations of the world, except where Mahommedan fanaticism has recovered for the Mongol and Negro races some sway over the weaker divisions of the Indo-European tribes. There are many groups of these languages, each group including a large number of dialects. The eastern group comprehends the ancient Persian idioms, the Sanskrit and the Pali of India. The western group, the Greek, the old Illyrian or Albanian, the old Italic language excluding the Etruscan, the old Prussian, the German, the Slavonian, and the Celtic: these are all very distinct and of very ancient date.

Now, it becomes very naturally a question, since no one conquering nation could introduce at once so many languages, whether the different nations were kindred tribes of some primitive stock, and derived the analogies of their speech from some common language which had gradually deviated from original identity by variations at first merely of dialect, but gradually increasing; or whether the facts will admit of any other explanation. It seems clear, that there is no other, and, indeed, there is internal evidence in the Indo-European languages themselves, sufficient to prove, that they did grow by gradual dialectic development out of one common matrix. 'Any one who possesses competent knowledge of these languages, and considers the nature of their relations to each other, the fact that the original roots are for the most part common, and that in the great system of grammatical inflection pervading all these languages there is nothing else than the varied development of common principles, must be convinced that the differences between them are but the result of the gradual deviation of one common language into a multitude of diverging dialects, and the ultimate conclusion forced upon us is, that the Indo-European nations are the descendants of one original people, and consequently, that the varieties of complexion, form, stature, and other physical qualities which exist among them are the results of deviation from an original type."*

The groups of languages referable to the second great family of European and Asiatic nations, differ in some fundamental points from that of the Indo-European race, and assist in this way to support the conclusion, which is indeed forced upon us by other evidence, that these races had overrun many parts of Europe, very far to the west, long before even the oldest of the races now existing were at all introduced. The languages are remarkable as having nouns nearly or wholly without inflexion or variation of case, number, or sex, which can only be expressed by appending additional words, and exhibiting these auxiliaries, and any possessive and relative pronouns of other languages as suffixes, or syllables placed after the words which they modify.

Of all the tribes possessing these languages, two only, with the exception of the Finns and Lapps, have effected a lodgment in Europe in such a way as to perpetuate to the present time any physical evidence of their former existence. These are the Magyars and the Basques. There are also phenomena in the Finnish, Lappish, and Celtic languages, which appear to render probable a former admixture with races which are now totally extinct.

Another family of languages belonging to the great continent is the Chinese, which, with its various Indo-Chinese dialects, consists of monosyllabic roots, not becoming dissyllabic by construction. These languages are not only incapable of inflexion, but do not admit the use of particles as a supplement to this defect, the position of words and sentences being the

---

* 'Report on Ethnology,' by Dr. Prichard, in the *Reports of the British Association for the Advancement of Science*, for 1847, p. 243. It is right to state that the substance of this section on language is borrowed from Dr. Prichard's Report.

principal means of determining their relation to each other, and the meaning intended to be conveyed.

The Syro-Arabian languages are a very ancient and important group, which appear to have been spoken from the very earliest times by the various nations inhabiting Asia to the westward of the Tigris. They also extended widely, and at a very early period, into Africa. The principal Asiatic idioms are the Chaldæan, the Hebrew, and the Arabic. Besides these are the Abyssinian dialects, the old Libyan dialects, and some others in Africa.

It appears probable from the present state of our knowledge, that only two races of people and two languages exist in the vast regions of Southern Africa. These are the Hottentots, in the most southern parts, and the great nation allied to the Kafirs of the eastern coast. They belong to one family, all their languages being dialects of one speech.

Central Negroland presents a multitude of languages or dialects which also have relations with each other sufficiently marked to induce us to regard them as being of one common origin.

The languages of the islanders of Polynesia are considered to offer resemblances, which cannot be the effect of casual intercourse, but are essential affinities deeply rooted in the construction.

In America, the northern extremity is peopled by the Esquimaux, whose language is known, and extends from Asia. Southwards, to a considerable distance, two great families of native languages are presented, one on the eastern, and the other on the western side; while still further southwards, and as far as Mexico, the Cherokees and other Indian tribes form a group with a distinct tongue. In Mexico are two principal and many less important languages, while South America contains a vast variety of different tribes, whose languages have been grouped into three, many of them, however, being very little known.

It may here be observed, that although languages, as intellectual creations of man, and closely entwined with his whole mental development, bear the stamp of national character, and as such are of the highest importance in the recognition of the similarity or diversity of race, they yet present many illusions to be guarded against, as well as a rich prize to be attained. Positive ethnological studies, supported by profound historical knowledge, teach us that a degree of caution is required in these investigations concerning nations and the languages spoken by them at particular epochs. Subjection to a foreign yoke, long association, the influence of a foreign religion, a mixture of races, even when comprising only a small number of the more powerful and more civilized immigrating race, have produced in both continents similarly recurring phenomena—namely, in one and the same race, two or more entirely different families of languages; and in nations differing widely in origin, idioms belonging to the same linguistic stock. Great Asiatic conquerors have been most powerfully instrumental in the production of striking phenomena of this nature.*

173 *Modification of the Races of Men.*—It is an important consideration that in many countries, where there has been no recent influx of different tribes, and where no cause of change is perceptible but the slow and gradual advance of civilization, and the progress of intellectual and moral development, there has yet been a very considerable modification of the physical characteristics of the prevailing races. It is desirable to consider how far this may have acted in past times with other portions of the great human family.

Civilization may, and in some cases does, produce two effects, as it not only occasionally modifies the existing race, but also drives before it and destroys less powerful, although indigenous tribes. Thus, if as seems probable, from the comparison of language, and from the occurrence of bones of men in places now covered up by deposits containing other human bones of great antiquity, there were originally Mongolic tribes over a great part or

* Humboldt's *Cosmos*, Col. Sabine's translation, (1846,) vol. i p. 354

the whole of Europe, including the British Islands, and if, as it is equally certain in Western Europe, and in the British Isles, there are no present indications of the race either in structure or appearance, we must conclude that the advancing and conquering nation has destroyed the indigenous tribes, without permitting the blood of the two races to become mingled. Examples of physical change in a race during the progress of civilization are seen in Germany, where the accounts given of the physical characteristics of the inhabitants only a few centuries ago oblige us to believe that the prevailing colour of the hair was then yellow or red, and that of the eyes blue. Without any further admixture of blood from a dark-coloured race, this has now undergone much alteration, for the prevalent colour, not only in the large towns, where mixture of blood may have been the cause, but also throughout the country, is certainly very different. With regard to this subject we may also refer to the authority of Dr. Prichard, who says, in his work on the *Natural History of Man*, already quoted, 'I can assert from my own observation that the Germans are now in many parts of their country far from a light-haired race. I have seen a considerable number of persons assembled in a large room at Frankfort on the Maine, and observed, that except one or two Englishmen, there was not an individual amongst them who had not dark hair. The Chevalier Bunsen has assured me that he has often looked in vain for the auburn or golden locks and the light cærulean eyes of the old Germans, and never verified the picture given by the ancients of his countrymen till he visited Scandinavia; there he found himself surrounded by the Germans of Tacitus.'*

It appears indeed beyond question, that not only the Teutonic race, but even the Celtic have undergone much change in this respect, for there seem to be abundant traditions asserting the prevalence of yellow, and even white hair among the people of that race, anciently inhabiting Ireland, Scotland, and Wales. Now, it is certain that the present Highlanders are by no means a yellow or red haired people generally, although some districts present this characteristic. The prevalent characters in most part of the north of Scotland are dark brown lank hair, with a fair complexion and grey eyes. Since the mixtures that have been most common in all the western nations have consisted of Celtic and Teutonic blood in some form, we thus have no reason in this respect for the change of colour. It must be referred partly, perhaps, to a modification of climate effected by drainage and the removal of forests, partly to different food, and partly to the different condition in which men now live.

The influence of a race of men migrating into a new country will necessarily differ in some respects, according to the circumstances under which they appear and are received. Conquest and simple colonization may, for example, produce different results, but still it appears from the experience of past times, and even of very recent immigration, that the more civilized race will generally prevail, and not only so, but will gradually destroy the aborigines of the newly visited tract. The traces that are seen in various ways of the existence of a race of men in Europe before the present Indo-European race was introduced, are so slight, and have apparently produced so little physical change, that they must be almost neglected in any consideration of this kind, and thus the new race must be regarded as having quite driven out and destroyed the earlier one. When we find a few tribes still retaining their places and natural characteristics in some mountain fastnesses, as the Basques in the Pyrenees, we see more clearly the possibility of such extinction of races, and may recognise the circumstances under which it is possible.

Of all cases of incursion presented in history, those of the Hellenic race into Italy from the south, and subsequently of the Teutonic race from the

* Prichard, *ante cit.*, p. 197.

north, and that of the Scandinavian branch of the same great family to Northern France and Britain, are the most remarkable and the most distinctly traceable. Others had occurred in earlier times in Asia, concerning which we know comparatively little that is definite, and a similar great experiment is now being tried in America, and also in Australia, New Zealand, and some of the other islands of the Pacific. In China, however, incursions have been made, the result of which is different, as there the conquering tribes, insufficient in number and inferior in cultivation, have only succeeded by superior physical energy, and have obtained the government without changing the people.

The lost races of antiquity naturally present many points of great interest, especially when from time to time their memory is recalled by the discovery of remains due to their labour or their ingenuity. Thus the Babylonians and Assyrians, the ancient and aboriginal tribes of Greece and the Etruscans, and the much later inhabitants of Lycia, nations which had attained to some degree of civilization, and amongst whom the arts of construction and sculpture were really and very successfully cultivated, have so far tended to modify succeeding and long subsequent generations of men, that we naturally inquire into the circumstances of their destruction. They appear before us as races of civilized men destroyed by barbarians; and although from these barbaric conquerors greater, more highly civilized, more intellectual, and more important nations have often arisen, still the first change was that of destruction effected by physical force against all the advantages of intellectual superiority. While, also, some of these nations—including several formerly inhabiting Asia Minor—were utterly destroyed and their cities buried in heaps of ruins, others, as the Jews, have survived, though as wanderers over the earth; while the Egyptians have retained their name and their place, although all the advance once made by them in civilization has relapsed into a monotonous and hopeless state of ignorance and slavery.

The events of the last two centuries have shown that the influence of civilized men determinately and permanently occupying a country may, as in North America, tend to the absolute extermination not only of tribes, but of many aboriginal races, and the day is perhaps not far distant when the so-called American Indians shall cease to exist, every effort having failed to induce them to adapt themselves to the circumstances forced upon them, and no real advance having been made in the modification of the race by the admixture of tribes or the introduction of civilization. Total extermination is manifestly a possible event with regard to a whole people, even where room is left for their existence, when they are encouraged to adapt themselves to new conditions, and when no check is put upon them beyond that degree of encroachment which would demand only a change of habit to render it harmless.*

174 *Mixture of Races.*—In various parts of the world circumstances have enforced a considerable mixture of the great natural families of men, and although there is some reason to believe that this mixture is not in itself natural, yet as it results in the production of such modified characteristics as may in the end form real groups, it becomes right to consider here some remarkable instances of the kind where the mixture of race has been complete, and where the two tribes combining are distinctly recognisable.

The extreme cases of mixture that can occur are, of course, those of different members of the three typical classes—namely, the Caucasian with the Negro or Mongolic, and the Mongol with the Negro. The mixtures of typical Caucasian, Negro, and Mongolic tribes with Americans and Malays are

* There is, however, an apparent exception in the case of the Cherokee nation, who are described as settling in villages, and giving up their wandering habits for the arts of civilization. The Indian tribes in some parts of North America, and especially in Canada, seem also to have cultivated the land to some extent, as within the historic period an Indian town stood surrounded by corn fields on the site now occupied by the city of Montreal.

interesting in the next degree; and many cases of admixture of the early derived races, such as Celtic, Teutonic, and Sclavic; Hindoo, Arabic, and Egyptian; or mixed European with mixed Asiatic races of the same original stock, are scarcely less interesting or important in an ethnological view.

Dr. Prichard has put it forward as his decided conviction, that races of men, of whatever kind, are equally prolific, whether marriages be contracted between individuals of the same or of the most dissimilar varieties, and he adds, 'If there is any difference, it is probably in favour of the latter.'*

America is a country where mixtures of the Indo-European race of various families (Spaniards, Portuguese, English, German, Dutch, and French, and even Jewish,) have been effected, under tolerably equal and favourable circumstances, with the American Indians of various tribes, and with many tribes of Negroes from the centre and west of Africa; and it has been calculated by M. Rugendas, (*Voyage dans le Brezil*, Paris, 1835,) that out of a population of upwards of thirty millions in various parts where settlements have been made, the proportion of mixed races is as much as fifteen per cent., that of the various Negro tribes being eighteen, of native Indians twenty-seven, and of whites of all kinds forty per cent.

Since the mixture of races appears in some cases to have produced a really new and intermediate stock, it may be well to mention the instances of this kind before proceeding to the subject of mixed races where there is still a doubt as to the permanence of unity of character of the produce.

Among the instances of new tribes formed by the mixture of two well marked races, that of the Griquas, or Griqua Hottentots, is mentioned by Dr. Prichard, as having been the result of the intermarriages of the early Dutch colonists of South Africa with the aboriginal Hottentots, while the so-called Cafusos form another race derived from the mixture of the native Americans of Brazil with the Negroes imported from Africa. The former tribes are a powerful and marauding race, living on the borders of the colonial territory on the banks of the Gareep or Orange River, along a distance of seven hundred miles. Some of them are thriving agriculturists, and others are collected into a large community settled under Moravian missionaries.

The Cafusos exhibit very remarkable physical peculiarities. They are described by Spix and Martius (*Reise durch Brazilien*) as being slender and muscular—of a dark copper and copper-brown colour—having an oval countenance, with high cheek bones, but not so broad as the Indians; broad and flattened nose, neither turned up nor much bent; broad mouth, with thick but equal lips, which, as well as the lower jaw, project but little; black eyes, intermediate in position between that of the Indians and the Negroes, and excessively long hair, half curled at the end, and rising almost perpendicularly from the forehead to the height of a foot or a foot and a half.

Another remarkable mixed race is seen in New Guinea along the northern coast, and in some adjacent islands, obtained from the mixture of Negro with Malay blood. These 'Papuans,' as they have been called, have large bushy masses of half-woolly hair, measuring from two and a half to three feet in circumference, and the people have for this reason been called 'mop-headed.' Their skin is deep brown, the hair black, the nose broad, and the lips thick, and the shape of the skull approaches that of the Malays.

The mixtures of white with negro blood in America offer many peculiarities worthy of notice. The first issue of the European and African (called *mulatto*) is a medium in colour, figure, and even in moral qualities; the colour being yellow, brown, or tawney, according to the complexion of the father, (mulattos derived from the marriage of a black man with a white woman are comparatively rare,) the hair curled and black, the iris dark, and the race superior in cleanliness, capacity, activity, and courage, to the Negro. The successive addition of European blood is considered to restore all European

---

* Prichard, *ante cit.*, p. 18.

qualities in the third generation, and the same number of generations is required to reduce the race to the original Negro. In the second stage, the *terceron*—the produce of Europeans and mulattos—the hair and features are European, and the former has no woolly curl, but the skin has a slight brown tint, although the cheeks are red. The next generation, the children of the European and the terceron (called the *quadroon*) are undistinguishable from whites.

An interesting variety is obtained by the mixture of European with native Indian blood in South America. The offspring in this case is called *mestizo*, and has the hair black and straight, the colour almost pure white, and the skin peculiarly transparent, the iris dark, the beard small, the extremities also small, and the eyes placed somewhat obliquely.

Among the various races of men, it is well worthy of notice, that the mixtures that most readily take place seem rather at the will of the lower than the higher race—the Negro woman willingly cohabiting with the white man at his pleasure, although the white woman rarely intermarries with the Negro man. It is also the case that the beardless or the woolly haired tribes acquire a Caucasian expression of beauty from a first intermixture, while very often both stature and form excel that of either type; and in another case, in the second generation, the eyes of the Mongols become horizontal, and the face oval. The crania also of the Negro stock immediately expand in their hybrid offspring, and the impression on subsequent generations is more durable than when the order is reversed.*

175 *Influence of Man on other Animals.*—There are perhaps many instances to be found in nature, where, owing to some local peculiarity of climate or vegetation, one race of animals multiplies to the injury or extermination of another, or is modified to adapt itself to altered circumstances It is only man, however, who is able to avail himself at will of the services of his fellow-creatures, and can induce them to change their place of habitation, their habits, and their natural tendencies, when such change conduces to his comfort or luxury. We must here consider a few of the cases where this modification is most decided, to understand fully the position of man in the scale of creation.

In establishing himself in a new country, the colonist will naturally endeavour to avail himself of the existing and indigenous animals, to introduce others most useful and necessary for his purposes, and to destroy those species from which he can expect no advantage, and which may injure the products he desires. In addition to this, and whilst introducing new animals and vegetables, he introduces also unwittingly others which depend on them for sustenance, and thus also tend to modify existing races.

The tribes of animals most useful to man, and which have been most generally domesticated, are, the dog and cat among carnivora; the ox, sheep, and goat among ruminants; the swine and horse among pachydermata; the rabbit amongst rodents. Each of these offers many facts showing the possibility of change in external form, and even internal structure, to a very remarkable degree, when exposed to the influence of civilization.

The dog as the companion of man in almost all countries has undergone changes so considerable, that it is now equally difficult to decide whether there was really but one original stock, or whether the numerous races are only fertile hybrids. Of all the dogs, that of Australia lives in the wildest and most natural state, and approaches in the structure of the skull most nearly to the wolf, exhibiting little sagacity, and being scarcely obedient to man. The Danish dog and mastiff come next in this respect, and are succeeded by the terrier and the hound, in whose skulls a larger cavity is left for the brain. The shepherd's dog has a very considerable capacity of cranium, and in the spaniel and water dog this capacity is still greater. These and the

---

* Hamilton Smith, *ante cit.*, p. 131.

other varieties differ much in their stature and size, and in the shape of their ears and tails, which latter have from sixteen to twenty-one vertebræ, varying in particular breeds. Some tribes have an additional toe or claw to the hind foot, and some have additional or false molars. The hair also varies greatly in different breeds, being in some almost absent, and in others extremely developed, either as long silky or woolly hair; and, in short, the dog presents all the varieties of hairy covering of the body met with in the entire class of mammalia.

Now all these changes and modifications of the natural and original condition of the dog are due to his association with and employment by man. He accompanies his master to all countries, hunts with and defends him in every climate and under all circumstances, never recurring to the wild state, or evincing any desire to recover his liberty. It is difficult to know which to admire most, the pliancy and adaptability of the servant, or the pertinacity with which the whole race clings to the intellectual and moral superiority of the master.

The ox and the sheep offer difficulties scarcely less considerable, and present varieties almost as marked as the dog. Whatever we regard as the source of domestic cattle, and whether they are of one or more original wild varieties, it is certain that they have undergone by domestication such changes in form, dimensions, structure, hair, horns, tail, and other important characteristics, that they are no longer to be traced back without the greatest difficulty. The breed of cattle introduced by the early settlers in South America has, however, succeeded in covering that part of the western continent, and is fast destroying many indigenous races. The sheep, also—one of the most anciently domesticated animals—is one in which very great varieties are displayed; and here it is probable that several species have become mixed, and that many of the breeds are fertile hybrids. Some when transported to foreign countries retain their peculiarities more distinctly than others, but all seem to undergo great change after a few generations, approximating to the local peculiarities of form and structure. In this animal, new breeds have been produced occasionally, by taking advantage of individual peculiarities and deformities, and no doubt the numerous varieties presented are all greatly influenced by human agency.

The horse is found wild in some parts of Asia and Africa, but it is very doubtful whether in either case we see the original species, and not a cultivated race escaped from civilization; and varieties of size, shape, and colour are so marked, that all resemblance is lost by which we can decide the question of original identity. The swine, if not so greatly varied, exhibits proof of change equally satisfactory, some breeds having solid hoofs, others very long ears couched upon the back, others a large pendant belly, and very short legs, while another, found at Cape Verd and other places, has large tusks, crooked like the horns of oxen.

On the whole, it undoubtedly appears that 'domestication effects a much greater change on the manner of existence than any removal from one country to another that can be imagined to take place during the continuance of the wild state. Its results are, in fact, more extensive on the nature of animals, for domestication is not a casual and temporary change effected in an individual, but the modification of a race, by which it becomes fitted to exist under new circumstances.'

The phenomena of variation thus offered, may be grouped under three heads, involving—first, differences of organic structure; secondly, physiological, and, thirdly, psychological differences.

The differences of organic structure depend at first either on an accidental variety propagated intentionally, and transmissible because of the tendency that exists throughout all nature to reproduce in the offspring the peculiarities of his immediate ancestor, or else of some modification directly produced by change of climate, better and more regular food, and more uniform shelter. External characters of many kinds connected with the skin, hair, &c., are easily modified in this way, and even the shape of the head and pelvis, the proportions of the extremities, length of neck, and other points of structure, admit of great variety.

Physiological varieties or diversities in the internal constitution are so frequently met with in individuals, that we can easily conceive differences to exist in races long detached from the parent stock, and subjected to the influence of man. The average duration of life, the number of the young produced at a birth, the period of gestation, the changes of constitution during life, these are points which may be regarded as specific; but even these yield, though to a smaller extent, to the effects of civilization and domestication. This is illustrated by the fact, that the cows of South America and those of Europe differ in the time of giving milk.

The habits and instincts of animals present, in the case of every species, a distinct psychological character, which has been less studied in its general natural-history value than as a subject of amusement and curiosity. These habits and instincts are, however, capable of modification in an extraordinary degree by association with man, and it is well worthy of notice, that instinct, to whatever degree it is cultivated in a race, is immediately and almost perfectly transmitted to the offspring, which accordingly will hardly require teaching to perform the same tasks. That this is the case in dogs, especially sporting dogs, has been long known; but it is also the same with other animals, as we are told 'the hereditary propensities of the offspring of the Norwegian poneys, whether full or half-bred, are very singular. Their ancestors have been in the habit of obeying the voice of their riders, and not the bridle, and horse-breakers complain that it is impossible to produce this last habit in young colts; they are, notwithstanding, exceedingly docile and obedient when they understand the commands of their master. It is equally difficult to keep them within hedges, owing perhaps to the unrestrained liberty the race may have been accustomed to in Norway.'*

On the whole, then, it is clear that man has by domestication, and especially as he has himself advanced in civilization, very much changed and modified many tribes of animals, removing them into distant countries, inducing them to accustom themselves to different climates, and training them to habits and instincts altogether new and peculiar; thus encouraging remarkable modifications in form, colour, integument, internal structure, and other points of animal economy, and, at length, permanently fixing numerous varieties, often more widely separated than the original type from nearly allied but very distinct species.

176 *Influence of Man on Inorganic Nature, and on the Vegetable Kingdom.*—Wherever man plants himself, and advances beyond the mere animal condition, by the exercise of his intellectual faculties—wherever, in a word, there is found any trace of *civilized man*, there we shall also find that external nature has undergone some change. Thus, when immigration takes place to a country covered thickly with virgin forests, which have continued in the same state for hundreds or even thousands of years, the forests are soon cut down, and are replaced by fields of waving corn. So where Nature has left wide stagnant pools, extensive barren tracts, or plains covered with plants useless to man, all these things are readily changed by his active exertions, and soon, in consequence of these alterations in condition, the climate also becomes modified; this again, as we have already seen in the case of Germany and elsewhere, reacting upon the physical characteristics of the inhabitants of the district.

In a former chapter, when speaking of the natural limits of distribution of certain vegetable and animal species, and the representative forms met with under similar conditions of climate in distant countries, some reference was made to the power of man in this respect, and his habit of introducing by

* Mr. Knight, quoted in Prichard, *ante cit.*, p. 72.

art many plants and animals into climates altogether new to them. This, we have also had occasion to consider, as far as animals are concerned, in the present chapter, and now it is only necessary to recal a few striking facts, which will illustrate the same general law in the case of plants and climate.

It is impossible even to imagine the original food of the human race, but we certainly know that the Banana and the Plantain must have been in use from a very early period, since neither of them, from the oldest times of which we have record, appeared in the state of nature, but only as essentially altered by cultivation. Very early, too, must men have made the large-seeded Grasses tributaries to his storehouse, for we know not the time when any of the plants now used as Bread-corn were transplanted from their native soil and rendered more useful to man.

'A striking phenomenon, which indicates the enormous antiquity of the culture of the *Cerealia* is that, in spite of many most profound investigations, we have not yet succeeded in discovering the proper native country of the most important kinds of Corn. Not one of the industriously inquiring travellers in America has ever met there with Maize otherwise than cultivated, or as evidently an outcast from culture. With regard to our European kinds of Corn, we have only very inaccurate indications that they have been found wild, here and there, in the south-western countries of Central Asia. But history proves that those regions formerly supported so large a population, and that there existed so high a condition of culture, that the assumption can scarcely be justified that those Corn-plants now found there are anything but descendants from plants which have escaped from cultivation.* From our knowledge of the great eastern portion of Asia, we are aware that in China a dense population can, by a certain degree of industrial culture, succeed in extirpating every wild plant, and in clothing the land exclusively with vegetables intentionally raised. Except some few water-plants in the purposely flooded rice-fields, the botanist finds scarcely any plant in the Chinese plains which is not an object of cultivation. Thus, it may not be at all impossible that the Cerealia—perhaps originally (as is the case now with so many Australian plants) confined to a narrow region of distribution, which was taken possession of at an early period by a strongly developing population—have actually wholly disappeared from our Earth in the character of original wild plants.'†

Other most important and beneficial changes have been produced by human agency in the case of various fruit trees (*e.g.* Apple, Pear, and Cherry), and in the common table vegetables of temperate climates. Who, for example, could recognise the Cauliflower, Savoy, and other Cabbages in the dry, nauseous, and bitter-flavoured Colewort—the undoubted stock of these vegetables; or who, comparing the cultivated with the wild Carrot, could believe that the one was derived from the other. In all these cases, by actual cultivation, man is able to modify particular plants, and render even those which are apparently injurious useful articles of universal and grateful food.

But much more than this is done—for the work is done on a far larger scale—by those processes of clearing and preparing for human habitation to which we have already alluded. Nor are these processes always successful in permanently improving the district subjected to their influence; for we find in ancient human records, or in those handed down by Nature herself, sufficient proof that parts of Egypt, Syria, Persia, &c., now burnt up by the sun, arid from want of water, and allowing only a very sparing population, were once clothed with vegetation, well watered by considerable streams, and capable of feeding as many thousands as there are now hundreds.

In contrast we may take the case of the Rhine and the country on its

---

* Wheat grown from seed obtained from Egyptian mummy cases of great antiquity has, within the last few years, been cultivated in England. It appears to have some peculiar and distinctive characters.

† Schleiden's *Plant*, translated by Henfrey for the Ray Society, p. 297.

banks, where is now raised one of the finest of European wines, but where in the time of Tacitus not even the cherry, much less the grape, would ripen. The disappearance of the forests commenced and originated the mighty change. So also, in other cases, the cultivation of clover, requiring a moist atmosphere, has passed from Greece to Italy, thence to Germany, and is now flying still further towards the Western Ocean. In Egypt, Pythagoras forbad his scholars to live upon beans; but no beans grow there now to feed them. The wine of Mareotis, celebrated by Horace, and capable of inspiring the guests of Cleopatra, grows there now no longer. The pastures at the foot of the richly watered Ida—Argos, once celebrated for its breed of horses—the Xanthus, with its hurrying waves—these are all histories of the past; they are reminiscences of what man has done, but they are now no longer possible.

We may conclude this view of the result of human cultivation in the words of Schleiden adapted from those of Elias Fries.*

'A broad baud of waste land follows gradually in the steps of cultivation. If it expands, its centre and cradle dies, and on the outer borders only do we find green shoots But it is not impossible, only difficult, for man, without renouncing the advantage of culture itself, one day to make reparation for the injury which he has inflicted; he is appointed Lord of Creation. True it is that thorns and thistles, ill-favoured and poisonous plants, well named by botanists *rubbish plants*, mark the track which man has proudly traversed through the Earth. Before him lay original nature in her wild but sublime beauty; behind him he leaves the desert, a deformed and ruined land; for childish desire of destruction, or thoughtless squandering of vegetable treasures, have destroyed the character of nature, and man himself flies terrified from the arena of his actions, leaving the impoverished Earth to barbarous races or to animals, so long as yet another spot in virgin beauty smiles before him. Thus did cultivation, driven out, leave the East, and perhaps the deserts, formerly robbed of their coverings; thus, like the wild hordes of old over beautiful Greece, this conquest is now rolling with fearful rapidity through America, the eastern countries becoming barren through the demolition of the forests only to introduce a similar revolution into the far west.'

177 *Effect of Inorganic Nature on Man.*—We have seen that whatever effect is produced by human agency on the animal and vegetable world, reacts on the human race in its turn, and thus at length modifies its physical characteristics. But the civilization of any great natural family of men is an event which depends on something more than accident, and which is doubtless very much influenced by the circumstances of external nature, so that it becomes necessary to consider how far we can fairly refer many differences that we see to such external influence as climate, fertility, and geographical position.

With regard to all these points, it seems certain that man, although perfectly capable of settling and becoming the permanent inhabitant of almost any part of the Earth, yet has not the higher qualities and powers of his nature developed except in temperate latitudes; where his time is neither entirely and necessarily divided between the search for coarse animal food and the repose and torpidity induced by extreme cold, nor, on the other hand, entirely at his own disposal, in consequence of the abundance of fruits presented by a too bountiful Nature and always ready at hand when he desires food. The former is the case with the Esquimaux and other tribes of Northern Asia and America, and the latter occurs in those warm islands and shores (of which there are many) where the labour of a day will supply a week's food, not only for an individual but for the family dependent on him, and where the lassitude arising from heat encourages almost total idleness. The north temperate zone has from the commencement of civilization been the cradle of all those races which have had force and energy to conquer, talents to govern, and ingenuity to advance in the mechanical and fine arts.

* Schleiden's *Plant, ante cit.*, p. 306.

Difficulties have always tended rather to excite the powers than to check the efforts of man; and, therefore, in the end, those who have had most to do in their contest with Nature have not only done the most, but have taken absolutely the highest place, and produced the greatest effect upon their fellow-men. At all times, the Chinese have exhibited a certain amount of civilization, and in ancient times the Egyptians, the Babylonians, the Assyrians, and the Chaldees, and the Hindoos in the eastern division of the great Indo-European world—more recently the Greeks, and after them the Romans—and in modern times, the inhabitants of countries still further west have taken the lead, and have carried the arts and sciences to gradually increasing perfection; but it is important to remember that this has been done in proportion as the climate of these countries has undergone change, and that the improved civilization of the western races has been accompanied, if not assisted, by a gradual equalization and amelioration of the temperature, the winter becoming less severe, and the summer longer and more available, even if the absolute amount of heat distributed in the year has undergone no considerable alteration. Thus each of the three great natural families of man inhabiting the temperate zone, have always presented some people of principal civilization, but those tribes dwelling in tropical countries have not advanced far, and many of them have never emerged from the darkness of absolute barbarism. And while we find the advancing nations of the western hemisphere always exhibiting their highest qualities where a necessity for exertion was evident without a satisfactory result being hopeless, the nations of America before the discovery of that continent by the Europeans had also attained a certain though small amount of civilization, presenting in some respects a parallel to the Assyrians and Egyptians, but not tending, it would seem, to any further or more useful advance, and thus to be compared with the Chinese rather than the Indo-European race.

Although an important relation certainly exists between the state and condition of nations and the circumstances of their physical geography, the opinion of M. Victor Cousin can by no means be entertained—namely, that if any country be examined in reference to the latter, it will be possible to tell *à priori* what is the condition of men in that country, and what part its inhabitants will act in history. The exceptions to this rule are important, for they occur in those cases where a mixture of blood or the immigration of a different stock has changed the tendencies of the inhabitants. The objects first to be obtained in a new settlement are food, needful raiment, and sufficient shelter from the inclemency of the weather. If these are either too easy or too difficult of attainment, the development of the race, so far as the exercise of the higher powers of human nature are concerned, is checked and prevented; but if these require moderate exertion and call for ingenuity, and if, moreover, the race is one of those in which intellectual advance is the rule, and not the exception, then may we expect that the very struggling to overcome difficulties will give fresh power and energy, and induce the exercise of the various useful arts and sciences.

178 *Statistics of the Human Race.*—There are some numerical and tabular facts regarding the human race in its various natural divisions, that seem worthy of notice in this place, as bearing upon the general subject before us. Thus, the estimated population of the globe, the way in which it is believed that population is distributed, the rate of increase, the limits of increase, the relative physical development of various races, the duration of life, and other similar matters, possess much interest, and assist us in obtaining accurate notions with regard to the human race.

According to Balbi, the actual present population of the globe is about 737 millions, distributed as follows:—

Europe, with its adjacent islands	227,700,000
Asia, ditto	390,000,000
Africa, ditto	60,000,000
America, (North and South,) ditto	39,000,000
Australasia, and other islands of the Pacific ...	20,300,000

The number of square miles of land on the Earth is estimated as about $51\frac{1}{2}$ millions, and, therefore, we have, on an average, about fourteen and a third persons to a square mile. To give an idea of the amount of increase conceivable, we may state that in China it has been estimated that more than a hundred persons, on an average, are planted on each square mile of that vast empire, although very large tracts are hopelessly barren; while, as the population of England and Wales at the last census was about fifteen millions, and the countries together contain about 50,000 square miles, there are seen to be with us not less than 300 on an average to each square mile. Of the whole population, however, one-third reside in large towns (of 10,000 and upwards).

The rate of increase of mankind it is not easy to calculate, except in very limited districts. In the thickly peopled districts of England, the increase in ten years, ending 1841, amounted in towns to 20·2 per cent.; in the rural districts to 11·2 per cent.; and in the whole population together to 14·4 per cent. The annual increase may, perhaps, be fairly estimated as being now about one and one-third per cent.

Of the whole population of the world, it is thought that about one thirty-third part (three per cent.) die every year, and that the stock is during the same interval increased by somewhat more than a thirtieth (three and a third per cent). This would give about $23\frac{3}{4}$ millions born, and $21\frac{1}{4}$ millions dying in each year. Although, however, the average mortality is reckoned so high, the mean average of life in the human race is much more than thirty years, and in spite of the large number of children and young persons who meet with an early grave, (one-fourth of the infants born dying before they are a year old, while half the whole number do not attain the age of twenty-two years,) the mean duration of life must be considered to amount to from thirty-eight to forty-two years, according to circumstances.

The number of male children born in civilized countries exceeds that of females by about one-twentieth part, but in consequence of greater exposure to accidents, the destruction of life by war, and unhealthy employments, the mortality of males is greater, and finally the women are more numerous than men. In Great Britain, at the last census, there was an excess of female population to the extent of 240,181, (being in the proportion of thirty-nine to thirty-eight nearly,) although there was during that period an annual excess of male births in the proportion of twenty to nineteen.

The average number of children to a marriage in Europe varies in different countries, from three and a half to nearly five and three-quarters, being least in Northern Europe and greatest in Savoy. It may be considered that the ordinary proportion in England is four births to each marriage. Perhaps one cause of the proportion being comparatively small in England is, that from prudential and other motives, marriages frequently do not take place till somewhat later in life than in many other countries in Europe; but another and more important one arises from the fact that so large a proportion of the inhabitants dwell in large towns.

The general proportion between births and deaths taken one year with another, and for a large extent of the civilized world, may be considered to vary between 100 and 150 births for every 100 deaths. It is probable that a larger proportion than the latter can hardly exist under the most favourable circumstances, while the former can only take place where there are some causes of unusual and even fearful mortality.

The true proportion between births and deaths for a number of years cannot at present be determined with certainty, owing to a want of accuracy in the registrations. In England, however, it is probably as 150 to 100.

With reference to the original peopling of the Earth itself, or of new countries, it has been calculated that under very favourable circumstances the human race may be tripled in about twenty-four years. It has, also, been supposed that the posterity of one male and female might in three hundred years, if not interfered with, amount to a population of about 4,000,000 of souls.

The ordinary mortality of a country with reference to its whole population varies, of course, according to the climate and mode of life of the people. In England (including Wales), it is estimated to amount to about one forty-sixth, that proportion of the whole population dying annually. In France, it is estimated at one-fortieth, and in Russia the same; while in some selected spots, as, for example, in North Wales and part of Surrey, it reaches to only one fifty-fifth.

In England, at the last census, the ages of nearly 16,000,000 of individuals were returned, thus giving very interesting facts with reference to the duration of human life. We quote this table as given in Macculloch's *Statistics of the British Empire*, (vol. i. p. 424) :—

Ages.	Population calculated for July 1, 1841.			Deaths registered in 1841.			Annual mortality per cent.			One death to so many persons living of each year as are in this table.
	Persons.	Males.	Females.	Persons.	Males.	Females	Mean.	Males.	Females	
0—1	429,419	210,507	218,912	74,210	41,444	32,766	17·355	19·726	14·984	6
1—2	429,803	215,493	214,310	27,268	13,987	13,281	6·353	6·503	6·204	16
2—3	437,276	218,208	219,068	15,027	7,516	7,511	3·441	3·451	3·432	29
3—4	410,077	203,653	206,424	9,914	5,028	4,886	2·422	2·474	2·370	41
4—5	401,555	201,238	200,317	7,164	3,620	3,544	1·786	1·802	1·771	60
0—5	2,108,130	1,049,099	1,059,031	133,583	71,595	61,988	6·349	6·833	5·860	16
5—10	1,906,576	953,893	952,683	17,868	9,093	8,775	·938	·955	·922	107
10—15	1,733,652	881,129	852,523	9,116	4,478	4,638	·527	·509	·545	190
15—20	1,588,340	782,425	805,915	12,056	5,604	6,452	·759	·718	·801	132
20—25	1,551,703	724,013	827,690	13,922	6,633	7,289	·900	·918	·882	111
25—30	1,284,020	611,390	672,630	12,889	6,045	6,844	1·005	·991	1·019	100
30—35	1,167,954	565,226	602,728	11,414	5,422	5,992	·978	·961	·995	102
35—40	885,306	435,430	449,876	11,195	5,385	5,810	1·266	1·239	1·293	79
40—45	888,806	435,991	452,815	10,510	5,251	5,259	1·185	1·207	1·163	84
45—50	639,202	313,709	325,493	10,244	5,322	4,922	1·607	1·700	1·514	62
50—55	634,940	307,435	327,469	10,811	5,673	5,138	1·710	1·849	1·571	58
55—60	392,166	189,816	202,350	10,552	5,418	5,134	2·700	2·860	2·540	37
60—65	440,110	209,248	230,862	13,813	7,090	6,723	3·155	3·395	2·915	32
65—70	259,839	120,829	139,010	14,071	6,881	7,190	5·412	5·706	5·178	18
70—75	224,431	104,138	120,293	15,569	7,630	7,939	6·974	7·341	6·607	14
75—80	120,015	55,653	64,362	14,525	6,992	7,533	12·152	12·586	11·717	8
80—85	70,494	31,136	39,358	11,681	5,358	6,323	16·662	17·242	16·083	6
85—90	24,008	10,149	13,859	6,550	2,841	3,709	27·418	28·047	26·790	4
90—95	6,541	2,493	4,048	2,243	898	1,345	34·677	36·091	33·264	3
95—100	1,421	497	924	604	220	384	42·972	44·352	41·592	2
100 and upwards	249	82	167	110	29	81	41·829	35·221	48·438	2
All ages	15,927,867	7,783,781	8,144,086	313,817	174,198	169,619	2·160	2·238	2·083	46

In this table the whole population of England is included, and the last column shows the mean mortality at any given age. Thus, between the ages of fifteen and twenty, one person out of every one hundred and thirty-two dies per annum. The annual mortality column, read without regarding the decimal points, expresses also the number who die each year of any age out of every hundred thousand.

The mean age of the male population of England, taken from this table, would be twenty-five and a half years, the young predominating, owing to the increase in the population, and the higher average of deaths in the earlier periods. If the community were stationary, the mean age of the people would be (*cæteris paribus*) thirty-two years, and the mean age of death a little more than forty-one years.

We have given these latter statistical details chiefly from our own country, because the information is, we believe, at least as full and accurate, and the general result as satisfactory, as is the case with any others that have been published. In many respects, too, they contain positive data not elsewhere to be obtained, but it is right to add that the Belgian statistics are also most carefully and minutely tabulated.

General Conclusion.

We have now reached the close of our work on this great subject of Physical Geography, and it might, perhaps, be thought advisable to revert to the main facts placed before the reader, or consider the general harmony of the subject and the mutual bearing of every part on the whole. But, in fact, it would be difficult to collect into a few pages the results of the numerous facts already presented in a condensed form, and it is better to give a simple outline of the advantage that ought to be derived by the student than endeavour merely to impress upon him the extent or the difficulty of the task. If we look back to the middle ages and notice the rarity of general information and the difficulty of obtaining it, we may perceive some excuse for the practical as well as intellectual ignorance of the multitude of that day. They could and did observe isolated facts, of whatever kind, even as we do now, and the phenomena of nature did not, we may be sure, then pass unnoticed by the shrewd and thinking men who were in a position to observe them. But there were no means readily at hand of spreading and comparing information, and thus, before the invention of printing, facts were almost useless, because they were isolated, and could not conveniently be worked into that form in which they become materials for generalization. The discovery of printing gave a facility for this, and then 'the sparks of information, from time to time struck out, instead of glimmering for a moment and dying away in oblivion, began to accumulate into a genial glow, and the flame was at length kindled which was speedily to acquire the strength and rapid spread of a conflagration.' But although this outbreak of science, and its sudden and vast expansion, and steady, unremitting progress up to the present time have indeed been marvellous, it is manifest that there is still much room for further increase when the people of each country shall be sufficiently well informed on every subject to bring their powers of observation into useful bearing, and occupy their leisure with distinct investigations of Nature and her works. It is the accumulation of knowledge by the people individually, that must be looked to as the source of great future discoveries, and such knowledge as that presented in the present volume is chiefly valuable as it gives useful, correct, and practical information to those who wish to learn and are willing to be useful. To quote again from the beautiful essay by Sir John Herschel, (already referred to above,) 'It is obvious that all the information that can possibly be procured and reported by the most enlightened and active travellers must fall infinitely short of what is to be obtained by individuals actually resident upon the spot.

Travellers, indeed, may make collections, may snatch a few hasty observations, may note, for instance, the distribution of geological formations in a few detached points, and now and then witness remarkable local phenomena; but the resident alone can make continued series of regular observations, such as the scientific determination of climates, tides, magnetic variations, and innumerable other objects of that kind required; can alone mark all the details of geological structure, and refer each stratum, by a careful and long-continued observation of its fossil contents, to its true epoch; can alone note the habits of the animals of his country and the limits of its vegetation, or obtain a satisfactory knowledge of its mineral contents, with a thousand other particulars essential to that complete acquaintance with our globe, as a whole, which is beginning to be understood by the extensive designation of Physical Geography; besides, which ought not to be omitted, multiplied opportunities of observing and recording those extraordinary phenomena of Nature which offer an intense interest from the rarity of their occurrence, as well as the instruction they are calculated to afford. To what, then, may we not look forward, when a spirit of scientific inquiry shall have spread through those vast regions in which the process of civilization, its sure precursor, is actually commenced and in active progress? And what may we not expect from the exertions of powerful minds called into action under circumstances totally different from any which have yet existed in the world, and over an extent of territory far surpassing that which has hitherto produced the whole harvest of human intellect? In proportion as the number of those who are engaged on each department of physical inquiry increases, and the geographical extent over which they are spread is enlarged, a proportionately increased facility of communication and interchange of knowledge becomes essential to the prosecution of their researches with full advantage. Not only is this desirable to prevent a number of individuals from making the same discoveries at the same moment, which (besides the waste of valuable time) has always been a fertile source of jealousies and misunderstandings, by which great evils have been entailed on science, but because methods of observation are continually undergoing new improvements, or acquiring new facilities, a knowledge of which it is for the general interest of science should be diffused as widely and as rapidly as possible. By this means, too, a sense of common interest, of mutual assistance, and a feeling of sympathy in a common pursuit, are generated, which proves a powerful stimulus to exertion; and, on the other hand, means are thereby afforded of detecting and pointing out mistakes before it is too late for their rectification.'*

It has been the object of the author to prepare a treatise which shall be useful in the way thus alluded to, and since ' one of the means by which an advanced state of physical science contributes greatly to accelerate and secure its further progress is the exact knowledge of physical data,' and that these data can only be known and made use of to advantage by the help of general knowledge of natural as well as mathematical science, he trusts that his portion of the present work is adapted to advance science in the right direction.

---

* Herschel's *Preliminary Discourse*, p. 349.

THEORY OF DESCRIPTION

AND

GEOGRAPHICAL TERMINOLOGY.

CHAPTER I.

§ 1. Nature and divisions of the subject. — 2. Of positive position. — 3. Of relative position.— 4. Of land and water in extent. — 5. Of land in elevation. — 6. Of water not in motion. — 7. Of water in motion. — 8. Of the natural productions of the surface of the earth.

NATURE and Divisions of the Subject.—Descriptive Geography has for its object to give the knowledge of the superficial character of the Earth's surface, and its productions, whether vegetable or animal. It is, however, impossible to confine it strictly to these things, inasmuch as no description of either its vegetable or animal productions would be satisfactory if it were not accompanied by the knowledge of the things on which they depend, as soil, climate, &c., which belong to the department of Physical Geography, and more especially of man, for whom the present state of the globe was designed, and those works of his by which it is covered. But this involves some historical considerations; for it must be evident that in the same place may be found the results both of man's present and past labours. The fisherman's hut stands on the ruins of Tyre, the black tent of the Arab on those of Nineveh, vegetables transplanted formerly may appear indigenous now, and therefore the description of any country must vary much, according to the time with reference to which it is given. Descriptive Geography is, however, more immediately concerned with the greater and more abiding features of the surface of the Earth; the division of the Earth into kingdoms and states, with its results, belongs rather to Political Geography; the changes effected by man's residence in particular places, to Topography; but the latter involves itself with the former so intimately that it cannot be separated from it, for the knowledge of places (τοπος, a place) includes both their natural character, and the effect of man's residence in them; the first coming under the head of Descriptive Geography, and the second under Political; but as Topography descends to minor details and measurements, which have no direct or at least apparent effect on the world at large with which Geography proper concerns itself, and as the limits of the present work preclude minute details altogether, the description of the surface of the Earth may more profitably be considered in it under two leading divisions :—

1. The Earth's surface and natural productions.
2. The Earth's surface as affected by the residence of man upon it.

The first, it will be observed, is but an extension of what has been already treated of in Physical Geography; the mode in which it is to be treated must, however, be different. Science, it is true, is one and indivisible, but it is presented to our minds under different phases and in various connexions, and the unity is preserved, if the principles on which it depends are not violated, even if it be viewed from another aspect.

To describe any given part of the Earth's surface, three preliminary considerations are required:—1. Position. 2. Extent, or horizontal contour. 3. Form, or vertical contour.

Position is both positive and relative. The first is determined by Mathematical Geography; the second is the result of extent and form, as has already been shown in Physical Geography. Extent is dependent on form; but inasmuch as we are accustomed to obtain our knowledge of the Earth's surface from artificial globes, maps, and charts, and that which is first apparent on them after the position, is the extent of the countries depicted, it is better in description to preserve the order in which they are given above.

2 *Of Positive Position.*—If the globe of the Earth were a perfect sphere, and did not revolve in one uniform direction, arbitrary means could alone be resorted to, to determine the position of places; but being an oblate spheriod, having its shortest diameter for its axis of revolution, two points and one circle are at once determinable on its surface. The points called the Poles, at the north and south extremities of that axis, are so named with respect to their relative position to a certain point in the heavens, to which the mariner's compass, by the magnetic power imparted to it, is directed. (See *M G.*, p. 6; and *P. G.*, p. 196.) In strict accuracy, a circle drawn round the Earth equidistant from those points, has its circumference greater than any other which can be described on the globe. (See *Chartography*, p. 179.) This circle, thus distinguished both in character and position, is called the Equator; by it the globe is divided into two equal parts or hemispheres, and another element for the right estimation of the position of any place obtained. In practice, however, the difference between this circle and any other drawn through two equidistant points on the globe, (having a longer diameter between them,) is inappreciable. As every circle is divided into 360 degrees, circles drawn through the poles, dividing the equator into that number of parts, or, if the scale admit, subdividing these again into minutes or other equal parts, will form limits by which the position of places may be ascertained; but as in a lateral direction—i. e. in the line of the equator—there are no fixed points like the poles, an arbitrary distinction between these circles has been necessitated, and this every nation has naturally made for itself, each reckoning these circles from some point apparently most desirable from local or political connexion. (See *Chartography*, p. 181.) We, in England, reckon from Greenwich, because the National Observatory is there; and these circles, called Meridians of Longitude, numbered from thence, enable us to ascertain the distance of any place from the meridian of that place in degrees; but as circles drawn through the same point approach each other, as they approach that point, so although the same number of degrees are estimated between each meridian, the length of a degree becomes less and less in proportion to its nearness to the poles. It becomes, therefore, necessary to limit the number of these circles, or the upper part of globes and maps would soon become confused by them; small divisions of lateral space must, on this account, be ascertained on a globe by the use of the brazen meridian and horizon, or by a graduated scale, or on a map by measurement. Degrees are thus estimated by inspection, but they may be reduced to miles by the rules already laid down (see *M. G.*, p. 72), or by reference to a table (see *Appendix* A), it being remembered that a degree at the equator is sixty geographical miles in length.

The meridians of longitude, or circles drawn through the poles, are of the same circumference*—viz., 360 degrees, of sixty miles to a degree, they are commonly called great circles; but, as those circles only can be great circles which are drawn through two points equidistant from each other, circles drawn, dividing them into equal parts, and consequently parallel to the equator, must be of less circumference, and gradually decrease as they recede from it: such circles are called Parallels of Latitude—parallel, because parallel to the equator, and of latitude now with justice, because they are on each side of it. The name, however, was adopted by the ancients when it was supposed that the extent of the Earth from east to west (its therefore so called longitude,)

* On the comparative magnitudes of small and great circles. (See *M. G.*, p. 21.)

was greater than that from north to south, therefore called its latitude. The latitude and longitude of any place—i. e. its position on the surface of the Earth—is ascertained by observing what meridian and parallel cut each other, or what minuter divisions intersect, where it is situated.

The position of the Earth with respect to the Sun, its annual and diurnal rotations, afford additional means of estimating position. The apparent path of the Sun on the surface of the Earth is indicated by a great circle cutting the equator diagonally, called the Ecliptic (see *M. G.*, p. 14) ; the two points equidistant from each other where the two circles intersect are called the Equinoctial points (see *M. G.*, p. 56), and these for certain periods afford points from which to measure distance in its relation to time and the seasons. The extreme distances north and south of the equator to which the ecliptic reaches, mark the extreme points at which the Sun is ever vertical; these are termed Solstitial: and the zone or belt thus formed round the Earth limited by circles corresponding to the 23½° of latitude, and called respectively the Tropic of Cancer and the Tropic of Capricorn, from the signs of the Zodiac farthest from the equinoctial points, is called the Torrid Zone, and any place lying within it is said to be within the tropics. Beyond this, as far north and south as the 66½° of latitude, the Temperate Zone extends, and from thence to the Poles, 23½°, the Arctic and Antarctic respectively.

In Physical Geography, as has been noted, other zones, having reference to temperature, climate, natural productions, &c., are recognised, and all these may be applied to the estimation of the position, but rather relative than the positive, of places on the surface of the Earth.

3 *Of Relative Position.*—As all estimation of position in longitude must be to a certain extent arbitrary, east and west are only relative terms, and although position, north or south, is capable of more exact definition, yet when applied to the position of places with respect to each other, they likewise become relative. A place near the South Pole may be north of another still nearer that point—may be north of one and south of another place, or east, or west, or *vice versâ.* This is relative position on the globe. Having determined the position of the great continental masses, we may, in describing any place consider—1. What position it occupies in them, and in which of its great natural divisions it is to be found; 2. To what physical division or district it belongs; 3. How it is affected by political divisions; 4. Its position with respect to commerce. Each of these may be again re-considered in a general or particular relation, in a topographical or restricted, or a geographical or more enlarged sense; and although our object is to avoid topographical details as much as possible, the description even of countries, whether considered in their physical or political relations, would be very incomplete were not both attended to.

Relative position may not only be considered in extent, but in elevation; the point of departure for calculation is, by common consent, assumed at the sea level; and it may be estimated not only in actual height in miles, yards, or feet, but in regions of temperature also, as already noticed, the temperature decreasing with the elevation. (See *P. G.*, p. 325.) As, however, this varies, not only with the elevation, but in proportion as it recedes north or south from the influence of the Sun's rays, position thus estimated is more especially relative. Vertical position may be reckoned not only above but below the level of the sea; some, but comparatively few, places on the Earth's surface being thus distinguished.

From the considerations already entered into in the part on Physical Geography, it is apparent that the horizontal contour of the land depends on the sea by which it is bounded, while that again is the result simply of depressions in the land; and thus the form or vertical contour of the Earth's surface is the origin of all its superficial divisions; it is also that which is most apparent to the eye of man; but, on the other hand, the elevations and depressions on the Earth's surface are, when compared with its extent, entirely insignificant.

4 *Of Land and Water in Extent.*—The principal divisions of the land are called Continents, those of the water, Oceans. Of the former, it was customary to reckon four, Europe, Asia, Africa, and America; to these some added a fifth, Australia. Having regard, however, to the meaning of the word, and guided by the practice of modern geographers, the definition already given (see *P. G.*, p. 216) has been adopted—Continent, that which is connected together and continuous. There are therefore only two continents, the Old and the New—the former containing Europe, Asia, and Africa; the latter, America, North and South; to these the terms east and west have been respectively applied. They are, of course, only relative. The oceans divide the continents from each other.

Ocean is a word adopted from the Greek, and, from the use of its cognates in languages of similar origin, seems to embrace ideas of extent and depth, as well as of production or generation. Bochart and others suppose it derived from a Syriac word which signifies to 'encompass.' This is probably consequent on the use of the word among the Greeks, who supposed the ocean to encompass the land, as its connexion with production appears to be the result of the mythological transmission of the history of the general deluge. In its largest extent it is now taken to mean the whole body of water on the surface of the globe, the surface drainage of those portions entirely surrounded by land alone excepted. It has been usually divided into five parts, all retaining the general appellation—the Atlantic, the Pacific, the Indian, the Arctic, and the Antarctic; until lately their respective limits were very indefinite, but in 1845 the Royal Geographical Society of London appointed a committee to consider the subject, and their report is thus given in Johnson's *Glossary of Geographical Terms*:*

'That the limits of the Arctic and Antarctic Oceans, respectively, be the Arctic and Antarctic Circles; that the limits of the Atlantic on the north and south be the Arctic and Antarctic Circles, that its western limit be the coast of America as far south as Cape Horn, and thence prolonged on the meridian of that Cape until it meets the Antarctic Circle; that its eastern limit be the shores of Europe, Africa as far south as the Cape of Good Hope, and thence prolonged on the meridian of Cape Lagullas, till that meridian cuts the Antarctic Circle; that the Indian Ocean do extend from India and Persia on the north to the Antarctic Circle on the south; that its western limit be the shores of Arabia and Africa, as far south as Cape Lagullas, and thence along the meridian of that Cape to its intersection with the Antarctic Circle; that its eastern limit be the west coast of the Birman Empire, and a part of the Malayan peninsula, the west coasts of Sumatra, Java, Timor, and Australia, as far as the southernmost point of Van Diemen's land, and thence continued along the meridian of that point to its intersection with the Antarctic Circle; that the Pacific do extend from the Arctic Circle on the north to the Antarctic Circle on the south; that its western limit be the east coast of Asia and of the Island of Sumatra, the northern shores of Java, Horn, and Timor, and the coasts of Australia, from Melville Island, round to the southern point of Van Diemen's Land, and along its meridian to the Antarctic Circle; and that its eastern limit be the west coast of America and the meridian of Cape Horn as far as the Antarctic Circle. It was further agreed, that the Atlantic and Pacific Oceans be subdivided into three portions—a northern, a southern, and an intertropical—and that the Indian Ocean have but two divisions, an intertropical and a southern.'

It is obvious that such questions as these can only be decided arbitrarily, for it will be observed, that some of the limits given are natural and some artificial, and as without authority the universal consent of geographers can scarcely be expected, it is not only within the province of such societies as

* We beg to acknowledge here, once for all, our obligations to this very useful and able little work.

the Royal Geographical Society to express an opinion upon them, but the duty of every geographer to submit his individual opinion to their collective decision. If, however, the universal consent of all students of this science is to be hoped for to anything upon its own merits, it might well be to this, for the limits given are, as was to be expected, clear and well defined, and subject to no reasonable objection.

(The Distribution of Land and Water, their normal shape, &c., are treated of in *P. G.*, chap. iv.)

Besides these great and more general, the ocean is susceptible of smaller divisions, dependent like them on the configuration of the land. The next in extent and importance are usually said to be Seas. The word Sea is of very indefinite application, being often convertible with Gulf or Bay. It is used in contradistinction to land in a general sense, and in its special, applied to divisions of the ocean, but apparently without rule. Some seas, as the Mediterranean Sea, are very nearly surrounded by land—some more open, as the sea of Kamschatka. The etymology of the word (from the Saxon *sæ secge*) is rather suggestive of the former, meaning a repository, basin, cistern,—this would, however, include the Gulf of St. Lawrence, Hudson's Bay and Baffin's Bay among the seas. Some lakes have been denominated seas, as the Caspian, and the Lake of Gennesareth, called sometimes the Sea of Galilee. It is much to be desired that some decision was arrived at in this matter by the Geographical Society. The word Gulf is, as has been seen, sometimes used convertibly with Sea; it appears to be properly the intermediate term between that and Bay; it is derived from the Greek, *κολπος*, implying hollowness, depth. Homer uses the word for a bay or creek, (*Il.* b. ii. l. 560,) and it is explained by Eustathius and Strabo to mean a sea enclosed between two promontories; it is generally esteemed to differ from a Bay in being deeper than it is broad at its entrance; the latter word being derived from a Saxon root, signifying to bend, (or possibly from *byge*, an angle)—any deep bend of the sea should in propriety be called a Bay, and in contradistinction to a Gulf, it should be wider at its entrance than in depth; but this definition will not hold good in practice, for then Baffin's Bay could not be so denominated. In the absence, however, of any exact definition of these three terms, the following may be proposed—a Sea, any deep recess of the ocean which may be entered by more than one principal channel; a Gulf, any similar recess, having only one; a Bay, an indentation of the ocean, lying open to it. In case, however, of the adoption of this, or indeed any exact definition, the present names must be changed. The Mediterranean and Red Seas would cease to be so termed, and Hudson's Bay and Baffin's Bay would become Gulfs or Seas. The term Bight is synonymous with Bay.

The passages by which a gulf, or such seas as the Mediterranean and Red Sea, communicate with the ocean are called Straits—as the Strait of Gibraltar. The term strait, occasionally but erroneously used in the plural, is synonymous with channel, it is applied to passages between islands, as well as between the ocean and a gulf, or Mediterranean Sea; and the words Arm and Sound are sometimes used for the same purpose; but the word Channel is equally applicable to rivers, and arm more properly to deep indentations having no second outlet. Strait is the same as straight, and is derived from words which imply elongation (stretching, straining). It is customary to write *straight* when the meaning is direct, *strait* when narrowness is implied, apparently without reason. A strait is a narrow passage, and the word has been applied to a defile or pass, between mountains. The word Sound has a similar derivation originally, but the Saxon *Sund* was used for a narrow sea or *swimming*. A Sound is therefore to be distinguished from a Strait, in not of necessity having a double communication with the ocean, and possibly as being of comparatively little depth—being in soundings, which is usually held to mean a depth of water of not much more than eighty fathoms. (For depths of Ocean, see *P. G.*, chap. v.) In the east of Scotland such indentations or channels are called Firths or Friths, which, if esteemed cognate with the Latin *fretum*, indicate the roughness of the water caused by passing such narrow channels; on the west coast of Scotland and in Ireland, Lochs, i. e. Lakes—the primary sense of this word is to shut in or enclose; and in Norway, Fiords. A small strait is also called a Gut. This word is also applied to the narrowest part of a strait.

The smaller divisions of the ocean, as they are more immediately related to the coast line, in its minute indentations, so they are best described in connexion with the land. Continental land has been already referred to as dividing the continuous surface of the globe into two great parts. All the minor appellations given to divisions of land in extent, excepting those which are properly diminutives, have no relation to size, and are therefore used equally for larger or smaller portions of the same character.

In describing land in extent it is desirable, first, to secure an accurate perception of its general shape, whether it approaches a square, a triangle, or any other mathematical figure, whether it be simple or compound, without paying attention to the minute indentations of the coast. This may be called its normal shape.*

The lines by which this figure is bounded may be measured either from one extreme point to another, or a mean may be taken, the latter plan has been adopted for the descriptive part of this work; their contents should next be ascertained; this may be done by reducing degrees and minutes of longitude and latitude into miles, and proceeding by the rules given, *M. G.*, ch. iv. §§ 2—6, with reference to the scale and projection of the map, by which the calculation is made—(see *Chartography*, p. 178, *et seq.*)—or by simple measurement on an artificial globe.

Having thus obtained a general idea of the shape and size of the land to be described, it must be considered in detail, first marking the larger and then the less important indentations or extensions of the coast-line. The principal extensions of land into the water, for they are applicable to all situations—are called Promontories: the derivation of this word from the Latin *Promontorium* (*pro*, before, *mons*, a mountain), indicates first its origin—viz., from the elevation of the land above the sea level—(this must always be remembered when the shape of land is considered); and secondly, that it is more properly used to denote high land. The word Promontory has no reference to size. The great southern triangular projections of the continental lands already referred to (see *P. G.*, p. 216) are thus named; smaller ones, of course, are very numerous. There are, however, diminutives used in the description of projections of very small size,—a Point is the low extremity of a Promontory,—a Cape (from *caput*, head) is a projection of the coast, or termination of a promontory, neither of great elevation nor yet altogether deficient in it. It may be properly used as a generic term for any projecting land, having no relation to elevation, or as intermediate between Point and Headland, the latter always indicating considerable altitude; a Point of small magnitude is termed a Spit or Tongue; a small Headland, a Bluff—this word is specially localized on the Ohio and Mississippi rivers in America. Foreland is synonymous with Headland, and the word Ness (i. e. nose, a projection) affixed to a descriptive appellation has the same meaning. This word is localized on the east coast as Bill, having the same meaning as on the south coast of England. Spits are sometimes found below Capes and Headlands. The word Tongue is usually the diminutive of Point, and applied to a small extension of low land.

Land projecting into the water, of whatever shape, attached on one side to a larger mass, whether continental or insular, is called a Peninsula, (from the Latin, *pene*, almost—*insula*, an island; in Greek, χερσονησος, *chersonesus*,

* Normal, from *norma*, a square—i. e., right angle, or angular measure—hence the use of the word to signify by rule, on principle, elementary.

land—island.) This word applies to any tract bounded on three sides by water. It is a mistake to suppose that all peninsular tracts of land are united to the main land by an isthmus; some are, it is true; but that which we call the peninsula,—viz., the countries of Spain and Portugal, as being the most important peninsula with respect to England, is not. An Isthmus (from the Greek, *ισθμος*, a neck or narrow passage,) is a narrow neck of land connecting a peninsula to a continent, or two peninsulas together. It is, however, perhaps more correct to explain the word as meaning a neck of land joining two peninsulas, as a continent becomes peninsular when thus attached. North and South America would be islands if they were not joined by the Isthmus of Panama, or rather of Central America; but the diminutive size of some peninsulas makes the former definition more easy of immediate apprehension, and it is most correct when applied to peninsular tracts in inland seas, lakes, or rivers—the detaching of which from the mainland would not alter its character.

Promontories and Peninsular tracts of land, Points, Capes, and Headlands derive, as has been noted, their extension from their elevation above the water; but land surrounded by it is termed an island, (see *P. G.*, p. 217,) (from *insula*, Latin, any detached place or building.) It is obvious that, if this word be taken in its customary acceptation, the two great continental masses are islands; its derivation, however, shows this to be incorrect, it should be a part of something, because detached Australia has, therefore, by some geographers been taken from out this category: a glance at the map will, however, show that it cannot be separated from the Malay Peninsula and its appendant islands. A number of islands in near juxtaposition is termed a group—many groups form an Archipelago. This word is, however, more justly applicable to a sea studded with groups of islands. It was originally applied to the sea between Greece and Asia Minor; its etymology is disputed, but it is probably from *αρχος*, that which rules, chief, and *πελαγος*, sea; either because of the Archipelago being the chief or most important sea to the Greeks, or because the islands command it.* Islands ranged in a line, whether straight or curved, are termed a Chain; such frequently connect a group to the mainland, or promontories and peninsulas to corresponding portions of the opposite coast. The Aleoutian Islands thus connect North America with Asia—the West Indian, North with South America. A small island is called an Islet or Ait: smaller elevations above the water-level, if composed of hard material, Rocks—if of soft, Banks.

Rocks when numerous or extended are called Reefs; when these run parallel to the coast, they are termed Fringing reefs; when they cross or impede a passage, Barrier reefs; when raised by the labour of zoophytes, Coral reefs; and these when depressed in the centre, or raised in a circular form, and inclosing water, are called Lagoon reefs or atolls. Rocks when serrated, or rising in sharp peaks, are termed Needles; to these when isolated, and rising abruptly from the sea, the term *vigia* (from the Portuguese, implying a necessity for watchfulness) is applied. Low rocks lying horizontally, especially when laminated, are called Shelves. Precipitous banks or rocks, whether near the margin of the water, or enclosed, are termed Cliffs, (from the Saxon, implying *cleavage*, i. e. cleft;) when steep and rugged, Crags, (i. e. broken, from the Celtic.) Berg is a German word, adopted with reference to the hilly banks of streams and elevations supposed to be the result of former fluvial action; it is also applied to masses of ice rising high above the water. The term Bank is often applied to portions of the land (either natural elevations or deposited by tides or currents) which are never above the water; these are also termed Shoals, but shoals are generally sufficiently near the

* This word was not in use among the Greeks, and seems to have been brought into the west of Europe in comparatively modern times. It is supposed by some to be the result of mispronunciation of *Αιγαιον πελαγος*, the Ægean Sea; but it seems difficult to account for the letter *r* being entirely dropped,—especially if its use be traced to the Italians, the first traders to that sea after the establishment of the Turkish power.

surface to be dangerous to navigation, which banks are not. The word Bank has also the more extended signification—the Banks of Newfoundland, for instance, occupy an enormous area.

As the larger projections and indentations of the land form the divisions of water called seas, gulfs, bays, &c., so there are particular terms applicable to those formed by the smaller; Headlands and capes form small bays; these, if nearly surrounded by land, are called Harbours (from the verb *to harbour*), because they afford protection to shipping. Where protection is afforded from all winds, the harbour is said to be land-locked; where partial protection only is afforded, it is called a road or roadstead; this word is also applied to any portion of the water where ships may anchor in safety from some winds; a small harbour is called a Haven, (from the Saxon, *hæfan*, in Welsh, *havyn*, a still place). If a harbour or haven have on it a town where trade is carried on, it is called a Port. Still smaller indentations of the coast are termed Inlets, Creeks, and Coves. The former is more properly used with reference to a small strait. The word creek is explained by its etymology from the Saxon *crecca*, a crack, and is therefore deeper and more irregular in form than a cove. Cove is the diminutive of bay, and indicative of an arched form. If access to a harbour or inlet of the sea, or river's mouth, is impeded by a shoal, or bank, or reef, the impedient is termed a Bar, because a barrier; these are described according to character and position, whether they are rocky, sandy, or muddy, shifting or permanent, central or on one side.

The margin of the sea is called a littoral, coast or shore. The Latins used the word *litus*, from the verb *lino lĭtum*, signifying to overlay, to anoint, for the line of the land which is washed by the sea; hence our word littoral. It is termed by sailors the sea-board. The Austrian Provinces on the coast of the Adriatic are especially termed 'littorale.' The word coast is derived from the Latin *costa*, a rib, which was applied to the margin of the sea, probably because it encloses or bounds the sea. The modern acceptation of the word is, however, somewhat more extended. It is applied to all land near the sea, and is synonymous with, but more commonly used than littoral; while the word shore is applied to the part which is washed by the waves (yet the expression going ashore is equivalent to landing). Shore is applied to lakes, but coast is not. The word Coast is also, but with less propriety, used for the districts adjacent to the boundary or frontier of any country whether limited by sea or land.

The coast line is the line drawn on maps and charts to indicate where land and water meet. The expression, line of coast, is more general. A coast is said to be high or low, rocky or sandy, continuous or indented, concave or convex, fertile or barren.

The character of the coast is important with respect to the commerce, as well as the defence of any country, it should, therefore, be always carefully described. This may be done under three heads, as suggested in the *Glossary of Geographical Terms* already referred to, and as, indeed, all land ought to be described.

1. The outline or plan of the coast; 2. The profile; 3. The composition.

The first has reference to extent, the second to elevation, the third is more properly geological.

The shore is said to be shelving or steep-to, according as the angle formed by it with the water line is small or great.

When shelving, and alternately covered and exposed by the ebb and flow of the tide, it is called a Beach, (possibly derived from the Saxon *bec* or *boc*, equivalent to the Greek *φαγος* in the sense of corroding, it being washed away or altered in form by the waves.) If composed of small stones, it is termed shingly, (perhaps from the Greek Σχιζω, to divide.) The adjective muddy is sometimes united to the word shore—a muddy shore is when a continuous bank is formed by the current throwing up the mud brought down by the rivers, as on the coast of Guiana; this, as will be seen, frequently alters the course of the mouths of the rivers themselves.

The action of water in wearing away parts of the coast of the sea, or shore of a lake or river, exposed to its influence, is termed (from the Latin) abrading or abrasion. (See *P. G.*, p. 251.)

When the water forced by the tide, or wind, or even by a current, over rocks or shoals, foams and roars, the term Breakers is applied to it, and sometimes, but incorrectly, to the rocks or shoals. When, in like manner, it breaks directly on the shore, the word Surf (? from the French *sur-fait*). The flow of water in one direction is called a Current, when forced rapidly between parallel ledges, or reefs of rocks, or sandbanks, a Race. When the tide wave, compressed in a narrow channel, rises with great rapidity and a terrible noise, it is called (from the Saxon) a Bore. (See *P. G.*, p. 232.) This is to be observed in the extremity of the Bristol Channel, the Bay of Fundy, and, more or less, in all similar situations, especially where exposed to the direct action of the tidal wave. When by the force of the tide or current pressing the water diagonally against the shore, or between rocks or banks, a circular direction is given to it, or where a similar effect is produced by the meeting of two currents, or by deep holes producing a downward suction, this is termed an Eddy; in the latter case, when very large and powerful, it is called a Whirlpool. These words are used indifferently with respect to both salt water and fresh, to lakes and rivers, as well as the ocean.

5. *Of Land in Elevation.*—Under the appellations which have been explained are included all that relates to extent of land, and by which it may be described in that relation. This is, however, rather apparent than real, being, as before observed, entirely dependent on contour, or the elevation and depression of its surface; but as the level of the sea is the apparent limit of the land, all beneath it belongs more properly to the division of Marine Hydrography. From the horizontal profile of the land, description must proceed to that on which it depends, the vertical profile. From the level of the sea the land rises irregularly. The highest elevations appear to man much more considerable than they really are; he judges of them by their relative proportion to himself and the limited sphere of his own observation, and not with reference to the globe on which they are raised. When their height is estimated by this rule, it will appear that though on the elevation of the land all its other superficial features depend, as well as those of the water by which such large portions of it are covered, yet that they are relatively very inconsiderable. Kunchinginga, which is now generally considered to be the highest mountain in the world, is about 28,177 feet in height; the mean diameter of the earth is 7912 miles; but estimating the greatest elevation on the surface of the globe at 30,000 feet, and the diameter at 8000 miles, to make the relation more apparent, the proportion will be as 30 to 42,240, or 1 to 1408. Mr. De Morgan, in his very able work *On the Use of the Globes* (c. iii.), gives the following calculations with reference to the irregularities of the Earth's surface:—'The Earth is really a slightly flattened sphere, having the axis passing through the shortest of all its diameters. The shortest radius, or semi-diameter, being half the axis, is 3949 miles. The longest, which belongs to the great circle having the ends of the axis for its poles (called the equator), is 3962 miles. On a globe of eighteen inches in diameter, this difference of thirteen miles would not amount to so much as the thirtieth of an inch, and it would be altogether useless to take any account of it. (See *Chartography*, p. 179.) We shall then suppose the Earth to be a sphere, with the mean semi-diameter of 3956 miles, so that, roughly speaking, 1000 miles are $2\frac{1}{4}$ inches, (more accurately 2·275 inches.) The mountains are not represented; one of thirteen miles high (and we know of none such) would not prick the fingers through the varnish with which the globe is covered, which, therefore, much more than represents a universal deluge. Supposing the atmosphere to be forty miles high, it would nowhere rise a tenth of an inch from the globe.' With such knowledge, the inconsiderable relation of the highest elevations to the size of the globe need not be insisted on, but in their relation to Physical Geography, and to man, they are of the greatest importance. The tendency of water to seek its level makes

the position and quantity, as well as character of the waters of the globe, dependent on its contour; every conical projection, every ridge, in short, every elevation of what sort soever it may be, becomes a watershed; and that knowledge of the height, slope, and direction of the various watersheds of the Earth's surface the first step to its general contour. The word watershed in geographical definition, implies the line by which any waters are divided from each other, and the watershed of any country is no doubt such a line; but as every slope sheds water, and many rivers have their rise on slopes below the main watershed, some further division of the word, some classification of the districts to which it is applicable, appears highly desirable. As this does not seem to have been ever attempted, the following is offered as a suggestion:

That there is a line in every country, which may be termed its principal watershed, will not be disputed; every country has some one district, usually in the direction of its greatest length, more elevated than another, from the sides of which the waters collected from snows, dews, rain, and springs, pour down, until they are received into the basin of some inland water, or at last into the sea; this may, therefore, be properly termed its primary watershed; but, as the mountains of the world cannot be satisfactorily considered except in their relative connexion, the highest ranges extending through the greatest length of the continental masses, the term primary watershed should be confined to these; beyond them others of less considerable elevation are found, the slopes of which are presented towards the primary watershed and form with it deep hollows, into which their united waters are poured, while from the opposite slope the waters collected descend in a different direction. These may, not inaptly, be termed secondary watersheds, as paying the tribute of part of their waters to the primary, and forming the inferior limit to the principal river basins; while others rising beyond may be called tertiary. It will be observed that this classification affords not only a systematic division of the elevated land, but also of the waters of the globe; as appertaining to any of its parts, rivers having their rise in the primary watersheds may also receive a similar designation, as may their basins; others may be termed secondary or tertiary, according to their position and the watersheds to which they belong.

The highest elevations on the surface of the Earth are called Mountains, but this term is applied to elevations varying from less than 3000 to more than 28,000 feet, and it has long been a difficulty in geography to find an accurate definition for this word, which, derived from the Latin *mons*, (*quasi μονος*, as standing alone,) was applied originally to very inconsiderable elevations. Mountain and Mount appear to differ from each other in the latter being single, and the former, possibly, collective; many mounts may assist in forming a mountain; but in the lower elevations the words mountain and hill are used synonymously, as we say, the Welsh hills or the Welsh mountains. Some have proposed to confine the word Hill (Saxon, from a root signifying elevation, or, possibly, to hide.) to summits not rising more than 1000 feet above the level of the sea. If this were done, some classification of mountains besides that of elevation above hills, would still be necessary. Others have been disposed to regulate the application of the term by the geological structure of the elevation in question, esteeming mountains the effect of upheaval, hills of denudation, but this could scarcely be a test of its geographical propriety; for the same reason the connexion between the classification proposed and the geological characteristics which may be traced in its divisions, is not more enlarged upon, but taking the primary, secondary, and tertiary watersheds of the Earth as mountains, and all others as hills, we shall find the former ranging, on the average, above, and the latter below, 2000 feet. In lands detached from the great continental masses the mountains may be classified with the chains of which they are extensions, and thus opportunity will be afforded not only for systematic arrangement but systematic comparison. Undulating grassy hills are in

England called Downs; undulating sand hills, in some localities Dunes—words of kindred origin with the English *down* as opposed to *up*.

To describe the configuration of the land in its varying contour, many terms have been adopted by geographers. A more or less conical summit is called a Peak; a connected line of summits, a Ridge, or Range; to such, if they present many peaks, the term serrated (from the Latin *serra*, a saw in Spanish *sierra*,) is applied. Crest is a general term for the highest part of a mountain. A Pass is, as the meaning of the word would suggest, the place between the peaks, or higher elevations, where a mountain-chain is passable. Passes are usually at the angle formed by one part of a chain with another, or of a main chain with its spurs or branches, and consequently being at the head of valleys, are also (as will be seen) at the head waters of rivers. The word Branch is, however, more applicable to a river than a mountain. A pass was sometimes by the ancients called a gate, (by the Greeks, *πυλων*, *pylon*,) as it is now by the Spaniards; *port* is used on the Pyrenees, *pertuis* on the Jura; its French equivalent is *col*, narrow; a pass, or portion of a pass, more narrow than the rest, is termed a *Gorge*. This term belongs more properly to the channels of the upper waters of the smaller feeders of rivers and mountain torrents. It differs from a Defile in being always near the summit of a mountain, while the latter name is applicable to any narrow passage between precipitous rocks, especially if long and winding. All these terms appertain to mountains.

Both mountains and hills are the boundaries of valleys. The term Valley may be applied to any depression on the surface of the globe. The largest valleys form the beds of the great oceans. Seas, bays, gulfs, &c., are all valleys below, or partially below, the level of the sea. Valleys, in the common acceptation of the word, are those depressions which are observable above the sea level, and which form the beds of rivers and basins of inland seas, lakes, &c. They will naturally class themselves with the watersheds to which they belong. Those which lie between the primary and secondary ranges, and form the beds of the principal rivers, will be classed first. In Europe, for instance, we find four principal valleys, those of the Danube, the Rhine, the Rhone, and the Po. Valleys have been divided (see Johnson's *Glossary*, pp. 44, 45,) into principal, whether longitudinal with, or transverse in their direction to, the mountain-chains by which they are bounded; lateral valleys, those of inferior order, which join the principal; high, or mountain valleys; and low, or valleys of the plains. These terms, however, are rather descriptive epithets, and explain themselves, but do not afford any regular classification. Apart from their relation and position with respect to mountain-chains, valleys differ from each other in depth and shape as well as extent. The most important distinction to be remarked is, whether, as is most usual, a valley gradually expands from its upper extremity to its mouth, or is bounded and partially enclosed by lateral ridges, or even so surrounded as to afford no outlet for its waters. In the latter case, it was proposed by Malte Brun to call the lakes which such valleys usually contain Caspians. The word valley is from the Latin *vallis*. Vallum seems to have been applied indifferently to the ditch or the palisade, by which the Romans surrounded their camps. Vale is the diminutive, and is more properly used with reference to the undulating depressions between hills. The word intervale is used in America to signify the tracts of rich alluvial land often found in valleys; it has occasioned some difficulty, and has been variously explained. Dugald Stewart esteems it equivalent to '*inter vallos Spatium*,' the space between the palisades, and remarks that, having been first used to denote a limited portion of longitudinal extension generally, it became afterwards more usually applicable to portions of time.

Valleys seem to demand a double classification; first, with reference to position; secondly, as to character; the latter being in no manner dependent on the former. Valleys containing their own system of waters are found below the level of the sea as well as on high mountains, while those which have only a narrow outlet may contain either a river or a lake. This, however, offers a characteristic sufficiently well defined. Valleys may therefore be described as lake or river valleys; these, again, as longitudinal or circular, confined or open. The term basin might have been used with much propriety for enclosed valleys, had it not been adopted to express the whole surface drained by any system of waters (see *P. G.*, c. v., pp. 233, 239.) The word basin (possibly from the Greek *βασις*,) adapted from *bassin*, (Fr. basin or bowl,) has been defined (Johnson's *Glossary*, p. 10) as a more or less extensive, and more or less concave portion of the Earth's surface circumscribed on all sides, or on all but one, by watersheds, and formed of all the slopes whose waters are received into a common receptacle, whether this be a river, lake, or inland sea. Basins may be classified as lacustrine or fluvial, equivalent to lake valleys and river valleys. The word is also applied to valleys below the level of the sea, and may be Oceanic or Mediterranean. A fluvial basin may be either the confluence of all the valleys which unite their tributary waters in one stream, or each valley by itself; or, in general terms, it may be applied to any well-defined direction of the course of a river formed by lateral shores from the main watershed, thus it is not unusual to say, speaking of a river, 'the basin of its upper waters.' Lacustrine basins are, more properly speaking, those which contain caspians, or lakes which have no outlet for their waters, but it is not confined to them.

The watersheds are then the limits of the basins, the character of which determines that of the waters which are found in them; but not unfrequently sloping at a very small angle with the level of the sea, they spread out into extended tracts, to which various names have been given descriptive of their character, but varying with the locality and the language of the inhabitants. The words plateau (from the French) and table-land have been already applied (see *P. G.* p. 223) to tracts of considerable elevation and of small inclination. These may be on the tops of mountains or on their sides; plains are to low land what plateaux are to high land. The whole surface of the globe may be divided into hills, valleys, and plains; but very widely extended valleys, as in North and South America, become plains, from the extent being more than commensurate with the height of their watershed. Plains may be crossed by hills, may be undulating or flat, fertile or sterile, wet or dry; if green and even partially fertile, they are in North America called Prairies — i. e., meadows. These are classified as dry and rolling, or wet; to the latter, perhaps, the term Savannah would be most properly applied, for damp grassy plains are so called in America. On the contrary, Llanos are, like the former, dry; such are to be found in all parts of the world near large rivers alternately fertile and arid. To the south of the river Amazon, they are called Pampas, a word used indiscriminately for the raised surface of the great plains which extend from that river to the Straits of Magellan. The former appellation is more properly confined to the valley of the Orinoco; the latter to that of the La Plata. In South-eastern and Asiatic Russia, similar tracts are termed Steppes, (from *step*, barren, Russ.) The term desert is usually applied to vast tracts covered with sand. These, however, have not an unvaried character, fertile spots are occasionally met with wherever, from any cause, water is present. All these tracts derive their appellations from their leading features. The word wilderness differs from desert, in being applicable to land covered with spontaneous and abundant vegetation, as well as to wild barren spots, among rocky mountains, as in the peninsula of Arabia. In India, a wilderness (usually found in moist places) is called a Jungle. Plains covered with low plants are in France termed Landes; in Germany, England, &c., Heaths, from the plants most commonly found on them. Land having its surface saturated with water, 'which from the concave form and impermeable nature of the bottom does not drain away,' is termed a Swamp or Bog; the latter, of Celtic derivation, indicates its binding and tenacious character, the former (Saxon) its spongy nature. The term bog is generally thought to imply a peat formation, while swamp is used more generally. Swamps may have trees growing in them (cedar swamps are common in America). Marsh is from a Teutonic root, and nearly allied to moor; it has generally a flow or rivulet running through it; by some, marsh is thought to be the generic term, and is also used with reference to meadows occasionally overflowed by the sea, or under a system of salt-water irrigation, which are called salt marshes. Fen is applied generally to low moist lands.

Having explained the terms used in describing land in its vertical contour and varying character, we proceed to those used with reference to water above the level of the ocean. The water on the face of the Earth is either at rest or in motion.

6 *Of Water not in Motion.*—Dew and rain falling, and snow melting in water, on the surface of the globe, collect in hollows, or trickle down in rills: or again filtered through its superficial strata, form Springs, (see *P. G.*, pp. 209, 211, 238.) Small bodies of water collected in hollows are called Pools or Ponds, the former when they are filled with running water, the latter when isolated, though a very small pond is often called a pool. The bed of a river, when partially dry in summer, often presents a series of pools; these would be erroneously termed ponds. A large pond is a small lake. These are not the converse of islands, inasmuch as they are not always, nor indeed very frequently, surrounded entirely by land, as islands are by water, but receive into and emit water from them. Lakes may be described in position, from the watershed to which they appertain. In character—they are of four kinds:—

First. Those which neither receive nor transmit water, i. e. which are neither fed by nor are the source of streams—such lakes are more commonly found in mountainous countries, are generally of small dimensions. Lagoons are sometimes similar in appearance, but owe their existence to the infiltration of water from, or the overflowing of, either the sea or rivers; they are therefore usually found in low lands. Lagoons are for the most part shallow, frequently dry up in summer, not unfrequently at one time connected, and at another disconnected from their parent waters. This is the case at Holyrood Pond, St. Mary's Bay, Newfoundland, the entrance to which being formed in winter by the force of the waves, is annually stopped up by shingle in the summer, and affords the inhabitants a plentiful supply of fish, which are thus placed at their mercy: it was formerly an arm of the sea, and many similar lagoons are formed by the blocking up of small harbours, creeks and channels by sand or shingle. Lagoons, though having thus an apparent relation to, are not to be arranged in the first class of lakes. Lakes and ponds being the result of surface drainage; lagoons, of overflow or infiltration.

Lakes, of the second class, are those which receive into, but do not emit water from them These are usually salt and brackish, often found in mountainous districts, high above the level of the sea, not unfrequently the result of volcanic action; sometimes below the level of the sea, as Lake Asphaltites in Palestine, erroneously termed the Dead Sea, and the Caspian. Lakes of this class are the receptacles of inland systems of waters and rivers which do not communicate with the ocean, (see *P. G.*, p. 218.) The third class is formed of lakes which do not apparently receive, but emit their waters; some do so by subterranean channels, as Lake Copais in Beotia did, and Lake Jouxin does. Lakes of this class are usually found at the head of rivers, especially in the passes of the primary mountain chains, frequently, as in the Rocky Mountains, at the sources of the Saskatchevan and Frazer's rivers, and in the Alps at those of the Inn and the Po, in immediate proximity to each other, while those rivers which issue from them fall down the opposite slopes of the watershed. The word Portage, i. e. carrying-place, is applied to the land between two such lakes, as also between any streams or lakes, or the passage round a waterfall or rapid, where it is necessary to carry boats or canoes and launch them again, to continue the inland navigation. The fourth class is the most numerous, consisting of lakes which both receive waters into and emit waters from them. These are common in the middle and lower courses of great rivers. Wher following each other in succession, or clustered together, the same terms, chain and group, are used which apply to islands. A chain of small lakes linked together by a river or stream, is called by the Germans a chaplet river. Where, in America, a river in its tortuous course forms a deep and wide extending bend, the same term is applied which we use in similar cases with respect to small streams; it is called an Eddy; this is correct; for great and small are only relative terms, and both are the result of the same kind of action, only on a different scale.

The water of lakes is subject to the same definitions and description as that of seas and oceans; the irregularities of their outline are expressed in the same terms, but the word shore is more generally used to express the margin or border of a lake than coast. Some lakes have, as has been noticed, the level of their waters below that of the sea, but the majority are raised above it; many, however, have the bottom of their basins below that level. Lakes in Scotland are termed lochs. The term lacustrine is applied to whatever belongs to, or is connected with, a lake, as Lacustrine basin, &c.

7 *Of Water in Motion.*—Water running down the sides of mountains, hills, or other sloping grounds, collecting in small channels, forms Rills, Streams, or Rivulets; the former is from the German, meaning a groove or channel (or possibly from the Scandinavian *strila, ryller*, to run or glide), the latter the diminutive of river. Stream is Saxon, and used as a generic term for water in motion, whether salt or fresh, without reference to magnitude on the cause of motion.

Streams which flow into other waters are termed affluent, when they flow from them effluent. Tributary streams are those which contribute their proportion to any lake, river, or collection of waters. It has, however, been justly remarked, that 'a tributary is not necessarily an affluent, though an affluent must be tributary,' for an affluent may receive the waters of other streams, and convey them to one common recipient, to which they would all be tributary, while to it they would be affluent.

The term effluent is equivalent to branch, which is not applicable to an affluent; the branches which rejoin the parent stream are called 'ana' branches;* those which at the mouths of rivers enclose and divide triangular tracts of land, to which from the Nile the term delta (the Greek Δ) has been applied, are called deltic branches; those which divide a delta into islands, but return again into a deltic branch, not flowing directly into the sea, ana deltic; those which connect two rivers together, conjunctive branches; and those by which water from the main stream is drained off into marshy or sandy places, drain branches.

The terms convergent and divergent should be applied to waters flowing into or out of a river when their character is not known; it is obvious that the one may be an affluent or an ana branch, the latter a deltic, drain or ana branch; these terms are, therefore, important in the exploration and the description of countries imperfectly known. When a river spreads into two branches, it is said to bifurcate, (*bis*, twice, and *furcus*, a fork, Latin, a pleonasm.) A bifurcation is usually a branch, and confined to the same basin as its parent stream; but in some cases, as in that of the Cassiquare, by which the waters of the Orinoco are connected with those of the Maranon or Amazon River, it connects two basins together. This term has, but without necessity, been applied to mountains. The junction of streams is termed their confluence, (*con fluo*, to flow together;) this frequently gives local appellations to places; in Welsh, names beginning with Aber indicate such a position.

The difficulty of classifying elevations of land and of applying the

* Ana, said to be a contraction of anastomosing, anastomosis being in medicine the inosculation (στωμα, a mouth, Gr.) of vessels together, or of veins with arteries. This is, however, unnecessary, for ανα, in composition, signifies back again, or in return, and such branches bring back again the waters which they before had taken away.

names used to express them, has been already noticed. The difficulty is as great with respect to running water. Estimated by comparison, many rivers should have diminutives applied to them. Compared to the Amazon, the Thames is but a brook, yet here the Thames is an important river. The difficulty is, however, capable of the same solution. The classification of watersheds gives at once a classification of rivers. A river (from *rivus*, Latin, a channel) is a collection of small streams or rivulets; many small rivers may combine to make one large one. The use of the word is not, therefore, confined to a main stream any more than it is dependent on proportion. That from which a river takes its rise, whether spring, lake, swamp, or glacier, is called its Source. Most rivers have more than one source, and as in the case of the Mississippi, the name of the least importance is sometimes selected to designate the whole. The principal source is to be ascertained by its elevation, distance from the mouth, and by the volume and character of the water it contributes. The junction of a stream with the recipient of its waters, whether river, lake, sea, or ocean, is termed its Mouth. This is, however, only applicable as opposed to Source, for some rivers flow through lakes and marshes. Rivers can have many sources, and may have several mouths, but the words can only be used with reference to their extremities. The mouth of a river is also called, from the French, its *embouchure*. This word is applicable to the mouth of a river, whether it be in a lake or in the sea; but when, flowing into the sea, the mouth of a river is modified by and subject to the influences of the tides, it is termed an Æstuary, a name derived either directly from *æstus*, the tide, or from *æstuo*, to boil, (Latin, implying restlessness,) and thus indicative of the effect of the tidal wave meeting the current of the river. The expression, Course of a stream, implies its direction, its current, the motion of its waters. This varies much in different rivers and in different parts of the same river, and is a marked and important feature to be noted in all, especially its rapidity as indicative of the elevation of its source.

Fluvial, fluviatic, and fluviatile are adjectives, expressive of formation from, or connexion with, a river, as fluvial delta, fluviatile lagoon, fluviatic formation; the first is most appropriate.

Rivers which have their rise in the primary watersheds of the globe have themselves the same appellation. This class will be found to include all the largest rivers in the world. The secondary watersheds will give their appellation to the rivers which are derived from them, and the more navigable portion of rivers will usually be found without their limits, and so on, but no classification or distinctive appellation has yet been suggested with reference to the character of rivers. This is yet a desideratum, (see Johnson's *Glossary*, on the word *River*, p. 39;) some approach to it has, however, been made by dividing the course of rivers into three parts—the upper, middle, and lower. This, however, can only be done satisfactorily when a river is connected with more than one watershed. There is, however, another classification, which is most important, in considering the globe in reference to man—rivers are navigable or not. A navigable river may be so from the sea, or only inland, or both; its navigable character may be consequent on its natural depth, or the effect of the tidal wave; in any case the consequences will be important to the country through which it flows.

The cavity in which a river flows is called its Channel; the bottom of the channel its Bed; the sides its Banks; (*bank*, Saxon, a bench, mound, or pile,) both are of importance in the description of a river. The first regulates its depth; if rocky and broken, it forms a rapid or fall; if level and extended so that it may be passed on foot, a ford. The banks may be sloping or steep, rocky, or fertile: if sloping, the waters may be extended; if steep, and especially when approaching the perpendicular, they will be confined, and not unfrequently the compression of water between high rock produces apparently a fall of water. This in North-west America is called a Cañon, from a Spanish word meaning a cylinder, or bore. The bed and banks of rivers vary much in different parts of their courses, and are dependent on the profile and character of the country through which they flow. Sudden irregularities of the surface produce some of the most important features in the description of rivers—the fall of water over rocks. To characterize this, various names have been given. A Cataract is a large body of water precipitated from a considerable height; the word (derived from the Greek, *καταρακτος*) implying force, violence, power. A Cascade is a small cataract. In cascades the water sometimes descends by successive leaps. A Leap is the fall of water, unbroken, from an inconsiderable height. A Force is the result of the narrowing of the bed of the stream; it differs from a cañon in being of less extent. Of all these the generic term is Fall, which has no reference to character, elevation, or volume of water, being applied indifferently to a mountain stream and to the Niagara, to the Falls of Wilberforce and of the Clyde.

8 *Of the Natural Productions of the Surface of the Earth.*—In the description of the characteristics of different parts of the Earth's surface—the opposite features of fertility and sterility have been already noticed,—these not only involve, of necessity, all the intermediate stages of vegetable productiveness, but the kind as well as quantity of the vegetable produced. Fertility is always the result of moisture, in river or lacustrine basins by the waters they contain; it is so even in the smaller, as when in deserts either a depression of the surface, a quality of soil more capable of retaining moisture, or the presence of a spring, produces those oases (*habitable*, from the Coptic) in which the contrast of the verdure they present, and the refreshment they afford with the arid waste by which they are surrounded, is so grateful to the traveller. In plains, vegetation is kept up by the plentiful dews which fall upon them. The valleys are, as has been noticed, connected together by their head waters being in the gorges or passes of the mountains, often in close proximity. Plains are always passable.

Animal life depends on the nature as well as the quantity of vegetation, and thus man partakes of the characteristics of the soil which gave him birth. Not only, then, shall we find the proportion and relation of land and water depending on the contour or profile of the former, but the vegetation, and consequent on that, the animal life;* and lastly, the human beings whose existence depends upon them, and whose character is modified by them, not less than by the communication which can be maintained between different parts of the earth; the consequent dispersion of mankind over its surface; and the subsequent spread of civilization and religion. From the consideration of the horizontal profile of the Earth's surface, it was natural to proceed to its vertical; the next step is the knowledge of its productions, which leads as naturally, as it does imperceptibly, to that of its inhabitants. Among those productions, it will, however, be necessary to include some minerals, especially gold, iron, and coal, as having exercised a direct and powerful influence over the progress of population in the world.

These subjects have been treated of generally as a part of Physical Geography; it is not necessary here to enter more into detail, and to explain the terms employed in the description, as in the case of land and water. They being generally well known, and not belonging solely to Geographical Description, while some have technical or local application, which will be noted in the proper place; of some, as prairies, savannahs, silvas, heaths, &c., notice has already been taken, (see *P. G.*, p. 218 to 225.) In this place, therefore, they need only be referred to. The word Forest (of a Latin or Celtic origin, but in any case from a root signifying to depart, and hence in the Romance languages equivalent to *strange, foreign*) is applied, in Geography, to an extensive tract of land covered with trees. In law and custom in this country, tracts of land which have had those rights, under the laws for the preservation of game, which entitled them to the appellation, were and are still called forests, though some-

* See sections in *Physical Geography* on distribution of vegetables, &c.

times without trees; hence barren tracts, as Exmoor, obtain that name. The Saxon term Wood, which has naturally no relation to size, is now used to imply a smaller extent of surface covered with trees than is meant by forest. In the description of forests and woods, the most important consideration is the character of the trees of which they are composed, to what use the timber they produce can be applied, whether it is capable of supplying the wants of man, and therefore whether it invites man to its own destruction and extends his influence over the face of the Earth with commerce and civilization. These are, perhaps, more influenced by the forests of the globe than by anything else, for though the path across plains is open for man and beast, and the head waters of rivers direct to the practicable passes of the mountains, yet an easier and more direct path is afforded by the sea, by which the richest and most productive soil, the alluvium about the lower course of the rivers, is brought into use, and the mouths of rivers connected together, as their basins are by the mountain passes; to avail himself of this facility, man requires ships, and thus maritime nations have perhaps owed their possession of that most desirable characteristic to the presence of timber fit for ship-building. It was so with Hiram and his Phœnicians, it is so with us and our American brethren. Forests being inhabited by beasts of chase, producing also a race of hunters; as plains feeding cattle are inhabited by Nomads (from the Greek, νεμω, to divide, distribute, and thence to wander and to feed cattle.) In like manner soils capable of producing cereal plants, or others fitted for the food of man, have a tendency to locate men upon them. Hence cities have first sprung up in fertile valleys.

It has already been shown (see *P. G.*, ch. 10. § 129) that limits are assignable to the productions of most vegetables—these limits enclose tracts called zones, and vary, as has been shown, from position and elevation; both have respect in some degree to climate and soil. It has been noticed that the cereal plants, with some other species, as well as the domesticated animals, have followed man in his progress over the globe. They should, therefore, be noticed in connexion with him and his works; apart from him those only of indigenous character ought to be noticed. Yet where he has not been, the character of the indigenous vegetable and animal life is an index of what he may, with ease and propriety, introduce into any country; and not unfrequently the peculiarities of animal and vegetable life affect the habits and character of man to an infinite degree. The moss of Lapland, and the reindeer, from which it takes its name, and whose food it is; the camel and the horse, the date-tree and the coffee-plant of South-Western Asia; the llama of South America, and the bread-fruit-tree of Polynesia, may be cited as marked examples, all probably indigenous, as the horse, sheep, and cattle of America and Australia, and the potatoe of Ireland, are exotic. The limits of some of these and similar natural agents affecting the life of man, both social and political, will be found clearly defined in the atlas adapted to this work, and in most physical atlases. From it, in connexion with the chapters on Physical Geography, sufficient general information may be obtained on this subject; its application in detail must form part of the description of different countries, and will be considered as it affects them separately.

CHAPTER II.

1. Of political geography. — 2. Of historical antecedents.—3. Of the distribution of the human race. — 4. Of geographical statistics. — 5. Of the order to be observed. — 6. Of the civil divisions of the world. — 7. Of the civil divisions of countries. — 8. Of religious divisions. — 9. Of the dominant religion. — 10. Of religious sects. — 11. Of religious statistics. — 12. Of the industrial geography of countries. — 13. Of industrial divisions. — 14. Of occupation. — 15. Of the pastoral. — 16. Of the agricultural. — 17. Of the manufacturing. — 18. Of the commercial.

OF *Political Geography.* — Political Geography has been defined (see *Admiralty Manual of Scientific Enquiry—Geography*, p. 129) as including 'all those facts which are the immediate consequences of the operations of man exercised either on the raw materials of the Earth, or on the means of his intercourse with his fellow-creatures.' This corresponds to the division already made—namely, 'the effect of man's residence on the Earth;' and this may with propriety be, in the widest and most comprehensive sense, termed political. It has, however, been customary to apply the term political principally to the geographical divisions and limits of empires, kingdoms, and states, their laws, mode of government, &c.; but as the polity of some countries has a religious, of others a commercial basis; as in some countries the religious system is separate and detached from the civil, in others a military rule has been superimposed upon previously existing civil and religious institutions; as in one country one predominates, and in another country another; the adoption of this without subdivision does not seem likely to conduce to a clear understanding of the subject. Man in his works, as apparent on the Earth, may perhaps be most usefully considered in three relations—religious, civil, industrial.

2 *Of Historical Antecedents.*—As in few cases, if in any, the geographical limits of the three divisions will be found to coincide with each other, the arbitrary division of the Earth by its rulers having generally been made to suit present interests: seldom, if ever, the physical features and natural relations of countries, or what is equally important, their natural divisions, still less the relationship or dissimilarity of their inhabitants: in short, the interest of the few having been consulted, and not that of the many, it will appear necessary to look back on the history of countries and their inhabitants, in order that their present anomalous condition may be understood; for not uncommonly it will be found that, in consequence of the different circumstances in which they have been placed, and the different rule under which they have existed, races similar in character and origin are found in very different stages of progress; so different, indeed, that they present no outward indications of their relationship. It is naturally the part of Geography to show how these changes have been affected by the physical character of the countries which the people in whom they are observable have inhabited; of History, to inquire into the political causes properly so called. Yet these two branches of the subject cannot be entirely separated, the physical may depend on the political; despotism, whether civil or religious, may prevent the gifts of God from being turned to account: anarchy may destroy what has already been raised by the industry of man, the fertility of Egypt has since the time of Joseph been the cause of the oppression of its people; the desolation of many parts of Italy is the consequence of the dominion of Rome, whether imperial or papal, commencing with its rise, and continuing to the present time. If, therefore, we would comprehend the present condition of the surface of the Earth, an historical inquiry into the changes which have taken place upon it during 'recorded time' must precede its description. This will affect different parts of the

world in various degrees. Of the past history of many parts little is known; of some, nothing. Yet even where little is known, indications are not wanting of the importance of the past. Of this, the remains of an extinct race recently discovered in the valley of the Mississippi will afford sufficient evidence. Our knowledge of the ancient world is, for the most part, confined to the accounts of the Hebrew, Grecian, Roman, and Alexandrine writers, and limited to the extent of their information, the boundaries of the Persian, Macedonian, and Roman empires, with the inroads and incursions of their rulers on the neighbouring countries, and the discoveries of Phœcinian, Cathaginian, and Egyptian mariners; and on this account, as well as because its application is principally in illustration of their history, Classical Geography must assume a more topographical form, and will be presented in the first place and by itself, that it may form a satisfactory basis for further inquiry. In it, however, as of universal significance, the division and dispersion of mankind, and their effects upon the world, cannot be fully treated of, although they may be noticed. A general sketch of these great influences must therefore precede the consideration of the political state of the world in modern times, as that must be preluded by a general description of the features and character of its surface; and the same method must be followed in detail with reference to every separate country; whenever it is desirable or possible to extend it so far; the political inquiry will then follow easily and naturally.

3 *Of the Distribution of the Human Race.*—To the various families of the human race, their physical and mental characteristics, and the natural laws to which they are subject, general reference has been made in the chapter on Ethnology (see *P. G.*, p. 388). This has of late years taken its place as a separate science, and it is not therefore now the province of Geography to enter into the philosophy of the subject, with respect to man as an animal, but to state what is known of the present localization of his species, and the geographical causes which have led to it. The former has been described generally, and must be more particularly detailed with respect to every country as it comes under review. The latter will be found chiefly in the configuration of land in elevation and extent, directing migration into certain natural channels, of which the primary watersheds afford general indications; those of the Old World, separating the north from the south, and concentrating the energies of various races round the great Mediterranean basin, thus uniting them all in one common progress; while those of the New World, far removed from its eastern limit, rendering the entire continent accessible by the mighty streams collected from their lengthened slopes, have given facilities for the diffusion of the races of the Old World, developed in physical and mental energies by concentration and collision, over its surface.

The use of the various paths of migration has, however, depended on the power of man to avail himself of them. The great plains offered facilities of migration to the pastoral inhabitants of the ancient world, to whom the seas were impassable. The coasts of the inland waters were therefore peopled long before communication existed between them. The valleys of the head waters of rivers were always, and are now, the only practicable paths across the primary watersheds; by them, therefore, the stream of migration has been permitted to pass, and by them communication is maintained. The valleys of the great rivers have, therefore, received inhabitants from their upper as well as their lower entrances. The proximity of a primary watershed to the coast may, as in the case of Africa and America, entirely cut off one portion of a continent from communication with the other for many years, and therefore cause considerable difference in the character of their population; this is moreover also affected by the varying physical characteristics of the countries themselves, which are again consequent on their vertical contour; and thus it also happens that the commercial exchanges and consequent intercourse of countries is often rather with distant people than with their neighbours.

Since the development of navigation, commerce has been principally carried on by means of the sea; the old paths of inter-communication have been therefore abandoned; modern science has discovered means of cheap and rapid transport over the land, and we may thus fairly expect to see them re-opened. Their disuse caused the decrease of population and civilization in the districts through which they passed, their restoration will cause their re-peoplement and enrichment; and thus Syria, the valley of the Euphrates, Asia Minor, Persia, the Balkan, may before long be again important to the world, as Egypt has already become, and as we see Central America, Upper California, and Texas are becoming.

As the general distribution of the human race over the surface of the earth has been consequent on its larger physical features, so has the local arrangement been upon the presence of agricultural or mineral wealth. Agricultural districts, not requiring a large population, or the possession of the knowledge of mechanical power in any great degree for their cultivation, have been early peopled. It is to the presence of mineral wealth, and the development of manufactures and commerce, that the congregation of numbers in small districts is owing; hence we find the greatest accumulation of men in masses at the mouth of rivers, in harbours, and where natural paths of communication intersect, directed by the necessities of commercial intercourse, or in mineral districts. In ancient times, the presence of gold, copper, and tin exercised great influence on the diffusion of population, and the extension of commerce. To the former is attributable the first efforts to unite Greece with the eastern shores of the Baltic in commercial intercourse, of Solomon to carry Phœnician traffic across the Isthmus of Suez; the commencement of the era in which we live was marked by the discovery of the gold-producing countries of the New World, to which a constant stream of emigration has been since directed, and in our own day California, and possibly Australia, may owe their population to the same cause. Tin and copper have carried the ships of Carthage to England, and the ships of England to the Indian seas, Australia, and America. But since the use of machinery and the application of steam as power, coal and iron have exercised the greatest influence in this respect. Nor is the providence of God in directing the distribution of the human race limited by the supply of the wants of man, the provision for the cure of his diseases has its peculiar influence upon it. Even in savage countries among the natives, as among the beasts of the field, periodical visits to mineral springs have always been observable, and in civilized countries men have always congregated and cities been built around them or in their immediate vicinity, while, too, in smaller degree, even salubrity of atmosphere and beauty of scenery have influenced this localization.

This distribution, as has been already noticed, being irregular both in space and time, it will be found to affect Political Geography in all its divisions. The civil limits, divisions, and polity of countries; the industrial habits of their people; and their relations with others, whether distant or neighbouring, and specially their religious faith and its outward expression, will be found to vary accordingly.

4 *Of Geographical Statistics.*—In all the divisions of Political Geography, and the inquiries consequent upon their consideration, the province of Statistics must of necessity be trespassed upon. Geography relating to, or rather combining together, all sciences in their relations to the Earth and to man; as in the case of Geology, Meteorology, Ethnology, or any other, so in Statistics, while the application and results of the science will be taken advantage of, they will be dealt with generally and not in detail. In none perhaps are the details so uncertain, in none, perhaps, the general results more satisfactory, more conclusive, or more useful. Materials for statistical calculations exist only in civilized countries, and may, in fact, be considered as no small proof of advanced civilization: their character will vary with that of the people to whom they relate, and be especially influenced by their habits and mode of life. They may be more easily attainable in some countries in the religious, in others in the civil or industrial divisions. In most countries, even the very savage, military statistics can be procured; their existence by themselves is

perhaps to be considered the first advance in civil polity; solitary tribes on the shores of the Polar Sea, of New Caledonia, Africa, Australia, and Terra del Fuego, alone existing without it. Industrial statistics, whether agricultural, commercial, or manufacturing, occupy the second place; social, medical, and educational, the third and most advanced; but the latter of these are closely allied to religion, and religious statistics are evidently independent of advanced civilization. Educational statistics will be found to depend rather on the character of the religion of any country, than either its influence or the extent to which that influence is systematized, from which the statistical accounts of it must in the main result; possibly the most systematic and thoroughly organized form of religion the world has perhaps ever known, the Roman catholic, may be found to have retarded civilization in exact proportion to its domination over its members, the exact and regular working of its machinery, and the consequent amount of statistical knowledge attainable respecting it.

Statistical inquiry, as relating to Political Geography, comprises all calculations of number; under the head Civil, the amount of population in the various divisions; the proportionate number of representatives, if any; of militia, military, or naval force; of taxes, and other public burdens and contributions, may be considered: under that of Industrial, the proportion of population to surface; the numbers employed in various trades and occupations; the products of agriculture, mines, manufactures, and commerce: under that of Religious, the numbers and proportion of the various sects into which the people may be divided. The Statistics of Education and Science will belong to either or all, according to the country under consideration; in Prussia, for example, neither the industrial nor religious can be considered apart from the civil. In all, however, care should be taken not to extend the inquiry beyond its geographical relation.

5 *Of the Order to be observed.*—Of the three divisions which have been recognised, we have placed the Religious first, as being in a great measure independent of the other two; it may be convenient to maintain this order in general description, and to vary it in particular, to take first a general survey of the extent and influence of the different faiths professed by the people of the Earth, and independently of their civil relations, and then to describe more particularly the religious divisions consequent upon them; for while, on the one hand, the principal religious systems of the world extend themselves without reference to political divisions; on the other, the ecclesiastical polity may be distinct from, and independent of, the civil; yet in separate countries, and under distinct governments, it naturally adapts itself to the civil divisions; and in exceptional cases, when it does not, they will probably be found the best, if not the only means by which its limits may be defined. Particular religious belief often attaches itself to particular races, the civil divisions of countries are not unfrequently the consequences of the localization of distinct races, and in this way, again, the religious and civil divisions may be found to coincide.

In the consideration, therefore, of Political Geography in detail, the following sequence of its divisions should be observed: civil, religious, industrial; civil, from the Latin, *civilis*—i. e., appertaining to citizenship, that which belongs or relates to citizens, or its complement—the state.

6 *Of the Civil Divisions of the World.*—The larger civil divisions of the Earth's surface are dependent on the arrangements made by the great human societies which inhabit them for their government, and receive various names, most of which are now used without being limited by strict etymological propriety. The first in rank and importance should be, and in some instances are, termed empires. These are governed by an emperor, in whom is concentrated the authority of the whole, (as the word 'imperator,' first applied to the generals of the Roman armies in the provinces who were the representatives in them of the power of the state, seems to imply.) This word was adopted by those who claimed similar authority to that exercised by the Roman emperors

whether in Italy, Eastern Europe, France, Germany, or Russia. Its import is now very various; it is used equally with reference to Russia, Austria, Brazil, China, and the Island of Hayti, all of which are governed by a ruler styling himself emperor. It is sometimes supposed to express the agglomeration of many separate kingdoms, states, or provinces, under one supreme head; but in this case Great Britain and her dependencies would be the largest and most important empire at present in the world, if not that the world has ever seen. This application of the term is true with reference to Russia and Austria, and partially of Brazil, or more correctly, the Brazils. Great Britain is often termed an empire, but its monarch has not assumed the title corresponding to that designation.

Kingdoms, countries ruled over by a king or queen, (Saxon, *cyng cynig*, German, *konig*, implying military rule,) stand next in rank to empires; yet some kingdoms, as those of Great Britain and France, being of equal, if not superior importance to any existing empires, there is no strict propriety in the sequence. The term monarchy (from the Greek, *μονος αρχος*, monarch—i. e. sole ruler) is applied equally to empires and kingdoms where the supreme power is concentrated in an individual. Monarchies may be hereditary or elective, despotic or limited; the latter are frequently termed constitutional, because the constitution, to which both the monarch and his subjects have subscribed, defines the limits of his power and their obedience. In despotic monarchies, the will of the sovereign is law; in limited monarchies, the law is above all will, and the power of the government is divided between the supreme ruler and the assembled representatives of the other power or powers by which that of the monarch is limited. Parliaments, chambers of peers, senators, deputies, diets, or other names, are applied to these assemblies. They differ much in their constitution and powers; some are hereditary, as the House of Lords, in England; others elective, as the House of Commons. Different qualifications are also required for their members. These varieties of constitution belong to the political history of the world. Political Geography, however, of necessity concerns itself with the great principles on which these varieties are based, as indicative of the origin of the families of mankind in which they are found; the physical character of the country in which they have been educated; or of that in which they are located.

A limited monarchy is, perhaps, to be considered as the agreement of the three great elements of government—the executive, the deliberative, and the suggestive. The first is involved with the monarchical principle, the second with the aristocratic, the third with the representative. The first expresses the will—the second, the mind—the third, the body of the people. When the first predominates, and in proportion to its predominance, the monarchy becomes more and more despotic; the ruler a tyrant, in the original acceptation of the term, (from the Greek, *τυραννος*, implying the rule of an individual according to his own will—i. e., without law;) when the second preponderates, and in proportion to its preponderance, oligarchical, (from the Greek, *ολιγος αρχη*, the rule of the few;) when the latter, democratical, (from the Greek, *δημος*, the people, and *κρατεω*, to rule—i. e., the rule of the many.) In different countries and among different races, we find tendencies to different extremes, as will be hereafter noticed.

It will appear in the sequel that these principles develop themselves co-extensively with corresponding religious and industrial conditions of society, and may be considered partly as consequences of them, partly as resulting from the physical organization of the races adopting them, and partly from the physical character of the country they inhabit, as inducing the corresponding conditions referred to.

Simple despotism appears traceable to the congregating of men in masses: when in cities, as the consequence of democratic ascendancy; among nomad races, of warlike and migratory tendencies requiring a leader. The former is observable in the Greek cities and colonies; the latter, among the Mongul races. The monarchical principle, on the other hand, appears rather the extension of the patriarchal, the king originally having similar jurisdiction to that of a father of a family; it is generally found in connexion with tribal and aristocratic institutions, and has its further development in the constitutional monarchies of Europe, especially in England. Among the ancients, it is to be found among the earliest inhabitants of Greece, the Persians, the Etruscans, probably the Egyptians. It is at present confined almost entirely to the races which have been styled Indo-Germanic or Arian (see *P. G.*, p. 396), of which the Anglo-Saxon is the type. With tribal distinctions, classification of trades and employments, social divisions, as of caste in India, local government, guilds, and municipal institutions, are traceable, as well as a tendency to connect these divisional authorities, whether civil, religious, military, or commercial, with property and tenure of land. The families in which they are found have, therefore, agricultural tendencies, and have taken the lead at a comparatively late period in the history of civilization, their development being slow, their tenacity proportionately great.

Democracy naturally develops itself among commercial and manufacturing communities; its first necessity is numbers confined to a limited space: the apparently exceptional case presented by the United States of America is so only in name, the government of that country being of a mixed character.

The word republic, (from the Latin, *res publica*, commonwealth,) in its ordinary acceptation, implies a government dependent on the will of the people; it is, therefore, properly a democratical form of constitution. Yet Rome, under the empire, was a despotism with republican forms; it had been previously an oligarchy under similar conditions. The word state (from the Latin, *status*, condition,) may be applied to any country having supreme authority within itself; it is generally used with reference to smaller political bodies, especially those united together for mutual advantage; such are those of Central Europe attached to the German empire, such the United States in North America.

The word colony may be applied either to a detached province of an empire, kingdom, or state; a city founded in a foreign country, but preserving its connexion by tradition at least with its parent; or a body of men emigrating from one country to establish themselves in another. Great Britain has her colonies in the first sense in North America, Australia, and New Zealand; in the second, at Aden; in the third, in her emigration and colonizing companies, the first bodies of emigrants sent out by them being often so called. The second was the application more common among the Greeks and Romans; the third has been very general in all ages. In this sense the Flemings founded colonies in England, the English and Scotch in Ireland, the Germans in Hungary and Spain.

The word capital should be applied to those cities in which the government of the country is carried on.

7 *Of the Civil Divisions of Countries.*—Geographically considered, we find under this head—

1st. The limits or boundaries of the country under consideration; the character of the frontier line thus presented, whether natural or artificial; the relation to and points of connexion with the countries by which it is surrounded. These should be considered under this division simply with reference to their general government, and they may have either a military or commercial relation. Artificial frontiers have hitherto required barriers against armed aggression or contraband trade, far more numerous and expensive than natural frontiers. We cannot violate the arrangements made by the Great Creator of the universe without suffering by our folly, and the evil effects of this error are perhaps more apparent and more felt in the character of the people bordering on such a frontier, than in the expense incurred in maintaining it.

Not the least important portion of the frontier of any country is its seaboard, if it have one. The possession of this gives freedom of action and comparative freedom from aggression on that quarter; opens direct communication with countries far distant; and enlarges the sphere of political action. It is the happiness of this country to possess no other, and to it she owes probably much of her political as well as her commercial importance.

As on an inland frontier the lines of fortresses and other artificial defences should be systematically described, so, on a maritime, the ports and harbours available for the outfit and shelter of fleets, the dockyards and arsenals situated upon them, with their relative capacity and importance, as well as the natural or artificial defences of the coast, should be carefully noted.

The points of connexion between neighbouring countries must depend on the natural or artificial means of communication which exist. Rivers, canals, railroads, or great military roads, such as are found in Germany, will therefore come under this head; unless, as in England, most frequently, they have been constructed entirely for the purposes of commercial intercourse.

2nd. The general divisions of the empire or state: if the former, the states of which it is composed first, and then as in the latter when considered separately; the larger and more important division affecting its polity, whether judicial, military, or financial, as in different nations. These greater divisions obtain different names, and as these names are not always applied with strict reference to their meaning or etymology, and indeed are often historical—i. e., the legacies of former ages, and indicative of divisions made originally for other purposes than those for which they are at present used—it is better to consider them all as local terms, and explain them as their use becomes necessary. These first great divisions relating to the general and central government will probably be found susceptible of subdivisions—for example, in England we find first, the division into Shires and Counties, and these again subdivided into Hundreds, Tithings, &c., or Parishes, which are again formed into Unions, and as in military affairs, the larger divisions arranged in Districts.

The cities and towns will be susceptible of the same classification. The metropolis (from the Greek, mother city) belongs, as we have seen, to the first class, as do fortresses, arsenals, and public dockyards; while the principal towns of the larger divisions must be placed in the second.

It is difficult to distinguish exactly between a city and a town. The appellation may be consequent either on law or custom. Blackstone, in the Introduction to his *Commentaries on the Laws of England*, defines a city as 'a town incorporated, which is or hath been the see of a bishop,' and he distinguishes between borough and other towns. 'A borough,' he says, 'is now understood to be a town either corporate or not, that sendeth burgesses to parliament. Other towns there are to the number (Sir Edward Coke says) of 8803, which are neither cities nor boroughs; some of which have the privilege of markets, and some not, but both are equally towns in law.' From the context it appears, that he considered tithings, towns, or vills, to be marked by the possession of a church and the celebration of divine service, the sacraments, and burials; towns or tithings, subsequently called vills, consisted of ten freemen; demi-vills of five, and hamlets of less than five. (*See* SPELMAN's *Glossary*.) These divisions, as well as their extension to hundreds, and again to counties and earldoms, being of Saxon origin, and the civil being so intimately connected with the ecclesiastical, will show not only that in these acceptations they are originally to be confined to England, but that in them they cannot be now used even here, much less in any other country, and that their application must be governed by custom and analogy. The word town is derived from the Anglo-Saxon, *tynantun;* in the Dutch, *tuyn*, an enclosed place. The word vill (from the Latin, *villa*, a country-house, and having its application originally so confined) has, in modern times, been extended, as in America and the British Colonies, to considerable tracts of land called townships. Geography of course concerns itself principally with the limits of the divisions, and the localities of the cities and towns; their uses belong to Political History. It will be necessary, however, to enter sufficiently into this part of the subject to make the character of the divisions intelligible.

8 *Of Religious Divisions.*—It has been already noticed (see section 5) that the religious divisions of the world have no direct connexion with the political, although they have with those which are consequent on similarity of race. In modern Geography, these are few, easily defined, and extensive in their operation.

They may be characterized in principle as Monotheistic and Polytheistic, it being now generally admitted that no nation or society of men can be strictly termed Atheistic; and Chevalier Bunsen does not hesitate to name religion and language as being the first facts that may be predicated of any nation.

Of the monotheistic systems the principal are Christianity and Mahomedanism, to these may not improperly be added Buddhism, and that of the nations inhabiting America when it was discovered by Europeans. If this classification be adopted, more than two-thirds of the inhabitants of the world may be considered as worshippers of one God. In all these, however, a tendency towards polytheism is apparent among certain nations and families in connexion with a personal, physical, or objective development of the faith professed. It is less observable in the Mahomedan than in the others, because the unity of the Deity is the fundamental article of that creed, but it is found even there in the worship of saints, and the same among the Buddhists. It is the cause of the two great divisions of Christianity, the Roman-catholic and the Protestant, for in this respect the Greek Church may be considered protestant.

Christianity being a religion divulged, not for a race, but for mankind, may and does flourish among all races and families. It has, however, taken deepest root among the Indo-Germanic race already referred to. The Celtic being the more impulsive, are all but universally Roman Catholics; the Teutonic, the more thoughtful, as generally Protestant. The Greek Church (the principal characteristic of which is its entire dependence on a civil head—the Emperor of Russia) has its principal root among the Sclavonic races, remarkable for their subserviency of disposition. Mahomedanism has prevailed chiefly among the races inhabiting south-western Asia and Africa, belonging to the Negritic division, as already indicated. (See *P. G.*, p. 395.) Buddhism is co-extensive in the East with the Mongul race. The other religions of the world appear scarcely capable of enlarged classification, being chiefly traditionary, and unintelligible equally to those professing them as to others.

9 *Of the Dominant Religion.*—Under this head must first be noted the prevalent religion, or that recognised by the civil government of the country, and the principal seats of ecclesiastical power and religious worship. These must of course obtain under different names, according to the nature of the religion and language of the country. The localities of great religious meetings or festivals; of universities or schools devoted principally or entirely to ecclesiastical purposes, or carried on under ecclesiastical supervision and authority, should also be noted. These may, however, belong to the subdivision of this subject, following in natural order, in which the larger ecclesiastical districts of the country are described. This will depend on the character of the supervision exercised, whether general or sectional; it may also be local. The national schools of England partake of all these characteristics,—they are national as under government inspection, or that of the National Society; sectional or diocesan, the clergy exercising so large a share of their direction; local, because in most cases parochial. It will be obviously impossible to enter into such considerations in detail; in most cases it will be possible only to indicate the number, extent, and locality of the minor divisions. Under the second head of this, as in the civil, the chief towns of the subdivisions may with propriety be noticed, whether bishops' sees or otherwise.

10 *Of Religious Sects.*—Having considered the leading or dominant religion in its geographical relation, the sects which may exist in the country

under description must be taken in order of importance; their centre of locality noted, if any; if not, their proportionate distribution. From the circumstances of artificial division already alluded to, it often happens that of the same country politically considered the inhabitants differ essentially in their religious character, and are not unfrequently connected by it more intimately with their neighbours than with their countrymen. This may have an historical explanation, being the result of difference of origin, immigration, or otherwise, or it may be consequent on the physical character of the country: the former is, perhaps, more often the case.

This division of Political Geography, as has been noticed, is not unfrequently found closely connected with both the others; especially it will be observed that civil and religious liberty walk hand in hand, and that their natural consequences are the advancement of education, the increase of agricultural or manufacturing industry, and the extension of trade and commerce.

11 *Of Religious Statistics.*—In this class, as in the preceding, some statistical information should be included. The numbers professing the national creed, and those of the principal sects; the proportion of numbers to area, if any sects be localized, should if possible be ascertained, and the industrial class to which they more particularly appertain should also be noted. From such facts general conclusions of much importance may be drawn. Care must, however, be taken that the inferences be correct; e. g., it might be correct to say that countries professing the Roman-catholic religion are less advanced in civilization than those which have protested against it; it would be incorrect to attribute this wholly to the religion, because those countries which have protested were once of the same faith; the answer must be sought in the connexion between the character of the people and their political and geographical position, resulting in the one retaining, and the other protesting against the faith in question. The cause of religious and social advancement may probably in like manner be found to be the same. In our own country, the manufacturing and mining districts are said to be strongholds of dissent from the established religion; it would be equally incorrect to refer this to any peculiar antagonism to the mode of faith arising out of the habits of the people, or the nature of their occupations; it should rather be attributed to the neglect of those districts by the government and the clergy, except in so far as the kind of labour may influence the development of the mental or bodily faculties respectively, as will be hereafter shown, or as the pursuit of wealth has a natural tendency to draw men away from religion; and thus we find that the employers have taken no care of the spiritual welfare of their workmen, until danger to themselves has arisen from the neglect.

The materials for this division of inquiry into the Political Geography of the world are very insufficient, no good historical and statistical account of the religious systems extant in the world being at present in existence; even the aggregate estimate of the numbers professing the great leading religions of the world being very variously estimated, and details being obtainable only in those countries directly under the influence of the European races, and even in them they are usually very little to be depended upon.

12 *Of the Industrial Geography of Countries.*—The civil and religious divisions of countries have been described as for the most part rather arbitrary than natural, their connexion therefore with Geography proper is rather accidental than essential. The third—viz., the industrial, differs from the others in this, that the localities in which its great divisions are found, have usually a natural relation to them—i. e., the industrial occupations prevailing in them are consequent on their physical character. The truth of this will appear on very cursory inquiry. Land suitable for pasturage is seldom so well adapted, frequently is not at all suited to agricultural purposes. The localities of certain manufactures are dependent sometimes on the presence of the raw material, often, perhaps, on that which is necessary for its conversion to useful purposes. Thus the copper of Cornwall and Australia is carried to

the coal districts of South Wales for smelting; the cotton of America to the neighbourhood of iron and coal for machinery and fuel. In such cases the proximity of good ports and harbours, and their connexion with the interior by rapid and easy transit, both for the importation of the raw material and for the export of the manufactured goods, is indispensable. The rise of such commercial towns as Glasgow and Liverpool is naturally consequent, as are the rapid increase of population and the extension of internal communication. The influence therefore of mineral wealth is most considerable, and among minerals, coal and iron, as of most general application, occupy the first place.

13 *Of Industrial Divisions.*—The leading sub-divisions of this part of Political Geography have been already alluded to, as—1. Pastoral; 2. Agricultural; 3. Manufacturing; 4. Commercial.

These, of course, may frequently be found in close connexion in the same district, but the character of the district will be decided by the predominant industrial occupation.

Each of these must be considered, not only as to its locality, but its character; and as the character of the district and consequent occupation of its inhabitants react upon their character, both physical and mental, it will be necessary to consider them in this relation also.

14 *Of Occupation.*—The amount of mental effort necessary to direct physical labour varies with the nature of the employment. The predominance of the physical over the mental, or *vice versâ,* will produce a development corresponding to the proportion of those influences in the people subject to them.

Speaking generally, labour is not a characteristic of pastoral life; in agricultural, the labour required is rather bodily than mental; in manufactories, the labour employed is certainly skilled labour, but that often more the effect of habit than knowledge or mental effort; and this is especially the case in such as admit of considerable division of labour, more particularly so when the article manufactured is small and made in very large quantities; in such, the people employed may be considered rather as living machines than rational agents. Labour incident to commercial pursuits, especially that of navigation, seems, upon the whole, most conducive to an equal development of mental and bodily energies.

But it is not sufficient to consider the nature of the labour to which different classes are subject, the leisure afforded them must likewise be estimated, as well as their action and reaction on each other. The effect of leisure, like that of labour, differs according to its character and extent. In pastoral life, the labour, if ever considerable, is so only after long intervals of leisure; this leisure is of necessity spent among the works of nature; their contemplation is therefore a general consequence. The motions of the heavenly bodies mark the passage of time and the return of the seasons; the beauties of the Earth and her productions, and the order and harmony of the works of creation, produce corresponding ideas in the mind. Among pastoral tribes and nations, therefore, astronomy, music, and lyric poetry have been most frequently cultivated. The prevalence of leisure among them commonly gives to their relaxation the character of physical labour, and their habits of contemplation and solitude give self-dependence of character while they dispose the mind for the reception of superstitious rites, or even more to a speculative faith. It may be a question whether the peculiarities of their lives do not offer a serious bar to the reception of polytheism and idolatry.

In agricultural life, the regular and continuous strain on the physical powers produces corresponding exhaustion; leisure is used for rest, and enjoyment is customarily sensual. The physical development is in muscular strength, the mental is overpowered by it, the religious belief assumes a personal and sensuous character, and becomes often vulgarly and coarsely superstitious.

In the majority of manufacturing employments, the leisure is more that of the mind than the body, the labour being rather constant than severe; and when the employment assumes the character which has therefore been called mechanical, because like that of a machine, though applicable to a higher class of production, the mind may be entirely abstracted from the labour of the body, and not unfrequently handicraftsmen ply their trade with minds absorbed in mathematical calculations. The more mechanical, therefore, any employment is, the more the mind may be disengaged, and the more varied and extensive will be the mental pursuits of those engaged in it. Such labour is also debilitating to the body; a morbid habit is produced. The tendencies of this class are consequently towards abstruse speculations, mathematics, philosophy, politics. The shoemaker and the tailor may be the rival politicians of the country village. In districts entirely manufacturing, political societies and combinations are commonly found. The morbid temperament consequent on the nature of their employment enlarges real and suggests imaginary evils; nervous irritability takes the place of muscular strength; the enjoyments, often sensual, are chiefly, if not entirely, of a stimulating character; the religious tendencies are speculative, not imaginative; their development, deistic, if not atheistic. These are, therefore, the natural resorts of the political reformer and the religious schismatic.

The labour and leisure consequent on the pursuit of commercial industry are so varied in their character, that in their results they may resemble any or all the other classes. The sailor may, however, be fairly taken as the type of this class. The leisure in his case is similar to that of a pastoral life, excepting inasmuch as it wants most of the beauties, while it abounds in the sublimities, of nature; it produces, therefore, a character imaginative and superstitious, perhaps, but scarcely poetical. The constant realization of danger makes the recognition of a personal providence customary in him, but the equally constant conquest of the dangers to which he is exposed, by science, skill, courage, and physical power, gives him a mental and bodily self-dependence unequalled, perhaps, by any other. Accustomed to discipline, obedience is his political characteristic, though, inasmuch as his life is spent almost entirely apart from civil institutions, he can scarcely be said to have any political creed.

The conclusions which follow on these considerations appear, then, to be, that pastoral life produces a simple, impulsive, imaginative race, possibly deficient in reasoning powers; religious, but superstitious, and not idolatrous; recognising an immediate connexion with the Deity, and therefore conscious of inherent dignity. The political character will be tribal, tending to royalty; the physical, that of energy rather than strength.

The agricultural will be the contrary of this: heavy in body and mind, sensual in character, his religion will be gross—his political habit submissive—his self-dependence that of brute force; he will be the slave of the despot and worshipper of idols.

The mechanical will produce highly-developed reasoning faculties, combined with low physical but highly-nervous energies; the deist and the democrat. Cities, especially manufacturing, have therefore been the originators and supporters of democratic forms of government; then of equality, productive of anarchy, as among the ancient Greeks and modern Italians—the dominion of one, an empire, as in the case of Rome and Paris. Commercial cities have the same general characteristics, softened by more extended intercourse with the rest of the world; and in them the sailor often becomes a political tool, from his habit of obedience and his want of civil associations.

From these it follows, moreover, that countries possessing the most varied physical features produce, on the whole, the most highly-developed race of inhabitants. Such are the countries which have borne, and will continue to bear, rule in the earth. Such were Persia, Greece, Italy; and such, but in a far higher degree, is England. (See GUYOT's *Lectures*, c. 1.)

15 *Of the Pastoral.*—The true pastoral districts are those which are only suited to the production of short and sweet herbage, and therefore unfit for tillage, either from the lightness or superficial nature of the soil. It not

unfrequently, however, happens that low lands, on which luxuriant grasses can be produced by irrigation, either natural or artificial, and which could also be made to bear large crops of other vegetables, are devoted to the rearing of cattle. These are not properly to be reckoned in the pastoral districts, and yet they can scarcely be otherwise classed than in them; and a comparison must therefore be instituted between districts of such different character as the downs of Sussex and Hampshire, the hills of Cumberland and Westmoreland, and the rich valleys of Hereford, Somerset, and Devon, and the flats of Lincolnshire.

Land recovered from, or occasionally overflowed by, the sea is often devoted to the feeding of cattle, the saline character of the herbage being, for short periods, very conducive to their health. This again can scarcely be considered pastoral, and with the preceding, while classed among pastoral in its productions, may, in the character of its inhabitants, be rather considered agricultural.

Pastoral countries generally present a nomad population; in them, cities, are of course rare, and the peculiar character of their inhabitants is dependent on that of the animals they rear, and the uses they put them to. The Laplander who tends his reindeer to supply the necessaries of life, differs less from the Arab in this than in the consequences of the climate he resides in, while both perhaps differ equally from the Guacho of the Pampas, who rears his herds of wild cattle to carry on a trade in hides and horns. When therefore these districts come under notice, these peculiarities must be specified. The portions of the world naturally adapted to pastoral life, are usually found between the primary and secondary watersheds of the continents on the side of their least rapid declivity and greatest extension, and form a very large proportion of its surface. They are not, however, fitted to support a population equivalent to their extent. From them, therefore, at various times great emigrations have taken place, which have had a marked effect on the history of the world. Pastoral countries may and usually have agricultural districts within them; countries not pastoral may have districts of that character. The influence on the people will in the one case be general, in the other, local. The social life of pastoral countries has been generally of a patriarchal nature, civil government scarcely recognised; their commerce usually carried on overland by means of caravans; their political combinations can therefore never be elaborate or lasting, their commerce never extensive. As the pastoral habit of life appears to have first prevailed after the Deluge, so the caravan (a word probably of Persian origin) trade seems to have been the first in use. We find it so in all countries in course of settlement, if suitable to it; it disappears with the erection of cities and the establishment of roads, and means of more safe and rapid communication.

16 *Of the Agricultural.*—The agricultural countries and districts of the world are, as the name implies, those which are capable of cultivation by man, upon which he can by manual labour raise vegetables necessary for the support of life, and essential to the arts and requirements of civilization. They are usually found in the valleys of rivers; the richest and most extensive in the alluvial formations about their lower course and beyond the secondary watersheds. Here are to be found the great corn and rice producing countries, those which supply others with the means of subsistence—the granaries of the world.

In a state of nature, those districts of the Earth which are best adapted to agricultural purposes are commonly covered with the heavy growth of vegetable life, often of trees. The character of this growth indicates the quality of the soil, and the nature of the crop it is most calculated to produce. The link which connects these districts with the commercial and manufacturing, is supplied by this circumstance—the agricultural districts requiring the produce of the manufacturing, while these again, not producing food for a superabundant population, must be dependent on them for it. The identity of the interests of all men and their mutual dependence on each other, thus appear to be the natural order of creation.

The agricultural districts are those which follow in course of settlement on the pastoral. Their settlement of necessity raises the question of tenure of land. The modes in which land may be held by individuals may be reduced under two heads; the one in which the occupier is the owner of the soil, the other in which he pays rent for his occupation. These have been considered respectively characteristic of different races of men, possibly they are rather distinctive of different stages of progress. Tenure by military service, the basis of the feudal system, and one form of tenure by occupation, has prevailed wherever the Indo-Germanic race has been diffused, and by its prevalence marks it as migratory and aggressive. We first read of rent for land in the book of Genesis, where Joseph bought all the land of the Egyptians for Pharaoh, and let it again to the Egyptians for a fifth part of the produce. (Gen. xlvii. 24.) These two modes of tenure, producing very different effects on an agricultural population, are important to be noticed in Political Geography.

It is, as has been observed, in districts of this character that cities have first arisen; in them, man being stationary, property has increased, and with the increase the mechanical skill of man has been developed to supply his artificial wants, the result of riches and society; a marked distinction thus arises between the dwellers in towns and the agriculturists—a distinction which becomes more marked in proportion to the increase of wealth and population.

The nature of the agricultural produce of any district must have its effect on the people inhabiting it, not only because of the difference of climate and soil necessary to the production of different plants, but of the effect which those used for food may have on the physical energies of the people. Thus, the corn-producing countries will be more favourable to physical development than the rice-producing. It is necessary also to consider whether the vegetable produce of the Earth be directly employed in manufactures, or transported for that purpose, as at present the three great staples, cotton, flax, and hemp are.

The transport of heavy raw material to a distance, for the purpose of manufacture, is evidence of a great advance in the industry of the countries engaged, especially that in which it is manufactured. It may also be taken as an indication that there is a surplus beyond the produce required for the food of the people. The returns will, therefore, be in manufactures or money, and the balance in favour of the country exporting.

17 *Of the Manufacturing.*—Manufactures are, in the early stages of civilization, carried on among a nomad or an agricultural population; they become localized when either the division of labour for their conduct on a large scale becomes necessary, or the presence of the raw material attracts them to any particular place. Since the extensive use of machinery in all manufactures, they have had a tendency to gather round the coal and iron producing districts; the facilities of transport afforded by railroads may have a tendency to disperse them again. At present, however, these minerals must receive special notice in connexion with the distribution of manufacturing industry over the face of the globe.

When the agricultural produce of any district is employed in neighbouring manufacture, the one is supported and enriched by the other, but it more often happens that the increase of manufactures in any district has a tendency to destroy its agricultural character. This happens especially in districts, the mineral wealth of which is the subject of manufacturing industry—and this, if only from the necessity of finding place for the refuse which has been brought to the surface with the desired mineral. In some mining districts, the coal in particular, the *disposition* of this rubbish is a problem often difficult and always expensive in its practical solution. But in any case, the necessities of a dense population, whether real or artificial, the supply of the wants of the poor and the luxuries of the rich, must reduce considerably the agricultural capabilities of the district.

It is also a question of importance whether the manufactures of any country are for home consumption or for exportation; if the former only, they must be very limited in extent; if the latter, they will of course be enlarged to meet the demand made for the article produced. The consequence will be, a return trade and enlarged commercial relations ; and here also a reactionary tendency may be observed, since much of this return trade will be in agricultural produce for the food of the manufacturing population.

The congregation of men in manufacturing districts, and the tendency of these employments to lower the amount of agricultural produce to be obtained for them, will thus compel a trade in articles of food; but as the food-producing countries are usually in a low stage of civilization, their consumption of manufactured articles is limited, and commerce therefore flows in two channels. The presence of mineral wealth is dependent on geological formation, by it the localities of certain manufactures are of necessity determined; and here also, as in the other divisions, we see the nature of the country influencing, if not determining, the character and occupation of its inhabitants.

18 *Of the Commercial.*—Commerce is dependent on manufactures; it is either internal or external, maritime or over-land. Commerce is the exchange of surplus commodities; even where it is carried on with a circulating medium on one side, this is strictly true; there must then be a surplus of money.

These exchanges can only be made between places where the surplus is different. The commercial relations between different parts of the world are, therefore, determined by the character of their productions. Commerce is therefore, in its geographical distribution, not the result of accident, but subject to fixed laws.

The paths of commerce also are regulated by physical causes. The caravan trade of old was carried, as it is now, over table-lands, deserts, and prairies. The passes of the mountain chains have directed it first into certain districts, and brought those thus connected by the head-waters of their rivers into early and most immediate commercial relations. In maritime commerce, islands and inlets of the sea had an early share, voyages were then made across the ocean, but even its broad expanse did not give unlimited facilities for traffic. There also physical difficulties formed barriers, imperceptible indeed, but still effective. Currents and trade-winds directed commercial intercourse into certain channels, from which not even steam navigation has materially diverted it. The extension of railway traffic seems, however, likely to bring back much of the commerce of the world into the old overland routes, and by making speed the first element in the calculation, to invest those parts of the continental masses that approach nearest to each other with an importance they have not enjoyed since the earliest periods of commercial enterprise, as affording the more immediate means of communication.

From what has been already said, it will be apparent, that, as extent is the result of elevation, or in other words, the horizontal development of the land is the consequence of its vertical contour, upon this also depends the distribution of animal and vegetable life over the surface of the earth, the variety of produce of different countries, their consequent relative value as a residence for man, and the commercial relations which may exist between them, and no less the physical development of man himself, his habits of life, employments, and mode of thought, and hence, in no small degree, the character of his religious and political life—upon this also has depended the distribution of mankind over the Earth, both in time and space, the earlier or later peopling of different districts, the source from whence they have been peopled, and the paths of migration,—these have had their own proper effect on the history of the world, specially in the diffusion of language and literature—have made the western part of the old continent progressive, while the eastern has remained stationary, if it has not retrograded.

The presence of minerals and metals has also been shown to be dependent on the same cause, being found only in certain parts of the geological series. They are available only when those portions are presented. The rocks which have been formed by fluvial deposit, and especially the coal measures, could only have been so formed in entire or partial basins, and their localities have therefore been determined by vertical contour at the period of their formation; while those minerals and metals which are formed in connexion with rock of earlier place in the series, are only available for the purposes of man where they make their appearance above or through the others. The localities of manufacturing and mining industry have therefore been pre-arranged by the same cause. It has been shown that commercial exchanges are the result of variety of produce, that this variety is the consequence of variety of contour, that the paths of commerce by land are determined by, and that those by sea have been, and are now dependent on the same causes. It has also appeared that all these have a reciprocating effect on each other; for not only do manufactures encourage and develope agriculture, if not at home, of necessity elsewhere, that commerce arises and is maintained by the variety of supply and demand; but that different kinds of manufactures and variety of commercial intercourse, as well as of agricultural produce, stimulate and encourage those with which they are connected; and thus it becomes apparent that countries possessing the greatest physical development are capable of the greatest industrial development also. The knowledge therefore of vertical contour must be the basis of all true geographical knowledge, and from the consideration of its effects we must conclude that the Great Creator in giving form to the Earth disposed certain causes to necessary ends, and that in this disposition he proposed the ends to which he has adapted the means, and that we, as parts of his creation, more especially those to whom as his intelligent servants he has given the rule and use of his inferior creation, shall act most to his glory, and best fulfil the conditions of our own existence, when we direct our actions, whether political or social, with an intelligent appreciation of them; and that his original designs and beneficent intentions towards the world cannot be fulfilled by us, until we know, appreciate, and apply to their proper purposes, the capabilities, not of one but of all countries, until we consider not only what one country may be made to produce, or what one people are capable of producing, but how the produce thus obtained will affect other countries, how advantage may result to others also; in short, till the good of the many be consulted, instead of that of the few, and we fulfil generally, as well as particularly, the royal law, to do to others as we would have them do to us.

To this desired consummation, the knowledge of geography in its highest relations is necessary. This can only be attained by careful initiation into its elements. The importance of the end to be attained may well stimulate to more laborious and uninteresting investigations than this science requires.

END OF PART I.

LONDON
SAVILL AND EDWARDS, PRINTERS, 4, CHANDOS STREET,
COVENT GARDEN.

MANUAL OF GEOGRAPHICAL SCIENCE.

PART THE SECOND.

DESCRIPTIVE GEOGRAPHY,

CONTAINING

I.

ANCIENT GEOGRAPHY,

BY THE REV. W. L. BEVAN, M.A.
VICAR OF HAY, BRECON.

II.

MARITIME DISCOVERY
AND
MODERN GEOGRAPHY,

BY THE REV. C. G. NICOLAY, F.R.G.S.

CONTENTS.

Ancient Geography.

Maritime Discovery.

CHAPTER II.

CHAPTER III.

CHAPTER IV.

CHAPTER V.

Descriptive Geography.

Part the Second.

DESCRIPTIVE GEOGRAPHY.

PART I.

ANCIENT GEOGRAPHY.

INTRODUCTION.

CLASSICAL Geography in its widest extent consists in the description of the world as it was known to the ancients, from the earliest recorded ages until the decline of the Roman empire. Its office is, in the first place, to give a sketch of the lands and places which were the scenes of the most interesting events of ancient history: in the second place, to trace the progress of geographical knowledge—to define the systems, whether fabulous or true, which were contemporaneous with the various eras of civilization and literature—and to follow the widening circles of discovery and scientific research as they successively opened upon the human mind. The importance of the first of these, as an auxiliary to history, is too evident to require proof: the second, the history of geography, is hardly less important to the classical student, both from the interesting nature of the subject, and as it serves to illustrate the writings of antiquity by placing him in the point of view from which the writers themselves regarded the world.

CHAPTER I.

HISTORY OF ANCIENT GEOGRAPHY.

§ 1. Primitive notions. — 2. The Phœnicians. — 3. Argonautic expedition. — 4. Homer. — 5. Advance of colonization. — 6. Hesiod. — 7. Greek colonies. — 8. Necho's expedition. — 9. Ionian philosophers.—10. Logographers.—11. Scylax, Hanno, Himilco.—12. Æschylus.— 13. Herodotus. — 14. Ctesias. — 15. Xenophon. — 16. Democritus, Eudoxus. — 17. Alexander the Great. — 18. Pytheas, Euthymenes. — 19. Accounts of India. — 20. Aristotle. — 21. Eratosthenes. — 22. Hipparchus, Polybius. — 23. Strabo. — 24. Roman writers: Pomponius Mela. — 25. Ptolemy. — 26. Arrian, Pausanias. — 27. Roman Itineraries.

THE sources whence we can draw materials for a history of geography in the earliest ages are scanty and uncertain: in the absence of any definite treatise on the subject among the writers of antiquity, we have to fall back upon the scattered notices of travels by sea and land, the advance of colonization, the lines of commerce, military expeditions, and the traditional accounts of distant places, as common report described them. Certain primitive notions respecting the figure and position of the Earth seem to have been very generally held by nations in a primæval state of civilization. Before intercourse with other lands extended their knowledge, the Earth appeared to be a flat circular disc, surrounded on all sides by water, and covered with the heaven as with a canopy, in the centre of which their native land, or more nearly still, the chief seat of divine worship was situated. Thus the Hebrew writers speak of 'the circle of the Earth,' (Isa. xl. 22; compare Prov. viii. 27,) and of Palestine as in the 'middle' or 'navel' thereof, (Ezek. xxxviii. 12; marginal translation,) and still more particularly of Jerusalem as 'set in the midst of the nations round about her,' (Ezek. v. 5.) Thus also, the early Greeks conceived the world to be a flat circle surrounded by the river Ocean, and Mount Olympus, the residence of the gods, or in later times Delphi, the seat of the most renowned oracle, as the centre. The same notion has been found to prevail among the Chinese and Hindoo geographers. It has certainly been questioned whether the Hebrew writers in the passages referred to did not merely adopt the popular belief without intending to express any definite philosophical opinion on the subject: it may have been so; but as we know for a certainty that the notion actually existed in Greece, and was not exploded for many centuries, there is no difficulty in believing that a like opinion may have prevailed even among the more enlightened Hebrews.

2 The Phœnicians were certainly the first to communicate to the natives of Greece, at that early period not a sea-faring people, any information as to distant lands. Before the age of Homer, these adventurous traffickers had navigated all parts of the Euxine and Mediterranean Seas, and had even passed beyond the Pillars of Hercules into the western ocean. But with the selfish view of retaining the commerce in their own hands, they either attempted to withhold their knowledge altogether from others, or invested distant countries with imaginary horrors, by peopling them with fabulous monsters. From them the Greeks first heard of the Ocean, of the Cimmerians, of the Cassiterides, and other places. The Phœnicians were also the first nation who extended their geographical knowledge through colonization. Besides various settlements nearer home, on the islands of Crete, Cyprus, &c., and on the southern coast of Asia Minor, they founded the distant colonies of Gades, (B.C. 1085,) and afterwards Carteia, Malaca, and Hispalis, in Spain; Utica, (about the same date as Gades,) Carthage, (B.C. 878,) and Hadrumetum, on the coast of Africa; and Pronectus and Bithynium, on the southern shore of the Euxine.

3 The fame of their successes and of the wealth they obtained, stimulated the Greeks to undertake a commercial expedition into the Euxine Sea. Such was, in all probability, the object of their first attempt at distant navigation, the history of which forms the groundwork of the far-famed story of the Argonautic Expedition. About the year 1260 B.C., a bold band, starting in search of the golden fleece, passed the dangerous Cyanean rocks at the mouth of the Thracian Bosphorus, and penetrated to the city of Æa in Colchis, at the eastern extremity of the Euxine. The route which they followed on their return is variously stated: according to some accounts, they passed from the Euxine into the North Sea, either by the course of the Phasis or of the Tanais, and thence through the Adriatic to Greece; another account represents them as returning through the Erythræan Sea, that is, the Southern Ocean, and across Libya. To discuss the various myths connected with this expedition is foreign to our subject: it is more to the purpose to remark that the assignment of Colchis, as the scene of their exploits, is an addition of comparatively modern date. Homer does not mention, and probably was not acquainted with the name of Colchis; no traces of any town of the name of Æa existed on the Colchian coast in historical times. It appears that the scene of action was in each age removed backward to the extremity of the known world, until it reached the most easterly point of the Euxine. As the voyage to Colchis was deemed hazardous in the latest times of ancient history, it is by no means likely that the Argonauts penetrated so far: the utmost limit of the expedition would be the Tauric Chersonese, and there we must place the town of Æa, if indeed we do not rather consider that name as a mere appellative in Homeric geography for any extremely distant land.

4 The first traces of anything like a geographical system occur in the Homeric poems. Without attempting to affix any date to these compositions, we should be warranted in saying that they represent the state of geographical knowledge down to the commencement of the ninth century, B.C. Not that there is any methodical exposition of the views of the age on this subject—the nature and matter of the poems would not admit, nor lead us to expect, as much,—but the incidental notices are numerous enough to enable us to picture to ourselves the world as Homer conceived of it, and have therefore obtained for him the reputation of being the first geographer. In considering the details of the Homeric geography, we must attempt to separate the mythical from the true: the former will throw light upon the allusions in the poems; the latter will enable us to ascertain the progress of discovery in that age.

Homer, like many of his successors, was totally ignorant of the *spherical* form of the world: he conceived it to be a flat circular body, the upper face of which was the habitation of *men*, while the lower was the region of Tartarus, the abode of the punished *gods*. Over the earth stretched the vault of heaven, and round it flowed incessantly the stream of Ocean. The heaven rested in its extremities on the surface of the earth; but more especially was it supported in the west by the Pillars of Atlas. Whether we are to understand under that name the mountains in the west of Africa, is a matter of doubt: it is possible that a rumour of that lofty range reached Greece through the Phœnicians: but the terms applied to it lead us to think of Atlas as a *god* rather than as a mountain, and in this sense it may be a personification of the power which upheld the heaven at the horizon, whose abiding-place would naturally be transferred from spot to spot, as discovery advanced westward, until it rested in the last great chain of mountains which appeared to bound the world in that direction. The Ocean which surrounded the earth, like the rim of a shield, is always spoken of as a *river* or *stream*, differing in character from all other bodies of water, and yet the parent of them. If we ask whence the Greeks, who had not themselves passed the Pillars of Hercules, derived their knowledge of the Ocean, two explanations may be proposed. Either they received information of its existence from the Phœnicians, or else they were led by instinct to suppose that as the lands with which they were acquainted were islands surrounded by water, so the whole world was one large island terminated by a similar boundary. For the first of these suppositions, it has been alleged that the word 'Oceanus' is of Phœnician extraction, *ogh* signifying in their language an 'encircling stream': for the latter, it might be urged that a similar belief has obtained among most rude tribes in other parts of the world where no such channel of information was open to them. Distinct from the Ocean was 'the Sea'—πέλαγος or πόντος—by which the Mediterranean is designated, which communicated with the Ocean at its western extremity, and which formed the receptacle for the various minor rivers of the world, whose springs, however, were all connected with the Ocean-stream by subterraneous passages—an idea possibly founded upon the not unfrequent phenomenon in Greece of rivers disappearing for some distance in the earth, and re-issuing, another and yet the same. Out of the Ocean, or, more correctly, *on the other side of* its stream, the sun arose at morn, and into it he sank at eve; and the two points where he appeared to touch the water formed the cardinal points in Homeric geography. The world was divided into two portions: the side towards the *rising*, and the side towards the *setting* sun—the region of day, and the region of night. Where the sun rose, there (perhaps in reference to some report of the Caspian Sea) was placed the Lake of the Sun: on its shores dwelt the Æthiopians—i. e. the *burnt-faced*, probably placed there under the idea that the sun, in rising, came into close proximity with the earth; or, as others have supposed, from a rumour of the singularly dark complexion of the Colchians. Here, too, lay Æa, the most distant of lands. Corresponding with this distribution of localities on the morning side of the world, we find on the evening side, near the spot where the sun sank, another race of Æthiopians, and a second isle of Æa. Here were situated the gates of the Sun, and the rock Leucas—i. e., *glittering*, significant of the brightness of the setting orb. In this quarter also, imagination suggested that the regions of death and darkness, and the abode of departed spirits, would be found. As the rising sun is to all persons an image of life and vigour, so is the setting sun of death and decay. All nations have concurred in fixing the locality where departed spirits rest after death towards the west. In the Homeric system, therefore, Hades is supposed to lie *across* the Ocean-stream—i. e. on the opposite bank to the world, behind the spot where the sun sets—a dark, gloomy region—a fit place for the punishment of the wicked, where the fabled Cimmerians* dragged out their existence in perpetual mists. Along with this notion of Hades, we meet with another in Homer, which seems to have been more generally entertained, that Hades was not on the face of the earth, but *in* the earth. Numerous expressions apply to this subterranean Hades, whence some have been led to think that this was the real abode of the dead, and that the other across the Ocean-stream was merely the *entrance* from the upper world to the lower. However, it is clear that the two notions of a Hades *above* and a Hades *in* the earth were contemporaneous, and are equally expressed in the Homeric poems. Nor is it difficult to account for the existence of this idea of a subterraneous Hades: all material bodies in a state of dissolution return to the earth, and are mixed with its substance: the bodies of men are deposited below its surface; and all the lines of decay point downwards: so that it is no wonder that from an instinctive feeling the abode of departed spirits was placed in the bowels of the earth. It must be further observed, that the position of Hades is *in* the earth, while Tartarus is *under* the earth, on the lower face of the world's disc. This was regarded as being to the gods what Hades was to men. It was also covered with a vault, the counterpart of the heaven on the upper surface. One important locality in mythical geography remains yet to be noticed: since both the above conceptions of Hades involved the idea of gloom and misery, it was necessary to assign a place of happiness for the souls of the just: Elysium was their abode—still in the west, for that was the region of death in every form, but on *this side* of the Ocean-stream, and thus enlightened and warmed by the rays of the setting sun. This, like all other mythical localities, was moved further westward as discovery advanced: in the time of Homer, as the Mediterranean Sea had not been explored much beyond Sicily, it would be situated somewhat to the west of that island.

If we turn from the general view of Homer's geographical system to consider the various localities described by him, we find that the land of Hellas was deemed the centre of the world's circle. The continents are not distinguished as such, nor are they designated by any general names: for Asia applies only to the pasture land in the upper valley of the Cayster: and Europe, which first appears in one of the Hymns ascribed to Homer, seems to be confined to Greece north of Peloponnesus, while Libya signifies a part of the African coast west of Egypt. Asia was the quarter with which Homer was best acquainted: we have mention of the Halizones and Amazones in the district afterwards called Pontus,—the Paphlagones and Heneti in Paphlagonia—the Caucones in Bithynia—the Phrygians—the Lycians with the promontory Chimæra in the south coast of Asia Minor—the Solymi in Cilicia—the Erembi in the eastern coast of the Mediterranean, north of Phœnicia—the Arimæi (in whose name we recognise the Aram of Scripture)

* Two derivations are proposed for this name: the Greek word, χειμέριος, 'wintry,' and a Shemitic word, *kumar*, 'darkness.' According to the latter, the Greeks would have heard of the Cimmerians from the Phœnicians: either notion is equally adapted to the position assigned to this people both in Homeric and later systems of geography; for the land behind the sun would be deemed a land of winter and storm as well as of darkness; just as afterwards when experience proved that no such land existed towards the west, the abode of the Cimmerians was transferred to the north.

in Syria—and in the west coast of Asia Minor, Mæonia, later Lydia—the Cilicians in Mysia—and the Dardani about the Propontis.

In Africa, we read of the land and river of Egypt (the name of Nile does not yet occur) with the ancient Thebæ, and the isle of Pharos, a day's sail from the mouth of the river—Lybia to the westward—then the Lotophagi, who doubtless dwelt about the modern Tunis and Tripoli, where the Lotus, or jugube, is still an article of food—the Æthiopians in the west, and in the south, the fabulous Pygmæi. Some have concluded that Homer was acquainted with the Lake Triton, but the epithet, 'Triton-born,' applied to Juno, refers, without doubt, to the Bœotian stream.

In Europe we meet with many descriptive and topographical notices of the midland provinces of Greece and the Peloponnesus, with which the writer appears to have been personally acquainted; but beyond this his knowledge was uncertain. The Leucadian rocks set a limit to the coasting navigation of that day, so that even Corcyra, which is indubitably the Scheria of Homer, was rarely visited, while northwards of that island the unexplored Hadriatic was supposed to extend as far as the limits of the world, enclosing the island Ogygia, 'the navel of the sea,' far up to the north-west. To the west, discovery had made known the existence of Sicily and the Æolian isles, and probably of the lower districts of the Italian peninsula: but even here there was much uncertainty: Sicily is not mentioned by name (for Trinacria, which from its etymology would suit it, is described in terms that cannot apply to Sicily): it appears as the residence of the Cyclopes, the Læstrygones, and the Sicani, occupying respectively the southern, northern, and eastern coasts of that island. The Æolian islands correspond with the Homeric Planctæ (i. e. the *wanderers*), a title elsewhere attributed to *groups* of islands which appear to a sailor to change their relative positions and wander about; Trinacria may be one of these islands; it lay, at all events, to the north of Sicily, and in the neighbourhood of Scylla and Charybdis; and lastly, the isle of Ægusa, to the west of the Prom. Lilybæum, is described as an island abounding with goats. On the continent north of Midland Greece, mention is made of Dodona, the residence of the Selli in Epirus; of Pieria, later Thessaly; Emathia, later Macedonia; of the Cicones and Mysians in Thrace, the former near the Propontis, the latter on the shore of the Euxine, south of the Danube; and of the Hippomolgi, a Scythian tribe, still more to the north.

5 Colonization was in the meantime paving the way for more extended views. In the twelfth century before Christ three successive migrations had issued from Greece to Asia Minor, and occupied the eastern coast; and these, favoured by their maritime position, and encouraged by the success of their commerce, planted subordinate colonies in distant countries both to the east and west, and thus opened new scenes and fresh lines of commerce. The larger islands of the Mediterranean were at this early period centres of commerce. The Æginetans were deemed the original navigators of the Ægæan Sea; the Cretans, inhabiting the Cyclades, were also famed for their bold adventures; Rhodes had gained its highest prosperity about 900 B.C., and had planted colonies in Iberia and on the coasts of Italy; the town of Chalcis, in Eubœa, founded Cumæ 1030 B.C., and even before this, Metapontum had been built by the inhabitants of Pylos, and the Phocæans had established a vigorous trade with the southern coast of Gaul and the western islands of the Mediterranean.

6 We shall not be surprised, then, to find that in the age of Hesiod (800 B.C.) the knowledge of geography had considerably extended, particularly towards the west. He mentions, for instance, the Tyrrheni, and their king Latinus, in Italy: in Sicily, Ætna and the town Ortygia, later Syracuse: in the south of Gaul, the Lygians: and in Spain, the garden of the Hesperides, in reference to the citrons and oranges of that country. In the far west lay the islands of the blessed, and in place of Homer's Elysium the island Erytheia at the spot where the sun sank to his rest: beyond the Ocean-stream, and on the surface of the Earth, was the abode of the dead, Hades.

The story of the Cimmerians in the west seems to have been exploded, and the scene of fable is translated to the north where dwelt the happy Hyperboreans, where also he had heard of the amber-yielding Eridanus, probably the *Radaune*, a tributary of the Vistula. The Ister was known to him, and the Phasis, to the east of the Euxine, and the nomad races in those quarters: the Hippomolgi of Homer received their proper appellation of Scythians: the Nile also is mentioned under its proper name, and the south of Africa became the recognised abode of the Æthiopians, whom Homer had placed in the east and the west.

7 The cyclic poets who form the link between the Homeric and the tragic periods of Grecian literature, record little or nothing of the advance of geographical knowledge. Nevertheless, there must have been a great accession to their store of knowledge during this period, through the progress of colonization. In the west, numerous flourishing settlements were planted in Sicily and Grecia Magna:—Syracuse, B.C. 735; Naxos, 733; Sybaris, 720; Croton, 710; Tarentum, 707; Rhegium, 668; Selinus, 630, and many others. About the year 700, B.C., the Samians, under Colaus, penetrated the Straits of Gibraltar and reached Tartessus, which had never before been visited by any Greek. The Phocæans seem to have been the first to establish any regular commerce with it: they are said to have settled there about 630 B.C. Towards the south, Libya was now, for the first time, opened by the foundation of Cyrene, B.C. 631 by Theræans, and still more by the wise and enlightened policy of Amasis, king of Egypt, who allowed the Greeks to settle at Naucratis, B.C. 540, and to carry on an active trade with his hitherto exclusive subjects. At the very same period, the vessels of Miletus were roving freely over the Euxine, with which they became so familiar, that they changed its name from Axenus, the *inhospitable*, to Euxinus, the *hospitable*. On its coasts they planted the flourishing colonies of Sinope in Paphlagonia, Amisus in Pontus, Phasis and Dioscurias in Colchis, with several others of lesser fame; and from these depôts they carried on an extensive commerce with the interior in grain, wood, fish, metals, &c.

8 The close of the seventh century witnessed the first essay at maritime discovery in the well-known attempt of the Phœnicians to circumnavigate Libya. Under the patronage of Necho, king of Egypt, as Herodotus relates, a Phœnician expedition entered through the Red Sea into the Southern Ocean, and in the third year returned by the Columns of Hercules to Egypt. Herodotus does not tell us whether he believed or disbelieved the general narrative: he only throws discredit upon the report which the Phœnicians brought back, that in sailing round Lybia they had the sun on their right hand. Whether these Phœnicians did really double the Cape of Good Hope and return to Egypt through the Straits of Gibraltar, has been a *vexata quæstio* among geographers. Rennel has supported the credibility of the story with strong arguments: but the particular circumstance on which he and others, who have taken the same view of the story, lay so much stress, that the sun appeared to the sailors to be on their right hand, would not necessarily prove that they sailed round Africa, but would only show that they advanced some distance south of the equator. Without going into the arguments urged on either side, it is important to remember that no mention is made of this voyage by later geographers, as Strabo, Pomponius Mela, or Pliny: and that the circumnavigation of Africa always remained a problem to the ancients much in the same way that the north-west passage has been to navigators in modern times.

9 The sixth century is remarkable for the introduction of scientific geography. The founder of the first school of philosophy among the Greeks, Thales, a native of Miletus, flourished between the years 640 and 548 B.C. The extensive commerce of the Ionian cities had served to explode the mythical account of the world's form and extent, and to open the way for more enlightened, though hardly more correct, theories. Thales taught that the heaven was a hollow ball, in the midst of which the Earth, in

form like a tambourine (i. e., circular, solid, and with two surfaces, an upper and a lower), floated just as a cork floats on water. His pupil and successor, Anaximander, also of Miletus, (611—547 B.C.) held nearly the same opinion; he compared the world to a cylinder, on the upper surface of which our abode was fixed. He is also reputed to have been the first man to draw a map of the world. Neither he nor his successor, Anaximenes, nor indeed any of the Ionian school, had the slightest suspicion of the *spherical* form of the earth: the merit of this discovery is due to the Pythagoreans, who came to that conclusion from astronomical observations. Whether Pythagoras himself was aware of the truth, is uncertain: probably the discovery was made considerably after his time, as we do not find it received generally in Greece until the age of Plato.

10 While philosophers were thus busied with speculations as to the physical conformation of the Earth, another class of writers, the Logographers, conferred most signally to the advance of Practical Geography by the descriptions they gave of various quarters of the globe. Their writings have unfortunately perished, with the exception of a few fragments: but the mere titles of the works serve to illustrate the progress of geographical knowledge in the age before Herodotus, and also enable us to estimate the value of that eminent historian's researches. Not to mention the less important writers, Dionysius of Miletus, about 510 B.C., is said to have written a description of the world, as well as a full account of Persia and a narrative of the Argonautic expedition. Hecatæus, the most famous of the school (549—486 B.C.), also wrote a description of the world, divided into various sections for each particular country. He adhered to the old notion that the world was a circular disc surrounded by the ocean: so at least we have reason to conclude from Herod. 4. 36, who is supposed to refer to the opinions of Hecatæus. He divided the world into two continents—a northern and a southern—separated in the west by the Straits of Hercules, and in the east by the Caucasus and Araxes, or as some suppose, by the Tanais: and he thought the northern half, Europe, equal in extent to Asia and Libya together in the south. He was intimately acquainted with the lands frequented by the Greeks, and he gives notices of numerous seaport towns, not mentioned by other writers. His account of the west of Europe is much more full than the scanty notices in Herodotus would have led us to expect. It did not indeed fall in with the general aim of the latter historian to describe Gaul or Spain; and to this, rather than to ignorance, we must assign his comparative silence as to the west. Hellanicus of Mitylene (496—411 B.C.) wrote an account of various lands—Troas, Persia, Egypt, and Greece. Many names, nowhere else mentioned, occur in his writings; and he is believed to have been the first Greek writer who mentioned Rome. Lastly, Pherecydes of Leros, about 500 B.C., remains to be mentioned: he, like Hecatæus, considered the world a circular disc, divided into two continents—the northern and the southern. He mentions the Eridanus, Tartessus, the lake Triton, and other distant places; but the fragments of his works are so scanty, that they add nothing to the information to be derived from his predecessors.

11 To the Logographers we must add another class of men, whose works were directed exclusively to geography, those, namely, who wrote accounts of their own travels. In the year 509 B.C., Scylax of Caryanda, undertook an expedition, at the command of Darius, to explore the mouths of the Indus; starting from Caspatyrus, in Pactyice—supposed to be *Cashmir*—he descended the Indus and coasted along the Indian Ocean to the Red Sea and Egypt. His account of his travels is lost, the Periplus of Scylax, which now exists, being a compilation of a much later date. Another expedition was sent out by the orders of the same monarch, under Sataspes, a nobleman who had incurred his displeasure, and who was sentenced to sail round Africa as a commutation for capital punishment. He passed through the Straits of Gibraltar, and steered to the south, doubling Prom. Solœis, *C. Cantin*, but

being detained by baffling winds—about *Sierra Leone* in all probability—he returned to Persia after some months. A more noted expedition in the same direction was conducted by a Carthaginian, Hanno, about 500 B.C. All the circumstances connected with it have been made a matter of discussion, even to the date of its occurrence, which some have placed as early as 1100, and others as late as 317 B.C. The chief cause of the difficulties lies in the brevity of the narrative which has come down to us. The original document appears to have been an inscription in the Punic tongue, suspended in a temple at Carthage, and thence copied by a Greek merchant, who translated it into his own tongue; this translation, itself possibly incorrect, is our only source of information. The object of the expedition was to found colonies on the coast of Libya, as well as to explore the coast itself; Hanno succeeded in the first object so far as to lay the foundations of six—one, Thymiaterium, on the northern side of Prom. Solœis, *C. Cantin*, and five on the other side, between it and the river Lixus. Thence, sailing southward, he fell in with an island, Cerne,—a river, Chretes,—two great bays, called the Western Horn and the Southern Horn, and a hill, which he called Theon Ochema, i.e., the chariot of the gods. Without going into the details of the narrative, and of the views founded on it, it will suffice here to state that three widely different opinions have been expressed, each with some grounds of probability. Gosselin terminates the voyage at *C. Nun*, opposite the Canaries; Bougainville supposes it to have extended into the *Bight of Benin;* while Rennell, with greater probability, limits it to the neighbourhood of *Sierra Leone*, identifying Cerne with the island *Arguin*, the great bay with that containing the *Bisago Islands*, and the South Horn with *Sherbro' Island*. Whichever hypothesis we adopt, it is certain that the voyage of Hanno did not contribute to rectify the erroneous notions as to the shape of Africa, which prevailed to a very late period. Contemporary with this expedition of Hanno, was another no less interesting to ourselves, undertaken by the same enterprising people. We refer to the voyage of Himilco, whose narrative is to a certain extent preserved to us in the works of Avienus. He discovered the British isles, Albion and Ierne, and mentions the Œstrymnides, *Scilly Islands*, which he calculated a four months' voyage from the coast of Tartessus.

12 We have thus traced the progress of geographical knowledge from its infancy to the time of Herodotus. His writings form an era in geography, as being the commencement of a more real and enlightened system, the materials of which were drawn from actual observation and scientific research. Before proceeding to a consideration of his system, it will serve to elucidate the opinions of the age in which he lived, if we collect the scattered notices to be found in the poems of Æschylus. Omitting any attempt to reconcile the account of the wanderings of Io with true geography (for the most careful and ingenious explanations are unsatisfactory, and only serve to show the impossibility of coming to any conclusion), we shall confine our attention to the general notions which he held, and to such specific remarks as betoken the extending sphere of geographical knowledge among the Greeks.

He represents the world as a circular body, with Delphi in the centre, surrounded by the ocean, which he rightly deemed a sea, and not a river. In place of the *two* sides of the world, we hear of the *four* quarters, north, south, east, and west. We further find that he adopted the division of th e world into *three* continents: the Phasis separating Asia, and the Straits of Hercules Libya, from Europe. He retained the Homeric position of the Æthiopians, one branch of whom lived in the east, the other in the west, where the sun sank into a lake. The knowledge of the east had evidently been much increased by the unfriendly intercourse with the Persians, for we first hear of the land of Cissia, of Babylon, Ecbatana, Bactria, Syria, and Tyre. In Africa the cataracts of the Nile, the city of Memphis, and the lake Triton, are mentioned. In Europe, the Rhipæan mountains containing the sources of the Ister, the Mæotic Sea, and the Cimmerian Bosphorus, were the limits of his knowledge towards the north-east; while towards the west he mentions the Tyrrheni, Rhegium, Ætna, the Ligyes in Gaul, and probably the Adriatic Sea, under the name of the Gulf of Rhea. It need not surprise us to find that the mythical element still retained its place in the poetical works of the day, which would after all be an indication more of the *popular* belief than of the opinions of the learned.

13 Herodotus, of Halicarnassus (who was born 484 B.C., and died about the end of the Peloponnesian war), has always been considered the father of ancient geography. As the object of his work was directed to a narrative of the disputes between the Greeks and Persians, we should not anticipate any systematic or general delineation of the world and its subdivisions. Nevertheless, the incidental notices of what he had himself seen and heard in the course of his travels in Asia Minor, Phœnicia, Palestine, Syria, Mesopotamia, Assyria, Media, Egypt, and the north coast of Africa, Sicily, and Magna Græcia, embrace a description of almost all the lands known to the Greeks of that day. Towards the west of Europe, indeed, his knowledge was very limited, as we have already had occasion to notice; towards the north-east he had himself penetrated to Colchis and the Phasis; he knew as much or more about the Caspian Sea, than his successors to the time of Alexander; he had navigated the Euxine, and had visited the Borysthenes; and southwards he had gone as far as Elephantine.

Herodotus can hardly be said to have formed any distinct notion as to the Earth's form and size: while his knowledge was sufficient to disprove the correctness of the mythical system, it was insufficient to lead him to replace it by any more certain theory. Thus, he ridiculed the idea which had hitherto prevailed, that the world was *circular:* he did not feel sure that it was surrounded on all sides by water; and as for the Homeric opinion of the Ocean-*stream*, he set it down as a mere poetical fiction: the division into the three continents, Europe, Asia, and Libya, which appears to have been pretty generally received, he also rejected as false and unreasonable. According to him, the world would be rather of an *oval* shape, having its extension east and west, surrounded in all probability by water, not divided into separate continents, but rather to be regarded as one vast island. He was inclined to adopt a twofold division of the Earth's surface: to the northern half, Europe, he assigned all that we call Northern Asia; to the southern half Asia with Africa, which he deemed a peninsula of Asia: the boundary between the two continents ran from west to east, through the Straits of Gibraltar, the Mediterranean, the Euxine, along the course of the river Phasis, and was thence carried onward to the unlimited east by the river Araxes, under which title Herodotus describes not only the Armenian river of that name, but also the Iaxartes, *Sirr*, which now flows into the *Sea of Aral.* Europe was thus equal to, or, as some interpret the words of Herodotus, greater in breadth than Asia and Africa together; but inferior in depth. The world was bounded on the south by the Red Sea, a name evidently intended to apply to the whole of the Indian Ocean; and on the west by the Atlantic: its boundaries to the north and east were unknown.

The following brief sketch of each continent, as known to Herodotus, will serve to show the extent of his knowledge. In the west of Europe, he mentions Spain under the name of Iberia, with the towns, Tartessus, Gadeira, *Cadiz*, and the neighbouring isle, Erytheia, *Trocadero:* to the westward—for he appears to have given Europe a much greater extension beyond the Pillars of Hercules than it actually possesses—the Keltæ, with the town Pyrene, where the Ister had its rise, evidently a mistaken allusion to the *Pyrenees:* beyond the Keltæ, the Cynetes or Cynesii, whose locality cannot be settled. He had heard of the Cassiterides, and of the river Eridanus, whence amber was procured, about the shores of the Baltic, but he knew nothing further of them. In later Gaul, he mentions Massilia, *Marseilles*, the Ligyes, and the Elisyci. The island *Sardinia*, the size of which was much exaggerated in the east, appears by the name Sardo, and *Corsica*, with the Phocæan colony, Alalia, by the name Cyrnus: Sicily, with its towns, was known intimately to him. The name Italia occurs for the first time in his writings, applied, however, only to the lower coast of the peninsula, or what was afterwards called Magna Græcia; while the remainder of the peninsula is noticed as the residence of the Ombrici, in whose name we recognise the Umbri, and in parts, as Œnotria and Tyrsenia. Rome he does not mention, though it was probably known to the Greeks of his day. In Illyria he mentions incidentally the Heneti, on the Adriatic,* the Enchelei, and the river Angrus. The course of the Ister, which he deemed the greatest of all rivers, is described at length, with its tributaries. These are, on the right bank, the Alpis and the Carpis, in reference to the Alps and Carpathian mountains,—the former possibly representing the *Inn;* the Brongus, *Save,* with its tributary, the Angrus, *Drin;* the Scius, from Rhodope, *Isker;* a little lower down the Artanes, *Mid;* then the Noes, *Kara Lom;* the Athrys, *Jantro,* and others which cannot be identified with any certainty. On the left bank, the Maris, *Marosch,* and five other large tributaries—the Porata, *Pruth,* Tiarantus, *Aluta,* Ararus, *Sereth,* Naparis, *Jalomnitza,* and Ordessus, *Argish.* The lower course of the Ister, Herodotus supposed to run in a direction, not from west to east, but from north to south; and thus he deemed the Ister to correspond completely with the Nile; for as the latter river ran, in his opinion, from west to east, and then turned at right angles, and flowed northwards to the Mediterranean, so the Ister, which preserved in its first course an easterly direction, turned southwards when it approached the sea, and flowed at right angles to its former course. This mistaken view of the course of the river will serve to explain the description of Scythia: Herodotus says that it was a quadrangle, bounded on two sides by the sea—viz., by the Euxine on the south, and by the Palus Mæotis on the east, (to which, it must be observed, he gave a most extravagant length upwards, describing it as little less than the Euxine itself,) and on the west by the Ister. The Ister and the Palus Mæotis were thus parallel to each other, the river forming the boundary between Thrace on the *west,* and Scythia on the *east* bank: in which case he might with consistency speak of the country beyond the Ister, *north* of Thrace, as being desert, in reference to the district on the opposite bank of the river, in its *easterly* course. In reality, Scythia lay beyond the Ister, and north of Thrace; but from his mistaken view of the course of the river, he conceived Scythia to lie to the *east* of Thrace. The same error has influenced his description of the other rivers of Scythia, to which he also gives a course from north to south, instead of from north-west to south-east. The rivers which he thus mentions are the Tyres, *Dniester,*—the ancient and modern names being said to be appellatives for 'water;' the Hypanis, *Bog,* which he correctly states to approach very near the Dniester in its upper course; the Borysthenes, *Dnieper,* with a port at its mouth, where *Cherson* now stands; the Panticapes, by some supposed to be a tributary of the Borysthenes, by others one of the coast streams which join the Euxine near that river; the Hypacyris, which empties itself near the town Carcine; the Gerrhus, also a branch of the Borysthenes; and the Tanais, *Don.* Though of these streams three, the Panticapes, the Hypacyris, and the Gerrhus, cannot be now identified, it does not follow that they did not exist when Herodotus visited those regions: the well-established instances of changes in the courses of the rivers to the east of the Caspian, would allow us to conclude that very great changes may also have occurred in the lapse of ages on the northern coast of the Euxine.

The continent of Asia was better known to Herodotus than Europe: its boundaries have already been described; while the general opinion declared the Tanais to separate it from Europe, Herodotus preferred the Phasis, which

* Herodotus probably gave to the Adriatic considerably too great an extension northwards, as some of his contemporaries certainly did: on this supposition alone can we understand him when he says that the Sigynnæ *north* of the Ister, lived next to the Heneti on the Hadriatic.

led to the great extension eastward which he assigned to it. In describing the relative positions of the countries of Asia, he not improperly takes his stand on the high ground between the Euxine and the South Sea, regarding this as the centre of the western Asiatic system. Here dwelt, contiguous to each other from north to south, the Colchians, the Saspirians, the Medes, and the Persians. He then proceeds to say, that from this region two *actès* strike out, towards the west and towards the south. By an *actè* he means, not strictly a peninsula, but a projecting region washed on most of its sides by water, and connected with the continent by a base, either extensive or confined, as the case might be. The western *actè* corresponds with Asia Minor, the southern with the great Arabian peninsula, including Assyria and Mesopotamia near its base. Of the remainder of the continent, Herodotus knew but little: it was bounded to the east by the Red Sea, into which the Indus ran, with a course from west to east: as far as India, he says, the country is inhabited, beyond it is a sandy desert. The Caspian he supposed to have its extension east and west, instead of north and south; and the river Araxes, rising to the west of that sea, flowed onward to the east of it, discharging a portion of its waters into the sea in passing, and finally being absorbed in a number of marshes. Almost the whole of Asia was subject to the Persian power in the age of Herodotus; he therefore describes it according to the division established by Darius Hystaspes into twenty satrapies, and takes occasion to mention incidentally the few nations, such as the Colchians and southern Arabians, who were not subjected: on this portion of his geography it is unnecessary now to dwell, as the details will subsequently come under consideration.

Libya, or Africa, was not deemed by Herodotus a separate continent from Asia, for the simple reason that it was connected with it by the isthmus of Suez. He speaks of it as a portion of the great southern *actè,* or rather as a continuation and excrescence of it. He nevertheless speaks of it as a separate *district,* and evidently did not consider it as below Europe or Asia in importance. It is necessary to remark that the name Libya is used by Herodotus in a twofold sense—sometimes as a collective name for the *continent,* sometimes as describing the coast district to the west of Egypt. Thus he says in iv. 42, that Libya is surrounded by water in all parts except where it touched Asia: here he must refer to the continent, Egypt included: in iv. 41, however, he represents Egypt as contiguous to Libya, and in another passage, iv. 197, he distinguishes between the Libyans and Ethiopians. That he included Egypt in Libya as a *continent,* is evident from his observations in ii. 16, 17. He divided the continent into three districts, Egypt, Libya, and Ethiopia. It is unnecessary to make any remarks on his description of Egypt, as it agrees with the later accounts of that land, with the exception that he does not recognise the threefold division generally adopted by the Roman geographers, but speaks only of the Delta and Upper Egypt. The Nile had been explored by him as far as Elephantine, and he had heard of the separation of its stream further to the south; from which point he believed the main stream to flow from west to east, perhaps in reference to some report of the great inland river of Africa—the *Niger.* Libya was the name of the whole of northern Africa, from Egypt eastward, to the Atlantic and Prom. Solœis, *C. Cantin,* westward: Herodotus describes this as consisting of three belts or parallel districts, widely differing from each other—1. The coast; 2. The wild district infested by wild beasts; and 3. The sandy desert. The following tribes occupied the coast:—the Adyrmachidæ in Marmarica as far as the Catabathmus—the Giligammæ to the westward, until the isle Aphrodisia, *Derna:* then the Asbystæ, separated from the sea-coast by the Cyrenians. Herodotus knew only one Syrtis, probably the Syrtis Major, on the coast of which the Auschisæ dwelt: the Nasamones followed, a powerful tribe, to the south of the great Syrtis, who went annually to Augila, *Aujilah,* to gather dates: then the Psylli: and between the greater and the less Syrtis the Macæ and the Lotophagi; the Machlyes on the east, and the Ausenses on the west of the river Triton; the Zaueces to the south of Carthage; then the Gyzantes to the sea, with the island Cyraunis, identified by Niebuhr with the Cerne of Hanno, *Arguin*. It appears that Herodotus materially contracted the distance between the lesser Syrtis and the Pillars of Hercules. It would also appear that he was ignorant of the extensive bend that the sea takes to the north of the lesser Syrtis, though this may be explained on the supposition that he follows in his description of the coast tribes, the parallel of latitude in which he had started; for the tribes Zaueces and Gyzantes lived to the south of the Atlas range, while Carthage and its important territory to the north-west of the lower Syrtis is passed over in silence. In the interior, Herodotus mentions only one Oasis by name, which lay, according to his account, in the latitude of Thebes—viz., the great Oasis, or *El Khargeh*. His description of the other localities is confused, from his having placed the Oases in the same parallel of latitude. Thus, speaking of the kingdom of the Ammonians, now the *Wady Siwah*, with the temple of Jupiter Ammon, he says that it is ten days' journey west of Thebes, which places it four degrees of latitude south of its real position; at a similar interval of ten days' journey came Augila, still called the Oasis of *Aujilah*, to the south of Barca; and again, at a similar interval, the Garamantes in *Fezzan*, south of the Lotophagi and the modern *Tripoli;* next came the Atarantes, supposed to be *Tegerry*, the most southerly point of *Fezzan;* and lastly, an Oasis in the vicinity of Mount Atlas, which cannot be identified with any degree of certainty. Of course the regularity of the intervals between the several Oases is imaginary, and introduced to give precision and uniformity to the narration. The notices of the third great nation of Africa, the Æthiopians or Negroes, are very few. He mentions the Troglodyte Æthiopians to the south of the Garamantes, where modern travellers have found tribes living in catacombs. He also speaks of the Macrobians, who lived by the southern sea in *Abyssinia;* the Automoli, mentioned ii. 30, lived between the Macrobians and Egypt, considerably to the south, or according to the course that Herodotus conceived the Nile to take, to the *west* of Meroe. He seems to have extended the course of this river westward, as far as the region of the Atlantes; the position of the Negro tribe, whom the Nasamonians discovered by the side of a river abounding with crocodiles, cannot be fixed with any certainty: it has been supposed that the river was the *Niger*, and the town they arrived at, *Timbuctoo*, or some neighbouring place.

14 Herodotus was succeeded by a writer who delighted far more in the extraordinary, Ctesias of Cnidos, physician to the Persian king Mnemon (about B.C. 400). His works on geography, of which fragments only have come down to us, relate to Persia, India, and other countries of Central Asia. He notices places and people previously unknown, or at all events, unmentioned; as the Derbicæ in Margiana; the Carmanii; the Barcanii, neighbouring upon the Hyrcani; the Hypparchus, and the Hypobarus, rivers of India; the Lake Side in the same country. It does not appear that Ctesias was considered an authority among the ancients: he is accused of ignorance and mendacity; modern scholars have judged less harshly of him, regarding his extravagancies merely as the colouring usually found in Oriental writers.

15 The Peloponnesian war brought the Greeks into contact with many tribes in the north and the west, with whom they were hitherto unacquainted, and particularly improved their knowledge of Sicily and the west. The writings of Thucydides, the historian of this war, abound with topographical and descriptive notices of spots in Greece, and other scenes of operation; but as they do not take us beyond the limits of earlier writers, they do not contribute many materials to historical geography.

His countryman, Xenophon (B.C. 445—355), in his interesting account of the retreat of the 10,000, gave accurate descriptions of various countries, with which the Greeks were but partially acquainted. The route the army took through Armenia betokens the ignorance of the day on geographical points; for they struck off too much to the north-east, thinking probably that the

Euxine extended very far to the eastward. It will be sufficient to give a general sketch of their course, in order to show the range of geographical notices in the Anabasis. They started from Ephesus, went northwards to Sardis, and crossed thence to the vale of the Mæander, by Colossæ in Phrygia; their course was circuitous in that province; after going eastwards to Celænæ, they returned to the north-west, and reached the confines of Mysia at Keramon-agora; thence, bending southwards, they followed the ordinary route to Syria by Laodicea Combusta, Iconium, and the Ciliciæ Portæ of the Taurus; they rounded the eastern point of the Mediterranean by the Amanian Gates and Issus,—and thence struck across the plain of Syria from Myriandrus to the Euphrates, crossing midway the river Chalus, *Koweik* or river of *Aleppo*. Thapsacus was the point where they came upon and crossed the Euphrates, and thenceforward they followed the left branch of the river for the whole length of the plain of Mesopotamia; the fertile field of Cunaxa, which proved fatal to their leader Cyrus, was the farthest point to the south. Instead of returning by the same route, they followed the course of the Tigris, which they crossed at Sitace, marching along its left bank up to the point where in its upper course it bends round to the west. Here they struck off to the north, through the high ground of Armenia, crossing the Centrites *Buhtanchai*, the Teleboas *Kara Su*, a small tributary of the Euphrates, and the Euphrates itself, that is, the *Murad Su* or southern branch, near its source. From the Euphrates they went westward for awhile to Khanus, *Kalehsi;* and then they fell into the great mistake of going eastward to the Phasis, or Araxes, north of *Ararat*, and even beyond that into modern Georgia, as far as *Tiflis;* they were obliged to return almost in their own footsteps to the Harpasus, *Arpachai*, a tributary of the Araxes, which they crossed, and proceeded to the north of the last-mentioned river to Gymnias (probably *Erzeroom*); having gained the summit of the Teches, whence they descried the Euxine Sea, they easily found their way to the coast, near *Trebizond;* at this place some went by sea, and others by land to Cotyora, and then all by sea to Heraclea Pontica; here they disembarked, and made their way by land to Chrysopolis, and thence across the Bosphorus to Byzantium; they re-embarked at Perinthus for Lampsacus, and so crossed the plain of Troas to Pergamus.

16 Herodotus was not the only Greek writer who travelled for the sake of information, and recorded what he learned for the benefit of his countrymen. Many, indeed, were actuated by a more scientific spirit than he showed, among whom we may mention Heraclitus of Ephesus, who journeyed to the Ocean; Democritus of Abdera, who travelled in Babylon, Persia, and Egypt; Antiochus of Syracuse, contemporary with Thucydides, who described Sicily and Italy; Ephorus, and many others, who contributed largely to the geographical literature of the day, but whose works have almost wholly perished. Two men deserve particular notice, Eudoxus, about B.C. 360, a friend of Plato, who discovered the spherical form of the world, and divided it into zones, and who also wrote accounts of various countries in which he had travelled; and Scylax, the author of the Periplus already mentioned, containing a description of the Mediterranean Sea, the Euxine, and the Atlantic, as far as the island of Cerne, on the coast of Libya. He must be distinguished from Scylax of Caryanda, who also wrote a Periplus, not extant, of the Indian Ocean; the author of the extant work lived in the reign of Philip of Macedon.

17 With the age of Alexander commences a new era in the history of geography; hitherto the knowledge of Asia was co-extensive only with the Persian empire. That great man carried his conquests to the banks of the Indus and the Oxus, and opened Northern and Eastern Asia. Nor was he only concerned with extending his dominions: he forwarded science by taking in his train professional geographers, such as Diognetus and Betus — by requiring the governors of the conquered provinces to send in descriptions of their territories—and also by sending out expeditions to explore and survey various points. To show what new scenes were opened at this time, we will commence with a brief sketch of his own military expedition. From the Granicus,

on whose banks he first engaged with the Persians, he passed southwards to Ephesus, Miletus, and Halicarnassus; thence by Patara and the south coast of Lycia, rounding the headland of Climax, to Perga; from this point he turned northwards, passing through Celænæ to Gordium in Bithynia; then to the south-east, through Ancyra and Tyana, Tarsus and Mallus in Cilicia, to Myriandrus; finding that the Persians were in his rear, he returned to Issus, and having again proved the conqueror, hastened through Cœle-Syria and Palestine, besieging and taking Tyre, Sidon, and Gaza, and visiting Jerusalem. Egypt submitted without a contest; and the Emperor's visit was chiefly celebrated by his adventurous visit to the temple of Ammon, in the lesser Oasis, and by the foundation of Alexandria; from Egypt he returned to traverse the central provinces of Asia; he crossed the Euphrates at Thapsacus, and the Tigris near *Mosul;* Gaugamela, to the south of this point, was the scene of another victory, which was followed by the capture of Babylon. Thence he passed by Susa, and through the Persian gates, to Persepolis; returning on his track to Opis on the Tigris, he passed by Ecbatana and Ragæ, through the Caspian gates, through Hyrcania, Margiana, Aria, Drangiana, and Bactriana, to Sogdiana, in which country he wintered at Nautaca; the Iaxartes was the limit of his progress to the north. He returned southwards to Bactra, and crossed the Paropamisus, *Hindookoosh,* by the route of *Bameean,* to the banks of the Cophes *Cabool.* Below the town Nicæa he turned northwards by the course of the Choes, the same river that is also called the Choaspes or Evaspla, now the *Kameh,* to subdue the tribes of the Aspasiacæ and Guræi, crossed the upper valley of the Guræus, *Pargikora,* and descended between the course of that river and the Indus, to Peucela, and along the course of the *Cabool* river to its junction with the Indus. After a second campaign northwards along the Indus, as far as Dirta, he crossed that river just above the entrance of the *Cabool,* and passing by Taxila, a town to the south-east of the modern *Attock,* he encamped on the banks of the Hydaspes, *Jhelum,* in the *Panjab,* either near *Rotas,* or, as some suppose, lower down, near *Jellalpore.* He first effected the passage of this river at a point some miles higher, and having defeated Porus, traversed the plain that intervenes between the *Jhelum* and the Acesines, *Chenab;* thence to the Hydraotes, *Ravee,* where he found a town, Sangala, on the site of *Lahore;* then, in the same direction, to the Hyphasis, *Beas,* above the point of its junction with the Hesudrus, *Sutlege.* The great Indian desert put a stop to further progress. He returned to the Hydaspes, and followed the course of that river to its junction with the Indus, and thence to Pattala, *Tatta.* He here divided his forces, despatching a naval expedition, under the command of Nearchus, to explore the coasts of the Indian Ocean and Persian Gulf, while he himself returned overland through the wastes of Gedrosia and Carmania, to Susa. His subsequent visit to Ecbatana, and afterwards to Babylon, require no notice here. An account of Nearchus' discoveries has been preserved to us in Arrian's works; he coasted along the shores of Gedrosia and Carmania, leaving the mouth of the Indus in October B.C. 326, and arriving in the Euphrates in February, 325. In addition to this, other expeditions were sent to explore the coast of Arabia under Hiero, Archias, and Androsthenes; but their discoveries were not of any great importance.

We can easily conceive that the achievements of Alexander gave a great impulse to the spirit of geographical inquiry: a host of writers followed in quick succession, who gave descriptions of the newly discovered lands. Onesicritus, a pilot, wrote an encomium of Alexander, with accounts of India and the eastern provinces of Asia. It serves to illustrate the state of knowledge in that day that he speaks of India as in size the third part of the whole habitable world, and of Taprobane, *Ceylon,* (first mentioned by him,) as twenty days' sail from the continent. Clitarchus also described India, and wrote of the Celts and Cimbri in the west. Anaximenes, Aristobulus, to whom Arrian is indebted for his materials, Callisthenes and

Hieronymus followed very much in the same track. The latter was the first Greek writer who described the antiquities of Rome. We may also here mention Hecatæus of Abdera, a writer of the same age, who advanced out of the beaten track to describe the Hyperboreans and the Northern Ocean, which he names the Amalchium Mare, stating that it began from the river Paropamisus.

18 The east, however, was not the only direction in which the spirit of discovery found an outlet. While Alexander was pushing his conquests in Asia, a less celebrated but not less adventurous man, Pytheas of Massilia, was conducting an expedition to the north-west coasts of Europe. He was both a mathematician and an astronomer, so that his observations on the phenomena he witnessed, as the ebb and flow of the tide, the length of the day in northern climates, &c. &c., were valuable to his contemporaries. He followed the coast of Spain and Gaul, passed up the British Channel, and thence along the east coast of England; leaving the extreme northern point of Britain, he penetrated for six days into the Northern Ocean until he reached Thule. Deterred from further advance in that direction by the mists, he returned to the mouth of the Rhine, and thence to the coasts of the Baltic, where he heard of the Teutones and the Gothones. A contemporary, Euthymenes, sailed through the Pillars of Hercules to the Southern Ocean. It serves to illustrate Herodotus' notion of the Nile's course, that he represents that river as communicating with the Atlantic Ocean. Lastly, Dicæarchus, a pupil of Aristotle, combined all the discoveries of the age in well executed and valuable maps, accompanied with descriptions of the world and of particular countries. Two fragments of his work on Greece are still extant, giving descriptions of Bœotia and Attica.

19 The successors of Alexander forwarded the progress of geographical knowledge by their military expeditions, and more especially by their embassies. Megasthenes, the ambassador of Seleucus to king Sandrocottus, wrote an account of India generally, and particularly of the districts bordering on the Ganges, as well as of the island Taprobane. Daimachus and Dionysius, the former sent by Seleucus Nicator, the latter by Ptolemy Philadelphus, spent many years at Palimbothra, and published accounts of India. Patrocles navigated the Indian Ocean: he maintained the notion, of which we find traces both before and afterwards, that the Caspian was a gulf of the Northern Ocean, and that the eastern coasts of Asia might be circumnavigated. Seleucus himself undertook an expedition beyond the Indus, the details of which are little known to us; he penetrated probably as far as *Patna*.

20 In the meantime philosophy was paving the way for a more correct and scientific system of geography. Already had Plato, and after him, with greater certainty, Aristotle, perceived the spherical form of the Earth; both had also surmised the existence of other continents besides those with which their age was acquainted, and the latter had attempted to lay down the extent and the proportions of this upper hemisphere. Subsequent observations confirmed the important discovery of the Earth's real form, which was believed by all but the Epicurean school, who still adhered to the primitive notion that it was a flat surface. The views of Aristotle were disseminated by the writings of his pupils, Theophrastus the Lesbian, and Heraclides Ponticus: the former did further service by publishing a work on the topography of Italy; the preserved fragments of the latter refer to the Cimmerians and other peoples and places in the north of Asia.

21 We now enter upon a new era in the history of Geography. About the year 220 B.C., it took its place among the sciences, under the able management of Eratosthenes of Cyrene, who was born 276, and died 194, B.C. This man was educated at Athens, whence he removed to take the office of librarian at Alexandria, at the invitation of Ptolemy Euergetes. With stores of knowledge at his command, and living in a place which was at once the centre of commerce and learning, he had every opportunity of

acquainting himself with the discoveries of others in every part of the world, together with physical and mathematical science to correct and systematize the vast mass of materials before him. His work on Geography is unfortunately lost: he treated the subject methodically, dealing with the physical, the mathematical, and the political portions in separate books: he also constructed maps on mathematical principles, and was the first to use parallels of latitude and longitude. He considered the Earth to be spherical, surrounded by a firmament of similar shape, both of which revolved about one and the same axis, and had one centre. The equator was supposed to divide the hemisphere into two equal halves—a northern and a southern—and the distance to each pole he computed at 63,000 stadia, so that the whole circumference would equal 252,000 stades. From the equator he drew eight parallels at unequal intervals—the first passing through Taprobane; the second through Meroe; the third through Syene; the fourth through Alexandria; the fifth, which was deemed the great central parallel of the northern hemisphere, through the Straits of Hercules, Rhodes, Issus, the Caspian gates, and the Paropamisus; the sixth through the southern point of the Euxine; the seventh through the mouth of the Borysthenes, and the eighth through Thule. These parallels were crossed at right angles by meridians, seven in number; the central and most important passing through Meroe, Syene, Alexandria, Rhodes, Troas, Byzantium, and the mouth of the Borysthenes. He considered, that only a portion of the northern half of the hemisphere was inhabited, equal to an eighth part of the world's surface, and the extent of this he calculated at 78,000 stades in length, by 38,000 in breadth, so that the oblong shape resembled a Macedonian *chlamys*. The extreme points of the habitable world were, in the East, Thinæ in the land of the Seres, *China;* in the West, the Prom. Sacrum, *Cape St. Vincent*; in the South, the Cinnamon Coast of Africa, and in the North, Thule. As to the details of his geographical system, we learn from Strabo sufficient to prove that he had gone beyond his predecessors in topographical knowledge. He mentions, for instance, the rivers Anas and Tagus, and Prom. Calpe in Spain; Orkynia, the *Hercynian Wood*, in Germany; the two branches of the Nile, Astaboras and Astacus, which surrounded the kingdom of Meroe; the mountain Imaus, *Himalaya*, in Asia; the promontory of Thinæ in China, and the Ganges. On the other hand, it shows his ignorance in some particulars, that he represents the Ister as communicating by an arm with the Adriatic Sea, and that he conceived the Persian Gulf as equal in size to the Euxine. Eratosthenes took great pains in ascertaining the distances between different places, which in many instances he has shown with great accuracy, considering that his calculations were based on measurement only.

22 Hipparchus of Nicæa, about 150 B.C., succeeded Eratosthenes in the rank of ancient geographers. A severe critic of the statements, he nevertheless followed generally in the footsteps of his predecessor. His chief merit consists in having brought astronomy to bear upon geography, inasmuch as he learnt to fix the relative position of localities, not from measurement, but by observation of the heavenly bodies. He adopted, in his map, the meridian of Eratosthenes through Alexandria, Syene, &c., and the same separation of parallels of latitude, though with some varieties in their position. From what we know of the details of his works, the field of practical geography does not appear to have made any advance.

Polybius (B.C. 205 to B.C. 123) deserves notice as a topographical writer of great merit, and still more as having perceived the intimate connexion between history and geography. His extant works are directed, in the main, to the former science, but we know that he also wrote some treatises on geography. He is peculiar in his division of the world into *six* zones, instead of five; the torrid, according to his system, being divided into two by the equator. He does not appear to have promulgated any new theory, or to have indulged much in speculation. On one occasion, indeed, he ventured an opinion, of which we find traces in the writers immediately before him, that Asia and Africa were connected in their southern extremities, and that the Indian Ocean was merely a vast lake. Generally, however, his writings are descriptive; and they probably conduced to a better acquaintance with the western nations of Europe, Syria, and the north-west coast of Africa.

During the interval that elapsed between the ages of Eratosthenes and Strabo, there were many voluminous works published, which served as authorities for the latter writer, but which have been wholly lost to us. Among these the poetical works of Scymnus of Chios, B.C. 100, and of Alexander of Ephesus—the former, descriptive of Greece, Sicily, and Italy; the latter, of the world—the treatises on Homeric Geography by Apollodorus of Athens, B.C. 140, and by Demetrius of Scepsis—the Journals of Artemidorus of Ephesus, B.C. 100, who explored the coasts of the Mediterranean and the Red Sea, and part of the Atlantic Ocean—the geographical works of Agatharchides of Cnidos, B.C. 120, and of Cornelius Polyhistor, who described the world in forty books, are frequently mentioned by later writers.

23 The valuable work of Strabo has fortunately escaped the general fate. This eminent man, a native of Amasia in Pontus, was born about the year 66 B.C., and died about 24 A.D. His whole life was devoted to the study of historical and geographical science, which he further followed up and improved by extensive travels through Asia Minor, Greece, Italy, Egypt, and Syria. His geographical treatise was written in the later part of his life, and embodies the results of his multifarious labours: it is divided into seventeen books, the two first of which are devoted to an Introduction, wherein the works of his predecessors, and especially the physical and mathematical statements of Eratosthenes and Polybius are noticed; the next eight books contain the description of Europe, the following six of Asia, and the last of Libya. Though Strabo availed himself most largely of the discoveries of his predecessors, he unfortunately underrated the writings of many who would have supplied him with valuable materials. It is a matter equally of surprise and regret, that while he sets great store upon Homer he casts aside Herodotus, and that while he cites Ephorus, Artemidorus, and others, he neglects Ctesias, Pytheas, and all the Roman historians and writers. It is also to be regretted that he did not follow the example of his great master, Eratosthenes, in a more systematic treatment of his subject, and in devoting more attention to physical and mathematical geography. His aim, however, appears to have been, not to write a philosophical treatise, but to supply the 'reading public' of the day with an interesting and instructive manual of *descriptive* geography, which should serve alike for the student, the merchant, and the general reader.

In the general theory of geography he follows closely in the steps of Eratosthenes, representing the world as spherical, and surrounded with a concentric orb of sky, which moved round it from east to west, while the Earth was itself stationary. He divided the hemisphere into two parts by the equator and into five zones, and he adopted the same chief meridian through Meroe, and the same parallels of latitude and longitude. The habitable world was, according to his calculations, twice as long as it was broad, and resembled in shape a Macedonian *chlamys*, the eastern and western extremities of the world being contracted like the lappets of that robe. It was surrounded on all sides by the ocean, which formed four large bays, connected with it by very narrow channels,—viz., the Caspian Sea, which was connected with the Northern Ocean, the Persian Gulf, the Red Sea, and the Mediterranean. The Northern Ocean he describes as unnavigable; nor had any one ever penetrated the channel of the Caspian Sea. The Persian Gulf lay due south of the Caspian, and the Red Sea in a similar position with respect to the Euxine. The Mediterranean far exceeded the others in size, and consisted of numerous basins, as the Ægean, the Euxine, &c. This sea, together with the range of Taurus to the east, divided the world into two halves—a northern and a southern division—which, however, did not lead Strabo to reject the generally accepted distinction of the three continents, Europe, Asia, and Africa.

In his description of particular lands, there are numerous and glaring errors: Spain, for instance, is represented as a parallelogram, like a 'hide stretched out,' separated from Gaul by the Pyrenees, which would thus run from north to south, parallel to the west coast. Celtice, or France, is also very much misshapen; the Pyrenees and the Rhine form the boundaries to the east and west, the Ocean and the Alps to the north and south, but the sea coast, it will be observed, runs in his map straight from Spain to the Rhine and Elbe, the peninsula of Brittany and the Bay of Biscay being altogether omitted. This great error led him into a further mistake as to the position of Britain, which he describes as triangular in shape, its longest side, which runs parallel to Gaul, terminating in two promontories, the eastern opposite the mouth of the Rhine, the western opposite to Aquitania and the Pyrenees. Strange as the latter statement may appear, it is not so very inconsistent with his calculation of the length of the Celtic coast, which, from the Pyrenees to the Rhine, amounted to only 4300 stades. Ierne, *Ireland*, lay to the north of Britain, and beyond that no one could penetrate on account of the cold. No notice is taken of Thule, nor yet of the discoveries of Pytheas to the east of the Elbe, which river he makes the limit of the known world in that direction. He perhaps conceived the coast carried on in a straight line as far as the outlet of the Caspian Sea, whence it commenced a gradual decline to the south-east, thus cutting off the vast regions of China, Siberia, and Mongolia. Thinæ, the most easterly point, lay in the latitude of Rhodes, at the termination of the great central range of Imaus, near which point the Ganges reached the sea, flowing from west to east. The coast then trended southwards to Prom. Coliacum, *C. Comorin*, and the island Taprobane, and returned thence to the westward in nearly a straight course. The continent of Asia was divided into two parts by Taurus—viz., Northern Asia, which was subdivided into four districts:—1. The lands between the Tanais and the Caspian Sea; 2. Those to the eastward of that sea; 3. The countries lying along the range of Caucasus, as Media, Armenia, Cappadocia, Cilicia, &c.; 4. Asia Minor within the Halys, and Southern Asia, which included India, Ariana, Persia, Mesopotamia, Syria, and Arabia. Africa took the shape of a right-angled triangle, the Red Sea and the Mediterranean representing the sides containing the right angle, and a line stretching across the Desert from a point south of *C. Guardafui* to the *Straits of Gibraltar*, forming the hypothenuse. His account of this continent is scanty, and adds nothing to the discoveries of his predecessors. He mentions the two branches of the Nile, Astacus and Astaboras, and also a lake, Pseboa *Dembea*, in Abyssinia. In this continent, indeed, geography had actually lost ground during the five hundred years that elapsed between Herodotus and Strabo.

24 The wars of the Romans brought distant tribes, particularly of the north and the west, into contact with the civilized world, and tended to a considerable enlargement of the field of practical geography. Thus, the wars in Spain against Viriathus and Sertorius (B.C. 149—133, and 80—72), the campaigns of Cæsar in Gaul and Britain (B.C. 56—50), of Augustus in the countries about the Danube (B.C. 15), of Drusus, Tiberius, and Germanicus (B.C. 12 to A.D. 16) against the Germans, followed up as they were by the establishment of military colonies and the formation of roads, led to an intimate knowledge of these quarters. But the greatest service was done by the survey of the Roman empire, commenced by Cæsar and completed by Augustus, which comprised a description and measurement of every province, accompanied by charts and tables. The most celebrated Greek geometricians—Zenodoxus, Theodotus, and Polycleitus—were employed in the work, and an impetus was given to the study of practical geography, the effects of which may be traced in all the historical writings of the Augustan age—Sallust, Cæsar, Tacitus, and others.

The characteristic feature in the Roman school of geography consists, as the genius of the Roman people would lead us to expect, in the predominance of the *practical* over the philosophical element. Indeed, no advance was made by them in the study of the physical or mathematical branches of the subject, in which respects they adopted the opinions of the Alexandrine school. Rome, nevertheless, produced two very illustrious geographers—Pomponius Mela and Pliny. The first of these, by birth a Spaniard, lived in the reign of Claudius. His extant work entitled, *De Situ Orbis*, consists of three books, in which he delineates the form and relative position of the countries of the known world. He takes the sea as his guide, and in the first book describes the African and Asiatic coasts of the Mediterranean Sea, with the adjacent provinces; in the second book, the maritime provinces on the European coast of the same sea; and in the third, the countries adjacent to distant seas, as India, Germany, &c. He is more exact than his predecessors in his account of the western and northern countries of Europe, and especially of Britain and Ireland; but in his account of the south and the east, he falls back to the age of fabulous geography, and peoples the world with sphynxes, griffins, and other fanciful creatures. He expresses his belief that Africa had been circumnavigated by Hanno and Eudoxus; and he surmises that Ceylon was the commencement of another continent, as no one had yet sailed round it. He held it probable that, in the southern hemisphere, beyond the ocean, an unknown continent existed, inhabited by Antichthones, and he conjectured that the Nile had its springs there, and passed under the ocean by a subterraneous passage, to re-appear in this northern continent.

Pliny, who flourished between the years 23 and 79 A.D., devoted four out of the thirty-seven books of his work on natural history to geography. To his unrivalled industry in collecting information, both from reading and conversation, he added the advantage of having travelled in Spain, Gaul, Germany, and Africa. His work bears few traces of originality, being chiefly a compendium of the statements of former writers, who often contradict or vary from each other; still there are, occasionally, valuable hints as to the productions and peculiarities of districts, and the customs of their inhabitants. It is unnecessary to present any detail of his statements, as but little fresh ground was broken by him. He surpassed Mela in knowledge of the East, as he correctly affirms Taprobane to be an island, and not the commencement of a new continent: he also seems to have had some knowledge of the Arctic regions; for he tells us that in Thule and the Ripæan mountains there was only one day and one night in the year. He also mentions the Sinus Codanus, and the islands, Scandinavia and Baltia. The interior of Africa had been penetrated to some distance from the coast, and he gives accounts of Mount Atlas, the course of the Niger, and of various towns on its banks. Asia, to the north of the Iaxartes, and to the east of the Ganges, remained a *terra incognita*.

25 The study of Ancient Geography attained its greatest perfection under Claudius Ptolemy, the founder of the later Alexandrian School. This celebrated philosopher flourished at Alexandria about the middle of the second century after Christ. Besides several mathematical and astronomical works bearing upon the science of geography, he composed a work directly bearing on that subject in eight books, which was deemed the most perfect system of geography during the middle ages, and even down to the sixteenth century. Ptolemy does not deserve, nor indeed does he claim, all the gratitude that posterity have bestowed upon him; much of the valuable materials in his work had been previously collected and arranged by Marinus of Tyre (about 150 A.D), whose writings, themselves lost, are embodied in the work of Ptolemy. The great merit of Marinus consists in his having fixed with greater certainty the latitude and longitude of the most famous towns and places, by a careful study of Itineraries, compared with the measurements recorded in earlier works. He drew maps upon a new principle, increasing the number of the parallels, still however retaining the great error of making them cut each other at right angles, and proceed in *right*, instead of *curved* lines.

In his description of the world he is clear and methodical, commencing with the places between the two most northern parallels, which he goes through from west to east, and thence going southwards through the separate intervals to the equator. In knowledge of topography and general geography, Ptolemy is far in advance of Strabo. The imaginary limits of the world to the east of Asia and the south of Africa had been exploded by recent discovery, and these continents now stretched out in an unlimited expanse of land, unencircled, as far as experience could decide, by any circumambient body of water. The well-known countries of the world had received very nearly their correct shape and size. The only fault in the form of Spain consists in its being somewhat elongated; the western side of France receives its due curve by the introduction of the Bay of Biscay; Great Britain—Albion, as he calls it—is no longer triangular, but extended towards the north, with a singular distortion, however, in its northern half, which is made to bend considerably to the east. Ireland is no longer represented as lying to the north, but to the west of England; still the old mistake may be traced, in its being placed too much to the northwards, its northern point being higher than the extremity of Britain. No great advance had been made in the knowledge of the north of Europe; Scandia is still mentioned as an island; the Baltic as a part of the Northern Ocean: the Chesinus, *Dwina*, was the limit of his knowledge in that direction; he mentions the Cimbric Chersonese, the Danish isles, and the Sinus Venedicus of the Baltic. The coasts of the Mediterranean are tolerably correct; the peninsula of Greece is produced below that of Italy; and Sicily is brought into its true latitude. The peninsula of Italy is, however, from some cause or other, unduly directed to the eastward. His description of the Euxine, and of the great rivers falling into it, is tolerably full and correct.

In Asia, discovery had made great strides. The Caspian was now known to be an independent body of water, though its direction had not been ascertained; for it was still thought to lie east and west. The constant traffic across the Imaus with the Seres had led to an acquaintance with *China* and the region of *Cochin China*, while navigators had coasted along the shores of the *Bay of Bengal* to the Aurea Chersonesus, *Malay Peninsula*, and even to the Sinus Magnus, *Gulf of Siam*. India is misshapen in outline, the peninsula not being produced sufficiently towards the south: the interior, however, with its towns, rivers, &c., is very particularly described.

Africa, the native soil of Ptolemy, was the least known of the three continents. On the east coast his knowledge extended to Prom. Prasium, probably *C. Del Gado*, which appears to have been the extreme point to which the coasting trade was carried. Thence, he supposed the coast to trend off to the east, until it formed a junction with the south-eastern extremity of Asia. He mentions an island, Menuthias, opposite to the Prom. which some have taken for *Madagascar*, but which should rather be identified with *Pemba*, or one of the lesser islands on the coast of *Zanguebar*. On the western coast, no advance had been made since the days of Hanno: the Fortunatæ Insulæ, *Canaries*, occupy a prominent place in his system, as the spot whence he reckoned his longitude. The rivers which he mentions are difficult to identify. In the interior we meet with notices of one, which can hardly be any other than the Niger, with various towns on it, Gana, Tagana, &c. The Mountains of the Moon with the sources of the Nile are also mentioned, but the Desert is very much contracted in breadth, and the interior is thus brought into too northerly a latitude.

26 The history of Classical Geography is generally considered to end with Ptolemy. No one followed him worthy of the title of geographer in the proper sense of the term; nor was anything new added either to the science or the practice of that branch of knowledge. There are, nevertheless, some few names worthy of record of men who have illustrated particular provinces or subjects. Of Greek writers, Arrian and Pausanias stand foremost; the former was born towards the end of the first century, at Nicomedia, and died in the reign of Antoninus Pius. He wrote a history of Alexander's expedi-

tion, a treatise on India and its inhabitants, and a survey or (as it is named) Periplus of the Euxine Sea, which was undertaken by the command of the Emperor Hadrian, full of interesting information as to places, harbours, and the tribes dwelling on the coast of that sea. Pausanias, his contemporary, travelled extensively in Greece, Macedonia, Asia, and Africa. He published a topographical description of Greece in ten books, with accounts of the various public buildings as they appeared in his time. This work contains numerous incidental notices of distant countries, some of which betray a tendency to credulity in the author. Agathemerus, who lived about the commencement of the third century, was the author of an epitome of geography of no great merit, extracted chiefly from the larger work of Ptolemy. He reiterated the exploded errors that the Caspian Sea was a bay of the Northern Ocean, and that Britain stretched from Spain to Germany. Dionysius Periegetes, the author of a geographical poem, lived, in all probability, towards the end of the third century. He adopted the earlier system of Eratosthenes and Strabo, and therefore deserves no praise as a geographer; nevertheless his poem seems to have been extensively used for purposes of instruction, as it underwent several revisions and commentaries, and was twice translated into Latin.

To this period are to be assigned various anonymous writings in the form of Peripli, descriptions of coasts and seas. Such are the Periplus of the Red Sea assigned to Arrian, a Periplus of the Great Sea, another of the Euxine, and another of the Euxine and the Mæotic Gulf. Marcianus of Heraclea, at the beginning of the fifth century, composed a work of this nature, entitled a Periplus of the Outer Sea, descriptive of the coasts of India and Persia, the north and west of Europe, and the east and west coasts of Africa. But the most valuable work of this age, unfortunately almost wholly lost, was the Geographical Dictionary of Stephanus of Byzantium, who flourished in the commencement of the sixth century. This was a species of encyclopædia of geography, compiled with great care and industry, in which towns, islands, and people, were described in alphabetical order, with historical, ethnological, and mythological notices. All that has come down to us of this most useful book is an epitome, very imperfectly put together, from the hand of Hermolaus, towards the end of the seventh century.

27 Lastly, we must not omit mention of the Roman Itineraries as a most important and authentic authority in respect to ancient geography. These were of two sorts, either written or illustrated: the first contained merely the names of places on the several routes, with the distances from each other; the second, a painted description of the routes, and the towns, rivers, forts, and other objects along their courses. Of the former species we possess several specimens—viz., the two Itineraries of Antonine, the one containing an account of almost all the main roads in the Roman empire, the other the usual lines of traffic by sea; the Itinerary of Jerusalem, compiled by a Christian of the fourth century, giving an exact description of the route from Bourdeaux to Jerusalem; and the Itinerary of Alexander, designed for the use of the Emperor Constantine in his campaign against Persia. Of the second species, one specimen only, and this probably only a copy of the original, has descended to us. This is commonly called the Peutingerian Table, after the name of its possessor, Conrad Peutinger. It was executed about 230 A.D., and was designed to be hung up for reference in a colonnade. The routes are depicted in straight lines, without regard to deviations, with memoranda as to the distances from place to place, the names of provinces, cities, woods, and lakes.

We now take leave of the history of Classical Geography, and proceed to review the materials which the writers, whose lives and works we have briefly noticed, have left for our information. Preserving as far as possible the order which history suggests, we shall begin with Asia, the cradle of the human race, and the scene of the earliest political and historical events with which we are acquainted.

CHAPTER II.

I. ASIA.—II. ASIA MINOR.

I. *Asia.*

THE name Asia is of doubtful etymology: its use may be traced up to the time of Homer, who speaks of the 'meadow of Asia' about the Cayster, and of the Asiones who inhabited it. *When* the name was transferred from this locality to the continent, is uncertain: we meet with it in this extended sense in Æschylus and Pindar. Asia was bounded on the W. by the Tanais, Palus Mæotis, Pontus Euxinus, Mare Internum, and Sinus Arabicus; on the S. by the Mare Australe; on the E. by the Oceanus Eous; and on the N. by the Oceanus Scythicus.

The mountain systems of Asia are simple and clearly defined: from the extreme west proceed two ranges, Taurus and Caucăsus, the latter from the north, the former from the south of the Euxine Sea, which gradually converging, form a junction in Armenia, and thence proceed in a due easterly direction to connect with the Himalaya and the other chains of Central Asia. Taurus takes its rise in Lycia, and follows the coast of the Mediterranean as far as the confines of Syria and Armenia: there it divides, one branch, the Antitaurus, taking a northerly direction towards the Euxine, and connecting with Scordĭsus and Paryadres, offsets from the Caucasian range, while the other continues its easterly direction, and under the name of Niphātes, joins Mount Abus, the southern limb of Caucasus. Caucasus takes its rise at the eastern side of the Thracian Bosphorus, and pressing close upon the Euxine as far as its coast preserves an easterly direction, forsakes it when it trends to the south, and crosses the intervening space to the shores of the Caspian. In its course it sends forth lateral ranges, the Moschĭci Montes in Colchis, and the Abus range in Armenia, which contains the sources of the Euphrates and Araxes, and culminates in Mount Ararat. The former connects, as has been already observed, with Antitaurus, the latter with Niphates, the continuation of Taurus. From the point of junction to the east of the Tigris, the direction of the Caucasian range is preserved in a south-easterly range called Zagrus, which follows the valley of the Tigris, and the coast of the Persian Gulf, and declines in the plains north of the Arabian Sea. The main ridge of Caucasus and Taurus meanwhile preserves a due easterly direction, skirting the southern coast of the Caspian Sea, where it received the name Caspius, *Elburz,* and rising to its greatest height in M. Corōnus, *Demavend:* then passing between Asia and Margiāna, under the name of the Sariphi Montes, it finally united with the Paropamīsus, containing the sources of the Indus and the Oxus.

The easterly direction is still preserved in the Imaus and the Emōdi Montes, which together make up the *Himalaya* range, terminating in the Bepyrrus, containing the sources of the Doanas, *Irawaddy,* and in the Damassi and the Samanthini Montes in *Cochin-China.* The northern branch of the Imaus,* the *Bolor,* sends forth the great range of *Kuenlun,* distin-

* The ancients seem to have been aware of the existence and position of the four great ranges which constitute the framework of Central Asia; but their accounts of them are confused, and it is with only a certain degree of probability that we can identify their descriptions. This uncertainty may partly be attributed to the indefinite application of the name Imāus, which, like Taurus and the modern Alps, seems to have been significant of any high range of mountains. In etymology it resembles *Himalaya,* and from the description of Ptolemy it would represent the western half of the Himalaya range: at the same time as geographers divided Scythia into two parts, Intra and Extra Imaum, they must have included under that name the range now called *Bolor,* which runs northward from the Indian Caucasus.

guished by the ancients as the Emodi Serici, which bound the plain of *Gobi* on the south, having a continuation, the Cavii Montes, in *China*, containing the sources of the Bautisus, *Hoang-ho:* beyond these, to the north, lay the Asmiræi Montes, bounding on the east the territory of the Issedones, the modern *Mongolia.* Returning to the central range of *Bolor*, the Comedarum Montes represent the *Thian-shan* range, while the Sogdii and Oxii Montes, which bounded Sogdiana to the north, and contain the sources of the Iaxartes, correspond with *Kara-tagh* and *Ak-tagh*, the westerly continuations of the *Thian-shan* range towards the Caspian Sea. The mountains that lay furthest to the north—the Annibi, Amarœi, and Auxacii Montes—were probably various ranges of the *Altai*, north of Mongolia.

Next to the mountain ranges, the rivers demand our attention, as influencing the political divisions of this continent. A particular account of these belongs to the description of the countries with which they are connected: in this place it is only necessary to state, briefly, the relative positions and direction of the most important streams.

From the southern declivities of the great central chain, four large rivers pour their waters into the Indian Ocean, in the following order, from W. to E., the Euphrates, the Tigris, the Indus, and the Ganges, which to this day preserve their classical names. The Euphrates rises in the highest mountains of Armenia, one of its streams issuing from M. Paryadres, the other from M. Abus: it follows the south-westerly direction of the lower Caucasian ranges, until it is turned by Antitaurus: thenceforward it flows in a south-easterly direction to the Persian Gulf. The Tigris has a considerably shorter course: it has its rise in M. Niphates, and, striking to the south-east, preserves the same direction, with very slight deviations, to the Persian Gulf, running parallel with the Zagrus range on its left bank, and gradually converging to, until it forms a junction with, the Euphrates. The Indus rises on the southern declivity of Paropamisus: its course is southerly, with a slight inclination to the westward: receiving numerous and important tributaries from the eastward, it closely follows the ridges of the *Sooliman Mountains*, and flows into the Indian Ocean. The Ganges rises in the Emodi Montes: thence, in a south-easterly course, it follows the general direction of the Himalaya range, receiving all the streams that flow from it, and discharging itself into the Sinus Gangeticus, *Bay of Bengal.*

On the northern side of the great central range there are two important water-basins, the Caspian Sea and the Sea of Aral. Of the rivers that flow into the former, the most important are the Cyrus, *Kur*, the Rha, *Volga*, and the Daix, *Oural.* The Cyrus has its rise in the Coraxici Montes, the southern limb of Mount Caucasus: it runs in a south-easterly course, parallel to the main ridge of Caucasus, and after having received the Araxes, *Aras*, a river of equal importance, discharges itself into the Caspian Sea. The Rha and the Daix come from the north, rising, the first to the west, the second to the east of the Hyperborei Montes, and flowing in parallel courses into the Caspian. The Aral Sea* receives two important streams, the Iaxartes, *Sirr*, and the Oxus, *Gihun*, which, in all ancient accounts, however, are represented as flowing into the Caspian. The Iaxartes—the Araxes of Herodotus—rises in the Oxii Montes, and in a north-westerly course seeks the Aral Sea: the Oxus rises in Paropamisus, and consequently has a more northerly direction than the Iaxartes: there is little doubt, that at one time it actually flowed into the Caspian Sea, but that its course has been diverted by the accumulations of sand which it has deposited.

Having thus laid down the prominent physical features of the continent

* The Aral Sea is not mentioned by any geographer but Ammianus Marcellinus, in the fourth century. Ptolemy certainly mentions a lake, Palus Oxiana, and Pliny, Oxus Lacus, but these notices refer to some small mountain lake in connexion with the Oxus, rather than to the Aral Sea.

of Asia, it remains for us to sketch out the main territorial and political divisions noticed by ancient writers.

The north of Asia was divided into three parts:—1. Sarmatia from the Tanais to the Rha, and southward to the Euxine and Caspian Seas: 2. Scythia from the Rha in the W., to the borders of Serica in the E., and separated on the S. by the Oxus and the Oxii Montes from Sogdiana, and by the Imaus and Emodi Montes from India: and 3. Serica, northern *China*, eastward from Scythia to the sea. Below Serica lay the region of the Sinæ, in *Cochin-China;* and below Eastern Scythia, India, divided into Intra Gangem, *Hindoostan*, and Extra Gangem, the *Birman empire*. The Indus formed the eastern boundary of the Persian empire: the provinces that lay between that river and the Tigris were comprehended under the general name of Persis. Westward of the Zagrus range, to the banks of the Tigris, lay Assyria, now *Koordistan*, reaching northwards to the Niphates range, and touching Susiana in the S.: between the Tigris and Euphrates were Babylonia, *Irak-Arabi*, from the point where the two rivers converge to the Persian Gulf: and Mesopotamia, *Algesira*, above the point of convergence to the Masius Mons. To the north of Assyria and Media lay Armenia, bounded on the N. by the river Cyrus, and on the W. by the ranges of Scordisus and the Moschici Montes; the high land between the Euxine and Caspian Seas was occupied by the small territories of Colchis, Iberia, and Albania. The large peninsula that runs westward from Euphrates to the borders of Europe, between the Black and Mediterranean Seas, is usually called Asia Minor, *Anatolia*. The eastern coast of the Mediterranean was divided between Syria and Palestine: while the Arab tribes occupied the vast sandy plain which intervenes between the Euphrates and the Red Sea, and which still retains the name *Arabia*.

II. *Asia Minor.*

§ 1. General description. — 2. Political divisions. — 3. Mysia. — 4. Lydia. — 5. Caria. — 6. Lycia. — 7. Pamphylia. — 8. Cilicia. — 9. Cappadocia. — 10. Lycaonia and Isauria. — 11. Pisidia. — 12. Phrygia. — 13. Galatia. — 14. Bithynia. — 15. Paphlagonia. — 16. Pontus.

1 Asia Minor is the name assigned to the collection of provinces, which lay westward of the river Euphrates to the Ægæan Sea, and between the Euxine and the Mediterranean seas. It includes certain districts, which would more naturally be reckoned as belonging to Armenia; such as Armenia Minor, Cataonia, and Commagēne, which are separated from the main peninsula of Asia Minor by the Antitaurus range. The name Asia Minor is of comparatively modern date, not appearing before the fourth century of our era. Classic writers applied no general name to it; but they designated various portions of it as Asia within the Halys, Asia cis Taurum, and the Roman province of Asia propria.

The peninsula is formed by continuations of the great Asiatic ranges of Taurus and Caucasus; the former running parallel to the south coast from Lycia to Cilicia, and turning northwards on the borders of Syria; the latter following the line of the Euxine Sea, and ultimately crossing the Bosphorus into Europe. These ranges received various names in the provinces through which they passed, Taurus and Caucasus being general names significant of any high ridge. The Taurus range commences in the S. W., opposite the isle of Rhodes, with Prom. Sacrum; passing upwards through Lycia with the ridges Climax and Chimæra, it takes an easterly direction through Pamphylia: in Cilicia it sends out several offsets, such as Cragus and Imbarus, but leaves a considerable plain to the eastward of these, in that part of the province called Cilicia Campestris. At the north-eastern extremity of this province it divides; one limb, Antitaurus, *Ildistagh*, strikes off to the N., bounding the basin of the Euphrates, and uniting with Scordisus and the other Caucasian ranges; it attains its greatest height in M. Argæus, *Ardschisch,* in Cappadocia; another limb, M. Amānus, *Almadagh,* turns sharp round to the S., pressing close upon the Mediterranean Sea near Issus, and afterwards connecting with the Syrian Libănus; while the main ridge of Taurus retains its original easterly course. In the N., M. Scordisus, or Scœdises, *Chisheshi,* forms the connecting link between Antitaurus and Caucasus; the course of this important range may be traced through Pontus in the rugged Paryadres, *Kuttag,* and further onward in the Bithynian and Mysian Olympus, and in numerous inferior ranges along the western coast. Between the two high ranges which thus form the framework of the peninsula, lies an extensive plateau of level pasture land, severed from the coast districts by a continuous mountain wall.

A glance at the courses of the river will show that the *fall* of the country is toward the north; thither flow the Sangarius, the Halys, and the Iris, the most considerable rivers of Asia Minor. The Halys, *Kizil-irmak,* is by far the largest and most important; it rises on the south side of M. Scordisus, follows the direction of Antitaurus into Cappadocia, curves round in the plains of that province, and passing through Galatia, falls into the Euxine on the borders of Pontus and Paphlagonia. The Sangarius, *Sakkariyeh,* rises in central Phrygia, skirts the base of the Olympus range, and after a most sinuous course, in which it preserves mainly a north-westerly direction, joins the Euxine to the eastward of the Bosphorus. The Iris, *Yeshil-Irmak,* receives the waters that flow from the mountain ranges of Pontus; two large streams contribute to form it, the Lycus from the E., rising on the north side of Scordisus, and the Scylax from the W. The rivers that flow into the Mediterranean from M. Taurus are necessarily short, as that range seldom admits any passage from the interior. The Sarus, *Sihun,* and the Pyrămus, *Jyhun,* in Cilicia, form exceptions to this rule, both rising to the northward of Taurus, and having a course of considerable length. The southern provinces are, however, well provided with water, as the streams, though not large, are frequent and well filled. They bring down large quantities of deposit, which in many cases, as in the Eurymĕdon and the river of Tarsus, barred the entrance to vessels of any size; and in some instances, has considerably changed the lower course of the rivers.

The interior of Asia Minor is so level as not to admit of a watershed; hence the numerous lakes with which Phrygia abounds, Tatta lacus, Caralitis, and others. Towards the west of this province the higher ground declines towards the Ægæan, and breaks up into wooded ridges, such as Temnus, Ida, and Gargărus, in Mysia; Sipўlus and Olympus, in Lydia; and Messōgis and Pactyas, between that province and Caria. The rivers flowing between these ridges have carried down vast quantities of alluvial soil, which being deposited at their mouths, has formed new ground, and has in many cases materially altered the line of the coast. Thus, the Mæander has pushed out so much land as to enclose the island of Lade, and fill up the Sinus Latmĭcus. The same fate has befallen the island Leuce, at the mouth of the Hermus; the advance of the land in that locality was remarked by Pliny, who states, that at one time Temnus stood at the mouth of the river, but that when he wrote the land reached to the rocks called the Myrmēces; these have since been added to the continent, and are now enclosed in an alluvial plain. The Hermus, *Koduschay,* rises in M. Dindўmus, in Phrygia, traverses the region Catacecaumĕne, and the rich valley of Lydia, receives in its course two tributaries, Hyllus and Cogămus, and joins the Ægæan in the bay called after it, Hermæus Sinus. The Mæander, *Minder,* rises more to the southward in Phrygia, passes between the ranges of Messogis and Cadmus, the former of which it skirts for some distance, and receiving the Harpăsus and Marsyas from the S., discharges its waters into the Ægæan, just to the north of M. Latmus.

The high land in the interior abounds with traces of volcanic agency; the most remarkable instance of its effects is witnessed in the district called Catacecaumĕne—i. e., the *burnt* land, on the borders of Lydia and Phrygia, a plain of lava and scoriæ; hot springs and caves emitting mephitic vapours are common; while the ruins of once flourishing cities attest the violence of the earthquakes with which these regions have been visited.

The coasts of Asia Minor are very varied; the northern approaches nearest to regularity, for with the exception of a considerable sweep to the northward in Paphlagonia, where there are two promontories, Carambis, *Kerempe*, and Lepte or Syrias, *Indsche*, there is no deviation worthy of notice. The outline of the western coast is, on the other hand, singularly irregular; from the Propontis two bays project inland, the Sinus Astacēnus and Sinus Cianus, divided from each other by the M. Arganthonius, and Prom. Posidium. The bays on the coast of the Ægæan are very numerous; the most remarkable from N. to S. are:—the Sinus Adramyttius, opposite the island Lesbos, also called Idaicus, from the proximity of the M. Ida; the Elæus Sinus, which receives the waters of the Caicus; the Hermæus Sinus, *Bay of Smyrna*, receiving the Hermus; the Sinus Caistriānus, receiving the Cayster, terminated to the south by the M. Mycăle and Prom. Trogilium, opposite Samos; the Sinus Latmĭcus, into which the Mæander flows; the Sinus Iasius, and Sinus Ceramĭcus, in Caria, the latter terminating with Prom. Scandaria, in the N., and Prom. Triopium, *Cape Krio*, in the S. The southern coast is also irregular, but the irregularities are on a larger scale. The bays and promontories are as follows from W. to E.:—the Sinus Schœnus, in Caria, with Prom. Cynossēma at its eastern entrance; the Mare Pamphylium, a considerable gulf between Lycia and Cilicia, terminated by Prom. Sacrum, *C. Khelidonia*, in the former, and Prom. Anemurium, *C. Anemour*, in the latter province; and the Sinus Issĭcus, *Bay of Scanderoon*, at the north-eastern extremity of the Mediterranean.

2 The earliest settlers in the eastern provinces of Asia Minor appear to have been of the Syrian race: their descendants occupied, in historical times, Cilicia, Cappadocia, Pamphylia, and parts of Paphlagonia and Lycia. The western provinces were occupied by Thracian tribes, probably the remnant of that important race which crossed over the Bosphorus into Europe: such were the Mysians, Mæonians, Bithynians, Carians, and Phrygians. To these original elements of population we must add some settlements of Pelasgi on the western, and of the Phœnicians on the southern coast, which existed in ante-historical times.

In the Homeric era there were three empires in existence—the Trojan, Phrygian, and Lydian, the last of which survived, and under the reign of Crœsus, embraced the two former, extending over all the countries west of the Halys. The century succeeding the Trojan war witnessed the successive immigration of the Hellenic tribes, in consequence of the return of the Heracleids. These divided the western coast between them, the Æolians occupying the northern portion from Abydus on the Hellespont to the Hermæan Gulf, the Ionians following them from the Hermæan to the Iasian Gulf, and the Dorians occupying the south-western coast of Caria. These colonies attained such importance as to give the distinct appellations, Æolis, Ionia, and Doris, to their respective districts.

The Lydian empire—the first of any great importance in Asia Minor—ceased with the capture of Sardis by Cyrus, B.C. 546; and the whole of the country, east and west of the Halys, was merged in the great Persian empire. In the political subdivision established by Darius, Asia Minor constituted four out of the twenty satrapies, the various tribes occupying the same ground as before, and giving name to the districts they occupied. During this period, Phrygia included, besides the province so called by the Romans, Mysia, Galatia, and Lycaonia; and Cappadocia extended over Pontus to the borders of Colchis.

The conquests of Alexander, B.C. 334—323, transferred Asia Minor, with the rest of the Persian empire, to the Macedonian kingdom. After his death, the largest portion of it—viz., the provinces Phrygia, Lycia, and Pamphylia—fell to the share of Antigonus; Lydia to Menander; Mysia to Leonatus;

and Cappadocia to Eumenes. In the meantime, various states, which before the conquests of Alexander had yielded only a nominal supremacy to the Persian kings, established their independence. Thus Bithynia, Cappadocia, Paphlagonia, and Pontus, became separate kingdoms; and shortly after the death of Alexander, Pergămus also, which under Eumenes II. (B.C. 197—158) extended over the whole of western Asia Minor. The dominant power, however, during the era succeeding Alexander, was the Syrian dynasty of the Seleucidæ, which obtained all the dominions of Antigonus and Eumenes, and which retained a supremacy until the entrance of the Romans. A new territorial division arose through the entrance of a Celtic tribe—the Galatæ, or Gallo-Græci (B.C. 278): invited by Nicomedes I. of Bithynia, they poured over in vast numbers from Europe, and finally settled in the northern part of Phrygia, where they established an independent republic.

The Romans first gained footing in Asia about 200 B.C., and by friendship or arms, the whole of Asia Minor fell into their hands. The kingdom of Pergamus was bequeathed to them by the last king, Attalus III. (B.C. 133), and was formed into the province Asia; Bithynia became theirs in a similar manner, by the will of Nicomedes III. (B.C. 75); Cilicia was subdued by Pompey (B.C. 66); Pontus and Paphlagonia ceased to be independent after the third Mithridatic war (B.C. 64;) Galatia and Lycaonia did not fall in until the death of the Tetrarch Amyntas (B.C. 25); Cappadocia (A.D. 17) at the death of Archelaus; and finally Lycia and Armenia Minor, after having been transferred from hand to hand, were annexed by Vespasian. Asia Minor was divided by the Romans into seven provinces: Asia (i. e., Mysia, Lydia, Caria, and Phrygia); Lycia; Cilicia, with Pamphylia; Cappadocia; Galatia, with Lycaonia; Bithynia, with Pontus; and Armenia Minor. Lastly, under Constantine's division, it formed a portion of the Præfectura Orientis, which contained in all five dioceses: Cilicia and Isauria were annexed to the Diocese of the East; the old province of Asia, with the adjoining districts, formed the Diocese of Asia (Asiana Diœcesis), subdivided into eleven provinces; and the eastern districts formed the Diocese of Pontus, also divided into eleven provinces.

3 In the north-west corner of Asia Minor lay MYSIA, a mountainous, well-wooded district, bounded on the N. by the Propontis, on the W. by the Ægæan Sea, on the E. by the range of the Mysian Olympus and the valley of the Rhyndacus, which divided it from Bithynia and Phrygia; and on the S. by the Temnus range, dividing it from Lydia. It is supposed to derive its name from a Celtic word signifying 'swampy land.'

The physical features of this district suggested to the ancients a twofold division: the northern portion of it inclining towards the Propontis was named Mysia Minor, Hellespontĭca, or Olympēne; the southern, with the streams flowing towards the Ægæan, Mysia Major, or Pergamēne. The chief mountain ranges were—1. Ida, *Ida*, which runs from south-east to north-west, in a course nearly parallel to the sea, containing the sources of the Simois, Scamander, Granĭcus, &c., and attaining its greatest height in Mount Gargărus. 2. Temnus, *Kara-dagh*, which skirted the southern and eastern boundaries of Mysia, and forms a junction with Olympus in the north-east: it contains the sources of the Macestus, Caicus, and Mysius. And 3. Olympus, *Cheshish*, on the frontier of Bithynia.

The only river of importance in point of size—the Rhyndăcus, *Lupad*—flows into the Propontis: rising in Phrygia, it enters Mysia between the ranges of Temnus and Olympus, follows the base of the latter northwards, and having received the Macestus, *Suku*, from the south-east, not far from its mouth, joins the sea at the western point of the Cianus Sinus. On its banks Lucullus defeated Mithridates (B.C. 73). The other streams flowing into the Propontis are the Æsepus and the Granĭcus, *Kodsha Su*, which both rise in M. Cotylus; the latter is the most westerly of the two, and celebrated for the victory gained by Alexander over Darius (B.C. 334). The

Hellespont receives numerous small streams from the range of Ida, insignificant in themselves, but deriving an interest from the Homeric poems: such as the Percōtes, Practius, Sellēis, Rhodius, and Simois, *Ghiumbre*. The last of these rises in M. Cotylus, receives about two miles from its mouth the Scamander, or Xanthus, *Mendere*, and joins the sea above the promontory of Sigæum. The ancients represent the Scamander as the most important, and the Simois as the tributary; the latter was, however, the larger stream, but not so much esteemed, as its waters occasionally failed. These streams now lose themselves in a marsh, the sea-coast having advanced through the accumulation of sand which they have brought down. In the southern part of the province we meet with two rivers—the Evēnus, *Sandarli*, and the Caïcus, *Aksu;* both having their sources in M. Temnus, and flowing into the Elæus Sinus. The latter receives the tributaries, Mysius, *Bergma*, Cetius, and Selinus. The line of the coast is irregular, and contains the following headlands: Abarnis, on the Hellespont, near Lampsăcus; Rhœteum, south-west of Abȳdos; P. Sigeum, *Jenidscheer*, at the southern entrance of the Hellespont; P. Lectum, *C. Baba*, formed by the extremity of Mount Ida, crowned by the altar of the twelve gods built by Agamemnon; and Cane, *C. Coloni*, opposite Lesbos, in Æolis.

Beyond the twofold division of Mysia above mentioned, certain portions of this province received particular designations: thus, the district bounded by the Sinus Adramyttenus on the south, and northward to Lampsacus, was called Troas; the coast south of this, Æŏlis; and a small district south of Temnus, about the Caicus and its tributaries, Teuthrania.

The chief towns of Mysia lay along the coast, the interior being but thinly inhabited; the following are deserving of notice. Cyzĭcus, *Balkiz*, on the Propontis, was founded by a colony from Miletus; it stood a long siege against Mithridates; its harbour was excellent, and from the beauty of its situation, it became a fashionable place of resort to the Romans. Lampsăcus, *Lamsaki*, on the Hellespont, founded by a colony from Phocæa, was celebrated for its wine, and as the original seat of the worship of Priapus. Abȳdos, *Aidos*, stood on the narrowest point of the strait opposite Sestos; it had an excellent harbour; at this spot Xerxes threw his bridge of boats across the Hellespont; the town is also famous for its heroic resistance to Philip II. of Macedon. Midway between Abȳdos and the promontory of Rhœteum lay Dardănus, with a district named after it Dardania; whence the straits have derived their modern appellation, the *Dardanelles*. Westward of this, towards the Portus Achæorum, the remains of the Mound of Ajax are still visible. Sigeum was founded by Mitylenæans, on the promontory of the same name, near the mouth of the Simois: it was destroyed by the Ilians after the fall of the Persian kingdom. In the plain near it stood the burial-place of Achilles, Achillæum, where Alexander and Caracalla celebrated games in honour of the hero. To the south of Rhœteum, on the banks of the Simois, and about four miles and a half from the Hellespont, stood the far-famed Ilium; its position is probably identical with the spot now called *Bunarbaschi*, but no remains are to be found. It is necessary to distinguish from it the Ilium of historical times, Ilium Novum, which lay about three miles to the northward; this rose into importance in the Macedonian era, and was patronized by the Romans, who esteemed it the original Troja. The old town is supposed to have stood on the right bank of the Simois, with its citadel, Pergamum, on the other bank, between the Simois and Scamander. Thymbra probably stood half a mile further down the stream. Alexandria Troas, *Eskistamboul*, on the sea coast, nearly opposite Tenedos, was built by Antigonus at the command of Alexander, and rose to great eminence under the Roman emperors. Very few vestiges of the town exist, the stone having been removed to build Constantinople. On the southern coast of Troas lay, from W. to E., Assus, later Apollonia, founded by Æolians, celebrated for its wheat and the peculiar stone (lapis Assius) used for coffins; Gargara, a colony of Miletus, at the foot of the highest point of Ida; Antandrus, *Antandro*, at the foot of a hill on which its citadel was placed, founded by Pelasgians, and subsequently enlarged by Ætolians; and Adramyttium, *Adramyti*, at the mouth of the Caicus, with a good harbour.

The rich plain about the head of the Bay of Adramyttium was called the Plain of Thebe, after the Homeric town of that name, which lay about seven miles to the north-east of Adramyttium. To distinguish it from other towns of the same name, it was called Hypoplacia, from the hill Placus: the inhabitants of the city and plain are called Cilicians by Homer. Not far from Thebe stood Scepsis, on the Æsepus, a Milesian colony, chiefly known as the spot where the works of Aristotle and Theophrastus were buried.

The district of Æolis extended from the head of the Sinus Adramyttenus southwards, over the border of Mysia to the Hermus. On this they possessed (until they were deprived of Smyrna) twelve cities—viz. Atarneus, Cane, Pitane, Elæa, Grynium, Myrina, Cyme, Ægæ, Temnus, Neonteichos, Larissa, and Smyrna. Herodotus, in his enumeration of the confederate cities of Æolis, mentions Cilla, Notium, and Ægiroessa, in the place of Atarneus, Cane, and Elæa. Many of these towns were utterly destroyed by the violent earthquakes in the reigns of Tiberius and Trajan. The district of Teuthrania contained the important town of Pergămum,* *Bergma*, the capital of the Attali, celebrated for the manufacture of parchment; the splendid library, collected by its kings, was transferred to Alexandria by Cleopatra.

The islands off the coast of Mysia attained great importance in ancient times, both from their proximity to the continent, and from their own resources. Lesbos, now called *Mytilene*, after its principal town, is divided from the mainland, by a channel six miles wide, and lies opposite the ranges of Gargarus and Ida, of which indeed it may be considered as a continuation. It is very rocky and irregular on its coast: but possesses spots abundantly fertile in corn, wine, and oil. The Pelasgians first settled here: subsequently the Æolians made it the head-quarters of their confederacy, and erected five cities—Methymna, destroyed by the Spartans in the Peloponnesian war, and Antissa, on the north-west coast; Eressus and Pyrrha, on the south-west; and Mytilēne, on the east coast. Lesbos was the birthplace of Pittacus, Sappho, and Alcæus. Between Lesbos and the main land lay three small islands called Arginūsæ—the scene of a naval contest between the Athenians and Spartans, B.C. 406. The island of Tenĕdos, *Tenedos*, off the coast of Troas, resembles Lesbos in its features and character: but it was much smaller, and contained only one town, Tenedos, on the northern coast; it was of importance as a station for vessels to put into, passing to and fro from the Hellespont. North of Tenedos lay the small group, Calydnæ; and in the Propontis three islands, Proconnesus, *Marmara*, (whence the modern name of this sea is derived,) Ophiusa, and Alone.

4 LYDIA lies immediately to the S. of Mysia, separated from it by M. Temnus: towards the E. it was contiguous to Phrygia; towards the S. to Caria, M. Messogis forming the boundary. In the Persian era its limits were extended as far as the valley of the Mæander towards the south, so that it would include many towns properly belonging to Caria.

This province consists of two considerable valleys or water-basins—viz., that of the Hermus in the north, and that of the Cayster in the south, divided from each other by the high range of Tmolus. The course of the Hermus has been already described. The Cayster, *Kara Su*, or *Lesser Mindere*, rises on the southern declivities of Tmolus, and, in a southwesterly course, meanders through the rich alluvial plains that lie between Tmolus and Messogis, until it reaches the sea at Ephesus.

The central range of mountains is the Tmolus, *Boz-dagh*, which forms the watershed between these valleys; it commences on the border of Phrygia,

* Pergamum is mentioned in the Book of Revelations as one of the seven churches of Asia; the others were, Ephesus, Smyrna, Thyatira, Sardis, Philadelphia, and Laodicæa.

bends round to the north-west, and approaches the sea at Smyrna, where it received the name of Olympus. The southern ridge, Messōgis, *Musatag,* divides the valleys of the Cayster and Mæander: connecting with M. Tmolus at the head of the valley of the Cayster, it trends off towards the south-west, approaches the sea near Ephesus, where it was known as Mount Pactyas; then as Mount Mycăle forms a long promontory, terminating in the headland Trogilium, *Cape St. Marie*: the Messogis range reappears in the island of Samos, which is separated from the main land by a channel, not exceeding a mile in width, the scene of the Grecian victory over the Persians, B.C. 479. The same range may be traced across the valley of the Cayster in the high ground, which first, under the name Gallesius, then as Mimas, runs out to the north-east, and forms the peninsula of Erythræ, and beyond that the island of Chios: it terminates on the main land with the promontories, Coryceum, *Koraka,* Argennum, *C. Blanc,* and Melæna, *Kara Burnu.* The promontory Myonessus, the scene of the naval fight between the Romans and Antiochus, is situated to the westward of Lebedus.

The names assigned to the districts of Lydia are indicative of the features of the country: thus we read of the Cilbiani Campi, in the upper valley of the Cayster; the Campus Caystrianus; the Campus Hyrcanus, in the upper valley of the Hermus; and the Hermæus Campus. The meadow of Asia, of which Homer speaks, lay in the upper valley of the Cayster, between the Tmolus and Messogis. The most important territorial division was that which lay along the coast, where the Ionians settled, and established a powerful confederacy of twelve cities—viz., Phocæa, Erythræ, Clazomenæ, Teus, Lebedus, Colophon, Ephesus, Priēne, Myus, and Miletus, on the main land; and Samos and Chios, on the islands: it extended beyond the limits of Lydia into Caria.

Phocæa, *Palæa Foggia,* the most northerly town in Ionia, was built on a tongue of land, on either side of which was a good harbour, protected by the island Bacchium in front. Smyrna, *Smyrna,* founded originally by a colony from Ephesus, but occupied afterwards by another from Cyme, lay near the innermost point of the Sinus Hermæus, where the clear stream of the Meles joined the sea. Originally a member of the Æolian confederacy, it came B.C. 688, into the hands of the Ionians: it was soon after destroyed, and for four centuries its inhabitants were scattered among the neighbouring towns, until Antigonus founded a new city on the other side of the bay, about two and a half miles from the old town, which became a flourishing sea-port, and in the Roman era was deemed the most handsome of the Ionian cities. Clazomĕnæ, *Kelisman,* follows, twenty-five miles to the westward; the town was originally built by Colophonians on the main land, but afterwards removed to a small island, a quarter of a mile from the shore; by the orders of Alexander a mole was carried across the intervening channel. Erythræ, *Ritre,* was situated on the west side of the peninsula formed by Mount Mimas: Alexander attempted to cut a canal across the neck of this peninsula, in order to facilitate communication between Smyrna and Ephesus. Outside the neck, southwards, stood Teos, *Bodrun,* the birthplace of Anacreon and Hecatæus: its inhabitants, galled by the Persian yoke, mostly emigrated to Abdera. About fifteen miles lower down the coast was Lebĕdus, which fell through the removal of its inhabitants to Ephesus, by Lysīmachus; it was famous for hot baths. Clarus, a small place, with a celebrated temple and shrine, sacred to Apollo, stood half-way between Lebedus and Colophon. The latter, was situated on the stream Hales, about two miles from the sea, with a harbour, Notium, whither the remainder of the inhabitants removed, when Lysimachus transferred the mass of its population to Ephesus—this was the town called New Colophon. Ephĕsus, *Ayasaluck,* was situated on the left bank of the Cayster, covering the declivities of the hills Prion and Coressus, and the plain intervening between them and the river. It was first occupied by the Leleges, then by Ionians, under Androclus: it rose to great eminence, and is described by Pliny as the 'light of Asia;' the mouth of the Cayster formed its harbour, Panormus, and supplied the lagoons called Selenusiæ, on the right bank, near which some suppose the temple of Diana to have stood. The chief towns in the interior were—Thyatīra, *Ak Hissar*, on the river Lycus, and on the road between Pergamum and Sardis: Magnesia ad Sipylum, on the left bank of the Hermus, *Manisa*, the spot where Antiochus was defeated by Scipio, B.C. 190; Sardis, *Sart*, built on both sides of the Pactolus, in a plain at the foot of Mount Tmolus; it was the ancient capital of Lydia, and the residence of the Persian satraps; the houses were thatched, and in consequence the town was frequently destroyed by fire: it was not walled in until after Alexander's time; its citadel stood on a spur of Mount Tmolus. To the north of Sardis was the lake Colœ or Gygæa, artificially constructed to receive the superfluous waters of the Hermus, and so check the inundations to which the valley was liable. Beside the lake stood the necropolis of the kings of Lydia: several tumuli of enormous size are yet to be seen—one, called the tomb of Halyattes, having a circumference of half a mile. Philadelphia, *Allah Shehr*, lay at the foot of the Tmolus, on a small stream that fed the Cogamus: it suffered severely from the earthquakes in the reign of Tiberius.

The most important islands lying off the coast of Lydia are Chios and Samos. Chios, *Scio*, may be deemed a continuation of the peninsula of Erythræ; a chain of hills runs from north to south, terminating in the promontories Melæna and Phanæ. The chief town, Chios, was situated on the eastern coast of the island, opposite the main land, from which it was about seven miles distant. Chios was celebrated for its vineyards, and was reputed to have produced the first *red* wine. Samos, *Samos*, lies in the direction east and west; the Ampelus range, a continuation of Messogis, traverses it, forming the promontories Posidium in the east, and Cantharium in the west. Its town, Samos, *Megalikora*, was situated opposite the promontory Trogilium, and was deemed one of the most beautiful towns of the ancient world; it was surrounded with a wall by Polycrates, and its harbour was defended from the prevailing winds by a mole a quarter of a mile long. Samos was about sixty miles in circumference; Chios exceeded one hundred. Icarus or Icaria, *Nikaria*, is evidently a further continuation of the same elevation; the range here received the name of Pramnus, and the eastern promontory, Dracanum, *Phanar*, with a town of the same name.

5 CARIA occupied the south-western corner of Asia Minor. On two sides it was bounded by sea—namely, by the Ægæan on the W., and by the Mediterranean on the S. Towards the N. the Messogis ridge separated it from Lydia, and towards the E. the river Glaucus from Lydia, and the Cadmus M. from Phrygia.

The most important valley is that of the Mæander, *Mindere*, which, it will be observed, receives all the important streams of Caria from the south, leaving only one valley in the eastern part of the province, which opens towards the Mediterranean. The course of this river is remarkably tortuous, its bed lying on a broad alluvial plain, which it has perhaps formed, at all events has considerably extended by the copious deposits of sand brought down from the upper country. It receives on its right bank the Lethæus from M. Pactyas and the Gæson, a small stream from Mycale; and on its left, the Marsyas, *Thsina*, a considerable stream that joined it opposite Tralles, the Harpasus, *Harpasu*, higher up, and the Orsinus. The water basin of the Mæander in Caria is headed by the ridges Cadmus and Sabbacum towards the east, on the other side of which follows the valley of the Calbis, (occasionally called Indus by Latin authors,) *Tavas*, which rises in Phrygia, and in a south-easterly course reaches the sea opposite Rhodes. The Glaucus is but a small stream; with the bay into which it flows, it formed the eastern boundary of Caria.

The mountain ranges are by no means uniform in their direction; Messogis in the north has been already noticed: south of the Mæander, two parallel ranges run towards the south-east, Latmus, which directs the course of the

Marsyas on its left bank, and Grion, which runs out to the westward, forming the peninsula in which Miletus is situated, and terminating in Prom. Posidium. A continuation of this, M. Phœnix, extends to the south, where it meets with a range running at right angles, M. Lide, in the neighbourhood of Pedăsus, which extends westward, forming the peninsula of Halicarnassus. In the east the ridges of Cadmus, Salbacum, and Dædala, offsets of the Taurus system, run from north to south. Besides the promontories already mentioned, Triopium, *C. Krio*, where the games in honour of Apollo were celebrated, and Cynossēma, *C. Cavaliere*, deserve notice.

The territorial divisions ofCaria are not numerous; Ionia continued along the coast as far as the head of the Iasius Sinus, where it met the district occupied by the Dorian colonies. The chief seat of the Dorian confederacy, consisting originally of six cities, was Rhodes, where they possessed three cities, Ialȳsus, Camīrus, and Lindus; on the main land they owned Cnidus and Halicarnassus; Cos, on the island of the same name, completed the number. The district bordering on the south coast opposite Rhodes was distinguished as Peræa, more properly Peræa Rhodiorum—i. e., the land *across* the sea from Rhodes.

The most important towns of Caria were situated on the coast; the first we meet with from the north is Priēne, which, with Myus and Myletus, were the three Carian towns of the Ionian confederacy; it was situated at the foot of a spur of Mycale, with its citadel on the heights behind; originally on the sea, it had ceased, even in Strabo's time, to be considered a sea port, as the constant accession of land had pushed out the shore five miles. Myus was also once a seaport town, at the mouth of the Mæander; the bay, however, became choked up with soil, and left a stagnant lake, which bred such a plague of flies, that the inhabitants removed to Miletus. Miletus, *Palatia*, the most flourishing and enterprising of all the Ionian colonies, was situated at the southern entrance of the Latmian bay. In the time of its prosperity it carried on a lively trade with all parts of the Mediterranean and Euxine Seas; and it was also famous as a school of literature and science, as the abode of Thales and Anaximander, Cadmus and Hecatæus. It consisted of an inner and outer city, with four harbours, protected in front by the islands Lade and Asteria; the site of the city is now covered with a pestilential swamp. Intimately connected with Miletus was the temple of Branchidæ, at the other extremity of the peninsula, about twenty miles distant. Iassus, *Asynkalesi*, lay further down the coast on a small island hard by the continent; it belonged to the Milesians, who made it a fishing station. Myndus, *Mendes*, lay somewhat to the north-west of Halicarnassus; it was fortified, and possessed a good harbour. Halicarnassus, *Boodroom*, a colony from Trœzen, was built on rising ground close to the Sinus Ceramicus; the citadel which crowned the steep behind was deemed impregnable. Originally a member of the Dorian confederacy, it was rejected and became afterwards the seat of successive tyrannies. Alexander destroyed it; but it revived, and was a place of considerable importance in the Roman era. It was famed for the mausoleum, erected by Artemisia in honour of her husband, and as the birth-place of Herodotus and Dionysius. Cnidus, the metropolis of the Dorian confederacy, was situated partly on the promontory Triopium, partly on a small island connected by a mole with the main land. In the neighbourhood was the temple where the Dorian cities met for consultation. It is further known in history as the spot where Conon vanquished the Spartan Pisander, B.C. 394. Along the fertile coast of Peræa, which the Rhodians possessed until the time of the Persian conquest, lay the towns Physcus, the entrepôt for Rhodian commerce, and Caunus, founded by Cretans, and a place of considerable importance. In the interior the towns of importance were Magnesia ad Mæandrum, *Inkbazar*, on a spur of Mount Messogis, said to have been founded from Magnesia in Thessaly, but in historical times in the possession of Miletus, well known as the residence of Themistocles: Tralles, *Guzelhissar*, in a similar position to the eastward, a place of large trade, and a favourite resort of the wealthy Romans: higher up the valley of the Mæander, Mysa, at a spot called *Sultanhissar:* on the south side of the Mæander, Alabanda, in the valley of the Marsyas, celebrated for the luxurious habits of its inhabitants: further to the south Statonicæa, *Eski-hissar,* erected by Antiochus Soter, in honour of his wife Statonice: it was much adorned by the Seleucidæ, and became a free city under the Romans: Labranda, with its famed temple sacred to Zeus Stratius, between Alabanda and Mylasa, to which latter town it belonged: Mylāsa, *Melasso,* the chief town in the interior; it was situated in the valley between the ranges of Latmus and Grion, ten miles from the sea; an isolated marble rock, which afforded stone for the many splendid buildings with which Mylasa abounded, rises out of the plain close by the city.

The most important island lying off the coast of Caria is Rhodus, *Rhodes,* extending from N. to S., and evidently a continuation of the range of Cadmus. From its position, its fertility, and the excellence of its commercial regulations, it became a place of great trade. Its chief town, Rhodus, lay on the northern coast, opposite the main land; it was built B.C. 408, in the form of an amphitheatre, and possessed two harbours, the entrance of which was spanned by the colossal statue of the Sun. The Dorians were settled in the towns Lindus, *Lindo,* and Camīrus, *Camiro,* on the eastern coast, and in Ialȳsus, *Neocastro* on the northern. The island Cos, *Co,* in earlier times called Meropis, lies at the northern entrance of the Sinus Ceramicus, having its greatest length from E. to W. Its chief town, Cos, was situated on the eastern coast, with the celebrated temple of Æsculapius in its neighbourhood. The island has received a considerable increase from the accession of soil deposited by the currents. Besides these islands, many were scattered about between Icaria and Rhodes, of which we may mention Patmos, *Patmo,* which derives an interest from having been the abode of St. John, at the time that he wrote the Revelations; Leros, *Lero,* tenanted by Miletus, opposite the Sinus Jasius; Nisyros, off Prom. Triopium; and Syme, in the Sinus Schonus.

6 LYCIA adjoins Caria to the E. Towards the N. it was contiguous to Phrygia and Pisidia; towards the E. to Pamphylia; towards the S. it projects into the Mediterranean Sea, which also flanks its south-eastern coast with the Mare Pamphylium and its south-western with the Glaucus Sinus. It is intersected by numerous offsets of the Taurus range, running for the most part from north to south. The main ridge of Taurus was considered to commence with Prom. Sacrum, *C. Khelidonia,* opposite the Insulæ Chelidoniæ; rising immediately from the sea in regular elevations, whence it received the name Climax—i. e., *ladder,* it reached the height of ten thousand feet, terminating in the peaks Chimæra, Hephæstis, and Olympus, the names of which indicate their volcanic origin. In the western part of the province M. Cragus bounds on the west the valley of the Xanthus; it terminates in a cluster of headlands, now called *Yedi-Booron,* or *the seven capes;* between the ridges of Cragus and Climax, M. Massycȳtus intervenes, crossing the country from the Xanthus to the Limyrus. The coast is rock-bound, and offers few spots of egress to the waters of the interior; the only river of any importance is the Xanthus, *Etchenchay,* which skirts the base of Mount Cragus; the Limyrus in the east is an inconsiderable stream.

The original name of this province was Milyas, and of the people Solymi; these were driven back from the coast by the Termilæ, so that in historical times, the name Milyas was restricted to the district lying on the borders of Lycia and Pisidia, while the name of the people was preserved in the mountain Solyma. The chief towns were—Telmessus, *Makri,* on the Glaucus Sinus: Patăra, *Patara,* at the mouth of the Xanthus, celebrated for the worship of Apollo; it possessed an excellent harbour, now filled with sand,—and served as the port of Xanthus, the metropolis of Lycia, which lay about seven miles up the river of the same name. Xanthus was twice destroyed—viz., by the Persians, and by the Romans under Brutus: two miles east of Patara, Portus Phœnicus, *Kalamaki;* then Antiphellus, *Andifilo,* originally the port of

Phellus, which lay in the interior; Andriăce, the port of Myra, *Myra*, a considerable town situated three miles from the coast: and Phasēlis, *Tekrova*, situated on a tongue of land at the foot of Mount Climax; its position made it a favourite spot for pirates, on which account the town was destroyed by Servilius Isauricus.

7 Proceeding along the coast of the Mediterranean, we next enter upon PAMPHYLIA, which, strictly speaking, consisted only of a narrow strip of coast lying along the Pamphylicus Sinus, between Lycia and Cilicia. As the title of a Roman province, it included, down to the time of Constantine, Pisidia and Isauria. The boundaries of Pamphylia Proper to the E. and W. are uncertain; the river Melas appears the natural limit on the side of Cilicia; yet a district the other side of that was not unfrequently considered to belong to Pamphylia: again, Strabo fixes the commencement of Pamphylia towards the W., at Prom. Sacrum; Scylax, on the other hand, reckons Olbia and Perge among the cities of Lycia. We shall here consider it bounded on the E. by the Melas, and on the W. by M. Climax.

The Taurus range, in this province, recedes from the sea, and leaves a well-watered district, intersected with low ridges running towards the south. The chief streams are, the Catarrhactes, *Duden-su*, a violent mountain torrent in the western part of the province; the Cestrus, *Ak-su*, rising in Pisidia, and reaching the sea to the eastward of Catarrhactes; the Eurymĕdon, *Kapri-su*, famed for the victory of Cimon over the Persians, B.C. 466; and the Melas, *Menavgat-su*, on the borders of Cilicia.

The inhabitants of this district were, as their name implies, a mixed race of aborigines, Cilicians, and Greek settlers. The towns along the coast, from west to east, were Olbia, *Adalia*, on the innermost point of the Pamphylium Mare, probably identical with the town built by Attalus II., and called Attalia: Side, *Eski-Adalia*, an Æolian colony from Cyme, situated somewhat to the westward of the Melas; it stood on a low peninsula, and was much frequented by pirates: and in the interior—Perge, a short distance from the right bank of the Cestrus, about seven miles and a half from the sea, interesting as the spot where St. Paul entered Asia Minor, on his first apostolical visit; and Aspendus, an Argive colony on the Eurymedon, about the same distance from the sea. Both the Cestrus and the Eurymedon were in ancient times navigable as high as these towns.

8 CILICIA was bounded on the W. by the river Melas, and on the S. by the Mediterranean. The main ridge of Taurus separated it in the N. from Phrygia and Cappadocia, and the ranges of Amanus in the E. from Commagene and Syria. Within these limits lay two districts widely differing in character, and suggesting the division of this province into Cilicia Trachæa, or Aspera (i. e., the wild), and Cilicia Pediæa, or Campestris (i. e., the level), which was also occasionally designated Cilicia Propria. The former district lay to the west, where the lateral ridges of Mount Taurus, under the names Cragus, Andricus, and Imbarus, push down close to the sea, in a south-westerly direction, terminating in a succession of cliffs and headlands, which made the navigation of this coast highly dangerous. The river Lamos may be considered the limit of Cilicia Aspera, a low, gravelly beach and open plains succeeding to the eastward of that river, with districts of remarkable beauty and fertility. The inhabitants of these districts differed, no less than the districts themselves, in character and occupations: the mountaineers, allied in race to the Pisidians and Isaurians, led a wild, piratical life, and for a long time bade defiance to the arms of Rome; the inhabitants of the plains, where many Greek settlements were formed, were devoted to agriculture and commerce, and reached a high state of civilization.

The province was bounded to the north by an almost unbroken wall of mountain, which, while it served as a protection from hostile incursions, was prejudicial to the climate, inasmuch as it screened Cilicia from the cooling breezes of the north, and left it to the influence of an almost tropical heat.

It was traversed by two passes, one leading from Labranda in Lycaonia to Seleucia in Cilicia Aspera, the other from Tyăna in Cappadocia to Tarsus, in Cilicia Campestris. The latter is the celebrated Portæ Ciliciæ — the Tauripylæ of Cicero—now *Golek Boghaz*, by which Xenophon and Alexander entered Cilicia. The entrance to this pass follows from the north side a tributary of the Sarus for some distance, which it forsakes for a lateral valley leading to a level summit, about four thousand feet above the sea; thence it follows the streams that flow into the Cydnus, the river of Tarsus. The pass on the northern side was so narrow as only to admit of the passage of eight horses abreast. Artificial defences were here erected, the remains of which are yet visible. On the side of Syria, there were two passes over the mountain of Amanus: the most southerly was situated between Baiæ and Antioch, and named Syriæ Portæ, *Pass of Beilan;* at its entrance, the mountain descended quite to the sea shore, and left a narrow passage* for about a third part of a mile, which was defended by strong gates. The more northerly was named Amanicæ Portæ, and was situated between Ægæ and Baiæ: its position is somewhat uncertain; probably, however, the Cyclopean remains at *Temir Kapu*, on the western point of the plain of Issus, near the *Bay of Iskenderoon*, are identical with the gates by which the pass is said to have been guarded. This pass must be clearly distinguished from another over the main ridge of Amanus behind it, which lay at the head of the valley of the Pinarus, and led across to Commagene, and which has also been described as the Amanicæ Pylæ or Portæ. By this Darius crossed the Amanus in the rear of Alexander, and so brought on the battle of Issus.

The rivers of Cilicia Aspera rise on the southern declivities of Mount Taurus, and flow to the south-east; those in Cilicia Campestris, on the other hand, rise, for the most part, to the north of the Taurus range, and flow towards the south-west. They lie in the following order from W. to E.: the Calycadnus, *Ghiuk-su*, a considerable stream rising on the borders of Pamphylia, and joining the sea between the promontories Sarpedon and Zephyrium; the Lamos, *Lamos*, already described as forming the boundary between the two districts of Cilicia; the Cydnus, *Tersuschai*, remarkable for the coldness of its water, rising near the pass of the Portæ Ciliciæ, and flowing by Tarsus; the Sarus, *Seihun*, which, rising in Cappadocia among the ranges of Antitaurus, forces a passage through the Taurus, and, flowing through the rich Aleion Campus, joins the sea eastward of the Cydnus; the Pyrămus, *Jyhun*, which rises in Cataonia, and passing through a narrow cleft of Taurus with tremendous violence, follows the course of M. Amanus, and originally discharged itself near the promontory of Megarsus, now, however, much to the eastward, near the ancient Ægæ.

The chief towns of Cilicia, from W. to E., were these: Coracesium, *Alaya*, situated on a precipitous headland, and one of the last haunts of the pirates; Selinus, *Selinty*, or Trajanopolis, at the foot of Mount Cragus, and surrounded by the sea; it derived its second name from the death of the Emperor Trajan having occurred there; Anemurium, on a promontory of the same name; Seleucia Trachæa, *Selef-kieh*, on the Calycadnus, founded by Seleucus Nicator, and in the Roman era the most flourishing town of these parts, about nine miles from the sea; Corўcus, *Korykos*, on the coast midway between the rivers Calycadnus and Lamos; about two miles distant was the celebrated Corycian cave, a deep, rocky ravine, with a cave at the furthest extremity: in Cilicia Campestris—Soli, later called Pompeiopolis, as being the town where Pompey confined the Pirates,—with an excellent harbour; it was reputed to be a colony from Argos, and attained great prosperity: Tarsus, *Tersoos*, the capital of Cilicia, situated on the Cydnus, about twelve miles from its mouth, in a fertile and beautiful plain; it was made a Roman

* In this passage were the Portæ Ciliciæ et Syriæ, mentioned in Xenophon's *Anabasis*, I. 4; between which flowed the Cersus, *Merkez-su*.

city by one of the early emperors, and attained celebrity as a place of literature: it is further interesting as the birthplace of St. Paul, and the burial-place of Julian the Apostate. Eastward of the Cydnus the shore runs very low, and is interspersed with lagunes. The Aleian Plain stretches inward from this between the rivers Pyramus and Sarus. Mallus was situated at the old mouth of the Pyramus, at the entrance of the Sinus Issicus; at the head of this bay, the remains of Nicopolis and Castabala are visible near each other; and on the eastern coast of it was Issus, on the right bank of the small river Pinărus—the scene of contest between Alexander the Great and Darius, B.C. 333. On the road between Tarsus and Issus lay two towns of importance—Adăna, *Adanah*, on the Sarus; and Mopsuestia, *Messis*, on the Pyramus.

9 CAPPADOCIA, with ARMENIA MINOR.—Before the Persian era, all the provinces lying between the Euphrates and the Halys, and between the Euxine Sea and the Taurus range, were designated by the general name, Cappadocia. A division was then established, the northern district bordering on the Euxine receiving the title Cappadocia ad Pontum — the southern resting on the Taurus range, Cappadocia ad Taurum. Subsequently, the former lost altogether the name of Cappadocia, which was applied solely to the southern district until the time of Tiberius, who assigned to the province of Cappadocia its original extent. Cappadocia Proper, which we here treat as distinct from Pontus, was bounded on the S. by the Taurus, and on the E. by the Euphrates; towards the W., an imaginary line running in the meridian of the Tatta Lacus separated it from Lycaonia; towards the N. it was contiguous to Galatia and Pontus. It is said to have derived its name from the Cappadox, a tributary of the Halys.

Cappadocia consists of two distinct regions, separated by the range of Antitaurus, running from south-east to north-west. The westerly of these contains the highest ground of Asia Minor, extensive grassy uplands, broken by ravines, and interspersed with lofty mountains, with the streams flowing into the Halys, and seeking generally a northern direction; while the easterly assimilates in character and productions to the provinces of Central Asia, the streams flowing towards the south-east, and belonging to the water-basin of the Euphrates. The former was adapted for sheep; and its inhabitants, the progenitors of the *Turkomans*, partook of the nomad character: the latter offered many valleys and plains, adapted for agriculture and the growth of fruits. Antitaurus forms the water-shed between the Halys and the Euphrates; it culminates in the celebrated Mount Argæus, *Ardshisch Tagh*, whence (as it was currently believed) the Euxine and the Mediterranean Seas were visible. Besides this, it sends out other offsets hardly inferior in height, which have not received specific names in classic writers. Most of these mountains betray signs of volcanic agency; the numerous caves, formerly the asylum of persecuted Christians, and even now harbouring a troglodyte population, form a distinguishing feature in this district. The only river of importance is the Halys, which flows through the upper portion of the province in a wide and fertile valley, receiving numerous tributaries, one of which, rising in Mount Argæus, is known as the Melas, *Kara-su*. This must be distinguished from the tributary to the Euphrates of the same name, which rises on the eastern declivities of Antitaurus, and flows through the fertile district designated after it Melitene. From the same lofty region issue the head waters of the Cilician rivers Sarus and Pyramus. In the western districts, the waters find no outlet, but collect in lakes, of which the Tatta Lacus, *Great Salt Lake*, is the most remarkable for size and for the briny qualities of its water: it is situated in a plain, and surrounded by marshes.

The territorial divisions are as follows: in Cappadocia west of Antitaurus,—Tyanitis, in the south-west, about the town Tyana; Garsauria, northward to the Tatta Lacus; Chammamene, in the north-west; Cilicia, about the M. Argæus; and southward of it, Bagadania: in Cappadocia east of Antitaurus—Melitene, containing the valleys of the Melas and its tributaries down to its confluence with the Euphrates, and Cataonia to the southward, bordering on Cilicia.

The chief towns were—Mocissus, *Mujur*, in the valley of the Halys; Mazaca, *Kaiseriyeh*, the capital, situated on the north side of Argæus, and on the banks of the small stream Melas; it was enlarged by Tiberius, and afterwards called Cæsaræa, whence its modern name; south of Mazaca, Cybistra, the military station of Cicero in the Parthian war, and Nora, *Zinzibar*, the stronghold of Eumenes; in the south, Tyāna or Dana, *Kiz Hisar*, on the route from the north-west to the Portæ Ciliciæ, celebrated as the birthplace of Apollonius, with a remarkable spring in its neighbourhood. In Cataonia there were no towns in existence so late as Strabo's time, but only mountain fortresses; the chief town in later times was Comāna, surnamed Aurea, at the foot of Antitaurus, remarkable for a temple and oracle. In Melitene, a town of the same name, near the confluence of the Melas with the Euphrates, now *Malatiyeh*, rose to considerable importance under Trajan, and became ultimately the capital of Armenia Secunda.

The mountainous district of Armenia Minor was generally considered as belonging to Cappadocia, and as such was incorporated in the Roman province of that name. It lay between Antitaurus and the Euphrates, separated from Pontus in the N. by the Paryadres range, and contiguous to Melitene in the S. Occasionally the districts of Melitene and Cataonia were included in Armenia Minor. After the Roman conquest of Mithridates, it was handed over as a present from one person to the other, and was not finally united to Cappadocia until the time of Trajan. In the upper valley of the Lycus, which fell within the limits of Armenia Minor, stood the city Nicopolis, near *Devriki*, on the spot where Pompey conquered Mithridates.

10 LYCAONIA AND ISAURIA.—Lycaonia, during the Roman era, consisted of a large extent of table-land to the west of Cappadocia, having Iconium as its centre, and extending westward to Phrygia. Originally the name was assigned to a more easterly district, commencing near Iconium, (which then fell into Phrygia,) and including the lower parts of Cappadocia and Cataonia. In character, Lycaonia resembled the west of Cappadocia, though surpassing it in flatness: there are no hills or rivers of importance, but a succession of plains, with occasional lakes, the waters of which are strongly impregnated with salt.

The chief town was Iconium, *Koniyeh*, styled by Pliny, 'urbs celeberrima:' it lay on the great route from the west to Syria, through the Portæ Ciliciæ, and attained considerable prosperity. Laodicæa Combusta, *Ladik*, lay on the same route, somewhat to the north-east of Iconium; its name would suggest the existence of volcanoes in the neighbourhood; no traces of them, however, have been discovered, and it has been suggested, that the title Combusta arises from its having been burnt down by accidental fire. Numerous wealthy towns lay in the southern portion of Lycaonia, as Derbe, at one time the residence of an independent prince, Laranda, *Karaman*, and Lystra, situated nearer Iconium: the first and last are associated with the history of St. Paul's travels.

ISAURIA was a strip of wild mountain land between Lycaonia and Pisidia, with which the ancients were little acquainted, in consequence of the wild habits of its inhabitants. The Isaurians were attacked by Servilius, surnamed Isauricus, and also by Pompey, by whom they were not so much subdued as confined to their mountain fastnesses. Politically speaking, the Isaurians were more connected with the inhabitants of Cilicia than with the Lycaonians; in geographical position they belong rather to the latter. The chief and only important town in this district was Isaura, which suffered severely on two occasions—viz., when burnt down by Perdiccas, and afterwards when destroyed by Servilius.

11 PISIDIA, lay to the N. of Pamphylia, among the ridges of Mount Taurus. Its boundaries are very uncertain: towards the N. and W., it was contiguous to Phrygia; towards the S., to Lycia and Pamphylia; and towards

the E., to Isauria. It extended, according to some accounts, into Phrygia Paroreia, so as to include Antioch; Cabalia and Milyas were reckoned sometimes with it, sometimes with Lycia and Caria.

This province is for the most part mountainous: towards the N., however, it assimilates in character to the plain of Phrygia. Here the waters collect in lakes, of which the two largest were named Caralitis, *Beysher*, and Trogītis, *Eyerdis:* in the S. it was watered by the upper courses of the Cestrus, the Eurymedon, and the other rivers which crossed Pamphylia to the Mediterranean Sea. The only territorial divisions in this province were Milyas and Cabalia, both lying in the south-western angle. It is impossible to fix the limits of these with any precision: Milyas seems at one time to have included the southern portion of Phrygia; then to have been applied to the district between Termessus and Sagalassus; and, lastly, to the border land of Lycia and Pisidia. Cabalia lay to the westward on the border of Caria, with which it was occasionally reckoned, about the course of the river Calbis.

The chief towns in Pisidia were—Antioch, *Galabatz*, in a plain of the Paroreia, founded, it is said, by colonists from Magnesia, and visited by St. Paul: Sagalassus, *Aglason*, near the source of the Cestrus, of Lacedæmonian origin; its citadel, situated on a precipitous rock, offered a stout resistance to Alexander's army: Cremna, *Germe*, south of Sagalassus, also remarkable for its strong position: Selge, on the Eurymedon, which claimed Sparta as its parent state, and certainly showed a martial spirit worthy of such descent: its inhabitants maintained their independency until a very late period. In Cabalia there were four cities, forming a confederacy, named after the principal member of it, the Cibyrate Tetrapolis, which existed until about 80, B.C.:—viz., Cibyra, a Lydian colony, near the banks of the Calbis; its inhabitants were skilled in working iron: Œnoanda, Balbura, and Bubon, which lay more to the south, and never attained any great importance.

12 PHRYGIA (in the limited sense which the name received under the Romans) was bounded on the N. by the Sangarius, and a branch of the Mysian Olympus, and on the S. by M. Taurus; on the W., where it joined Mysia, Lydia, and Caria; and on the E., where it touched Galatia and Lycaonia, it had no natural boundary.

The aspect of this province is varied: its general character is mountainous, but occasionally extensive plains occur. The range of the Mysian Olympus traverses the northern border, and terminates in M. Dindȳmus on the confines of Galatia: another Dindymus, in the western part of the province, contained the sources of the Hermus: in the south, offsets from the ranges of Cadmus and Taurus enter in various directions, and gradually decline towards the central plateau. Phrygia contained the head-waters of most of the rivers flowing into the Ægæan Sea. The Mæander rises in a limestone rock called Aulocrēne, behind Celænæ; it unites with the torrent Marsyas, (the Cataract of Herodotus,) in a small lake, in which both the streams disappear by a subterraneous passage, emerging again by different channels, and re-uniting near Apamēa. The Mæander thence flows towards the south-west, receiving on the borders of Lycia another tributary, the Lycus, *Tchoruk Su*, which rises on the declivities of Cadmus. The small stream Obrimas, *Sandukli Chai*, (?) is supposed to have joined the Mæander near Celænæ. The Hermus rises in the heights of M. Dindȳmus, and flows to the south-west; on the same range rise also the Mysian Rhyndacus and the Thymbres, a tributary of the Sangarius, with which it united on the borders of Bithynia; it is probably the same river which was afterwards called Bathys. The Alander, another tributary of the Sangarius, rises in central Phrygia, and flows towards the border of Galatia. There were numerous lakes in Phrygia strongly impregnated with salt: that which was called Anaua, lay to the south of the valley of the Mæander, between Colossæ and Celænæ: it is probably identical with the lake Ascania, which Alexander passed by.

This province abounded more than any other with the effects of volcanic agency. We have already mentioned the extensive burnt plain, Katakekaumene, on the borders of Lydia, which produced a superior quality of vine. Besides this, the numerous caves with mephitic exhalations, the subterraneous passages, in which the rivers occasionally disappear, and the frequent incrustations of lava, are attributable to a similar cause. It was also visited by most violent earthquakes in the reign of Tiberius, which overthrew the principal cities, and ruined the prosperity of the province.

Phrygia was divided into four districts—Epictētus, (i. e., the added,) in the north, so called because it was recovered from the Bithynians, and adjoined to the province to which it before belonged; Salutaris, (i. e., the healthy,) in the centre; Pacatiāna, on the western border; and Paorēa, in the south, on the borders of Pisidia and Lyaconia. The chief towns were:—in Phrygia Epictetus, Dorylæum, *Eskishehr*, on the Thymbres, on the high road from Byzantium to Syria; and Cotyæum, *Kutaya*, higher up the course of the same river. In Phrygia Salutaris, Synnada, celebrated for its marble quarries; Ipsus, an unimportant place in itself, the scene of the contest between Antigonus and the generals of Alexander, B.C. 301; Celænæ, *Dennair*, situated not far from the sources of the Mæander and the Marsyas, which both skirted the town, and united just below it; the citadel of Celænæ, situated on a precipitous rock, was almost impregnable; it sank under the Syrian dynasty, and its inhabitants were removed by Antiochus Soter to a city which he built a little to the west, Apamæa Cibōtus, which became one of the most important towns of Asia Minor: about thirty miles to the west of Apamæa stood Peltæ, on the Mæander, and in the centre of an extensive plain, Campus Peltēnus, *Balkan-Ovah:* it was celebrated for its dyed wool. In Phrygia Pacatiana, Colossæ, near *Chonos*, on the river Lycus, which is said to have disappeared into the earth, near the town; in the Persian era it was a town of much importance; it sank under the Syrian kings by the foundation of Laodicæa and Hierapŏlis: but it derives some interest from the existence of a Christian church in apostolic times, to which St. Paul addressed an Epistle; out of its ruins the town of Chonæ was built, on the site of the modern *Chonos*. Laodicæa, *Eskihissar*, surnamed ad Lycum, after the river on which it stood, on the border of Caria, built by Antiochus Deos, and named after his wife Laodice: it rose to such eminence that it became the capital of the Roman province Pacatiana: much of its wealth was derived from the glossy black wool produced in the neighbourhood: it suffered considerably from earthquakes: a little to the north, and on the other side of the valley of the Mæander, Hierapolis, *Pambook*, probably a Grecian town; it was also remarkable for its wool, and for the numerous hot springs and mephitic exhalations in the neighbourhood: in Phrygia Parorea, Thymbrium, to the south-east of Synnada, and Apollonia, formerly Mordiæum, celebrated for quinces, on the border of Pisidia.

13 GALATIA, or GALLO-GRÆCIA, originally a part of Phrygia, owes its existence as a separate province to the immigration of a Celtic tribe, the Galatæ. The original seat of this people lay between the Danube and the Alps. Marching eastward, after the dismemberment of Alexander's kingdom, they crossed the Hellespont, B.C. 278, and having gained a footing in Asia Minor by serving in the army of Nicomedes I., king of Bithynia, they finally settled down in the district named after them.

Galatia was contiguous to Bithynia and Paphlagonia on the N., to Pontus and Cappadocia on the E., to Lycaonia and Phrygia on the S. and to Phrygia and Bithynia on the W. In the northern parts it is wild and mountainous; in the south it partakes of the general character of central Asia Minor, consisting of high pasture lands, undulating and intersected with shallow ravines. The chief range of mountains, Olympus, *Ala-dagh*, lay on the borders of Bithynia, extending from east to west; in its defiles Manlius defeated the Tolistobogi. Lateral ridges, enclosing the various tributaries of the Sangarius, extend towards the south as far as Ancȳra: the lofty M. Magăba, *Kurg-dagh*, in the neighbourhood of that place, was the scene of a contest between the Romans and Galatians. The range of Olgassys, *Alkuz*, on the borders of Paphlagonia, in the north, and of Adoreus, *Elmah-dagh*, on the borders of Lycaonia, in the south, are the only other ranges deserving of notice. The most important river in Galatia is the Halys, which flows through the centre of the province in a broad and sinuous course, bending round from the westerly direction it had hitherto preserved, to follow the north-easterly direction of the Olympus and Olgassys chains. The western part of the province is watered by the tributaries of the Sangarius, *Sakkariyeh*, flowing towards the north-west.

The Galatæ were divided into three tribes: the Tolistobogi, who occupied the valleys of the Sangarius; the Tectosăges, who lived in the centre of the province about the Halys; and the Trocmi, to the east of them, towards the border of Pontus. There were but few towns of any importance. Ancȳra, *Angora*, the capital of the Tectosages, situated in a high plain to the north of M. Magaba, owed its prosperity in ancient as in modern times, partly to the superiority of the wool produced in the neighbourhood, partly to its central position on the road from Byzantium to the east. Pessĭnus, the capital of the Tolistobogi, was situated at the foot of M. Dindymus, and is only celebrated for the worship of Cybele, who possessed a famous temple on a spur of that hill. To the same tribe belonged the town of Gordium, on the Sangarius, an old residence of the Phrygian kings, chiefly known by the famous Gordian knot, on which the sovereignty of Asia was thought to depend; under the Romans it received the name of Juliopolis. The capital of the Trocmi was Tavium, ruins at *Boghaz-Kieui*, to the east of the Halys, remarkable for a colossal statue of Jupiter, and a temple, with an asylum, sacred to him.

14 Bithynia, to the north-west of Galatia, lay along the Propontis and the Euxine Sea, between the rivers Rhyndacus on the W. separating it from Mysia, and the Parthenius on the E. separating it from Paphlagonia. These boundaries give the greatest extent to the province under the Roman power; originally, the Sangarius seems to have been its eastern limit; at a later period, Xenophon extends it to Heraclea. This province, the residence, in early times, of the Bebryces, Caucōnes, and Mygdōnes, was afterwards occupied by Thracian tribes, who emigrated here from Europe. Of these, the Thyni held the coast from the Sangarius westward to Chalcēdon; the Bithȳni lived in the south; while a tribe, unconnected in race with the Thyni—the Mariandȳni—held the coast between the Sangarius and Parthenius rivers.

Bithynia, though mountainous, is rich and fertile. In the interior there are numerous plains, adapted for sheep-feeding. Towards the sea-coast, the mountains, which in their upper regions are clothed with magnificent forests, open into sheltered valleys, where the vine, the fig, and all sorts of grain, were cultivated. The chief range of mountains is the Olympus, *Cheshish-tagh*, (a distinct range from that already mentioned in the description of Galatia,) which commences on the border of Mysia, and traverses the province with several lateral ridges, all preserving a direction parallel to the Euxine. One of these ridges, M. Arganthonius, forms the high ground between the Cianus Sinus and the Astacenus Sinus. Of the rivers, the Sangarius and the Rhyndacus have been already mentioned. The Parthenius, *Bartan-su*, takes its rise in the Paphlagonian mountain Olgassys, and after no great length of course, joins the Euxine to the west of Amastus. The sea-coast of the Propontis is irregular, and from this circumstance offers numerous advantageous sites for towns. Two bays, Sinus Astacenus, *Gulf of Ismid*, and Sinus Cianus, penetrate a considerable distance into the interior; the latter is connected with a lake, Ascania, *Lake of Isnik*, which has its extension in the same direction as the bay.

The important towns of Bithynia were Nicomedia, *Ismid*, the capital of Bithynia, on the Sinus Astacenus; it was built by Nicomedes I., and peopled with the inhabitants of the neighbouring town, Astăcus, or Olbia, an ancient colony of the Megarians, which had been overthrown by Lysimachus; it attained a high state of prosperity, and was a favourite resort of the later Roman emperors; it is further interesting as the birthplace of Arrian, and the latest abode of Hannibal, who was buried at Libyssa, *Harakah*, on the northern shore of the Sinus Astacenus: Chalcēdon, *Kady-Kieui*, on the same bay, near the entrance of the Thracian Bosphorus, a colony from Megara—an important and flourishing town, commanding the entrance to the Euxine, and affording a ready transit to Europe, and hence selected as the fleet station by the Persians in their wars against Greece: a little higher up the coast, Chrysopŏlis, on the site of the modern *Scutari*; the name is said to have been derived from the circumstance of the Persians keeping their treasury there: Heraclēa Pontĭca, *Erekli*, the only town of importance on the Euxine Sea in this province, a colony from Megaris, situated at the mouth of the Lycus, in the district of the Maryandini; it reached its highest prosperity under the tyrant Dionysius, but sank under the Bithynian kings, and was finally destroyed by the Roman general Cotta: Prusa ad Olympum, *Brusa*, at the foot of Olympus, the residence of Prusias: Nicæa, *Isnik*, at the eastern extremity of Lake Ascania, founded by Antigonus, with the name Antigonia, which was afterwards changed to Nicæa by Lysimachus, after his wife's name, Nice; before the foundation of Nicomedia, it ranked as capital of Bithynia; it derives, however, its chief interest from the general council held here, A.D. 325.

At the mouth of the Thracian Bosphorus, in the Euxine, two rocks—Cyanĕi Scopuli—rendered the entrance to that sea dangerous. The ancients, as usual, invested these islands with imaginary horrors. It was thought that they shifted their position (whence the name Pianctæ), and that they closed upon and destroyed vessels (whence the name Symplegades). The rocks are now called *Urek-jaki;* a passage of about two miles' breadth intervenes between them.

15 PAPHLAGONIA adjoined Bithynia to the E., occupying the coast of the Euxine from the river Parthenius to the Halys, and extending inland to Mount Olympus and the borders of Galatia. The name is supposed to be derived from Shemitic words signifying 'the point of division,' the Euxine Sea being, as it were, divided by the projection of the coast, near Sinōpe, on the one side, and the Tauric Chersonese on the other. The general character of this province is mountainous, but fertile. Towards the sea are spreading plains, in which the olive and the other fruits of Asia Minor flourish. The interior is broken up by ranges of well-wooded hills rising to the height of about two thousand feet above the sea, and terminating in the usual high pasture grounds. The ranges of hills, and consequently the river courses, preserve a direction more or less parallel to the sea. The chief range received the name Olgassys, *Alkuz;* the minor ridges were not known by any specific name, with the exception of Cytōrus, near the coast, celebrated for the growth of the box-tree. In the interior, there are frequent remains of copper-mines.

The rivers of this province are mostly tributaries of the Halys. This river forms the boundary on the side of Pontus, flowing for the most part in a deep stream between precipitous banks, and admitting of an entrance to that province only at one point, through a gorge now named *Kara-Depeh*. Its tributaries are the Amnius, *Kara-su*, on whose banks Mithridates defeated the Romans; and the Doros, higher up the country. These rivers rise in Olgassys, and flow towards the east; other streams, from the western declivities of this range, flow in the opposite direction, and seek the Parthenius and Billæus.

The province was occupied by three distinct races: the Paphlagonians, a

Syrian tribe, who surpassed the rest in numbers and power; the Henĕti, a Celtic tribe, dwelling on the sea coast, about the Parthenius, and deemed the progenitors of the Italian Venetians; and the Chalȳbes, a Thracian tribe, who inhabited the mountains in the eastern part of the province, and were chiefly occupied in working the mines. The chief towns were—Sinōpe, *Sinub*, a famous colony from Miletus, situated on a peninsula, on either side of which was a port; it was the most important of all the Greek colonies on the Euxine, and itself the parent of not unimportant colonies. Under Mithridates Eupater it became the capital of the kingdom of Pontus, and was subsequently colonized by the Romans; it is further known as the native place of the Cynic philosopher, Diogenes. Pompeiopolis, *Tash Kupri*, on the Amnius, with mines in the neighbourhood; it was erected on the spot where Pompey and Mithridates engaged: Flaviopolis, *Zafaran-boli*, in the south-west, both ancient and modern names indicating the abundance of saffron in the neighbourhood; and Hadrianopolis, on the Billæus.

16 Pontus, anciently called Cappadocia ad Pontum, lay along the coast of the Euxine from the Halys to the border of Colchis, the river Acampsis being generally regarded as its limit to the E., but sometimes the river Phasis; towards the S., it was contiguous to Cappadocia and Armenia Minor. In shape this province was an irregular triangle; in character, wild, mountainous, and unfruitful, with occasional plains and valleys admitting of cultivation. Two important mountain chains occur in this province: the Paryadres, *Kuttag*, which runs parallel to the sea coast in the northern district, sending out numerous spurs towards the sea; and the Scædises, or Scordiscus, in the south: the Teches, whence the ten thousand under Xenophon obtained their first glimpse of the Euxine, forms the connecting link between the two.

The only important rivers besides the Halys, which had both its source and its termination in Pontus, were the Iris, *Yeshil-Irmak*, with its tributary the Lycus, *Kulei-hissar*, and the border stream, Acampsis, *Bitumi*. The Lycus rises on the western declivities of Scædises, and flows to the north-west until it falls in with the Iris and the Scylax from the south-west; after their junction, the united stream was known as the Iris; the Acampsis rises in M. Teches, and follows the course of the Moschici Montes to the north-east, and finally to the north. It is a violent mountain torrent in its upper course, whence it received the names Boas and Lycus—the former probably the indigenous, the latter the Greek appellation for such streams.

Pontus was tenanted by a variety of wild tribes, of different race and character. The most interesting of these were the Chalybes, or the Chaldæi, as Strabo calls them, who have been already noticed as living in parts of Paphlagonia; they were scattered about the Paryadres range, where they were employed in working iron ore, and also occupied the coast to the east of the Iris. After the termination of the kingdom of Pontus, the province was divided into three districts—Pontus Galaticus, on the western border, which was subjected to a tetrarch of Galatia; Polemoniacus, in the centre, so called from its governor, Polemo, son of Pharnaces; and Cappadocius, in the east, which belonged to Polemo during his lifetime, and afterwards became the property of Archelaus, king of Cappadocia.

The important towns of Pontus were—On the sea coast from west to east, Amīsus, *Samsun*, a good port, founded by Milesians, and after its destruction by the Paphlagonian princes, restored by the Athenians; Mithridates occasionally resided there; it was taken by Lucullus, and thenceforward gradually sunk: Themiscȳra, the old residence of the Amazons, on the Thermodon; it sunk, probably, in the Mithridatic war, as no mention of it is made during the Roman era: Pharnacea, *Kerasunt*, built by Pharnaces, grandfather of Mithridates, out of the spoils of Cotyora; the mines of the Chalybes were near it; it appears to have been called also Cerăsus, but is to be distinguished from the place of that name, whence the cherry was introduced to Europe, which lay nearly twenty miles to the eastward, and never reached the same size or importance: Trapezus, *Trebisond*, a colony of Sinope, which rose to great importance under the Romans, and was constituted capital of the adjacent district by Trajan; it was the first friendly town which the ten thousand met with on their retreat. In the interior, Amasia, *Amasiyeh*, on the upper course of the Iris, situated in a mountain gorge, where that river forces its way through mountains: Cabīra, on the Lycus, a royal residence of the kings of Pontus; Pompey enlarged it, and gave it the name Diospolis: Comāna Pontica, *Tokat*, on the Iris, famous for the worship of the goddess Anaitis, or Bellona, whose temple was served by six thousand priests, and endowed with great wealth: Zela, *Zilleh*, in the south-west part of the province, built on an artificial elevation between the rivers Iris and Scylax; Mithridates here conquered Priarius, and here also Cæsar gained that decisive victory over Pharnaces which he reported to the Roman people in the words 'Veni, vidi, vici:' and Sebastia, *Sivas*, quite in the south, on the banks of the Halys, a town which rose into eminence only under the later Roman emperors.

CHAPTER III.

I. COLCHIS, IBERIA, AND ALBANIA.—II. ARMENIA.—III. MESOPOTAMIA. IV. BABYLONIA.—V. ASSYRIA.—VI. PERSIS.—VII. SARMATIA. VIII. SCYTHIA, SERICA, AND SINÆ.—IX. INDIA.

I. *Colchis, Iberia, and Albania.*

FROM Asia Minor we proceed eastward to lands with which the Greek and Roman writers had a much less intimate acquaintance. The remainder of the continent was designated Asia Major, in contradistinction to the peninsula: but neither of these titles, as has already been observed, are used by classical writers. The Caucasus was the natural boundary of the Persian and Roman empires, and may likewise be regarded as the limit of the Orbis veteribus notus in this direction. The district intervening between the Euxine and Caspian Seas was divided into three provinces—Colchis, Iberia, and Albania; the first lying along the eastern coast of the Euxine; the last along the western coast of the Caspian, from the Cyrus northward; and Iberia between the two.

The general character of these provinces is wild and mountainous: but each possesses plains and valleys admirably adapted for cultivation, where the population congregated in towns and villages. Colchis produced flax, and its people were engaged in weaving: Iberia, oil and wine, in addition to grain of all sorts: while Albania abounded, in the southern districts, with rich pasture-lands and vineyards. The climate of these provinces was various: Colchis excessively hot in summer, and unhealthy; Albania and Iberia, mild and wholesome.

The political geography of these provinces is soon told: they were tenanted by a variety of independent tribes, differing widely in race, language, and degree of civilization. Colchis yielded a nominal submission to the supremacy of the Persians, and afterwards became part of the Pontic kingdom. It was presented by the Romans to Polemo, after the death of Mithridates, and finally became a tributary state to the Roman empire. Iberia yielded a similar submission, first to the Persians, afterwards to the Roman empire. Albania was occupied by twelve distinct tribes subject to one king, until the Persian empire gained its supremacy, from which it reverted, as the two former, to the Roman empire.

1 Colchis, *Mingrelia*, was bounded on the S. by the Acampsis, on the N. by Caucasus, on the E. by the Moschici Montes, and on the W. by the Euxine. The chief river was the Phasis, *Rion*, rising in the Moschici Montes, and flowing with a rapid and copious stream to the westward, until it joined the Euxine, near a town of the same name. It received various tributaries—the Rhion, Glaucus, &c. Besides this, a vast number of mountain torrents poured down from Caucasus to the Black Sea. Colchis is more famed in mythical than in historical geography. The name, indeed, occurs in no writer earlier than Æschylus; but the scene of the golden fleece is laid in this district, at a town named Æa, which does not appear in any subsequent account of the country, and which is probably altogether misplaced. The only places to be noticed are—Pityus, *Soukgoum*, a Grecian seaport town of considerable importance in the north of Colchis, which the Romans strongly fortified—Dioscurias, under the Romans named Sebastopolis, a Milesian colony, and a place of considerable commerce—Cytæa, on the Phasis, and Sarapana, on the same river, near the border of Iberia.

2 Iberia, *Georgia*, was bounded by the Moschici Montes on the W., Caucasus on the N., the river Alazonius on the E., and Armenia on the S. This mountain-girt land was accessible in only four points :—one pass followed the course of the Phasis, from Colchis; a second, the course of the Cyrus, from Armenia; a third led by the Alazonius to Albania; and a fourth, by the Sarmaticæ, Caspiæ, or Caucasiæ Pylæ, to the north. The chief river was the Cyrus, *Kur*, which rises in the western mountains, and flows in a south-easterly direction towards the Caspian Sea, receiving in Iberia two considerable tributaries—the Cambyses, *Yori*, and the Alazonius, or Abas, *Alazan*, which both rise in the Caucasus. The towns of importance were—Harmorzica, on the Cyrus; Mestleta probably in the neighbourhood of *Tiflis;* and Artanissa, somewhat to the north of the last named.

3 Albania, corresponding with the provinces *Daghestan* and *Shirvan*, lay along the Caspian Sea, from the Cyrus upwards to the Ceraunian branch of the Caucasus. It was watered by the tributaries of the Cyrus, as well as by numerous coast streams. A ridge of Caucasus penetrates the whole length of Albania, crossed in the neighbourhood of *Derbend* by a fortified pass, named Pylæ Albaniæ. Of the towns of Albania nothing is known beyond their names and positions—Gætara and Albana on the Caspian; Osica, at the confluence of the Alazonius and Cyrus; and Chabale near the Albanian gates.

II. *Armenia.*

Armenia followed to the south of the three provinces just described, separated from Albania by the river Cyrus, and from Iberia and Colchis by the Moschici Montes: it stretched southwards to M. Masius, on the border of Mesopotamia, and to the border of Assyria: the Euphrates formed its western, and the Araxes its eastern boundary. This district is still called *Armenia.*

Armenia is the highest ground of western Asia: it consists of a complicated knot of mountain ranges, whence the various important systems of Caucasus, Zagrus, Taurus, and Caspius, diverge to the north, south, east, and west. The centre and cradle of all these is the high plateau* of Armenia, a bleak and desolate region, intersected by various snow-capped and impassable ridges. The range of Taurus, on the eastern bank of the Euphrates, forks off into M. Masius, *Karajeh Dagh*, towards the south-east, and M. Niphātes, (i. e. the *snow* mountain,) *Hatraseh Dagh*, towards the east. Antitaurus, in the north, likewise connects with two ranges, viz.; by M. Capotes, with the central Abus, and by the Scædises and Paryadres, with

* The plain of Moosh, to the north of Niphates, has an elevation of four thousand feet above the level of the sea.

the lower limbs of Caucasus. In the eastern part of the province, these northern ranges verge towards the southern point of the Caspian Sea, where they unite with the continuation of Taurus and Niphātes under the name of M. Caspius. The southern boundary of Armenia is irregular; from the eastern termination of M. Masius, on the border of Mesopotamia, it crossed the Tigris, and followed the course of the Gordyæi Montes, the *Koord* mountains, to the north-west, until it met the valley of the Centrites, which it followed to the south of lake *Van* and then fell into the line of the M. Caspius.

The streams of Armenia flow in all directions—the Euphrates to the south-west, the Tigris to the south-east, the Araxes to the east into the Caspian, and the Acampsis to the west into the Euxine. The Euphrātes, divides in its upper course into two considerable streams: the northern, *Kara-su*, rises in the ranges of Scædises; the southern, which is the most important, *Marad-su*, in M. Abus. The latter branch is the Euphrates of Xenophon; it flows to the west, receiving the Teleboas, or Arsanius, from Niphates, and many other tributary streams. The Tigris, the Hiddekel of Scripture, rises on the southern declivities of Niphates, and receives in Armenia these three tributaries—the Nymphæus, river of *Meiaferikin;* the Nicephorius, stream of *Betlis;* and the Centrites, *Buhtan-chai,* flowing from the north-east, and joining the Tigris where it changes its course from east to south-east. The Tigris is a violent stream, running in a rocky bed, and hemmed in by the ranges of the Cardūchi Montes on the left, and M. Masius on the right bank. The Araxes, *Aras,* rises not far from the northern branch of the Euphrates: in its upper course it received the name of Phasis (the Phison of Scripture), under which title Xenophon describes it: flowing eastward it received the Harpăsus, *Arpa-chai,* somewhat to the north-west of Mount Ararat. The course of the Acampsis has already been noticed. Armenia contains several extensive lakes — Arsissa, *Van,* near the Tigris; Lychnitis, *Erivan,* to the north-east of Ararat, and Thospites, in the valley of *Diarbekr.*

Armenia was divided into numerous districts, the names of which may, in many cases, be identified with the modern appellations: for instance,— Chorzēne, *Kars;* Cardūchi, *Koords;* Ossarēne, *Erzeroom.* The district Sophene lay in the south-west, and with Acilisēne formed a separate kingdom, under the Seleucidæ. Armenia, though so inaccessible and unfavourable to an invading army, appears to have fallen an easy prey to the dominant power, whatever that might be. It formed in turn part of the Assyrian, Median, Persian, Macedonian, and Syrian kingdoms: under Artaxias, B.C. 189, it became independent. Towards the termination of the first century of our era, it became a bone of contention between the Romans and Parthians. Trajan reduced it to the state of a Roman province, and it remained part of the Roman empire until A.D. 440, when it fell into the hands of the Persians.

Armenia contained few towns of any size; the population was scattered about in villages. Artaxăta, *Ardaschat,* the capital, was situated on the Araxes, to the east of Ararat: it was said to have been founded by the advice of Hannibal: its fortifications were strong: nevertheless it was several times conquered, and was burnt down by Corbulo. Tigranocerta, the later capital of Armenia, built by Tigranes, was situated in the south of the province: its position is uncertain: some have, without good reason, identified *Sert* with it: it is more probably far to the westward, on the site of Amĭda, *Diarbekr,* on the upper course of the Tigris. Arsamosăta, a strong fortress, lay in the plain of Sophene, between the valley of the Euphrates and the sources of the Tigris. Artemīta, on the lake Arsissa, *Van,* and Amĭda, on the Tigris, were towns of a comparatively late date.

III. *Mesopotamia.*

MESOPOTAMIA was the Greek translation of the native name, Aramnaharaim—the 'land between the rivers' Euphrates and Tigris. The title seems to have come into use about the time of the Seleucidæ, before which period the Greeks treated it either as a part of Syria or of Assyria. The boundary on the N. was M. Masius, separating it from Armenia, and on the S. the Median wall, separating it from Babylonia. It is now denominated *Algesira.*

With the exception of the border range of Masius, and a spur of the same, M. Singăra, *Sindjar*, to the east of the Mygdonius, Mesopotamia was one extensive, unvaried plain, affording rich pastures to the north of the Chabōras, wherever there was sufficient irrigation, but to the south of that river degenerating into a mere sandy desert. It was devoid of wood, with the exception of the declivities of Masius, which supplied timber for the fleets said to have been built by Trajan and Severus in this province. The southern district cannot be better described than in the words of Xenophon, who calls it 'Arabia,' as being tenanted by a horde of Scenite Arabs: 'The land is on every side a plain as level as the sea, and full of wormwood; whatever other shrubs or reeds grow there have an aromatic smell, but no trees appear.' The rivers of Mesopotamia are, the Euphrates and Tigris, with the tributaries of the former, Chaboras and Belias. The Euphrates attains its greatest breadth at Thapsacus, where it is about 800 yards across; below that place it wears a deeper channel in the alluvial soil through which it flows, and suffers a diminution of its waters from the numerous artificial channels into which it is divided for the purposes of irrigation. The Chaboras, *Khabur*, the Araxes of Xenophon, has its sources in M. Masius; it flows towards the south, receiving the Mygdonius from the neighbourhood of Nisibis, and the Saocŏras from Singara, and joins the Euphrates at Circesium. The Mascas mentioned by Xenophon is not a river, but an artificial channel of the Euphrates, drawn round so as to insulate the town Percōte.

The political history of Mesopotamia is much the same as that of Armenia: it formed a portion of the ruling powers of the world in their various eras—Assyrian, Median, Persian, Syrian, and Roman. It was divided into two districts, Orsoēne to the north-west of the *Chabur*, and Mygdonia to the east and south-east of that river. The chief towns were as follow: Edessa, or Callirhoe, *Orfa*, on the Scirtus, a tributary of the Belias—probably the 'Ur of the Chaldees' of Scripture; Batnæ, to the south-east of Edessa—Sarug of Scripture; Carræ, Haran, or Charran, on the Belias, to the south of Edessa, where Crassus was defeated by the Parthians; Nicephorium, or Callinīcum, at the junction of the Belias—it was built by Alexander's orders, and completed by Seleucus Nicator; Circesium, Karchemish, *Kerkesiah*, at the junction of the Chaboras, a well-fortified town; Nisĭbis, otherwise Antiochus Mygdoniæ, *Nisibin*, on the Mygdonius, which ranked as the capital of Mygdonia, and was an important depôt of Eastern merchandize—it was three times destroyed by the Romans, and as often restored; Singăra, in the centre of the country, near the hill of the same name—it was fortified by the Romans, who sent a colony there; Atræ, *Heddur*, in the southern district, not far from the Tigris; and Cænæ, on the Tigris, above the confluence of the great Zab.

IV. *Babylonia.*

1 BABYLONIA, or CHALDÆA, the Shinar of Scripture, commenced on the south side of the Median wall, and stretched thence to the Sinus Persicus. It was bounded on the E. by the Tigris, on the W. it occupied both banks of the Euphrates, and extended some short distance into the deserts of Arabia. It corresponds with the modern *Irak-Arabi*, as far as the bank of the Euphrates.

This province consists of an unbroken alluvial plain, sinking at certain places into deep hollows where the waters collected in lakes and marshes, devoid of stone, and, with the exception of groves of palm and cypress trees, which were in ancient times abundantly cultivated, devoid also of wood. In this naturally monotonous country, the hand of man supplied various objects of interest: numerous artificial elevations, crowned with temples, broke the uniformity of the horizon; canals cut in every direction rendered the waters of the Euphrates and Tigris useful for irrigation, and regulated the periodical inundations of the former river, at the same time that they served as high roads of traffic, and contributed to the salubrity of the air; the absence of stone was compensated by an abundance of clay for bricks, and of numerous springs of naphtha, which supplied a powerful cement; and thus Babylonia was, in ancient times, (in strong contrast to its present appearance,) a land of cities and gardens, thickly populated, and abounding in all the necessaries of life. The Median wall, now called *Sidd Nimrud*, said to have been built by Semiramis, and to have had a height of 100 feet, a thickness of 20 feet, and a length of 60 miles, stretched across from Opis, on the Tigris, in a south-westerly direction, to the Euphrates, coming upon that river near the entrance of the first canal. The northern part of the province was intersected by four large canals, within a space of thirteen miles, in the neighbourhood of Seleucia; the largest of these was called Naarmalcha, or the *King's Canal*. There were also two large canals on the west side of the Euphrates: the Naarsăres, which struck off from the Euphrates near the Median wall, and ran nearly parallel to it, until it rejoined the united Tigris and Euphrates not far from the sea; and the Pallacŏpas, which left the Euphrates below Babylon, and discharged the superfluous waters of that river into a large lake. The Euphrates and Tigris joined their streams in Mesopotamia, (above the present point of junction at *Korna*,) in the valley now occupied by the *Shat-al-Hie*. The united rivers received the name Pasitĭgris, *Shat-el-Arab*, and discharged themselves into the Persian Gulf, probably by two mouths, Ostium Occidentale, as Ptolemy calls it—the Euphrates of Nearchus—and the Ostium Orientale, or the Pasitĭgris.

The territorial divisions of Babylonia were, Messēne, in the north, where the rivers approached each other; Chaldæa, in its restricted sense, on the right bank of the Euphrates, from Babylon to the sea; and a second Messene on the shore of the Persian Gulf. The capital was Babȳlon, or Babel, *Hillah*, built on both sides of the Euphrates, in the form of a quadrangle; the western half was the most ancient, and contains the ruins called *Birs Nimrud*. On the eastern side of the river, which was traversed by a bridge, was situated the palace of Nebuchadnezzar, with the celebrated hanging gardens. Babylon was taken by Cyrus, B.C. 538; Darius dismantled it of its walls; it sank finally through the erection of the towns Seleucia and Ctesiphon, so that in Pausanias' time only the walls remained. Seleucia, on the right bank of the Tigris, opposite Ctesiphon, and north of Babylon, was built by Seleucus Nicator, and soon became the most important place of trade in the country. It was ruined by the Romans, Trajan first having sacked it, and afterwards Verus. To the north of it, was Sităce, *Eski Bagdad*, about a mile and a half from the Tigris; then Cunaxa, not far from the Euphrates, below the King's Canal, where Cyrus the Younger engaged with Artaxerxes, B.C. 401; Pirisabōra, *Anbar*, a large city near the Median wall, and at the entrance of the Naarsares Canal; Apamea, *Korna*, at the present junction of the Euphrates and Tigris; Terēdon —perhaps *Bassorah*—on the western branch of the Pasitigris, near the sea; Ampe, whither Darius transplanted the Milesians, not far from the mouth of the Tigris; and Alexandria, or Charax, built by Alexander at the mouth of the Tigris, and rebuilt by an Arabian prince, Spasines, after whom it was named in later times.

2 The Babylonian kingdom is said to have been founded about 2000 B.C., and existed down to the time of the Persian conquest, B.C. 538. The territorial extent of this kingdom was, however, confined to the neighbourhood of Babylon, until the conquests of Nabopolassar, 625—604. That sovereign aided

the Medes in the destruction of Nineveh, defeated the Egyptian monarch Pharaoh-Necho at Circesium, and established the Chaldæo-Babylonian kingdom over Mesopotamia, Phœnicia, Syria, and Israel. This was the era of the greatness of Babylon, and the date of the most wonderful erections in and about that city. After the death of his successor, Nebuchadnezzar, the kingdom sank; it received its deathblow (538) in the capture of Babylon by Cyrus. Thenceforward it formed part of the kingdom of Persia: in the division of Alexander's dominions, the old Babylonian kingdom fell to Seleucus, and formed part of the Syrian empire, until the advance of the Parthians.

V. *Assyria.*

1 Assyria, like Babylonia, is the title of a kingdom as well as of a province. As a province, it was bounded by the Tigris on the W.; M. Choatras, and its continuation, Zagrus, on the E.; the Cardūchi Montes and Niphātes on the N.; on the S. it was contiguous to Susiāna. It was a long, narrow, mountain district, well watered by the tributaries of the Tigris, little wooded, but generally fertile, and abundant in asphalt and naphtha. It corresponds with the modern *Kurdistan*, and with the Ashur of Scripture.

The tributaries of the Tigris, which flow from the Zagrus M. towards the south-west are: the Lycus, or Zabătus, *Great Zab*, with its tributary, the Bumādus, *Khasir*, on the banks of which Alexander defeated Darius; it joins the Tigris below Nineveh; the Caprus, *Little Zab;* the Physcus, or Tornadotus, *Odorneh*, which joins just above Opis; the Gyndes mentioned by Herodotus, probably a branch of the *Kerah*, or *Kara-su:* at the head of the valley of the Silla, was the pass over the Zagrus into Media, called Pylæ Mediæ.

Assyria was divided into a variety of districts, of which we shall only notice Adiabēne, about the Lycus, and Aturia, about Nineveh. Both these names were occasionally applied to the whole province; they appear, however, not to have been strictly contemporaneous divisions, for Adiabene in later times included Aturia. The towns of Assyria were, the capital, Ninus, or Nineveh, *Nunia*, opposite *Mosul*, near the Mespylæ of Xenophon, on the left bank of the Tigris, above the junction of the Lycus: it was partially destroyed in the time of Sardanapalus, B.C. 817, and fully by Cyaxares the Mede, B.C. 606; the town never rose again, but there appears to have been a fort erected on its site by the Parthian princes: Ctesĭphon, the second capital of Assyria, opposite Seleucia, the ruins of which two cities are now called *Al-modain*—it was the winter residence of the Parthian kings, and in Julian's time strongly fortified: Arbēla, *Arbil*, in Adiabene, between the Lycus and Caprus, the head-quarters of Darius before his engagement with Alexander: the battle is sometimes called the battle of Arbela, but it actually took place at Gaugamēla, near the river Bumadus: Larissa, the Resen of Scripture, ruins of *Nimrud*, near the junction of the Lycus—it was deserted at the time of the retreat of the ten thousand; Ecbatăna, *Amadiyeh*, on a tributary of the Zabatus; and Opis, at the junction of the Physcus, an old commercial town, which early disappeared. A district named Calachene, lying along the Tigris, to the north of Nineveh, is probably the same mentioned in Scripture under the name Halah, whither the ten tribes were transplanted; in the same neighbourhood, the river *Chaboor*, may represent the Habor, if the passage in 2 Kings, xvii. be read, 'Habor the river of Gozan.' Habor is also identified with the Mesopotamian Chaboras, and with the hill Chaboras between Media and Assyria.

2 The kingdom of Assyria included in its greatest extent, Mesopotamia, Babylon, Media, and Persia. Shalmaneser, about 730, extended his conquests to the borders of Egypt. In the reign of Sennacherib it sunk, and it was finally overthrown B.C. 606 by the coalition of the Medes and Babylonians against it. It afterwards became part of the Persian empire, and shared its lot in the various revolutions which it underwent.

VI. *Persis.*

§ 1. Media. — 2. Median Empire. — 3. Susiana. — 4. Persis. — 5. Carmania. — 6. Parthia. — 7. Hyrcania. — 8. Aria. — 9. Drangiana. — 10. Gedrosia. — 11. Arachosia. — 12. Paropamisadæ. — 13. Bactria. — 14. Sogdiana. — 15. Margiana. — 16. Persian Empire. — 17. Parthian and Bactrian Kingdoms. — 18. The later Persian Empire.

Persis is a name commonly applied in Ancient, as Persia in Modern Geography, to all the countries lying eastward of M. Zagrus to the river Indus. This use of the name is improper, because it is neither co-extensive with the province or with the kingdom of ancient Persia; it has, however, been adopted by geographers, and is therefore adhered to. It includes the provinces Susiana, Persis, Carmania, Gedrosia, Media, Hyrcania, Parthia, Aria, Arachosia, Bactria, Margiana, and Sogdiana. We will first describe the western provinces, Media, Susiana, and Persis.

1 Media was bounded by the Araxes on the N., the Caspian Sea on the N.E., M. Zagrus on the W., and M. Charbanus, separating it from Susiana, on the S. It thus comprises the modern provinces, *Azerbijan* and *Ghilan*, with parts of *Irak-ajemi* and *Mazanderan*. It is generally a mountainous district, particularly towards the north, but eminently fertile; the plains and valleys of Atropatēne—the Nisæi Campi, famous for its breed of horses—and the coast district of the Caspian Sea, were and are famous for all sorts of vegetable productions. The mountain ranges are irregular in their direction: M. Caspius and the Zagrus range in the west have already been mentioned: the former reaches its greatest elevation in M. Corōnus, *Demavend*, on the border of Hyrcania; a lateral ridge of Zagrus, M. Jasonius, penetrates into the centre of the province. The chief rivers are—the Amardus, *Kizzil-ozien*, perhaps the Gozan whither the Israelites were transplanted, which rises in the heights of Zagrus, and flows towards the north-east into the Caspian Sea; and the border-stream Araxes. The Cambyses and the Straton were small coast-streams; the former in the north-west of the province, the latter near Hyrcania. An extensive lake, named Spauta, now the *Lake of Urmia*, is situated in the north-west corner of Media: its waters are excessively salt and bitter.

Media was divided into two districts—Media Magna in the south, and Atropatēne in the north-west, so called from Atropates, a native, who established an independent kingdom after Alexander's death. The chief towns were—Ecbatăna, called in Scripture Achmeta, *Hamadan*, in Media Magna, the ancient capital and treasury of Media, said to have been built by Dejoces, and surrounded by him with a sevenfold fortification: it was captured by Alexander, and afterwards by Seleucus and Antiochus; and so great a plunder was taken from it, that the Syrians coined four thousand talents out of the precious metals they found there; Ragæ, the Rages of Scripture, to the east of Ecbatana, near the Parthian frontier and the modern *Tehran*: it was reputed the largest city of Media; having been destroyed (perhaps by an earthquake), it was restored by Seleucus Nicator, with the name Eurōpus; the district about it was called Ragiāna, and contained the celebrated Nisæan plains; Gaza, or Gazăca, in Atropatēne, the summer residence of the Median kings; and Phraaspa or Vera, to the south-east, their winter quarters, the former to the south of the lake Spauta, and the latter at a greater distance to the south-east. The shores of the Caspian Sea were occupied by the Cadusii, or Gelæ, as far south as the Amardus.

2 Media was the seat of an independent empire, from B.C. 708 to 558. This empire, at its greatest extent, reached westward to the Halys, and eastward over Persia, though its limits in this direction are not known. The period of its highest prosperity was under Phraortes, circ. B.C. 640. It was merged in the Persian kingdom by Cyrus, B.C. 558.

3 Susiana was an extensive plain to the S. of Media, between the Tigris on the W., and the Parachoathras (a continuation of Zagrus) on the E.;

towards the S. it was bounded by the Persian Gulf and the river Arosis: it corresponds with the modern *Khuzistan*. It was a fruitful district, but unhealthy on account of the heat; the coast was inaccessible through lagoons and marshes. The chief rivers, besides the Tigris, are — the Choaspes, *Karoon*, which rises in Parachoathras, receives the Eulæus, *Abzal*, near Susa, with the Hedyphon, and joins the Pasitigris not far below the junction of the Euphrates and Tigris: the waters of this river were celebrated for their purity: the Coprates, a tributary of the Pasitigris, and the Arosis, *Tab*, on the border of Persis. Of the districts into which this province was divided, we will mention Elymæis, to the south-east of the Choaspes, from which the Scripture name Elam is applied to Persia; and Cissia, on the mid-course of the Choaspes, about Susa. The towns worthy of notice were—Susa, the Shushan of Scripture, ruins at *Shuster*, on the left bank of the Choaspes, the winter residence of the kings of Persia; it is said to have been founded by Tithonus, brother of Priam, and finished by his son, Memnon, whence it was called Memnonia; Seleucia, or Solŏce, on the Hedyphon; and Azara, on the same river, with a celebrated temple of Diana; it is supposed to be the town mentioned 1 Macc. vi. 1, 2.

4 Persis, the metropolitan province of the Persian empire, lay along the gulf from the river Arosis on the W., to the Bagradas on the E.; towards the N. it extended up to the central plateau, and was separated from Parthia by a low offset of Parachoathras. It corresponds with the modern province *Fars*. Little was known of it by the ancients except the north and west districts, which the expeditions of Alexander had somewhat opened. The route from Susiana to Persis crossed the Parachoathras by a succession of difficult passes, commencing with the Portæ Susiadæ, and terminating with the Pylæ Persicæ, the latter situated to the south-west of Persepolis. The chief river, Araxes, *Bend-emir*, rises on the borders of Susiana, and flows towards the east; it receives the Medus, *Pulwar*, near Persepolis, and discharges itself into a large salt lake, now called *Bakhtegan*. The Cyrus, earlier Agradatas, flowed by Pasargadæ, on the eastern border. There are, besides these, numerous small rivers flowing into the Persian Gulf. This province is very unequal in climate and character: the northern desert district, called Parætacene, is liable to the extremes of cold and heat, and is only fit for sheep-feeding; the central district contains many spots famous for fertility, such as the plain of Persepolis, and the modern valley of *Shiraz;* the seacoast is swampy and unhealthy. The chief towns were—Persepolis, north of the Araxes, destroyed by Alexander; the beautiful ruins are now called *Takht-i-Dschemschid:* and Pasargădæ, on the Cyrus, to the south-east of Persepolis, where Cyrus was buried; it is supposed by some, but without reason, to have been a suburb of Persepolis; its position is at present a matter of doubt.

5 Carmania, which still retains its ancient name in *Kerman*, bordered on the Persian Gulf from the river Bagrada in the W., to the promontory of Carpella in the E., and stretched inland to the borders of Parthia. The southern district was rich in grain, fruits, and precious metals. One district, named, *Nurmansher*, to the east of Persepolis, is still famous for its fertility; through this Alexander's route led on his return from India. On the other hand, the northern parts of the province adjoining the wilderness were barren, and only adapted for sheep-feeding. The only hill which received a specific name was M. Semiramidis, also called Strongylus, near the neck of the Persian Gulf. The chief towns were—Carmāna, *Kerman*, in the interior, possibly an emporium of eastern commerce in the most ancient times: and Harmuza, on the coast; the people retired thence to a neighbouring island, *Hormuz*, whence the straits are called. There are numerous islands at the entrance of the Persian Gulf.

6 Parthia, or Parthiene, now *Khorassan*, lay to the north of Carmania, between Media on the W., and Aria on the E.; towards the N., it was separated from Hyrcania by M. Caspius. It was a barren, sandy desert,

broken towards the northern frontier by the offsets of M. Caspius, and so little valued by the Persians, that it was considered as a mere appendage of Hyrcania. It was, nevertheless, the abode of a brave and warlike race, who opposed an effectual barrier to the Roman power in the east, and who succeeded in establishing a kingdom that extended from the Euphrates to the Ganges. There are no rivers of any importance. The chief town was Hecatompylos, usually identified with *Dameghan* — more probably *Jah Jirm*, situated under M. Caspius, in the northern part of the province; it received its name from the number of gates leading to the various routes. A later capital, named Sauloe, or Nisæa, in the district Nisæa, is of uncertain position.

7 HYRCANIA was a narrow strip of coast-land between M. Labuta and the Caspian Sea; M. Coronus separated it in the W. from Media; while towards the E. it stretched to the river Ochus. It corresponds with *Astrabad*, part of *Khorassan*, and the eastern part of *Mazanderan*. It was fertile in every sort of fruit and grain, and well-wooded, but much infested with wild beasts. The rivers have not been identified. The capital was Zadracarta, or Carta, probably also Syrinx, near the Caspian Sea. The Dahæ, frequently mentioned for their skill in riding and shooting, occupied the eastern part of the province; the Mardi the western.

8 ARIA,* the most important of the eastern provinces, lay to the E. of Parthia, bounded on the N. by Sariphi Montes, which separated it from Margiana; on the E. by the district of Paropamisadæ; and on the S. by Drangiana. It corresponds with the southern part of *Khorassan*. It is intersected in the N. by ridges of the Sariphi Montes, and in the centre by M. Bagous, *Ghoor*, the western limb of Paropamisus. Its fertility was very great, and it was especially famous for its wine. The only river, the Arius, *Herat* or *Herirood*, rises in Paropamisus, and flowing towards the north-west, by *Herat*, loses itself in the sands. The towns were—Artacoana, or Alexandria Ariana, *Herat*, on the Arius, founded by Alexander in his march through Aria, on the site of the older capital: and Susia, on the borders of Parthia, the ruins of which are visible to the north of *Mushed*.

9 DRANGIANA, to the south of Aria, did not form a separate province under the Persians, but was first distinguished as such by Alexander. It was contiguous to Gedrosia on the S., Arachosia on the E., and Parthia and Carmania on the W., and corresponds with *Seistan*. The rivers of this province are—the Etymandrus, *Helmund*, which rises in the Indian Caucasus, and flows towards the south-west, discharging itself into the Lake Aria, *Zurrah;* and the Pharnacotis, *Furrah-Rood*, which comes from the borders of Aria, and flows into the same lake. The northern district was named Anabon, with the towns Phra, Bigis, and Gari, on the sites of the modern *Ferrah*, *Beest*, and *Ghore*. In the south-east lived the Ariaspæ, or Euergetæ—i. e., *Benefactors*, so called because they rescued the army of Cyrus from death by starvation. They were for that service presented with their freedom. The towns of Drangiana were—Prophthasia, to the north of the Lake Aria; and Ariaspe, on the Etymandrus: the site of the former is probably at *Peshawarun*, to the north of the *Lake of Zurrah*.

10 GEDROSIA, now *Beeloochistan*, lay southward of Drangiana to the Persian Gulf, and occupied the interval between Carmania and the Indus. The north is generally fertile, but along the coast stretches an arid wilderness, in which the armies of Semiramis and Cyrus perished, and where Alexander's host, on their return from India, narrowly escaped the same fate. There are numerous mountain-chains in the interior, mostly running in a direction

* The eastern provinces of Persia were occasionally comprised under the common appellation, ARIANA, a name derived from one of the provinces, Aria, and still existing in the modern *Iran;* the geographical use of that term has, however, led to great confusion, partly from the interchange of the terms Aria and Ariana, which are both applied to the province—partly from the undefined limits of Ariana, which is sometimes extended over Parthia and Media, as well as over the eastern provinces.

parallel to the sea, down which the torrents pour in winter, and supply the wells, on which the natives depend. The cultivated grounds abound with palms and aromatic herbs. Altogether, this province is not so desolate or impassable as Arrian's account would lead us to think. The rivers are mere mountain-torrents, swollen in winter and dry in summer: the most important are, the Arabis, *Poorally*, and the Tomĕrus, *Bhusool*. The towns were—Ora, near the sea-coast, probably the same town as Rambacia, *Hoormara*, whither Alexander sent a colony: the inhabitants of the neighbourhood were of Hindoo extraction; Omana, a harbour in the west; and Pura, the capital in the interior, perhaps *Bunpoor*.

11 ARACHOSIA lay to the north of Gedrosia, between the rivers Etymandrus and Indus; on the north it was bounded by the ranges of Paropamisus. This mountainous and fertile province corresponds with *Candahar*, the north of *Beeloochistan*, and the south of *Cabul*. The chief range was known as the Parўeti Montes, *Soliman*, a southerly offset of Paropamisus. The river Arachōtus, which, according to Ptolemy, flowed into the Indus, is either the *Lora*, which flows westward and loses itself in the sand, or the *Urghundab*, a tributary of the *Helmund*. The town Arachotus is of uncertain position; by some, the ruins of *Gholani-shah*, in the south, are identified with it. The more modern town of Alexandria, founded by Alexander, is very probably *Candahar*.

12 The PAROPAMISADÆ, the inhabitants of the mountain ranges of the Paropamisus, *Hindoo Coosh*, and of the modern province of *Cabul*, occupied the border land of Persia towards India. Alexander crossed this district twice in his eastern expedition: it is intersected in every direction with mountains, which are capped with snow for the greater part of the year, and contain beautiful and fertile valleys. The rivers flow eastward to the Indus—namely, the Cophen, or Cophes, the *Cabul*, with its tributary the *Pendshir*, and the Choas, *Kameh*, a northern tributary of the *Cabul*. The tribes were numerous: the Cabolitæ lived in the north, and have bequeathed their name to the district: their chief town was Ortospana, or Carura, probably *Cabul*, at the point where passes from the north, south, and east met. Alexandria ad Caucasum, founded by the emperor, was situated at the foot of Paropamisus, to the north of Ortospana, perhaps at *Ghorbund*, or *Bamean*. Gauzaca is probably the modern *Ghuznee*.

13 BACTRIA, or Bactriana, *Balk* was bounded by the Oxus on the N. and E., by Paropamisus on the S., and by the desert of Margiana on the W. It is, on the whole, a mountainous district, but contains some very fertile steppes and valleys, the former of which afforded pasture for a fine breed of horses, while the latter produced all sorts of grain and rice. The Oxus with its tributaries, the Bactrus or Dargidus, *Dehas*, and the Artamis water it. The towns were—Bactra, *Balkh*, on the Bactrus; Zariaspe, to the westward, but of uncertain position; Aornus, near Bactra, with a strong fortress; and Drepsa, or Adrapsa, to the south of the province, probably *Indorab*. Another Alexandria was built on the northern side of Paropamisus, near *Khooloom*.

14 SOGDIANA, to the north of Bactria, was bounded by the Oxus on the S. and W.; the Iaxartes, *Sihoun*, on the N.; and the Comedarum Montes on the E.: it corresponds with part of *Independent Tartary* and *Bokhara;* some portion is yet called *Sogd*. This province consists of extensive steppes in the W., rising gradually towards the high mountain-chains of Central Asia. The rivers were—the Oxus, *Jihoon*, already noticed, and the Iaxartes, *Sihoon* or *Sirr:* the latter formed the extreme northern limit of Alexander's expedition. The towns were—Maracanda, *Samarkand*, in the fertile valley of the Polytimetus, *Sogd* or *Kohik*, the capital: Cyreshata or Cyropolis, to the north-east, on a tributary of the Iaxartes; it was built by Cyrus, and destroyed by Alexander: Alexandria Ultima, on the Iaxartes, probably near the modern *Khojend*, founded by Alexander as a border-fortress: Alexandria Oxiana, probably near the modern *Kurshee:* Tribactra, north of the Oxiana

Palus, perhaps near *Bokhara:* and Bagoe, in the north-west, on the border of the desert.

15 MARGIANA lay to the south-west of Sogdiana, between Hyrcania on the W., Aria on the S., from which it was separated by the Sariphi Montes, and Chorasmia on the N.: it corresponds with the northern part of *Khorassan:* it is for the most part a sandy waste, interspersed with oases, which now afford herbage for the flocks of the wandering hordes of Turcomans. The river Margus, *Moorghab*, rises in the Sariphi Montes, and flows towards the north-west; formerly it united with the Ochus, and afterwards with the Oxus: at the present day it loses itself in the sands. We read also of a river Ochus in this province: it may be the *Tejend*, but the name is applied to so many streams, being apparently an appellative for 'river,' that it is impossible to identify it with any degree of accuracy. The towns were—Antiochia Margiana, *Meru*, founded by Antiochus Soter, near the banks of the Margus, on the site of a deserted town, Alexandria; and Misæa, probably in the north-west, on the border of Hyrcania.

16 Having thus described the various provinces which made up the country Persis, it remains for us to define the limits of the Persian kingdom, and of the various sovereignties into which it was subsequently broken up. The establishment of the Persian empire dates from the conquests of Cyrus, B.C. 558—529. He subdued Media, Babylonia, (with its dependencies, Syria, Palestine, and Phœnicia,) Assyria, Asia Minor, and the whole of Persia to the Oxus northward, and the Indus eastward. His successor, Cambyses, 529—521, added Egypt, Lybia, and Cyrene. Darius, 521—485, though unsuccessful against the Scythians, enlarged his dominions towards the west, by gaining possession of Macedonia, and towards the east, by an expedition against the tribes on the banks of the Indus and its tributaries. The commencement of the fifth century may be deemed the culminating period of the Persian empire. Though it began speedily to retrograde towards the commencement of the fourth century, yet the body of the empire held together until the conquests of Alexander, who added its vast dominions to the Macedonian empire, B.C. 330. After Alexander's death, Persia formed part of the Syrian empire, under the Seleucidæ: this dynasty had but a weak hold over the subordinate governors of the distant provinces: and hence arose in the north-eastern part of Persia two powerful independent kingdoms, Parthia and Bactria, which deserve particular notice.

17 The kingdom of Parthia, under the Arsacidæ, was established B.C. 250, and lasted until A. D. 226. It reached its greatest extent under Arsaces VI., circ. 160 B.C., who extended his conquests westward to the Euphrates, eastward to the Indus, and northward to the confines of China. The capital of this empire was Ctesiphon, on the Tigris.

The kingdom of Bactria rose at the same time as the Parthian, but did not exist longer than about one hundred and thirty years, from B.C. 250 to B.C. 126, when it was incorporated with Parthia. We know little of the history of this kingdom: its rulers appear to have extended their sway over North India, Malabar, and as far as the confines of China.

18 The old Persian kingdom was restored, A. D. 226, by Artaxerxes, the first of the Sassanides, who incorporated Parthia and all the ancient provinces of Persia, between the Indus, Oxus, Euphrates, and the Persian Gulf, into an empire, which existed with various fortunes into the Middle Ages.

VII. *Sarmatia Asiatica.*

The countries that lie in the northern and eastern regions of Asia, beyond the Caucasus and the Iaxartes in the former direction, and beyond the Indus in the latter, were little known to the geographers of Greece and Rome. A very brief account of them will therefore suffice. The district immediately north of the Caucasus, bounded on the west by the Tanais, *Don*, and on the east by the Rha, *Volga*, was entitled Sarmatia Asiatica. The eastern ranges of M. Caucasus, which penetrate to the northern extremity of the Caspian Sea, were called the Ceraunii Montes; a low range between the *Don* and *Volga*, the Hippici Montes; and the western range of the Caucasus, near the Cimmerian Bosphorus, was distinguished as Coraxicus. The general course of the *Volga*, with its tributary, the *Kama*, is described with tolerable accuracy by Ptolemy. The *Don* was also well known, and one of its tributaries in Sarmatia, the Achardeus, *Manytch*, is mentioned: some of the lesser rivers also, as the Anticītes, *Kuban*, also called Vardanus; the greater and less Rhombites, the *Ieia*, and the *Beisu*, flowing into the Euxine; and the Udon, *Kouma*, and Alonta, *Terek*, flowing into the Caspian.

Sauromatæ or Sarmatæ is the generic name for the people inhabiting this vast district: of the numerous tribes, whose names are recorded, we will only mention the Sindi, who occupied the angle formed by the Palus Mæotis and the Euxine; the Bosporāni, about the Cimmerian Bosphorus, who subdued the Sindi, and established a kingdom of much importance; the Achæi, on the shore of the Euxine, reputed to be the descendants of some Achæan settlers, who came here after the Trojan war; the Siraceni, or Siraci, near the eastern extremity of the Euxine; the Aorsi or Adorsi, on the northern coast of the Caspian and north of them the royal Sauromatæ. The Budīni and the Thyssagĕtæ of Herodotus would also fall within the limits of Sarmatia.

The towns were—Sinda, a Greek town, south of the Bosphorus; Phanagoria, a Milesian colony, on the Bosphorus, the chief emporium in these parts; Tanais, also a Milesian town, at the mouth of the Don, a place of considerable trade; and Uspe, the capital of the Siraci. Between the northern extremities of the Caspian; and Euxine, Ptolemy places Columnæ Alexandri. As Alexander did not enter these regions, it has been conjectured that the pillars may have been erected here by Sesostris.

VIII. *Scythia, Serica, Sinæ.*

1 The remainder of northern Asia received the undefined appellation Scythia, which Ptolemy divides into two parts, Scythia intra and Scythia extra Imaum—i. e., to the W. and E. of Imaus. In the W. the Rha separated it from Sarmatia; in the S. the Iaxartes from Sogdiāna, and the Emōdus from India: towards the N. and E. its boundaries were undefined: in the latter direction it was contiguous to Serica. The Hyperborei Montes which formed the western barrier of Scythia correspond with the *Ural Mountains:* the northern ridges were called Alani Montes, the southern Rhymnĭci, E. of the Volga, containing the sources of the Rhymnus, *Gasuri,* which flows into the Caspian eastward of the Volga: the Norossus was another limb of the same range, containing the sources of the river Daix, *Ural,* which also joins the Caspian. The Aspisii Montes, the waters from which flow into the Iaxartes, correspond with the *Tchingis Mountains*: the Tapūri range lay to the eastward of the Caspian: Ms. Anarœi formed the connecting link between the *Ural* and *Altai* ranges, the Annibi and Auxacii of the ancients. Besides the Rhymnus and Daix we read of a river Paropamisus, probably the *Obi.*

The tribes of Scythia were distinguished in Herodotus's time into three classes—the royal, the agricultural, and the nomad—a distinction which, however, applies more properly to the European than the Asiatic Scythians; for Herodotus (it must be observed) extends Scythia over what is more generally called Sarmatia. The most important races in western Scythia were—the Aorsi, who occupied the country eastward as well as westward of the Rha, and the Massagĕtæ, a powerful tribe, occupying a great portion of *Independent Tartary, Khiva,* and the steppes of *Kirghiz,* southwards to the Iaxartes. They probably derived their name from the river *Mias,* which has its rise in the Ural Mountains. To the E. of these were—the Sacæ in the steppes of the *Kirghiz Khasaks* to the west of the great desert of *Gobi:* the great route to Serica lay through their country, where we may place the Turres Lapideæ or Hormeterium of Ptolemy, a fortified caravanseray, supposed to be situated in the pass called *Chalsatan:* the Thyssagetæ and the Iyrcæ, the progenitors of the modern Turks, lived about the upper courses of the *Volga* and the *Kama:* N. of these the Argippæi, also called by Herodotus Phalacri or Bald-heads, the progenitors of the *Kalmucks;* the name Argippæi denotes the use of white horses by this tribe—a peculiarity yet existing among some of the Siberian tribes: in the north were the Arimaspi, the inhabitants of the Ural range, whose occupation consisted in working the gold mines of that region. In Scythia extra Imaum, we hear of the Auzacitæ with a town Auzacia; S. of these, the extensive tribe of the Issedŏnes in *Thibet:* and the land of Casia to the westward under Imaus. In the extreme N. amid the ridges of *Altai,* dwelt the Abii and the Hippophăgi Scythæ.

2 Serĭca corresponds with *Mongolia,* and the north-western parts of *China.* It was intersected by the Asmiræi Montes, the *Siolki Mountains.* The rivers known to the ancients were the Œchardes, perhaps the *Amour,* and the Bautes, the *Hoang-ho.*

This country was celebrated for the manufacture of silk, which was carried overland through Scythia and Parthia to Rome and the western parts of Europe. The capital, Sera, was situated in the N.W. of China, perhaps near *Singan* or *Honan.* Other towns are mentioned of uncertain position, as Issedon Serica, Asmiræa, &c.

3 The Sinæ dwelt to the S. of Serica in *Cochin-China, Camboja,* and the southern parts of *China.* Ptolemy, who describes this country, does not assign the ocean as the eastern boundary, imagining that tho continent might stretch out farther. To the W. it was contiguous to India extra Gangem, from which it was separated by the Magnus Sinus, *Gulf of Siam,* the river Aspithra, *Bangpassæ,* and more to the north by the Semanthini Montes. The other rivers mentioned by Ptolemy are the Ambastus, *Camboja,* the Senus, and the Cottiaris, probably the river of *Canton.* The only towns known were Thinæ, perhaps *Nanking,* and Cattigara, *Canton.*

IX. *India.*

India was bounded on the N. by the chains of Paropamisus, Imaus, and Emodus; on the W. by the Indus; on the E. by the Aspithra and the Magnus Sinus; and on the S. by the Indian Ocean. It was divided by Ptolemy into two portions, India intra Gangem, corresponding to *Hindostan,* and India extra Gangem, the *Birman Empire,* part of *Siam,* and the *Malay peninsula.* The ancients were unacquainted with the direction of the coast between the Indus and Ganges: Herodotus describes the Indus as flowing to the E., and beyond it a desert; Eratosthenes gives the Indus its true direction, and carries us to the Ganges, but omits all notice of the peninsula of Hindostan, and places Taprobane, *Ceylon,* beyond the Ganges; Strabo falls into error in making the Ganges flow into the eastern Ocean; he rightly places Taprobane between the Indus and Ganges, but makes Coliacum, *C. Comorin,* the most eastern point of the world; Ptolemy lastly, who was acquainted with the form of the Malay peninsula, gives a very slight protrusion to Hindostan, and assigns an undue size to *Ceylon.* They were, nevertheless, well acquainted with the general features of the country; they gave distinct names to the various ranges into which the great Himalaya range breaks up to the N. of the Birman Empire—the Semanthini Montes, the Damassi, and the Bepyrrus; the western *Ghauts* in Hindostan were called M. Bittigo; the *Sautpura,* Sardonix; the M. Vindius, to the N. of the last mentioned, retains its name, the *Vindhy Mountains.* The promontories are also noticed—viz., Prom. Magnum, *C. Romania,* Malæi Colon, *Junk-Ceylon.* Cory, or Coliacum, opposite to Ceylon; and Comaria, *Comorin.*

The rivers were also known; but it is difficult for us to identify them with any great certainty. In the E., the Serus is probably the *Meinam,* the Dorias the *Thalcain,* and the Doanas the *Irawaddy.* The Dyardanes is the *Brahmaputra;* the Ganges and the Indus retain their ancient names;

the affluents of the Indus are described in the account of Alexander's campaign; viz. the Acesines, *Khenab;* the Hydaspes, *Jelum;* the Hydraötes, *Ravee;* the Hypanis, or Hyphasis, *Gharra;* the Hesidrus, *Sutlege;* and the chief tributary from the W., viz., the Cophes, *Cabul,* with its tributaries, the Choaspes, or Evaspla, or Coes, *Kameh,* and the Guræus, or Suastus, the *Punjkora,* a branch of the *Lundee,* or perhaps the *Lundee* itself.

India does not take any prominence in the political geography of the ancient world. Alexander the Great gained a temporary supremacy for himself over the inhabitants of the Punjaub; Seleucus penetrated to the Ganges, and succeeded in forming alliances with the independent kings, and in establishing an embassy at Palimbothra. The Bactrian kings extended their dominion over the western provinces, which, after the overthrow of their power, were divided between the Parthians and the Scythians.

The towns and places worthy of notice are—Perimūla, *Malacca;* Bessynga, *Pegu,* with the Golden region to the north: Gange, at the mouth of the Ganges; Pandionis Regnum, at the southern extremity of the peninsula of Hindostan; Comaria, *Comorin;* Ariaca, the central region from *Bombay* to *Hydrabad,* with its two capitals, Hippocura, *Hydrabad,* and Bætana, *Beder;* northward of Asiaca along the western coast, the district of Larice, with the towns Ozēne, *Ougein,* and Barygaza, *Baroche;* the district Pattalēne, about the mouths of the Indus, and the town Pattala, *Tatta;* in the Punjaub, Nagara, the same as the Nysa of Alexander's historians, *Nagar;* Peucela, *Pehkely,* on the Cophes; the district of the Gundaræ, between the Suastus and Indus; and Caspira, *Cashmir,* where we must place the town Caspatyrus, and the district Pactyica, mentioned by Herodotus. Taxila was not at *Attock,* but to the E. of it, in the district called Varsa.

Off the coast of India lie the following islands:—Taprobane, also called Simundu, and Salice, in which last we recognise the modern name *Ceylon;* Bonæ Fortunæ Insula, probably *Sumatra;* Jabadii, probably *Java;* Satyrorum Insulæ, the *Anamba* isles, off the eastern coast of the Malay peninsula; and Sindæ Insulæ, the *Nicobar Islands.*

CHAPTER IV.

I. SYRIA.—II. PHŒNICIA.—III. PALÆSTINA.—IV. ARABIA.

I. *Syria.*

SYRIA lay between the Euphrates on the E., and the Mediterranean Sea on the W.; towards the N., M. Amanus separated it from Cilicia; and towards the S. an arbitrary line through the desert separated it from Arabia. In its western parts it is mountainous, offsets from Amanus traversing it in a southerly direction to the borders of Palestine. The most important of these ridges are — M. Pieria, immediately to the S. of Amanus; M. Casius to the S. W. of Antioch, and in the S. the ranges of Libănus, *Lebanon,* and Antilibanus, *Djebel-esh-shurky.* M. Libanus runs parallel to the Mediterranean Sea, leaving a narrow interval of coast land: its summits are covered with perpetual snow, while forests of cedar-trees clothe its upper regions, and vineyards its base. Antilibanus commences more to the S. with M. Hermon, *Djebel-es-scheikh,* but does not run so far N.; its course is parallel to Libanus; the two ranges enclose a valley, about six miles broad, which was called Cœle-Syria—a name which was afterwards extended to the whole surrounding district. The eastern, and by far the most extensive portion of Syria, consists of an unbroken plain, which leaves the right bank of the Euphrates near Thapsacus, and thence extends into the neighbourhood of Damascus. The chief rivers are—the Orontes, *Asy,* which rises in Antilibanus, near Heliopolis, and flows in a northerly course until it reaches the vicinity of Antioch, where it bends round to the S. W., and reaches in that direction the Mediterranean; the Chalus, river of *Aleppo*, a small stream in the N. of the country, flowing by Berœa and Chalcis into a lake; the Singas, *Sensja*, and Daradax, tributaries of the Euphrates; the latter is taken to be either the *Sajur*, or an artificial canal near the ruins of *Ba'lis.*

Syria was divided into two districts, Upper and Lower; the latter was also called hollow or Cœle-Syria, being the region enclosed by the arms of Libanus and Antilibanus. Upper Syria was subdivided by the Romans into ten provinces: Commagēne in the N.; below it, Cyrrhestīce; Pieria, on the Bay of Issus; Seleucis about Antioch; Chalybonītis, eastward to the Euphrates; Chalcidīce, bordering on the desert; Apamēne, eastward from Apame; Cassiotis, between this and the sea; Palmyrēne, the desert region about Palmȳra, and Laodicene to the westward. The important towns were—Samosāta, *Someisat*, in Commagene, on the right bank of the Euphrates, the ordinary point of transit from the N. to Mesopotamia; Hierapŏlis, in Cyrrhestica, ruins at *Bambuch*, on the river Sangas, the capital of the N. in Constantine's time; it derived its name from the worship of Dereeto; Myriandrus, a sea-port town, originally colonized by the Phœnicians, on the Bay of Issus; it was afterwards called Alexandria ad Issum, and is now represented by *Iskenderun:* Seleucia, in Pieria, a very strong fortress built by Seleucus, situated on a rock, and accessible only on the side of the sea; it offered a stubborn resistance to Tigranes: Thapsăcus, the Tiphsah of Scripture, on the Euphrates, *el Deir*, the place where in early times travellers crossed this river for Babylon; Palmȳra, *Tadmor*, in the desert, about midway between the Euphrates and the sea; it was in existence in the days of Solomon, and in the first century of our era was the capital of a small independent state, between the Roman and Parthian empires: in the third century, Zenobia beautified it with the splendid buildings, the ruins of which yet exist; it fell about the end of that century by the Romans: Laodicēa Scabiosa, to the north of Antilibanus, built by Seleucus Nicator; Apamēa, the capital of Apamene, near the Orontes, built by Seleucus, and named after his wife, Apama; the town was surrounded on all sides but one by a lake formed by the small stream Axius; the ruins of it are supposed to be at *Kulat-el-Medyk;* the pasture lands about it supported an admirable breed of horses: Emĕsa, *Hums*, celebrated for the temple of the Sun, in which Heliogabalus ministered as priest; Antiochia, *Antakia*, on the banks of the Orontes—the splendid capital of the kingdom, built by Seleucus Nicator, and enlarged by his successors, Callinicus, and Antiochus Epiphanes; it was often partially destroyed by earthquakes, but as often restored; and it became the Proconsular residence under the Romans: lastly Laodicēa, *Ladikiyeh*, on the sea-coast, to the S. of Antioch, in Strabo's time one of the four great cities of Syria; it was built by Seleucus Nicator, on a tongue of land, and thus easily fortified; in addition to this, it enjoyed the advantage of an excellent harbour.

In Cœle-Syria, there were two celebrated cities, Damascus and Heliopolis. Damascus, which retains its ancient name, the ancient capital of Syria, was situated in a beautiful plain on the banks of the stream Chrysorrhoas, or Bardines, *Barada*, which divided into five channels before entering the town, and afterwards reuniting, discharged itself into a lake. One of the five branches, now called *Baneas*, is thought to correspond with the Abana of Scripture, while a small tributary of the Barada, the *Fidsheh*, answers to the Pharpar. Damascus sunk under the Syrian dynasty, but revived when Diocletian established a manufactory of arms there. Heliopolis, the Greek rendering of the native name *Baalbek*, lay between the ridges of Libanus and Antilibanus. It was celebrated for the magnificent temple of Jupiter, erected by Antoninus Pius. The cyclopian remains of the temple of the Sun, as well as the extensive ruins of Antonine's temple, are yet objects of wonder and admiration.

2 The kingdom of Syria extended far beyond the border of the province

of that name under the government of Alexander's successors. Before that time, it had not taken any position in history as an independent nation; when we first hear of it in sacred history, it seems to have been parcelled out into a number of small principalities; subsequently it became a portion of the Assyrian, Babylonian, Persian, and Macedonian empires. After the death of Alexander, and the dismemberment of his kingdom, Seleucus Nicator succeeded in establishing a dominion over all the Asiatic provinces. He fixed his capital in the first instance at Seleucia on the Tigris, but after the battle of Ipsus, transferred it to Antioch in Syria. His dominions extended from the western border of Phrygia in Asia Minor to the Indus eastward, and from the Iaxartes northward, to the Persian Gulf and the confines of Egypt. No sooner, however, was the kingdom established, than the work of decay began. Independent monarchies were gradually set up in Asia Minor; Parthia and Bactria seceded; Phœnicia and Palestine fell into the hands of the Egyptians; Antiochus the Great (223—187) for a while restored the fame and power of his family; but in about sixty years after his death, the dominion of his successors was confined to Syria and Phœnicia. In the year 64 B.C., Syria was added to the Roman empire.

II. *Phœnicia.*

Phœnicia was a narrow strip of coast land, shut off from Syria by the range of M. Libanus, extending northwards to Aradus, and southwards to M. Carmel, and in the Roman era lower still, to Cæsarea. The only mountain range is Libanus, which projects into the sea in the promontories of Theuprosōpon in the N., and Album, *White Cape*, in the S.

The towns in Phœnicia were: Aradus, (in Scripture Arvad,) *Ruad*, on an island about two and a half miles from the mainland; under the Seleucidæ it attained the rank of third city in Syria: Tripŏlis, *Tripoli*, on a spur of Libanus, with a good harbour; it consisted (as the name implies) of three separate towns, representatives of the three great cities of Tyre, Sidon, and Aradus: Byblos, *Jebeil*, the Gebal of Scripture, whence the 'stonesquarers,' the Giblites (1 Kings, v. 18, compare margin), came for the erection of Solomon's temple, a short distance from the sea, celebrated for the worship of Adonis: Berȳtus, Berothah in Scripture, *Beirut*, an ancient sea-port town, which, having been destroyed B.C. 140, was afterwards restored under Augustus, and made a Roman colony: it was much embellished by King Agrippa: Sidon, *Saida*, the oldest and after Tyre the most celebrated Phœnician town; it was situated on a narrow plain, with a good harbour and strong fortifications; it was dismantled and sacked by Artaxerxes Ochus, and never afterwards regained its original prosperity: Tyrus, *Sur*, probably a colony of Sidon, the celebrated capital of Phœnicia; it was originally built on the mainland, but after the siege it sustained by Nebuchadnezzar, it was removed to a small island, less than half-a-mile distant from the shore, and so confined that the inhabitants were obliged to build out on dams and piles: Alexander conquered it after a seven months' siege, B.C. 332, by running out a mole from the mainland: Ptolemāis, *Acre*, formerly Aca, the Accho of Scripture, which rose into notice after the decay of Tyre; it became a Roman colony under the Emperor Claudius.

III. *Palæstina.*

The name Palæstina, *Palestine*, is derived from Philistia — the land of the Philistines—and was never applied by Hebrew writers to anything beyond the maritime district occupied by that people. In the patriarchal era, it was usually called the 'Land of Canaan;' during the period of Jewish independency, the 'Land of Israel;' and lastly, after its subjection to the Romans 'Judæa,' being an extended use of the name originally attached to the southern district. Palestine was bounded on the W. by the Mediterranean (described in Scripture as the Great Sea) from its southern angle to M. Carmel, and thenceforward by Phœnicia; on the N. by the ranges of Libanus and Antilibanus; on the E. by an arbitrary line on the side of the Syrian desert, which in the north protruded so far as to include M. Alsadamus, *Hauran*, and the districts of Trachonitis and Decapolis, and then receded westward to the edge of the hilly country, which it followed to the course of the Arnon and the Dead Sea; and on the S. by an undefined boundary, which ran S. of Beersheba, separating it from the desert of Edom, *el Tih*.

Palestine is decidedly mountainous: the ranges of Libanus and Antilibanus, entering from the north, traverse its whole length in a series of parallel heights, divided by the river Jordan, and finally decline towards the deserts of Arabia and Syria. The chain is interrupted in the western district by the valley of Jezreel, and in the eastern by the high plain that extends eastward from the Sea of Galilee. The most prominent elevations are—M. Tabor, *Tur*, S.W. of the sea just mentioned; M. Carmēlus, *Carmel*, a long ridge running out towards the N.W. into the Mediterranean, and forming the only promontory on the coast of Palestine; M. Ephraim, passing down the centre of the province of Samaria, with the twin heights of Ebal and Gerizim, on the latter of which the temple of the Samaritans stood; M. Juda, the hill country of Judæa between the Dead Sea and the Mediterranean; Abarim Montes on the opposite of the Dead Sea, with the points Peor, Nebo, and Pisgah; M. Gilead, *Jelad*, eastward of Jordan, and south of the Jabbok; M. Hermon, *el Scheikh*, the highest point of Anti-libanus, generally capped with snow, extending southwards in a long ridge, now called *el Heisch*, towards the eastern shore of the Sea of Galilee; and, lastly, M. Alsadamus, *Hauran*, a group of isolated heights on the border of the Syrian desert.

The hills enumerated rise out of a high *plateau*, which is unequally divided into halves by the valley of Jordan: the western declines gradually towards the Mediterranean, leaving a fertile plain along the coast; the eastern similarly falls off towards the Desert; both descend sharply towards the Jordan, at some distance, however, from its banks, thus leaving a distinctly marked plain, varying from six to twelve miles in width along its midcourse. This plain, now called *el Ghoor*, lies at a remarkable depression below the level of the sea, varying from 300 feet at the Sea of Galilee to 1300 at the Dead Sea: it is consequently subject to intense heat, is devoid of springs, and unfit for cultivation. The Jordan, which traverses it, rises in the high ridges of Antilibanus: after a course of fifteen miles it enters the Lake of Merom, *el Huleh*, which, in the summer months, is a mere swamp, but becomes a considerable sheet in the spring: then after a short interval, the lake which was called indifferently after Gennesareth, Galilee, or the town of Tiberias, from which last it derives its modern name, *Bahr el Taberieh*. This lake is supposed to lie in the crater of an extinct volcano; it is fourteen miles long by six in breadth, and surrounded by hills, which rise precipitously on its eastern shore, but on the western, slope gradually down and admit of cultivation: it is described as still abounding in fish, and like all mountain lakes, liable to sudden gusts. The Jordan emerges at the south-western angle, receives on its left bank the Hieromiax, *Scheriat el Mandhur*, and the Jabbok, *Zurka*, and discharges itself into the Dead Sea. This remarkable lake was called, by the Hebrews, the Salt or East Sea, and by geographers, Lacus Asphaltites, or Mare Mortuum: its modern name is *Bahr Lut*—i. e., Lot's Lake. At its northern extremity, a sandy plain surrounds the mouth of the Jordan; at the southern, a rocky valley opens towards the western arm of the Red Sea. In all other parts it is surrounded with high, barren rocks, separated here and there by steep gullies. The waters are remarkably heavy and bitter, and the shores are covered with scoriæ and incrustations of salt and asphaltum: its length is about fifty miles, its average breadth may be about twelve: it occupies the site of the once fertile valley of Siddim, in which stood the cities of Sodom and Gomorrah. Besides the Jordan, the Arnon, *Wady Mojib*, and the Kidron, *Wady el Rahib*, discharge themselves into it, the former on the eastern, the latter on the western shore. The only other river of importance in Palestine is the Kishon, *Mukutta*, which rises in M. Gilboa, and traverses the rich valley of Esdraelon towards the N.W., discharging itself into the Mediterranean, just north of Carmel. The face of the country is further broken by numerous small valleys, some of which were watered by perennial streams, others by mountain torrents, which dried up in summer, while others were little else than ravines or gullies. The Hebrew language expressed these distinctions by appropriate terms.

All ancient writers agree in assigning to the soil of Palestine remarkable fertility, which was further increased by the most careful cultivation. The valley of Esdraelon, or Jezreel, along the Kishon, and the maritime plain of Sharon, extending from Cæsarea to Joppa, are much extolled for their productiveness; the sides of Carmel and the wide open country of *Hauran* (the ancient Bashan) afforded excellent pasturage; the high land of the interior yielded a good return to the husbandman, and the sides of the hills were clothed with the vine and the olive; wood for building and fuel was obtained from the tops of Carmel and Tabor, from M. Ephraim in Samaria, from the forest of Hareth in Judæa, and from the hill of Gilead in Peræa. The variations of temperature, corresponding with the different altitudes of localities, conduced further to increase the number of its productions.

The early historical notices of Palestine represent it in the possession of various tribes of the Canaanitish family, living independently of each other, and subsisting upon their flocks and herds. These were for the most part ejected by the Jewish nation, under Joshua, B.C. 1451, who divided the land between their twelve tribes—Reuben, Gad, and the half-tribe of Manasseh occupying the district east of Jordan. The division of the kingdoms under Jeroboam, B.C. 976, led to a further distinction, the two tribes of Judah and Benjamin forming the kingdom of Judah, and the remaining ten tribes the kingdom of Israel. The captivity of the latter, B.C. 721, was followed by the introduction of a mixed population in the northern and central districts. From the capture of Jerusalem, B.C. 599, Palestine formed a portion of the Babylonian and afterwards of the Persian empire. It was incorporated along with the latter in the vast empire founded by Alexander the Great, B.C. 332; after his death it was apportioned to the Syrian kingdom, but for a long period was under the actual power of the Egyptian Ptolemies: it returned to Syria, B.C. 205; separated from it under the Maccabees; and maintained its independency, until intestine divisions led to the interference of the Romans, who obtained a supremacy over it, B.C. 63, and at last annexed it, A.D. 7, to the province of Syria. At the time of our Saviour's appearance upon earth, Palestine, west of the Jordan, was divided into three districts—Galilee in the N. southwards to the river Kishon; Samaria in the centre, with the exception of the sea coast; and Judæa, which held the sea-coast from above Cæsarea together with all that lay south of Samaria. The remaining portion of Palestine was sometimes called Peræa—i. e., the land *across* the Jordan: it was subdivided into numerous districts—viz., Peræa, in its limited sense, from the Arnon to the Jabbok: Decapolis, about the Hieromiax, where a confederacy of ten towns existed, one of which, Scythopolis, lay westward and the rest eastward of the Jordan: Batanæa, part of the old kingdom of Bashan, bordering on the desert from the Jabbok to the *Hauran* range: Auranitis, the plain of *Hauran*, westward of that range: Trachonitis, north of the latter, on the border of the Syrian Desert: Ituræa (the Jetur of the Old Testament), in the north-eastern angle, not far from Damascus; and Gaulonitis, the mountainous region of Hermon. In the later division of the Roman empire, Palestine formed three provinces—Palæstina Prima, comprising Samaria and the northern half of Judæa; P. Secunda, Galilee and northern Peræa; P. Tertia, the southern parts of Peræa and Judæa.

The metropolis of Palestine was the holy city of Jerusalem—the ancient Jebus, and probably the Cadytis of Herodotus—in the tribe of Benjamin and the north of Judæa. It was situated on an elevated platform, and surrounded by yet higher hills, from which it was separated by deep ravines on all sides except the north. The platform sloped somewhat towards the east, and contained three eminences—Zion at the southern extremity, on which the ancient city of David, and in later times the palace of Herod stood; Moriah, towards the east, the site of Solomon's Temple; and Acra, in the north, on which Antiochus Epiphanes erected his citadel, and afterwards the Romans their fort of Antonia. Zion was the highest, and hence that part of the town was called the *upper* city—the *lower* was situated on Acra. In the time of the Herods a new quarter was added on the north side, named Bezetha, which Herod Agrippa surrounded with fortifications. The brook Cedron flowed in the valley below the Temple, and on the opposite side rose the Mount of Olives; a tributary stream, the Gihon, followed the base of Zion, on the west and south. Jerusalem was destroyed by Titus, A.D. 70, and restored by Hadrian, B.C, 126, with the name Ælia Capitolina.

The other towns of importance in Palestine were; in Judæa—Gaza, *Ghuzzeh*, a fortified town on the southern frontier, about two and a half miles from the sea, which stood a long siege against Alexander: Joppa, *Jaffa*, on the sea coast, the port of Jerusalem, in the fertile plain of Sharon: higher up the coast, Cæsarea, *Kaisariyeh*, originally an unimportant place, with the name Stratonis Turris, but enlarged and made the chief port of Palestine by Herod the Great: Vespasian changed its name to Colonia Prima Flavia; it was the residence of the Roman governors, and afterwards the capital of Palæstina Prima: Hebron, in the hill country, westward of the Dead Sea: Bethlehem, the birthplace of our Saviour, about six miles south of Jerusalem: Jericho, *Riha*, north-east of Jerusalem, on a rich plain which extended to the Jordan. In Samaria—Sichem, called by the heathen writers Neapŏlis, whence its modern name *Nablous*, situated in the valley between Ebal and Gerizim; it was the holy town of the Samaritans, having their temple on the neighbouring hill: Samaria, the capital, strongly posted on a hill in the centre of the province; it was built by Omri, and twice destroyed, but as often restored; Herod the Great enlarged and fortified it, giving it, in compliment to Augustus, the name of Sebaste, which is still preserved in the modern name *Sebustieh:* Jezreel, *Zer'in*, the royal residence of Ahab, in the fertile plain of Esdraelon: Scythopolis, (Bethshan in the Old Testament,) *Beisan*, about six miles west of Jordan; it derived its Greek name from a settlement of Scythians—a remnant of the horde which overran Western Asia in the latter part of the seventh century, B.C. In Galilee—Nazareth, *Nasirah*, the residence of our Saviour's parents, midway between the Sea of Galilee and the Mediterranean: Sepphŏris, *Sefurieh*, northward, an unimportant place until Herod Antipas enlarged it, and named it Diocæsarea: Tiberias, *Tubariyeh*, about midway down the western shore of the Sea of Galilee, also built by Antipas, and named after Tiberius; it ranked as the capital of Galilee: Capernaum, *Tell-hum*, towards the northern extremity of the lake, the usual place of our Saviour's abode: Bethsaida, the birthplace of Andrew and Peter, a little south of Capernaum: it must not be confounded with the Bethsaida Julias at the head of the lake. In Peræa—Cæsarea Paneas or Philippi, near the source of the Jordan, enlarged by Philip the Tetrarch, and named after him: Gadăra, *Umm Keis*, south of the Hieromiax, the capital of Peræa in Josephus' time: Bostra, or Bozra, *Busrah*, south of the *Hauran* mountains, the ancient capital of the Edomites: Pella, opposite Scythopolis, the spot whither the Christians retired on the destruction of Jerusalem: Ramoth-Gilead, on the southern declivity of M. Gilead: Rabbath Ammon, *Amman*, to the south-east, also called Philadelphia, after Ptolemy Philadelphus; and Rabbath Moab, Ar of Moab, and later Areopolis, on the banks of the Arnon.

IV. *Arabia.*

Arabia was bounded in ancient as in modern times, on the W. by the Sinus Arabicus and the *Isthmus of Suez*, on the S. by the Mare Erythræum, on the E. by the Sinus Persicus, on the N.E. by the Euphrates, and on the

N. by Syria and Palestine, from which it was separated by no natural limit. The term Arabia is frequently used in a more extended sense, to signify all the lands which the nomad Arabians frequented; Herodotus thus includes all Syria, and Xenophon the lower parts of Mesopotamia, under Arabia. It was divided into three regions, Deserta, the sandy desert in the north; Petræa, about the head of the Red Sea, to the confines of Egypt and Palestine; and Felix, by far the largest portion, to the south. A line drawn across the peninsula about three degrees below the heads of the Persian and Red Seas, would indicate the limits of Arabia Felix towards the north. The names of the several districts represent their character; Petræa, the *rocky*, Felix, the *fruitful*, a title certainly misapplied as respects the south-eastern coast and a great part of the interior, and Deserta, the *desert*.

The inhabitants of these various districts differed much in pursuits and character. Those on the sea-coast prosecuted an extensive trade with India and Southern Africa, and exchanged the produce of these countries for European merchandize; they were a clever, enterprising, wealthy, and luxurious class. The tenants of the vast plains in the interior (the progenitors of the modern Bedouins) led a simple nomad life, dependent on their flocks and herds, and maintained a patriarchal form of government. The border tribes were given to predatory habits, and attacked the caravans of neighbouring nations; they thus gained a character for ferocity.

The mountain system of Arabia is easily described; the ranges of Northern Asia entering from the north by the course of the Mediterranean Sea, divide into two branches; the ridges of the western form the peninsula of Arabia Petræa, while the other, following the direction of the Red Sea, and increasing in extent as it goes southward, terminates at the junction of that sea with the Indian Ocean. The mountains of Arabia Petræa received the appellation Nigri Montes; they culminate in the celebrated heights of Sinai, *Djebel Musa*, and Horeb, *Djebel Horeb*, in the southern part of the peninsula; Horeb is the lowest of the two points, and lies to the east of Sinai. The southern range did not receive any specific name. In its middle course an extensive range strikes off into the desert, M. Zamĕtus, *Djebel Aared*, and crosses to the Persian Gulf. From the south-western point of Arabia a range takes a north-easterly direction along the shores of the Indian Ocean, a part of which, rising into terraces, was named Mount Climax.

The earliest accounts of the inhabitants of Arabia are derived from Scripture. In Arabia Petræa, which the children of Israel traversed in their journey from Egypt to Canaan, dwelt the Amalekites from the border of Egypt to Sinai southwards; and eastward of them, the Edomites, in Idumæa to the south of Palestine as far as the head of the Ælanitic Gulf of the Red Sea; they occupied the high ridges of Seir, a wild, rugged region, interspersed with sheltered and fruitful valleys. From various passages of Scripture (Gen. xxvii. 39; Numb. xx. 17; Mal. i. 3) we may infer that it was in earlier times much more cultivated than at present. The name of Idumæa disappears from history in the first century of our era. The Themanites were a subdivision of the Edomites living eastward of Petra, in the neighbourhood of *Maan* S. of *Wadi Musa*. North of the Edomites, were the Moabites on the eastern shore of the Dead Sea, from the river Arnon southward to Zoar. Their chief town, Ar, or Rabbath Moab lay in the northern part of the district, the character of which, though mountainous, was eminently fertile. North of the Moabites, the Ammonites, between the rivers Jabbok and Arnon, with the town Rabbath Ammon, or Philadelphia. The Midianites were a populous tribe in the south of Arabia Petræa. Their original seats were to the west of Sinai, whence they removed eastward of the Ælanitic arm of the Red Sea. In the time of the Judges they were possessed of considerable wealth in flocks and merchandize. In later times the people inhabiting this district passed under the name of the Nabathæi (the Nabathites of the Maccabees)—i. e., the descendants of Nebaioth, son of Ishmael. Josephus represents them as occupying not only Arabia Petræa, but also Deserta to the banks of the Euphrates. Their permanent settlement seems, however, to have been near the Ælanitic Gulf, and about Petra, which was probably their capital town.

The towns mentioned in Scripture history in Arabia Petræa are, Elath, or Ælāna, a sea-port town at the head of the Ælanitic Gulf, whence Solomon's fleet set sail for Ophir; and more to the westward, Eziongeber, the same as the Berenīce of Josephus, also a sea-port. The capital of the country, Petra, is not mentioned in Scripture under that name, but is probably identical with Selah of 2 Kings, xiv. 7, (cf. margin,) and 'the rock' mentioned Judges, i. 36. It was situated midway between the Dead Sea and the Ælanitic Gulf, and was built on, or rather out of a rock, the habitations, temples, tombs, and other buildings, being hewn out of the solid stone. It was also surrounded by precipitous heights, and accessible only by a narrow pass on the east, which might be defended by one hundred men. It was important not more as a military than as a mercantile station, being the centre, in which the caravans from the coasts of the Persian Gulf, from the south of Arabia, from Egypt, and from Palestine and the north, met for the exchange of their commodities.

In Arabia Deserta, we read in the Old Testament only of the descendants of Kedar, who roamed over the wastes between the borders of Canaan and the Euphrates. In Classical Geography the tribes were called generally Scenītæ —i. e., dwellers in tents, with various specific names, among which the Saracēni, indicative of banditti habits, is the only one worthy of notice. It was applied by Ptolemy to a single tribe in the south of Arabia Deserta, and afterwards extended to all the predatory tribes.

The tribes of Arabia Felix are hardly known otherwise than by name. The Sabæi, indeed, are frequently mentioned, on account of the celebrated productions of their district—balsam and spices; they lived in the northern part of the modern *Yemen*, which corresponds with the Sheba of Scripture. Their chief towns were Sabæ in the interior, and Ocelis, or Acila, on the Straits of *Babel-mandeb*. In the early centuries of our era, the Homerītæ seem to have been the dominant tribe; their seats were in the extreme southern corner of Arabia, and their chief town was Arabia Felix, later Adăna, and now *Aden,* supposed by some to be the Eden mentioned Ezek. xxvii. 23: Adana has also been identified Ophir, whither Solomon's fleet went for gold; and, doubtless, this spot must be placed somewhere on the southern coast of Arabia, but whether at Adana or among the Omanitæ cannot be decided. The supposition that Ophir was merely an emporium of Indian wares, is an answer to all the objections against this locality which are founded upon the passages, 1 Kings ix. 28; x. 11, 22. The Chatramotītæ, an important tribe, lived to the eastward; their chief town, Sabotha, the great market for frankincense, probably stood on the site of *Mareb*. The Gerrhæi, on the shores of the Persian Gulf, were the great carriers of Arabia; they conveyed the merchandize of India and Southern Arabia northwards to Babylon and Thapsacus, and westward to Petra and the shores of the Mediterranean. Their chief town, Gerrha, may possibly be identical with *Katif*. The Gerrhenians, mentioned 2 Macc. xiii. 24, are not the inhabitants of this Gerrha, but of a town on the Mediterranean Sea, between Pelusium and Rhinocolura. Off the southern coast of Arabia, Dioscoridis Insula, *Socotra*, was tenanted by settlers of various countries for the sake of the valuable productions, cinnamon, &c., which were found upon it. In the Persian Gulf, Arădus and Tylus, the *Bahrein* Islands, were famous for pearls.

CHAPTER V.

I. EUROPE.—II. THRACIA.—III. MŒSIA.—IV. MACEDONIA.

I. *Europe.*

EUROPE has been recognised by ancient geographers as a continent distinct from Asia and Africa, ever since the division into continents was established. The *name*, as applied to the whole continent, does not appear in any writer before Herodotus. Homer uses it for the main-land of Northern Greece, as distinct from the Peloponnesus; and, perhaps, it may be derived from the 'broad view' (εὐρύς, ὤψ), which that part of the land presented to the inhabitants of the peninsula. The boundary of Europe to the eastward, where it is contiguous to Asia, was generally fixed at the Tanais, *Don;* in early times, however, at the Phasis, *Rion*, and by Herodotus, who included Northern Asia in Europe, at the Araxes, *Aras*. In all other directions it was believed to be limited by water—viz., by the Pontus Euxinus and the Propontis, on the east; by the Mare Magnum, or Internum, on the south; by the Oceanus Atlanticus on the west; and by the Oceanus Septentrionalis on the north.

The mountain chains of Europe preserve a similar direction to those of Asia, from east to west. From the narrow strait of the Thracian Bosphorus a line of lesser heights proceeds northwards to the lofty range of Hæmus, *Balkan*, which stretches from the shore of the Euxine westward, bounding the water-basin of the Danube; it is succeeded by the ranges Scomius, Orbelus, and Scordus, which last forms the connecting link with the chain of the Bebii Montes, in the neighbourhood of the Hadriatic Sea: the range then proceeds parallel to that sea towards the north-west, and is merged in the far more important and extensive chain of the Alpes, *Alps*, which sweep round from the Hadriatic to the Tuscan Sea, separating the Italian peninsula from the rest of Europe: farther westward we trace the same mountain system reappearing in the Pyrenæi Montes which separate Spain and Gaul, and traverse the former country to its western extremity.

From this series of mountains there proceed three most important offsets, (each of which becomes a secondary mountain system), forming the three peninsulas of Southern Europe. The first is emitted from the point of junction of Scordus and the Bebii Montes, and descends southwards between the Hadriatic and the Ægæan seas; it was known in Northern Greece under the names of Pindus, Tymphrestus, and Parnassus; and in Peloponnesus as Artemisius, Parthenius, Taygetus, &c. The second is the Apenninus Mons, *Apennines*, which, quitting the Alps at their western extremity, traverses the centre of the Italian peninsula. The third consists of the extensive ramifications of the *Pyrenees*, which form the high peninsula of Spain: these also take a southerly direction.

The knowledge of the ancients was, until a comparatively late period, bounded northwards by the central barrier of mountains just described. At the commencement of our era, France, Germany, and Britain had been just opened by the conquests of Cæsar: the countries north of the Hæmus, Mœsia and Dacia, were not colonized by the Romans until a later period: the vast districts eastward of the *Vistula*, (*Russia, Sweden, Norway, Denmark*, &c.,) which were included under the undefined title of Sarmatia Europæa, were almost utterly unknown.

The most important rivers of ancient Europe were, the Ister or Danubius, *Danube*, which rises in Abnoba Mons, the *Black Forest*, and flows eastward in a course of 1700 miles to the Euxine Sea; the regularity of its direction is interrupted only once—viz., on the border of Pannonia, where it takes a southerly bend for some distance: the Rhenus, *Rhine*, which rises in Adula Mons, *St. Gothard*, and flows northward into the Mare Germanicum: the Rhodănus, *Rhone*, also rising in the neighbourhood of *St. Gothard*, but pursuing a direction exactly opposite to the Rhine, westward through the Lacus Lemanus to its junction with the Arar, *Saone*, and thence southwards to the Mediterranean Sea: the Ibĕrus, *Ebro*, in Spain, which rises in the mountains of Cantabria, and flows in a south-easterly direction into the Mediterranean: and, lastly, the Padus, *Po*, which rises in Mons Vesulus, *Monte Viso*, and receives the waters from the southern side of the Alps, flowing eastward through Northern Italy into the Adriaticum Mare. Other rivers there are, equal to and even exceeding these in point of size, as the Borysthenes, *Dnieper;* the Vistula; the Albis, *Elbe;* and the Tagus; but these are not noticed here, inasmuch as they do not hold a prominent position in ancient geography.

The political divisions of Europe were defined for the most part by the natural boundaries already described; they were as follow: Thracia and Macedonia, between Hæmus and the Ægæan Sea; Mœsia, north of Hæmus, to the Ister; Græcia; Illyricum, the strip between the Adriatic and the Bebii Montes; Italia, the peninsula south of the Alps; Hispania; Gallia; Insulæ Britannicæ; Germania, between the Rhine and the Vistula; Vindelicia, Rhætia, Noricum, and Pannonia, south of the Danube, to the Alps and the *Save;* Dacia, north of the Danube, to the Carpathian range and the Tyras, *Dniester;* and Sarmatia Europæa, to the north of this boundary, between the Vistula on the west and the Tanais on the east, stretching to an undefined extent northwards.

II. *Thracia.*

Thracia as a Roman province was bounded by the river Nestus on the W., Mons Hæmus on the N., the Euxine Sea and Bosphorus on the E., and the Ægæan Sea, Hellespont, and Propontis on the S. Extensive mountain ranges serve as a framework to this country, and present formidable barriers to the sea: M. Hæmus, *Emineh Balkan*, in the north, is the highest, connecting at its western extremity with Mons Scomius and the ranges of the Illyrian Alps, and thence running in an eastern direction to the very shore of the Euxine; from this point it sends an offset to the south-east, skirting the coast of that sea to the mouth of the Bosphorus, and this again a lateral ridge to the south-west, which bounds the Propontis and forms the Chersonesus, ending in Prom. Mastusia, *C. Greco.* From the same point in the north-west issues the range of Rhodŏpe, *Despoto*, forming the western boundary of Thrace, and distributing its lateral shoots abundantly over the western half of the country towards the east, one of which near the Ægæan was named Ismărus. Between the two ranges now described, flows the Hebrus, *Maritza*, which rises in the north-west angle, and after running for its first half course to the south-east, thence turns to the south-west, and joins the Ægæan opposite Samothrace: it receives the tributary streams Artiscus from the north, and Agriānes, *Erkeneh*, with the Teărus and Contadesdus, from the east. The Nestus, *Mesto*, was a less important river, rising in Rhodope, and flowing in a southern course into the Ægæan, opposite Thasos. The small coast streams Compsatus, Travus, and Melas are, the first to the westward, the other two to the eastward of the Hebrus: the Compsatus flows into the Bistŏnis Lacus, the last into the Melas Sinus. The Ægospotămos is nothing more than a brook, on the eastern side of the Chersonese, flowing into the Hellespont. It was celebrated for the defeat of the Athenians by the Spartans, B.C. 405. The sea coast is broken up into bays and salt lakes, such as Melas Sinus, *Gulf of Saros*, which forms the western boundary of the Chersonesus: Stentŏris Lacus, formed by an outlet of the Hebrus: and, farther towards the west, Bistonis Lacus, *Lagos Buru*, near Abdera.

The Thracians were divided into various tribes, with local appellations; it is unnecessary to enumerate more than the following three,—the Cicōnes of Homer, who occupied the coast from the Hebrus to the Nestus; the Bessi, who held the fastnesses of Rhodōpe and Hæmus, in the north-west; and the powerful tribe of the Odrȳsæ, who lived about the middle course of the Hebrus.

The most important towns were—Byzantium, *Constantinople*, on the Thracian Bosphorus, founded by Milesians, B.C. 658, and very much increased by Constantine, A.D. 330, who named it after himself; Salmydessus, *Midiah*, on the coast of the Euxine; Apollonia, *Sizeboli*, higher up, also a Milesian colony, founded B.C. 650; and Mesembria, *Mesembri*, at the foot of Hæmus, founded by Byzantines, B.C. 500. On the coast of the Propontis—Selymbria, a Megarian colony, founded B.C. 675; Perinthus, *Erekli*, on a tongue of land to the westward, afterwards called Heraclea; Bisanthe, *Rhodosto*, with a good harbour; and Pactye, at the commencement of the Chersonesus. In the Chersonesus—Callipŏlis, *Gallipoli*, opposite Lampsacus; Sestus, *Jalova*, at the narrowest point of the strait, opposite Abydos; Elæus, at the extreme point of the peninsula, near Prom. Mastusia; and lastly, Cardia, on the western coast. On the coast of the Ægean—Ænus, *Enos*, on Lake Stentoris, mentioned as early as the Homeric age; Doriscus, a fort on the western side of the lake; and Abdēra, *Asperosa*, a colony of the Milesians, a seaport to the east of the Nestus. In the interior, the chief towns were—Hadrianopolis, *Adrianople*, on the mid-course of the Hebrus; Phillippopolis, *Philippopoli*, near the source; and Trajanopolis, *Orikkova*, on the lower course of the same river.

Off the coast of Thrace lie the following islands: Thasos, *Thaso*, evidently a continuation of Mons Rhodope, celebrated for its mines of gold and marble, with a town of the same name at its northern extremity; Samothracia, *Samotraki*, a small island opposite the mouth of the Hebrus, which, being colonized by Samians, was named, for distinction's sake, the Thracian-Samos; it was the seat of a famed temple of Cybele: Imbros, *Imbro*, and Lemnos, *Lemno*, which appear to belong to the range of high ground which forms the Chersonesus; the latter is farthest from the main land, and largest in size: it also bears a volcanic character, to which we may attribute its connexion with the fabulous history of Vulcan: it possessed two towns, Myrīna, on the west, and Hephæstia, on the east coast. Both Imbros and Lemnos were occupied by Pelasgians at the time of the Persian war. These islands possessed excellent ports, especially Samothracia and Thasos.

III. *Mœsia.*

To the north of Thrace and Macedonia lay Mœsia, stretching from Illyricum, in the W., to the Pontus Euxinus in the E., and northward to the Danube; it thus corresponds with the provinces of *Bulgaria* and *Servia*. The ranges of Hæmus, Scomius, Scordus, and Bebii Montes, which formed its southern boundary, protrude their lower ridges far towards the north, giving the southern and western districts a mountainous character, very distinct from the broad and lengthened plain through which the Danube runs in the eastern part of the province. Numerous rivers pour down from the northern declivities of these mountains to the Danube, of which the most considerable are—the Drinus, *Drinna*, which flows into the *Save*, and the Margus, *Morava*.

Mœsia was, in the time of Herodotus, inhabited by the Getæ, who afterwards crossed the Danube and settled in Dacia. The Mœsi are the same as the Mysi, of whom we have mention in Homer, a Thracian race, who settled partly on the west coast of the Euxine, and partly on the Asiatic side of the Propontis in the province of Mysia. A remnant of this people retained their distinctive name down to the time of Ptolemy, who places them about the Ciabrus, *Zibru*. Of the other kindred tribes, we shall notice the Triballi, mentioned by Herodotus and Thucydides, who lived about the Margus, and in the high valleys of M. Scomius; the Dardăni, on the northern declivities of Scordus; the Peucīni (a branch of the same people whom we afterwards find in Germany, north of the Carpathians) about the Delta of the Danube, which was called Peuce Insula; and the Scythæ, their neighbours to the west, in a district named after them, Scythia Minor.

Mœsia was incorporated into the Roman empire by Augustus, and appears as a province in the reign of Tiberius. It was divided, probably by Trajan, into two provinces; Superior, the upper or western, and Inferior, the eastern half, the river Ciabrus forming the boundary. After the withdrawal of the Romans from the province of Dacia, north of the Danube, A.D. 275, the name was transferred to Mœsia, from the Drinus to the Utus, *Wid*, with the addition of the name of the Emperor Aurelian, in whose reign the change was effected. This part was thenceforward called Dacia Aureliani, subdivided into D. Ripensis, the district along the bank of the Danube, and D. Mediterranea, the interior.

The most important towns were the Greek colonies on the shores of the Euxine, viz., Odessus and Tomis, founded by Milesians, B.C. 650; Callătis by the Pontic Heracleans, B.C. 580; and Istrus by the Milesians, B.C. 560.

IV. *Macedonia.*

The limits commonly assigned to this country represent it in the extent it attained in the time of Philip II., B.C. 359—336, when it reached the Nestus, in the E.; the range of Scordus, in the N.; in the W., the southward offset of that range which runs just east of the Lychnītis Lacus, and joins Lacmon; and in the S. the Cambunian range and the Ægæan Sea. Anterior to that period, however, Macedonia *proper*, as we may call it,—*i.e.*, the territory of Macedŏnes—was much more restricted. In the heroic age the Pæonians and the Bryges were the dominant tribes on the main land of this region, while Tyrrhenian Pelasgians occupied the peninsulas of Chalcidice. The Macedones appear to have settled first along the upper course of the Haliacmon. There they are found at the time of the Doric migration; while the rest of the country was tenanted by the Bottiæi along the coast between the Haliacmon and Axius; the Mygdŏnes and Bisaltæ, between the Axius and Strymon; the Tyrrheno-Pelasgi, as before, in the peninsulas; and the Edōnes between the Strymon and Nestus; the Pæŏnes occupying all the northern district, and the Bryges, the western border. At the time of the Persian war, Macedonia included the coast district about the head of the Thermaic Gulf with the lower valleys of the Axius and Haliacmon; Pæonia still remained by far the most extensive district. Philip II. succeeded in subduing the latter region, and also in adding the territory of the Bryges, in the west, and all that lay between the Strymon and Nestus in the east, and thus gave Macedonia its full extent.

The mountain range of Hæmus, which we have traced from the Euxine to the border of Macedonia, continues its westerly direction in the north of this province under the names of Scomius and Scordus. The last connects with the Illyrian ranges of the Bebii Montes, which, descending from the north-west, continue after this junction towards the south with the names Barnus and Bora, and finally connect with the Cambunian range and Pindus in the central height of Mons Lacmon. The Cambunian range forms the southern boundary of Macedonia: add to these the range of Rhodope, in the east, and we see that this province is girt on every side with strong mountain barriers except in the comparatively small space open to the Ægæan sea. Offsets from these ridges separate the river courses from each other; such as M. Bermius, between the Haliacmon and the Axius; Cercīne, a high and finely-timbered range between the Axius and Strymon; and on the other side of the Strymon, Orbēlus, and Pangæus valuable for its gold mines. The high ground of Cercine protrudes far to the south, and forms three peninsulas—Acte, the most easterly, with the high peak of Mount Athos, *Monte Santo*, at its extremity; Sithonia, ending in the promontories Ampĕlus, *C. Falso*, and Derris, *C. Drepano;* and Pallēne, ending in Prom. Canastræum, *C. Paliouri.*

The courses of the rivers have been partly described along with the mountains: the Haliacmon, *Indje Kara*, rises in the south-west corner, and sweeps round in a north-easterly direction to the Thermaic Gulf: the Axius, *Wardar*, rises in the north-west, in Scordus, and flows towards the south-east, through Pæonia: it receives on its right bank the river Erĭgon, *Kuchuk-Karasu*, and on its left the Astўcus, and falls into the Ægæan at the head of the Thermaic Gulf: the Strymon, *Struma*, rises in Scomius in the north-east, and flows towards the south and south-east: near its mouth it widens into a lake, Prasias or Cercinitis, *Takinos Lake*, and falls into the bay named after it, Sinus Strymonicus. The Nestus has been already noticed. The lake Bolbe was situated between the Axius and Strymon.

The line of coast is varied by the peninsulas already noticed: on each side of them the Ægæan opens into a spacious bay, the Strymonicus Sinus, *Orphano Gulf*, on the east, and Thermaicus, *Sea of Saloniki*, on the west: the two lesser bays between the peninsulas were named Singiticus, *Gulf of Monte Santo*, and Toronaicus, *Gulf of Kassandra.*

The most important towns of Macedonia were—Edessa, or Ægæ, *Vodina*, the old capital, in the district of Emathia; Heraclea, *Bitolia*, near the Erigon; Pella, *Alakilisseh*, the later capital and the birthplace of Alexander, situated on a lake, formed by a tributary to the Axius; Potidæa, *Pinaca*, a Corinthian colony at the neck of the peninsula of Pallene, which sustained a memorable siege against the Athenians, B.C. 432, and was afterwards destroyed by Philip, and restored by Cassander; Therma, *Saloniki*, afterwards called Thessalonīca in honour of Cassander's wife, at the head of the Thermaic Gulf, the seat of a Church to which St. Paul addressed his earliest Epistle: Amphipolis on the left bank of the Strymon, about three miles from the sea, colonized by the Athenians B.C. 437, and valuable from its proximity to the hills Cercine and Pangæus; and Philippi, further eastward on a spur of Pangæus, celebrated for the defeat of the republican army, B.C. 42, and interesting to us from St. Paul's visit, and the Epistle he addressed to the Church there.

The Macedonian Empire.

Philip II., on coming to the throne B.C. 359, found himself master of a small kingdom about the Thermaic gulf, and in the lower valleys of the Axius and Haliacmon. He defeated the Pæonians and Illyrians B.C. 359, and pushed his border forward to lake Lychnitis. The following year he captured Amphipolis and the Chalcidian cities, and extended his territory to the Nestus: he crossed the Cambunian range B.C. 356, into Greece, and in the year B.C. 344 had brought Thessaly to the condition of a Macedonian province. M. Scordus and the Bebii Montes were successively traversed, and the Illyrian tribes to the Adriatic in one direction, the Thracians to the Danube and the Euxine in the other, subjected to his sway. Alexander the Great succeeded him, B.C. 336. He crossed the Hellespont 334; the battles of Granicus 334, Issus 333, and Arbela 331, put him in possession of the vast territories of the Persian empire, extending to the Iaxartes, the Oxus, and the Caspian in the north, the Indus and Paropamisus in the east, the Persian Gulf in the south, and the Ægæan and Mediterranean Seas and the desert of Africa in the west. He advanced beyond the eastern boundary B.C. 327, and subdued the *Panjab*, as far as the Hyphasis, *Ghara*, which formed the extreme limit of his empire. Alexander died B.C. 323, and the dismemberment of his mighty kingdom immediately commenced. After twenty-two years of contest and intrigue between his successors, which ended with the battle of Ipsus, B.C. 301, three dynasties secured a considerable portion of the original empire—viz., the Seleucidæ in Syria, the Ptolemies in Egypt, and the

Antigoni in Macedonia. The latter division was by far the smallest in extent and importance, and its influence in the world was henceforward confined to Europe, and more especially to Greece. It reached its highest prosperity under the sovereignties of Demetrius, B.C. 294—287, who was in possession of Thessaly, Athens, and the greater part of Peloponnesus, and of his successor Lysimachus, B.C. 287—282, who added Thrace and parts of Asia Minor. The latter countries were wrested from Macedonia by the Gauls, B.C. 279, and its political influence in Greece gradually waned, until the final extinction of the independence of all the Grecian states by the advance of the Roman empire.

CHAPTER VI.

I. GRÆCIA.—II. THE ÆGÆAN ISLES AND CYPRUS.—III. ILLYRICUM.

I. *Græcia.*

§ 1. General description. — 2. Political divisions. — 3. Epirus. — 4. Thessalia. — 5. Acarnania. —6. Ætolia.— 7. Doris.— 8. Locris.— 9. Phocis. — 10. Bœotia. — 11. Eubœa.— 12. Attica. — 13. Megaris. — 14. Corinthia. — 15. Sicyonia and Phliasia. — 16. Achaia. — 17. Elis. — 18. Messenia. — 19. Laconia. — 20. Argolis. — 21. Arcadia.

IT is singular that a country so isolated from the rest of Europe as the peninsula of Greece should not have received some general appellation from its own inhabitants. Such, however, is the case: the name Græcia, which we have adopted, was introduced by Roman writers at a late period, and probably owes its origin to the tribe of the Graici, with whom they first came in contact: while the name Hellas, commonly in use among Greek writers, is significant of *race* rather than of locality, and was variously applied to districts where the Hellenic blood and language were supposed to prevail. Thus in the heroic age, Hellas meant merely a district in the southern part of Thessaly—thence it spread over the whole of that province; during the flourishing period of Grecian history, it signified all northern Greece, from the Cambunian range to the Corinthian Gulf. Sometimes, indeed, it was used as inclusive of Peloponnesus and the adjacent islands, in contradistinction to all *foreign* nations; and when Philip of Macedon proved his right to sit in the Amphictyonic council, it included even Macedonia and Illyria. Hence some geographical writers have excluded Epirus, and others have included Macedonia under that title: general considerations of topography and history rather lead us to acquiesce in the usual limits assigned to it, as signifying all that lies to the south of Macedonia.

Greece is a peninsula, surrounded on three sides by water—viz., by the Ægæan on the E. and S., and the Ionian sea on the W.: on the N., where it adjoins the main land of Europe, it is bounded by a barrier of hills, running from sea to sea, and thus shutting it off from easy communication with its northern neighbours. This range is connected with the mountain system of Illyria and Macedonia in the point Lacmon, *Zygo*, which stands at the termination of the united ranges of Scordus and the Bebii Montes. From this central height—which contains the springs of the five largest rivers of Greece, the Aöus, the Haliacmon, the Peneus, the Achelöus, and the Arachthus, flowing in different directions—ranges diverge to the east, west, and south. The eastern branch separates Thessaly from Macedonia, under the name of Cambunii Montes, ending in the heights of Olympus which overhang the vale of Tempe: the western traverses the northern part of Epirus, in the ranges of Tymphe, Lyncus, and the Ceraunii Montes, which terminate in the bold headland of

Acroceraunium, *C. Linguetta:* the southern retains the original direction of the Illyrian range, and under the name Pindus passes down the centre of Greece, separating Thessaly from Epirus. After a course of about sixty miles, it throws out a lateral ridge to the east, named Othrys, which declines towards the neck of the Pagasæan Gulf: Pelion and Ossa form the eastern boundary of Thessaly, which is thus girt with mountains on its four sides. South of M. Othrys, the central range assumes the name Tymphrestus, and, as such, bounds Ætolia on the north: a little lower down it trends off to the south-east, with the name Œta, bounding the valley of the Spercheius on the south, closely skirting the Malian bay, and thence continuing its course until it sinks into the plain of Bœotia, near the Copaic lake. At the point where it approaches nearest the sea, leaving but a narrow passage—the celebrated Thermopylæ—it was called Callidrŏmos, and lower down, Cnemis, whence the Locrians, who dwelled by it, were designated Epicnemidii. Returning to the spot where it assumes a south-easterly direction, we find it again dividing: one ridge, named Corax, penetrates Ætolia and takes a south-westerly course: on the border of Locris, it was called Myēnos and Taphiassus, and it finally ends in the promontory of Antirrhium: the other ridge retains the original direction of Mount Pindus: gradually diverging from Œta, with which it encloses, first, the triangular district of Doris, and then the broader valley of the Cephissus in Phocis, it culminates in the peaked heights of Parnassus to the north of Delphi: it reappears in Bœotia, south of lake Copais, under the name Helĭcon: more to the south it forms the northern boundary of Attica in the two ridges of Cithæron in the west, and Parnes in the east; and ends in the promontory of Sunium, at the extremity of the Attic peninsula.

The mountain system of Peloponnesus is connected with northern Greece by the Geranean hills of the Corinthian peninsula in the east, and by Mons Panachaicus in the west, corresponding to Corax and its continuation at point Rhium. The high land of Arcadia, with its mountain barriers, represents the heart whence the various ramifications spring. The eastern side of this country is the highest: here lie M. Cyllēne, *Zyria,* on the border of Achaia, Artemisius between Mantinea and Argos, and Parthenius, *Partheni,* eastward of Tegea: south of Arcadia, the high ridge of Parnon, *Malebos,* penetrates Laconia, and terminates in Prom. Malea, *C. St. Angelo,* reappearing, however, to the south, in the island Cythēra, *Cerigo.* On the western side of Arcadia there runs a range nearly parallel to that just described, assuming the names Lampēa, Pholoe, and Lycæus, on the borders of Elis, and then separating into the ridges of Taygĕtus and Emathia, the former of which separates Messenia from Laconia, and ends in M. Tænărus and the promontory of Tænarium, *C. Matapan,* while the latter continues to the south, through the centre of Messenia, and ends in Prom. Acrĭtas, *C. Gallo.* The eastern and western lines are connected by transverse ridges, Erymanthus and Cyllene in the north separating Arcadia from Achaia, and a line of inferior heights—the Nomii Montes, Boreium, and others—separating it from Messenia and Laconia.

The sea-coast of Greece varies exceedingly in character. From Olympus to the end of Pelion, it preserves an unbroken line to the south-east, without any shelter for shipping: thence a narrow passage between Eubœa and the mainland conducts to the Sinus Pagasæus, *Gulf of Volo,* which is so shut off from the sea that it bears the appearance rather of a large lake: at the neck of it was Aphĕtæ, a station for vessels: westward the passage contracts, but opens again into the Sinus Maliacus, *Gulf of Zeitun,* which receives the waters of the Spercheius: the channel between Eubœa and Locris was the high road of commerce to ancient Greece, as the eastern coast of Eubœa possessed no ports, and was exposed to violent storms; off Chalcis the Eurĭpus is so contracted that a bridge has been thrown across it both in ancient and modern times. There were various ports and roadsteads on either side of it; as Chalcis in Eubœa, Anthedon, and Aulis in Bœotia, and lower down, where the coast of Attica diverges to the south, Panormus and Thoricus. The Sinus Saronicus, *Gulf of Egina,* washes the coasts of Attica, Megaris, and Argolis, and on all sides affords excellent accommodation for maritime pursuits: Athens possessed three ports — Piræus, Phalerum, and Munychia; Salamis, a splendid bay; Megaris, the port of Nisæa; the Corinthian territory, Cenchreæ; and Argolis, Epidaurus, and the roadstead of Trœzen. In addition to this, the Saronic and the Corinthian gulfs approach so near, that vessels were drawn across the intermediate isthmus, and thus avoided the dangers of Malea and Tænarus. The south-eastern coast of Argolis is beset with islands, Hydrea and others, which rendered navigation perilous. The Argolicus Sinus, *Gulf of Nauplia*, supplied Argos with every advantage, from its sheltered position and its numerous bays. From Argolis the coast slopes off towards Prom. Malea, and presents only one shipping-station along the coast of Laconia, viz., Epidaurus Limera. The projecting ranges of Southern Greece, Parnon and Taygetus, admit the Laconicus Sinus, *Gulf of Kolokythi*, and the Messenicus Sinus, *Gulf of Koroni*, deeply into the interior; there were, however, few ports of any consequence in them; Gythium and Achillæus Portus in Laconia, and Corone in Messenia, were all indifferent, while the storms and currents that prevail about the promontories indisposed the Greeks from venturing too much on those seas. The western coast is more regular than the others: from Prom. Acritas to Prom. Hyrmīna, *Tornese*, it bears away to the north-west, opening into the Sinus Cyparissius, *Gulf of Arcadia*, and Sinus Chelonates, and affording in this part the ports of Pylos, *Navarino*, and Cyparissia: northward of Prom. Hyrmina, it takes a north-easterly direction to Prom. Araxum, *C. Papas*, and on this side offers only one good harbour, that of Cyllene, in the bay of the same name.

The Sinus Corinthiacus almost separates Peloponnesus from the rest of Greece: it commenced with the promontory of Araxum, and in this, its western portion, now the *Gulf of Patras*, it offers the ports of Patræ in Achaia, and Chalcis in Ætolia: eastward of Patræ, the channel is narrowed by the advancing headlands Rhium and Antirrhium, and thence opens into a spacious bay, *Gulf of Lepanto*, towards the south-east, gradually increasing its breadth, until at its eastern extremity it is divided into two lesser bays, the northern of which was called Mare Alcyonium, the southern, the bay of Lechæum. The northern coast of the Corinthian Gulf possesses the best harbours—Naupactus in Locris, Cirrha in Phocis, and Creusa in Bœotia: on the eastern coast, the Megarians had their port of Pagæ, and the Corinthians, Lechæum: the ports on the southern coast, Sicyon, Helice, and Ægium were poor, and little frequented. Returning to the neck of the Corinthian Gulf, we find the western coast preserving a generally uniform direction to the north-west: in the neighbourhood of Acarnania it is beset with numerous islands, Leucadia, Ithaca, &c., which rendered regular navigation dangerous, but at the same time covered the ports on the main land, and adapted them for piratical purposes. The only inlet of any importance is the Sinus Ambracius, *Gulf of Arta*, which connects with the sea by a very narrow channel, commanded by the projecting ground on which Actium stood; it opens into a spacious and irregular sheet of water, abounding with creeks and bays, very favourable to ancient navigation and colonization. To the north of the Sinus Ambracius, almost the only object of importance is the large island of Corcyra, *Corfu*: on the mainland were good roadsteads, such as Portus Glycys, and Panormus, little noticed by classical writers.

2 The next subject of importance in the geography of Greece is its political and territorial divisions. The ancient traditions of the country speak of two distinct races, the Pelasgi and the Hellenes, as forming at different times the dominant tribes of Greece, the former in the heroic, the latter in the historical age. The Pelasgi were deemed the original inhabitants: the Hellenes an immigrant conquering tribe. It is, however, the opinion of some that these were not distinct races, but that the Hellenes were a superior and more cultivated branch of the older Pelasgic stock. Supposing this, it is still desirable to keep up the distinction between the Pelasgic and Hellenic eras, as representing different stages of history and civilization.

Again, the Greek writers were in the habit of distinguishing between the Pelasgi and various other tribes, as the Caucones, Leleges, &c. These tribes are now recognised not as distinct from, but subdivisions of, the Pelasgic family, so that the name Pelasgi may be deemed a 'general one, like that of the Saxons, Franks, or Alemanni.'*

In the Pelasgic period from B.C. 1700 to 1500, the tribes were distributed as follow:—the Pelasgi (properly so called) in Arcadia, Argos, and Achaia: the Leleges in the south of Peloponnesus, (Messenia, and Laconia,) and also to the north of the Corinthian Gulf in Ætolia, Locris, and Phocis: the Caucones in Elis and Western Messenia; the Curetes in Acarnania; the Dryopes north of the Ambracian Gulf, and in later Doris; the Dolopes in Mount Pindus; the Chaones south of the Acroceraunian range; and the Thesproti and Molossi in central Epirus. Towards the latter part of this period, the Hellenic race seems to have been dispersed about Northern Greece as follows:—the Hellenes and Achæi in Epirus, near Dodona; the Minyans, Phlegyans, and Æolians, on the border of Macedonia; and the Dorians, near Mount Olympus.

The Heroic or early Hellenic period, B.C. 1500—1100, is marked by the great advance of the Hellenic tribes. They had crossed the Pindus, expelled the Pelasgi from the valley of the Peneus, and had established themselves in the central and southern parts of Thessaly; the Achæans were settled to the westward of the Pagasæan Gulf, which became the original Hellas; the Æolians, and a tribe connected with them, the Bœotians, held the central plain. The Dorians had descended from their mountain quarters, and had expelled the Dryopes from the upper valley of the Cephissus; the Æolians occupied the later provinces of Phocis, Acarnania, and Bœotia, and the west coast of Peloponnesus; the Ionians, the northern parts of the Peloponnesus; and the Achæans, the districts afterwards called Laconia, Messenia, and Argolis. The older occupants were either thrust back from the maritime districts to the interior, or else took refuge on isolated headlands and peninsulas. Thus the Pelasgi continued to hold Arcadia, the southern points of Messenia and Laconia, the north-east angle of Elis, and the interior mountainous districts of Ætolia and Phocis.

The latter part of the twelfth century, B.C., witnessed a great and a permanent change in the population of Greece. About 1124 the Thessali, probably a Pelasgic race, crossed the Pindus, expelled the Bœotians and Æolians, and occupied their country, which afterwards took its name from them. The Bœotians in turn dispossessed the Æolian settlers of the valley of the Cephissus and the plains south of the lake Copais, and gave the name Bœotia to their new territory. The expelled Æolians, together with other refugees, emigrated to the coast of Asia Minor and other places. Twenty years later, B.C. 1104, the Dorians descended southwards across the neck of the Corinthian Gulf into Peloponnesus; they conquered Laconia, Messenia, Argos, and Corinth. The Achæans, who had formerly occupied these provinces, retired for the most part to the north of Peloponnesus, and settled in the maritime district named after them Achaia: some, however, remained in the southern district of Laconia, and in the upper part of Argolis. The Ionians, dispossessed of Achaia, and not finding room in Attica, sought new quarters in Asia Minor. The Æolian branch of the Hellenes held their ground to the north of the Corinthian Gulf, in Ætolia and Locris, and in western Peloponnesus, where, under the name of Epeans, they occupied Elis, and as Minyans, the small district of Triphylia. The Pelasgic population remained undisturbed in Arcadia: in other parts they either took refuge in the Ægean islands or became merged in the dominant Hellenic race.

After this time the abodes of the races underwent little change, and Greece was henceforward subdivided into districts, the limits of which were partly fixed by geographical features, partly by the occupation of races. Of

* Bishop Thirlwall's *Greece*, vol. i. p. 41.

these districts there were in Greece, north of the Peloponnesus, the following ten:—Epirus, Thessaly, Acarnania, Ætolia, Locris, Phocis, Doris, Bœotia, Attica, and Megaris; and in the Peloponnesus the following nine:—Achaia, Argolis, Laconia, Messenia, Elis, Arcadia, Corinthia, Sicyonia, and Phliasia.

3 Epirus, the north-westerly province of Greece, was bounded on the N. by the Ceraunian range, on the E. by Pindus, on the S. by the Ambracian Gulf, and on the W. by the Adriatic Sea. The name Epirus signifies *mainland*, and was first applied to it by the inhabitants of the adjacent islands, Corcyra, Ithaca, &c.

The general character of this province is wild and mountainous, with valleys widening out into extensive and fertile plains as they approach the sea. The rivers flow for the most part to the south-west; the most important are—the Achelōus, *Aspro-potamo*, in the eastern part of the province, which exceeds all the other rivers of Greece in size and length; it rises in Lacmon, and in its upper course flows along a valley on the western side of Pindus: the Arachthus, *Arta*, flowing into the Ambracian Gulf: the Achĕron, *Souli*, so celebrated in mythical representations of the infernal regions, on the west coast, a river of no great size flowing along a valley of wild and sombre character. and discharging itself into a small bay, Portus Glykys, *Glyki;* and in the northern district, the important Aōus, *Boiussa*, which, unlike the others, flows towards the north-west, and receives tributaries from the northern declivities of Lyncus and the Ceraunian ranges.

Epirus was occupied by a variety of tribes, differing in race, and until a very late period of ancient history, independent of each other. Three, however, surpassed the rest in importance, the Chaŏnes in the north-west, the Thesprōti in the south-west, and the Molossi in the interior. Under the reigns of Alexander and Pyrrhus, Molossian kings, the Epirote tribes seem to have been united in one kingdom. The Chaones occupied the coast from the Ceraunian range to the river Thyamis; their chief towns were—Buthrōtum, *Butrinto*, opposite the northern point of Corcyra: Palæste, *Pallassa*, on the sea-coast under the Ceraunian mountains: in the interior, Phœnīce, near *Delvino*, north-east of Buthrotum: and Phanōte, *Gardiki*, yet more to the north. In the valley of the Aous dwelt the Atintānes and the Paravæi, the latter north, the former south of the river; and the Tymphæi about its sources, and even over the ridge of Pindus to the head-waters of the Peneus. The Aōus was hemmed in in its mid-course by the approaching ridges of Aeropus and Asnaus, which formed an important defile, Aoi Stena, near *Clissura.*

Thesprotia lay between the Thyamis and the Acheron, and possessed the towns of Pandosia and the Homeric Ephyre, near the latter river. Between the Acheron and the Ambracian Gulf lived the Cassiopæi. In later times, Augustus built at the extreme southern point of this district the town Nicopolis, *Prevesa Vecchia*, in memory of his victory at Actium.

Molossis extended inland from the borders of Chaonia and Thesprotia to the ridge of Pindus. The most celebrated spot in this district was Dodōna, the seat of the most ancient oracle of Greece. Its site cannot be ascertained with any certainty: it is now generally placed at the southern extremity of the lake Pambōtis, *Janina*. Eastward of Molossis, in the upper valley of the Achelous, lived the Athamānes, who became of much importance in the Roman wars, as they commanded the passes between Thessaly and Ætolia, and possessed forts on either side of the Pindus. The town Argithea was probably situated on the Achelous: of the rest, nothing more than the names is known.

There yet remains to be noticed, the territory of Ambracia, to the north of the gulf of that name. Ambracia itself, *Arta*, founded by Corinthians, was most favourably situated in a broad plain on the banks of the Arachthus, some few miles from the gulf: a steep hill, crowned with a citadel, commanded the town. The trade of Epirus would naturally pass through it, and thus it obtained great maritime importance in the time of the Peloponnesian war.

Off the coast of Epirus lay the island of Corcӯra, *Corfu*, the Scheria of Homer, and in his age the residence of the Phæacians. It is said to have been also called Drepăne from its resemblance to a *reaping-hook*. It is remarkable for its beauty and fertility, and historically famous for its connexion with the Peloponnesian war. The mountain chains which traverse it everywhere run out into four headlands;—viz., Cassiŏpe, in the north-east, *Point St. Catherine;* Phalacrum, in the north-west, *Drasti;* Amphipăgus, the extreme southern point, *C. Bianco;* and Leucimna, on the south-east coast, *Cape Lechino.* The town of Corcyra was situated on the eastern coast, and thus opposite the mainland, where the modern town now stands. It was colonized by Corinthians, B.C. 758, and stood just at the neck of a small peninsula, formed by two inlets of the sea, which afforded it a double harbour, the southern one of which, named the Hyllăic harbour, is now the lagune of *Calichiopoulo.* Opposite the northern harbour lay the small island of Ptychia; and between the southern point of Corcyra and the mainland, Sybŏta.

4 THESSALIA adjoined Epirus on the E. It was bounded by the Cambunian range on the N., Pindus on the W., Œta on the S., and the Ægæan Sea on the E. These limits embrace the valley of the Spercheius and the Malian territory to the south, as well as Magnesia to the east. The *name* Thessalia is of comparatively late date—it does not appear in Homer: perhaps it may be regarded as an extended use of the name of the *district* Thessaliŏtis, with a slight change in the form of the word.

Thessaly *proper* (to the exclusion of Magnesia and Malis) consists of an extensive plain, hedged in on every side with high mountain-barriers, and bearing a close resemblance to the dry bed of a lake. To all appearance the waters, which now find an issue by the valley of Tempe, stagnated here, and formed an inland sea, connected with the Lake Bœbeis and the Pagasæan Gulf. The plain is traversed by five large and several smaller streams, viz.—the Apidănus with its tributaries, the Enīpeus and Cuarius, from the south; the Pamĭsus from the west; the Peneus with its tributary, the Ion, from the north-west; and the Lethæus and Titaresius from the north. The four first unite in the western part of the plain, and the Titaresius lower down; and the united waters, with the name Peneus, *Salambria,* flow towards the north-east, through the vale of Tempe, into the Thermaic Gulf. The vale is about five miles in length, and in places so narrow that there is room only for the river and the road, above which the rocks rise precipitously to a great height: the road ran along the *right* bank of the river. This afforded the readiest access from the north into Thessaly; but it was not the only entrance: sometimes the pass was altogether avoided by a route to the north of Tempe, which struck off from Gonnos, and skirted the base of Olympus by the Lake Ascuris, descending into the plain opposite Heracleum. There was also a well-frequented route over the Cambunian range, which followed the course of the Titaresius, and dividing near Doliche, led either westward towards Elymiotis, or eastward by Pythium and Petra to Pieria: the former was called the Volustana Via. On the side of Epirus, Thessaly was accessible by two routes, one of which followed the course of the Peneus to the heights of Lacmon, and descended to the Arachthus and the interior of Epirus; the other, more to the south, left the valley of the Peneus at Tricca, and crossed by Gomphi into Athamania, thus communicating more directly with Ambracia and Ætolia. The fortress of Æginium, *Kalabaka,* commanded the first, and Gomphi the second.

Thessaly is generally said to have been divided into four districts—Hestiæŏtis, Thessaliotis, Pelasgiotis, and Phthiotis. But this division is neither co-extensive with the limits of the country, nor does it appear to have been universally accepted by ancient writers. To these we must add, at all events, Magnesia, Dolopia, Œtæa, and Malis, if, indeed, we ought not also to consider the district of the Perrhæbi as a distinct division.

Hestiæotis lay to the west, under Mount Pindus, and about the upper valley of the Peneus: besides Æginium and Gomphi, which have been already mentioned as commanding the passes of Pindus, it possessed the towns—Tricca, *Trikhala*, on the left bank of the Lethæus; the Homeric towns of Ithōme and Œchalia, the latter north of Tricca, the former eastward of Gomphi; Pelinna, north-east of Tricca; and Melibœa, still more to the north.

Pelasgiotis lay towards the north-east of the province on both sides of the Peneus: the district north of the river to the Cambunian mountains was occupied by the Perrhæbi, and hence is frequently called Perrhæbia: their chief residence appears to have been on the banks of the Titaresius or Eurōtas, *Saranta Poros*. This tribe commanded the important passes into Macedonia already mentioned. Not far from the head of the valley, they possessed three towns, or forts (whence the mountain district was called Tripolis), Azōrus, Dolĭche, and Pythium, the latter nearest to Olympus, and on the route which Xerxes, Brasidas, and others took across these mountains. Descending the valley of the Titaresius, we come to the towns Eritium on the left, Mallœa, Mylæ, and Metropolis on the right bank. The important town of Gyrton, *Titari*, was situated between the Titaresius and Peneus, on the road from Larissa to the pass. In the valley of the Peneus lay—Phacium, on the border of Hestiæotis; Larissa, which still retains its name, on the right bank, probably identical with the Argos Pelasgicum of Homer, at all events an old Pelasgian town, as its name indicates; its citadel was strongly posted on a hill, and it was an important point in the time of the Macedonian wars: Gonnus, at the western entrance to the defile of Tempe, on the left bank; and Lapathus somewhat off to the left on the mountain track to Heracleum. To the south of the Peneus lay—Crannon, the same as Homer's Ephyra, south-west of Larissa, the seat of the Scopadæ: Scotussa, at the source of the river Onchestus; and in its immediate neighbourhood the two hills named Cynoscephălæ, the scene of the Roman victory over Philip of Macedon, 197 B.C. These hills are at the extremity of the high ground which separates the lake Bœbeis from the Pagasæan Gulf: the lake is now named *Carlas*. Pheræ, *Velestina*, one of the most ancient towns of Thessaly, was beautifully situated to the north-west of the Pagasæan gulf: the fountains of Hyperea and Messeis lay in its vicinity.

Magnesia was the mountainous strip to the eastward of the lake Bœbeis from Tempe to the promontory of Sepias, which is traversed by the ridges of Ossa, *Kissovo*, and Pelion, *Zagora*. Prom. Sepias, *C. St. George*, was the spot fatal to the Persian fleet. The most important town in this district was Demetrias, founded by Demetrius Poliorcetes, B.C. 290, on the north-east point of the Pagasæan Gulf, justly termed one of the *fetters of Greece*, as it commanded the road to Thessaly: it was situated on the high ground of *Goritza*. A mile to the north was the old city Iolchos, the birth-place of Jason; and just at the head of the gulf, its port Pagăsæ, where *Volo* now stands: Aphĕtæ lay at the neck of the gulf.

Phthiotis lay to the west of the Pagasæan Gulf, in the angle formed by that and the Malian bay, stretching back thence to Dolopia. The range of Othrys penetrates this district, dividing it into two unequal parts, the southern one of which was named Lamieis after the town of Lamia. In Phthiotis lay the original Hellas; the position of it, whether we regard it as the name of a town or a district, was on the banks of the Enipeus, south of Pharsalus, and close by the more modern Melitæa. The chief towns were Thebæ Pthiotĭdes, south of Pheræ, not far from the sea and on the great Thessalian road: Halus on the stream Amphryssus, *Armiro*, also near the sea: Pteleum, *Ptelio*, on the coast opposite Aphetæ: Larissa Cremaste, the latter part of the name indicating the *steepness* of its situation, a Pelasgic town opposite Eubœa; Alŏpe somewhat to the westward; and Phalăra, *Stylida*, the port of Lamia. In the interior, were Melitæa, north of Othrys and on the left bank of the Enipeus, whence a mountain track led to Lamia across Othrys: Thaumăci, *Dhomoko*, an important fortress commanding the road just mentioned, on a spur of Othrys to the north-west of Melitæa: Phylăce, between Melitæa and

Thebes: Eretria, between Thebes and Pharsalus: and lastly, Lamia, *Zeitun,* near the western extremity of the Malian bay, the chief seat of the war between the Macedonians and Athenians.

Thessaliotis, was the district north-west of Phthiotis to the Peneus, watered by the rivers Enipeus, Cuarius, and Phœnix. Its chief towns were Metropolis, to the south-east of Gomphi: Cierium, the ancient Arne, on the road between Gomphi and Crannon; and Pharsālus, *Phersala,* famed for the contest between Cæsar and Pompey, B.C. 48, a short distance from the Enipeus.

Dolopia was the south-west district of Thessaly. It consisted of the highlands on each side of M. Pindus to its junction with Tymphrestus and Othrys, whence flow tributaries to the Achelous, the Spercheius, and the Peneus. The position of this land midway between Ætolia and Thessaly will account for its having been the scene of operations during the Ætolian wars. It was occupied by the remnant of the Pelasgian Dolopes and Dryopes, who retreated thither on the advance of the Hellenes. The names of several towns are mentioned by Livy; but their positions are uncertain, and the only one of which we have any particulars, is Ctimene or Cymine.

From the southern part of Dolopia, the land declines towards the valley of the Spercheius, *Hellada,* which commences at the point where Othrys and Œta part, and gradually increases with the divergence of these ranges, until it is closed by the Malian Gulf. This valley, in length about sixty miles, is equally celebrated for its beauty and its fertility. The upper half was occupied by the Ænianes, and called Ænania, or sometimes Œtæa, with only one town of any importance, Hypăta, *Patradjik,* on the route that led across Tymphrestus to Ætolia. The lower valley was occupied by the Malians, a Dorian tribe, with the town Heraclēa Trachinia, founded by the Lacedæmonians, B.C. 426, for the defence of their allies, the Trachinians, against the Œtæans; it was situated about two miles and a half from the sea, just below Mount Œta, on a spur of which stood the citadel. The old city of Trachis lay less than a mile off to the west; and Anticy̆ra, near the mouth of the Spercheius. The outlet of this country towards Locris was guarded by the famed pass of Thermopy̆læ. The coast has advanced so much, through the copious deposits of alluvial soil that the Spercheius has brought down, that the pass no longer exists. In the time of the Persian war, an advanced ridge of Œta, named Callidrŏmos, pressed close upon the sea, leaving a passage about fifty feet wide, which was defended by an artificial wall, built by the Phocians. At the entrance of the pass, on the Melian side, stood the village of Anthēla, and on the Locrian side Alpēnus; in the narrowest spot between these two towns, were the Phocian wall and the hot springs whence the place derived its name. The path Anopæa, by which the Persians arrived at the Locrian end of the pass, followed the course of the Asopus to the foot of Œta, and thence over Callidromos to Alpenus.

A group of islands lay off the coast of Thessaly, apparently a continuation of the mountain range of Magnesia—Scy̆athos, which retains its name; Halonēsus, or Scopĕlos, *Scopelo;* Peparēthus, *Khelidromi,* or, as some think, *Piperi;* and Scyros, *Skyro.* These islands were occupied by Pelasgi and Dolopes.

5 ACARNANIA was bounded on the W. by the Ionian Sea, and on the N.W. by the Amphilochian Gulf; towards the E. the Achelous separated it from Ætolia, except where a portion of the latter province, called Ætolia Adjecta, crossed the river in the neighbourhood of the Ambracian Gulf. The territory of Argos Amphilochicum to the east of the gulf, and sometimes also Ambracia (which has been described in this work as part of Epirus) are reckoned as parts of Acarnania.

Acarnania is intersected with well-wooded mountains, inferior in height to the central ranges of Greece. Some few of these received specific names, as Thyamus, which separated it from Ætolia Adjecta, and Crania, between the territories of Argos and Ambracia. Between the hills are spacious plains, (such as that in the neighbourhood of Stratus,) and some few lakes.

The Achelous, *Aspro-potamo*, brought down vast quantities of alluvial soil, so much so that it formed a district near its mouth, named Parachelois, and enclosed some of a group of islands, the Œniadæ, which formerly lay at some distance from the main land. It receives two tributaries on its right bank, the Petitărus, which rises in Amphilochia, and the Anāpus, to the south of Stratus.

Acarnania never attained any great political importance; the native tribes lived chiefly in scattered villages, and the towns which lined the coast were the property of other Greek states. The most celebrated spot in history is the promontory of Actium, *Punta*, at the neck of the Ambracian Gulf, the scene of the victory of Augustus over Antony, B.C. 31. The towns worthy of mention were—Anactorium, *Aios Petros*, eastward of Actium, colonized by Corinthians: Limnæa, *Kervasara*, at the south-east point of the gulf, the spot whence expeditions were more than once commenced against Ætolia and Acarnania: Argos Amphilochicum, *Neochori*, of Argive origin, advantageously situated on an elevation on the eastern coast of the gulf: Olpæ, to the north of it, and Idomĕne, on the borders of Ambracia: Stratus, *Lepenu*, the metropolis, on the right bank of the Achelous: Phytia, *Porta*, west of Stratus: Medeon, *Catouna*, a considerable place, to the north of Phytia: Œniădæ, *Trikardo*, near the mouth of the Achelous, rendered almost impregnable through the marshes which surrounded it; and on the west coast, Astăcus, *Dragomestre*, and Solium, a Corinthian settlement opposite Leucas.

Closely connected with Acarnania was the island of Leucas, *Santa Maura*, which, indeed, until a late period had formed a peninsula of the main land: it was separated from it by an artificial cut, originally constructed by the Corinthian colonists for the purpose of defence: in the time of the Peloponnesian war, this canal was choked up with sand, but was afterwards reopened. The southern extremity of the island was the celebrated Prom. Leucāte, *C. Dukato*, now an insulated rock, crowned with a temple sacred to Apollo, and well known as the scene of Sappho's leap. The island possessed three towns—Leucas, near *Amaxidhi*, on the Dioryctus or canal, a Corinthian colony; Hellomĕnum, probably the same as Phara, in the south: and Clymĕnum, on the east coast. The old Homeric town, Nerĭcus, stood at the northern extremity of the island. Between Leucas and the main land lies the group, Insulæ Taphiorum or Teleboarum, the principal one of which was called Taphos *Meganasi*. South of Leucas is situated the small but celebrated island of Ithăca, *Thiaki;* it consists of a double peninsula, the northern formed by the ridge Nerĭton, the southern by Neïon, separated by a bay on the eastern coast, named Rheithrum; on the ridge that connected the peninsulas, not far from the present town *Bathy*, the Homeric town Ithaca is supposed to have stood; the port of Phorcys was probably on the north coast; Mons Corax formed the north-west point. Between Ithaca and Cephallenia, which were only three miles distant, lay the small island of Astĕris, *Dascaglio*. Cephallenia, *Cephalonia*, called in Homer Same and Samos, is the largest island on this coast. Like the others it is a collection of rocks, the highest of which, in the south, received the name of Ænus. It contained four cities—Proni, on the south-east coast; Same, the capital, on the strait opposite Ithaca, strongly defended by a double citadel; Cranii, *Argostoli*, on the south-western coast; and on the western side of a deep inlet, Pale, *Lixuri*, which furnished a contingent for the battle of Platæa, and probably was at that time the most powerful of the four. The most southerly of the group was Zacynthus, *Zante*, a very fertile, and in ancient times a very well-wooded island. Its position with respect to Peloponnesus made its acquisition of great importance in all the Greek wars. The capital town, Zacynthus, was on the same site as the modern *Zante*, looking towards the Peloponnesus; near it rose the heights of Elătus, *Mount Scopo*. It now only remains for us to notice the Echinădes, *Kurzolari*

Islands, off the mouth of the Achelous, the chief of which, the Homeric Dulichium, has been connected with the main land by the deposits of that river.

6 Ætolia was bounded on the west by the Achelous, and on the N. and N.E. by the ranges of Tymphrestus and Œta; on the E. by Corax and Myenus, dividing it from Locris; and on the S. by the Messenian Gulf.

It is generally, but especially in the northern districts, mountainous and rugged; along the sea-shore, however, there stretches a broad and fertile alluvial plain, which was crossed by the road from Acarnania to Naupactus and Corinth. Ætolia was divided into two districts, geographically distinct: Ætolia Antiqua or Propria, south of Mons Panætolium; and the northern Highlands, Ætolia Epictētus or Adjecta, i. e., *added* or *acquired in addition to* the country properly so called. The only mountain range in the interior of Ætolia was Panætolium, just mentioned, which crosses in a north-westerly direction the ground between the valleys of the Evenus and Achelous: it derived its name from the meetings of the confederate Ætolian tribes having been held at Thermum, a town at the base of the ridge; it is now called *Viena*. There were only two rivers of any size, the Achelous in the west, and the Evēnus, *Fidari*, in the east: the Achelous is increased by a tributary, the Campy̆lus, on its left bank, and also by the surplus water of two considerable lakes, named Trichōnis, *Brakhori*, and Hyria or Lysimachia, which lie in the hollow between Aracynthus and Panætolium, and discharge themselves into the Achelous by the river Cy̆athus, *Neschio*.

There are but few towns in Ætolia, and these mostly on the sea-coast: the tribes of the interior were dispersed about in villages. Entering from Acarnania, we come to Pleuron Nova, *Castro of Irene*, at the foot of Mons Aracynthus: Caly̆don, *Kurtaga*, in the valley of the Evenus; and Chalcis on the sea, near the border of Locris. In the interior were Conōpe, afterwards Arsinoe, near the outlet of the Cyathus into the Achelous; Lysimachia, *Papadhates*, south of the lake Hyria; and Thermum, the ancient capital and arsenal of Ætolia, to the north of Lake Trichonis. Metăpa seems to have been situated just to the north-west of Lake Trichonis.

Ætolia Adjecta was occupied by several half-civilized tribes, of which the best known were—the Eurytānes, about the declivities of Tymphrestus and Œta; the Apodōti, about the mid valleys of the Evenus and Hylæthus; and the Ophionenses, in the upper valley of the Evenus. There were besides the following lesser tribes—the Bomienses, with their town Bomi, who lived about the sources of the Evenus; the Callienses, with the town Callium on the eastern side of Mount Corax; the Agræi, west of the Eurytanes, between the Campylus and Achelous, with the town Ephy̆ra on the former river; and the Aperantes, lower down in the valley of the Achelous, with the towns Aperantia, *Preventza*, and Agrinium, to the eastward. The towns of Ægitium, Potidania, and others, which Demosthenes reached in his Ætolian expedition, were on the banks of the Hylæthus. Œchalia, belonging to the Eurytanes, lay, probably, close under Tymphrestus.

7 Doris.—The small and rugged mountain district which was regarded as the cradle of the Dorian nation, lay at the head of the valley of Cephissus, where the ranges of Œta and Parnassus converge and ultimately unite. The stream which carries off the waters from these hills was named the Pindus, *Apostolia*, and joins the Cephissus in Phocis: on its banks were built the four cities that constituted the Dorian Tetrapolis, viz.: Pindus, near the source of the river; Erineus, lower down on the left bank; Cytinium, *Gravia*, on the right bank, the most considerable of the four; and lastly, Bœum, also on the right bank, to the south-east of Cytinium. A road from Amphissa in Locris crossed the valley of the Pindus at Cytinium for Heraclea in Trachis.

8 Locris.—The Locrians occupied two distinct districts, separated by the valley of the Cephissus and the provinces of Doris and Phocis. On the western side of Parnassus, and thence to the Corinthian Gulf, lived the Locri Ozŏlæ, and on the east of Œta, in the narrow strip that intervenes between it and the sea, the two other divisions, the Epicnemidii and Opuntii. The origin of the

two latter names is clear: the one is derived from Mount Cnemis, a continuation of Œta, the other from the town Opus: the derivation of Ozŏlæ is not so well ascertained: it is usually connected with the Greek word ὄζειν, 'to smell,' which may have referred either to some strong-smelling plant that abounded there, or to the goatskins in which the Locrians dressed. We shall describe the territory of the Ozolæ first: they occupied the coast of the Corinthian Gulf, from the promontory Antirrhium in the west, to the Crissæan bay in the east: inland their territory was circumscribed by the ranges of Parnassus in the north-east, and Corax and Myenus in the north-west. The only river in this province is the Hylæthus, *Morno*, which follows the course of Mons Myenus to the south-west, and flows into the Corinthian Gulf. The general character of the country is mountainous.

The first town, entering by the coast road from Ætolia, was Molycrium or Molycria, sometimes reckoned as belonging to Ætolia: it lay a little westward of the promontory Antirrhium. At this point the Corinthian Gulf is contracted to the breadth of about a mile: in ancient times a temple of Neptune, and now a fortress stands on either side: that at Antirrhium is called *Roumelia*. Eastward of Antirrhium, stood Naupactus, *Lepanto*, whence the gulf takes its modern name; the Athenians established the Messenians of Ithome here after the Persian war, and derived important advantages from this acquisition in their attacks upon Ætolia: the port was well defended, being actually inside the walls of the city. Œnĕum, *Magula*, was situated eastward: and farther along the coast, the unimportant towns of Anticyrrha, Erythræ, Tolŏphon, and Œanthe. The most celebrated town belonging to the Locri Ozolæ was Amphissa, *Salona*, at the head of the Crissæan plain. The citadel stood on an impregnable rock, which commanded the road from the north and west to Delphi. It was destroyed by order of the Amphictyonic Council, because its inhabitants cultivated the sacred plain of Crissa; but it seems to have been restored shortly after.

The confined district of the Locri Epicnemidii commenced at the pass of Thermopylæ, and followed the sea-coast to the south-east, as far as the town of Alope. The Malian Gulf recedes considerably from the range of Cnemis between these points, leaving a maritime plain in the neighbourhood of Scarpheia. The great northern road followed the sea-coast; but this district was also accessible from Phocis by two routes over Mount Cnemis, which passed through the towns of Tarphe and Thronium. With the exception of the plain already referred to, the district was broken up by spurs of Mount Cnemis.

The towns (commencing from the north, and following the main road,) were—Alpēnus or Alponus at the entrance of Thermopylæ; Nicæa immediately on the sea-coast; Scarphe or Scarpheia, about a mile and a half inland; Cnemis or Cnemīdes, by the promontory of the same name; and Daphnus, near *Neokhorio*. Inland were Thronium, *Romani*, the capital, on the Boagrius, strongly situated on a spur of Cnemis; and Tarphe to the westward, close under the main ridge.

The Locri Opuntii occupied the coast southward to the town Larymna, where an inlet of the Eubœan sea approached so near the Copaic lake, as to form a natural boundary. In general character, this district assimilates to Epicnemidia: the coast, however, protrudes *inwards* instead of outwards, and confines the plain of Opus on the east. The hills gradually decline towards the south-east; and from Opus, the main road struck across the range into the plain of Bœotia.

The chief towns in Opuntia were—Alŏpe; Cynus, *Libanitis*, a seaport at the northern commencement of the Opuntian bay; Opus, *Kardhenitza*, the capital, about two miles from the sea; and Larymna, *Kastri*.

Off the coast, in the Opuntian bay, lies the island of Atalanta, the modern name of which, *Talanta*, gives the title to the adjacent main land; it was occupied by the Athenians during the Peloponnesian war.

9 PHOCIS lay between the divisions of Locris. In shape it resembled an

irregular quadrangle, the Corinthian Gulf forming the base, and Cnemis the upper side; on the E. it was contiguous to Bœotia, and on the W. to Doris and the Locri Ozolæ. It was unequally divided by the range of Parnassus into two districts, totally distinct in character and in historical associations, the northern consisting of the rich and broad valley of the Cephissus, the southern of Delphi and its neighbourhood. The name of Parnassus is sometimes applied to the range, sometimes to the highest points of the range: to these, however, specific names were also given, the central double peak being called Lycorēa, and still *Liakura*, and the northern height above Neon, Tithorēa, *Velitza*. The former contains numerous stalactite caves, of which the Corycium Antrum, above Delphi, was the most celebrated. The summit, generally covered with snow, and the rugged and precipitous sides of this mountain, form the most conspicuous feature in the landscape of central Greece. The chief river is the Cephissus, *Mavro-potamo*, which rises near Lilæa in the western part of the province, is joined at a short distance from its source by the Pindus, and thence flows to the south-east through a valley, generally wide, but contracted to a narrow pass on the confines of Bœotia.

The chief towns in the northern district were—Lilæa, *Palæo-kastro*, on the declivities of Parnassus, near the source of the Cephissus; Elatēa, *Lefta*, on M. Cnemis, which commanded the pass over that mountain from Locris, and therefore formed 'the key of southern Greece;' Parapotamii, *Belesh*, on the river side, as its name implies, at the entrance of the pass into Bœotia; on the road between this place and Opus, Hyampolis, *Bogdana*, which seems to have been of some importance as commanding that pass; and Daulis, *Daulia*, situated at some distance from the right bank of the Cephissus, on the road from Orchomenus to Delphi.

Westward of Daulis, a road skirted the base of Parnassus, and was known as the Via Sacra: at a short distance from Daulis it was joined by a road from the south, leading to Ambrȳsus, *Dystomo*, and the point of junction was celebrated as the spot where Laius fell by the hand of his son: it was called Triodos, as three roads met there. Farther on, Anemorēa marked the boundary of the Delphian territory, and the road followed the course of the small river Pleistus, *Xero-potamo*, until it slightly diverged to the right hand for Delphi. The position of this town, the seat of the most sacred fane of antiquity, and the fabled centre of the whole world, was very remarkable. The range of Parnassus terminates southward in two bold rocks, the Phædriădes, specifically called Hyampēa and Nauplia, which formed at their base a natural theatre, gently sloping towards the Pleistus. On this declivity stood Delphi—the temple of Apollo with the sacred tripod, and the cave whence the oracular responses were given, being at the back of the town, and the stream or spring (as it was more commonly called) of Castalia, descending between the two rocks to the eastward, and flowing into the Pleistus. The town was enclosed by a wall; but several buildings, as the Stadium, Synedrium, and others, stood outside, and the approaches to the town were lined with statues and chapels; the spot is now called *Kastri*. Descending the valley of the Pleistus, we come to Crissa, which gave its name to the rich plain that stretches from the neighbourhood of Amphissa to the head of the Crissæan bay: Crissa (it must be observed) did not stand on the sea-coast, as the name of the bay would seem to imply; Cirrha, *Magula*, was in that position, and served as the port of Crissa and Delphi. The Delphian territory was separated from south-eastern Phocis by the range of Cirphis: in this part of the province we meet with the towns of Anticyra, *Aspraspitia*, on the western side of the bay of the same name, celebrated for its hellebore: Marăthus, opposite to it: Stiris, *Stiri*, to the eastward; and Bulis, sometimes reckoned as a town of Bœotia.

10 Bœotia was contiguous to Locris on the N., Phōcis on the W., and Attica and Megaris on the S.: on the E. and N.E. it was bounded by the waters of the Eubœan straits. In general features this province bears a close

resemblance to Thessaly, being girt in all directions by a circular belt of mountains, which enclose a rich and extensive plain, watered by the converging streams of the whole district. The valley of the Asōpus, which we must except from these observations, bears a similar position to the water-basin of Bœotia, that the Spercheius does to that of Thessaly. There is, however, one noticeable difference—that there is no vale of Tempe in Bœotia; the waters collect in the centre of the province; and we therefore have presented to us a picture of what Thessaly would have been, had the river Peneus never found an outlet. The Copāic lake discharged its surplus waters at its north-eastern extremity by subterraneous passages, now named *Catabothra*, three of which are known to have existed; these were of natural formation in the first case, but improved by art. The waters, having passed by these under the Opuntian hills, re-appear in the neighbourhood of Larymna, and discharge themselves into the Eubœan sea. The lake was in ancient times forty miles in circumference; it is now about sixty, but shallow, and in summer for the most part a mere marsh: its modern name is *Topolias*.

The heights that enclose the Bœotian plain were in the north, the Opuntian Cnemis, and a lateral ridge proceeding at right angles from it towards the Cephissus, called Hyphantium; in the west, the well-known range of Helicon; in the south, Cithæron and Parnes; and in the east, the lesser elevations of Ptoum, Messapium, and Mycalessus.

The approaches from the north were three in number; by the valley of the Cephissus, the road leading from Parapotamii to Chæronea; by a pass over M. Hyphantium, from Abæ to Orchomenus; or by the coast road of Opus and Larymna, which entered at the eastern extremity of the Copāic lake. The valley between Parnassus and Helicon gave egress towards Delphi and the west, by Daulis; and there was also a route in the same direction to the south of Helicon, starting from Thespiæ. Towards the south there were several routes, (1) the coast road by Creusa and Ægosthenæ, leading to Megaris, (2) the mountain pass of Cithæron by Dryos-cephălæ—i. e., *Oakheads,*—where the roads from Thebes and Platæa, leading to Eleutheræ and Athens met, (3) a more direct and easy route from Thebes to Athens, by the way of Phyle and Acharnæ, which took the low ground between Cithæron and Parnes, and (4) the coast road of Oropus on the eastern shore which divided near that town, and led either over the eastern declivities of Parnes by Decelea to Athens, or by Rhamnus and the coast as far as Marathon, and thence across Pentelicus.

Though Bœotia touched two seas, the Corinthian Gulf, and the Eubœan Straits, it never became a maritime country, partly through a deficiency of ports, (for Anthēdon and Bathys, *Vathi,* were neither of them good,) and partly through the richness of the soil, which encouraged agricultural pursuits. The only river in the north of any importance is the Cephissus, whose course has been already noticed; in the south, two rivers take their rise in the immediate neighbourhood of Platæa, the Oeroe, which flows westward into the Corinthian Gulf, and the Asōpus, *Asopo,* which flows eastward with a sluggish stream through a rich plain by Tanagra, into the Eubœan Sea.

Bœotia abounds with scenes of historical and classical interest: its position, midway between northern and southern Greece—the character of the country, well adapted for military operations—and the number, riches, and strength of its towns, made it constantly the arena of war—' the Low Countries' of antiquity.

The towns were numerous, and were for the most part built on the eminences which skirt the border of the Copaic plain. Orchomĕnus, *Scripou*, in the Homeric age the capital of Bœotia, was situated on the Cephissus, near its junction with the Copaic lake; it was celebrated for the treasury of Minyas: the Acropolis stood on a steep rock, the base of which was washed by the river. Chæronēa, *Kaprena,* stood a short distance from the bank of the Cephissus on the borders of Phocis, and was of importance as commanding the roads to Parapotamii and Daulis; it also had its Acropolis built on a steep rock; it was the scene of Philip's victory over the Athenians, B.C. 338, and of Sylla's contest with the army of Mithridates, B.C. 86. Lebadēa, *Libadia,* came next on the road to Thebes: a small stream, the Hercȳna, flowed by its walls, and discharged itself into the Copaic lake: it was situated on a northern spur of Helicon, with the celebrated oracular cave of Trophonius in its territory. Coronēa, near *Granitza,* followed at a distance of five miles, between the streams Curalius and Phalaros: this was the scene of Tolmidas' failure, B.C. 447, of the victory of Agesilaus, B.C. 394, and of several other military operations. In the neighbourhood of Coronea, five miles southwards, rises the consecrated height of Leibethrius, with the grove and grotto of the Muses. The scenery of this and of the neighbouring Helicon is more soft and verdant than is usual with the Greek mountains. Though the summit of the latter is generally covered with snow, it breaks up into romantic valleys: it is particularly celebrated for its clear gushing springs, two of which were sacred to the Muses, Hippocrēne and Aganippe, both on the north side of the mountain, the former flowing into the Olmeius, the latter by Ascra, the birth-place of Hesiod, into the Termessus. From Coronea, the southern road passes by Alalcomēnæ, *Sulinari,* to Haliartus, *Mazi,* on the shore of the Copaic lake, where the Lacedæmonian Lysander met his death, B.C. 395: it was destroyed by the Romans under Lucretius. A level plain intervenes between this place and Thebæ, still called *Thebes,* distant about fifteen miles. This celebrated town, the capital of Bœotia, was situated between two small streams, Ismēnus and Dirce, the former on the eastern, the latter on the western side of the city, which, afterwards uniting, flow into the Lake of Hylĭce, *Livadhi,* some five miles to the north: they are mere mountain torrents, insufficient even to supply Thebes with water. The Acropolis, which was named Cadmea, stood on a mound, elevated about one hundred and fifty feet above the plain, between Dirce and another small stream, called Cnopus. The whole city was surrounded with walls, through which seven gates gave egress in different directions. Thebes was several times besieged and captured. To the west stood Thespiæ, *Eremo-castro,* at the foot of Helicon, whose inhabitants sided so bravely with the patriotic Greeks against the Persians: in their territory, on the road leading southwards to Platæa, was Leuctra, *Parapunghia,* celebrated for the decisive victory of the Thebans over the Spartans, B.C. 371. Platæa was situated at the base of Cithæron, about the sources of the stream Oeroe, and near the modern village of *Kochla:* its name is associated with the achievements of the Greeks at Marathon and under its own walls, and with the stout resistance it offered to the Spartans in the Peloponnesian war. The fountain of Gargaphia was about a mile and a half to the eastward of Platæa; in the same direction was Hysiæ immediately under Cithæron, on the road from Dryoscephalæ to Thebes; and farther on, Erythræ and Scolus, both a short distance from the right bank of the Asopus.* The chief town in the valley of the Asopus was Tanagra, *Grimala,* on the left bank, strongly built on a rock; its territory produced excellent wine, and it retained its prosperity to a later period than the other Bœotian towns. A road led hence to Delium, leaving Œnophyta midway on the right hand; Delium, *Dhilessi,* was the border town on the side of Attica, and immediately on the sea; it was of importance, as commanding the coast road; the Athenians and Bœotians had a severe contest here, B.C. 424. Higher up on the coast were—Aulis, whence the Grecian fleet sailed for Troy; its port, Bathys, *Vathi,* to the south of the town; Mycalessus, about three miles from Aulis, on a hill of the same name; Salgăneus, on the north of the Euripus, considered an important point, as commanding the approaches to the strait;

* In Herodotus' account of the battle of Platæa, the Persian and Grecian armies are described as for some time stationed on opposite banks of the Asopus. The main stream cannot be intended, but rather one of the small tributaries flowing from the south.

and Anthēdon, *Lukisi*, farther north on the coast, occupied chiefly by a fishing population.

11 EUBŒA.—This important island faces the eastern coasts of Locris, Bœotia, and Attica: it was separated from the second of these provinces only by the narrow strait of Euripus. From its great length, compared with its breadth, it was occasionally called Macris. The modern name *Egripo*, or *Negropont*, is derived through a series of changes from the word Euripus.

A chain of hills traverses Eubœa from end to end. At the southern extremity they terminate in two promontories, Caphāreus, *Cape Doro*, looking towards the Ægæan, and Geræstus, *Cape Mantelo*, towards Attica, and distant about ten miles from the island of Andros. There are also two promontories at the northern extremity, but not of so great a height as the southern—viz., Artemisium at the eastern corner, *Cape Xyrochori*, the name of which was extended westward along the line of coast, and Cenæum, *Cape Lithada*, at the western. The hills which connect these extremities were known as Telethrium in the north, Dirphis in the neighbourhood of Chalcis, and Oche in the south.

The eastern side of Eubœa possesses no safe port or roadstead, and from its exposure to the north-east wind it was particularly dangerous for coast navigation. The extensive indenture, to the north of Prom. Caphareus, called Cœla, or Cava Euboica, proved fatal to the Persian fleet, and the promontory itself enjoyed an ill fame as the scene of the destruction of the Grecian fleet on its return from Troy. The traffic was from these causes diverted to the inland passage, by the straits of Artemisium and Euripus, and hence we find the most important towns on the western side of the island. The Euripus itself is not more than eighty yards across, and was bridged over by the Bœotians, B.C. 410.

The position of Eubœa, its fertility, and the marble quarries of Carystus, made it an object of great importance both to the Bœotians and the Athenians.

The chief town in it was Chalcis, *Egripo*, at the passage of the Euripus, an Ionian city of great celebrity. Its position made it, for warlike purposes, one of the 'chains of Greece,' and equally important as a commercial depôt for the produce of northern Greece; its soil was remarkably fertile, especially the Campus Lelantus; and the site of the town, on the declivity of Mount Canĕthus, was both beautiful and capable of easy defence. Eretria came next to Chalcis, both in importance and in geographical position; it was also Ionian; the old town was destroyed by the Persians after a six days' siege; it was rebuilt about a mile and a half nearer Chalcis. South of Eretria, to the port of Porthmus, *Bufalo*, the coast was known as Kale Acte—i. e. the *beautiful beach*. Styra, *Stura*, follows: then Carystus with its splendid marble quarries, and on the eastern side of Prom. Geræstus, a town and haven of the same name. The only towns on the eastern coast were Cyme and Cerinthus, neither of any importance. On the northern coast, in the district of Hestiæotis, was the important town of Histiæa, or, as it was called after the commencement of the Peloponnesian war, Orĕus; it commanded the strait between Eubœa and the main land of Thessaly.

12 ATTICA derives its name from its peninsular position (ἀκτή), being surrounded on two sides by the sea, and connected with the main land only on the north and north-west. In shape it resembles an inverted triangle, of which the promontory of Sunium would represent the apex, and the Bœotian border the base line. The physical features of this province deserve particular attention, as they are interwoven with the political state of its inhabitants.

The ranges of Cithæron and Parnes form a continuous boundary on the north, hardly broken by the intervening *dip*, along which the road by Phyle to Bœotia passed. The routes across these mountains have been already mentioned; their further course in Attica will be presently noticed. From Parnes two chains diverge, one of which runs in the direction of the bay of Salamis, ending in Ægaleus; while the other, rising, after a short interval, in the heights of Pentelĭcus, or Brilessus, *Mendeli*, takes a parallel direction, and under the names of Hymettus, *Telo-Vuni*, and Anhȳdros, *Mavro-Vuni*, terminates in the promontory Zoster, *Cape Vari*. These two ranges enclose the plain of Athens, τὸ πεδίον as it was emphatically called, on the east and west. The high ground about the head of this valley, which forms the watershed of the Attic peninsula, was called the Diacria, and occasionally Epacria, 'the *high lands*.' On the other side of the chain of Ægaleus lies the plain of Eleusis, stretching along the coast as far as the border of Megaris, and inland to the base of Cithæron. And again, on the other—i. e., the *south-eastern*—side of the Hymettus range follows another plain with occasional elevations, which rises towards the south and terminates in the headland of Laurium, the inhabitants of which were distinguished according to their locality, either as dwelling on the sea-coast 'Paralia,' or in the interior 'Mesogæa.' In a political sense, the inhabitants of the three plains of Eleusis, Athens, and Mesogæa, were classed together as οἱ πεδιᾶιοι: and thus were the divisions reduced to three—the Pediæi, the Paralii, and the Diacrii. These divisions were not established by any distinct boundaries, but followed the general physical features of the country.

Attica was divided by Cleisthenes, B.C. 510, into ten tribes, and these into demi, or *parishes*, of which 174 existed in the time of Strabo: the number of tribes was ultimately increased to thirteen.

The position of Attica, the character of its coast, and even the nature of its soil, exerted a material influence on its history. Placed midway between Northern Greece and the Peloponnesus, and yet off the line of communication between them, it was interested in the movements of all the Greek provinces. Two of its coasts were washed by the sea; and it possessed every facility for maritime commerce in the numerous ports and sheltered bays of the Saronic Gulf. And while there was this inducement to seafaring pursuits, the poverty of the soil offered no counter motive for agriculture: there were neither woods on the mountains, nor rich pastures in the plains: scattered shrubs and dwarf trees were all that met the eye, and the olive was the most valued production of the soil. The only wealth of Attica was in its minerals—in the silver mines of Laurium, and the marble quarries of Pentelicus. Thus every circumstance conduced to make Attica a *commercial* rather than an agricultural country, and to give her a strong interest in all the movements of the neighbouring provinces.

The simplest method of describing the towns and localities of Attica is to commence with Athens, which was the centre of the province in every other but a physical sense. It was situated on the right bank of the small stream Ilissus, between the hills Lycabettus, *St. George*, on the north-east, and Pnyx on the south-west, the range of Hymettus rising at a short distance off to the south-east. It thus stood on the southern verge of the plain, which stretches away towards Parnes in the north-east, and towards the sea, about four miles distant, in the south-west, the island of Salamis closing the prospect in this direction. In the centre of Athens rose the Acropolis, a massive oblong rock, one hundred and fifty feet high, having its extension east and west. The ascent led up from the south-western angle by a winding path through the Propylæa, erected by Pericles. Nearly in the centre of the platform stood the Parthĕnon; north of the Parthenon, the Erechtheium or temple of Minerva Polias, with the ancient statue of that goddess in olive-wood. The building was of irregular shape, and of small size compared with the Parthenon; the southern portico, called Cecropium, was the reputed burial-place of Cecrops. Facing the entrance of the Propylæa, and thus in front of the two temples mentioned, stood the colossal statue of Minerva Promăchus, seventy feet high, which was visible from the sea. There was also a third temple, dedicated to Artemis Brauronia. The Acropolis was most accessible on the north side, and this accordingly was earliest fortified by a wall, called after its builders the Pelasgic. The walls on the south side were erected at a later period by Cimon.

The other remarkable spots and buildings were—the Pnyx, a low hill, facing the Acropolis to the west, and about a quarter of a mile distant, where the public assemblies were held: the Areopăgus, reserved for the use of the highest judicial court in Athens; the Agŏra, in the hollow between the Pnyx and the Acropolis, an oblong inclosure surrounded by porticoes and other public buildings; and, below the south-eastern extremity of the Acropolis, the extensive theatre of Dionȳsus, formed on the side of the hill, the tiers of seats being cut out of the rock, and rising one above another in a semicircular form.

Closely connected with our associations of Athens are its suburbs—the grove of Academia on the banks of the Cephissus, about two miles north-west of the Acropolis, the spot where Plato taught; Colōnus Hippius, a little higher up the stream; Cynosarges under mount Lycabettus, where Antisthenes instituted the Cynic school of philosophy; and the Lycēum, Aristotle's school, on the same side of the city, nearer the Ilissus. The two celebrated streams, Cephissus and Ilissus, now lose themselves in the marsh that intervenes between Athens and the Piræus; in earlier time they united and flowed into the Phalerian bay.

Athens possessed three ports—Piræus, Munychia, and Phalērum, distant about four miles from the city. Phalerum, the most easterly, was the first used, but soon sunk into insignificance; it consisted of a large, unenclosed bay, with docks situated near the modern *Tripyrghi.* Westward of this bay the land runs out into a curved peninsula, which is almost cut off from the main land by a bay on each side. The smaller of the two bays, on the eastern side of the peninsula, formed the harbour of Munychia, *Porto Fanari;* the larger, on the western side, was the Piræus, *Porto Dhrako.*

The entrance to the harbour of Piræus was so narrow that a chain might easily be thrown across. Themistocles fortified Piræus and Munychia, by erecting walls across the neck of the peninsula, and along the line of the sea coast. Cimon, B.C. 465, connected the three ports with the city by means of two divergent walls, the northern one touching the sea at the western extremity of Piræus, and the southern at the eastern point of Phalerum. To these Pericles added a third, which had for its object the more immediate protection of the Piræus; its course was parallel to the northern wall, with a slight divergence as it approached the Piræus. These two parallel walls became the most important means of defence, and hence they were called the *northern* and *southern*, to the exclusion of the Phalerian wall, which was most properly the southern. When regard was had to the Phalerian, the third or intermediate was called the *middle* wall.

The most interesting localities in Attica were as follow. Eleusis, *Lefsina,* far-famed for the celebration of the Eleusinian mysteries, lay immediately on the sea-coast, north of Salamis, and was connected with Athens by a 'Sacred Road,' which issuing from the north-west of that city, and passing across the Ceramicus and the Athenian plain, and through the gap left by the ridges of Ægaleus—Corydallus and Pœcĭlum—followed the bend of the sea-coast to Eleusis: Eleusis possessed a small harbour, commanded by the Acropolis. The plain northward of the town was commonly called the Thriasian, after the town Thria, which lay northward of the Sacred Road, under Ægaleus: it is watered by a stream named Cephissus, which joins the sea in the neighbourhood of Eleusis: across the plain led the direct road to Platæa, passing by Œnoe and Eleuthĕræ. The relative position of these two places is still undecided: the extensive ruins at *Gyfto-castro,* just under Cithæron, probably represent Eleutheræ: Œnoe would in that case stand lower down the stream, where it turns to the south at *Blaches.* Acharnæ, *Kametero,* lay due north of Athens, about seven and a half miles distant, and on the western verge of the plain: it was the largest demos in Attica, and carried on a considerable trade in charcoal. The road to Thebes passed through it, and thence by Phyle, *Fili,* which lay at the southern base of Parnes. Two roads led from Athens to Oropus and Bœotia: the most direct crossed the Diacria by Decelĕa, *Tatoy,* which was situated on an elevated peak at the head of the Athenian plain, fifteen miles distant from Athens, commanding both the road and the plain: the other avoided the hills by keeping to the south of Pentelicus, and going round by the plain of Marathon: it passed through Alopĕce, skirted the northern base of Hymettus, then through Pallene below Pentelicus, and so to the region of the Ionian Tetrapolis and Rhamnus. The Tetrapolis consisted of an association of four towns, existing before the time of Theseus—viz., Probalinthus and Tricorȳthus, on the sea-coast; Marăthon and Œnoe, a short distance inland. In later times, Marathon obtained the ascendancy, and the plain on which these towns stood was more usually named after it. The coast here recedes inland, forming a small bay, protected by the headland of Cynosūra, *Stomi.* In the middle of the bay a small stream discharges itself, anciently called Charadrus, which rises in Mount Parnes. The spurs of this mountain and of Pentelicus approach the sea within a distance of about two miles, and enclose the plain on the west; while along the coast, north and south, two marshes, generally dry in summer, intervene between the sea and the hills. The plain thus has a length of about six miles. The modern village of *Marathona* stands on the Charadrus, but ancient Marathon was more to the south, on the site of *Vrana.* In the celebrated battle that took place here, B.C. 490, the Greeks were posted on the declivities bounding the southern border of the plain, while the Persians occupied the line of coast, between the southern marsh and the river. The Tumulus, *Soro,* which marks the centre of the Athenian position, stands about half a mile from the shore; it is a misshapen heap of earth, two hundred yards in circumference. The *Pyrgos* to the north of it is the ruin of the tomb of Miltiades. From Marathon the road led to Rhamnus, *Ovrio-castro,* situated on a rocky promontory, and celebrated for a temple sacred to Nemesis; and thence to Orōpus, *Oropo,* the border town of Bœotia, on the right bank of the Asopus. This town was originally built on an eminence, two miles from the sea; but at the time of the Peloponnesian war it had been removed to the coast. The district on each side of the Asopus was called Oropia or Peiraïce—i. e., the *border* country: in the contests between the Bœotians and Athenians it frequently changed hands. Aphidna was situated in the upper valley of the Charadrus, between Decelea and Rhamnus; and Cephissia, at the foot of Pentelicus, between Marathon and Athens. In the Paralia and Mesogæa, the districts south of Athens, the most important locality was Laurium, a hill in the neighbourhood of Sunium, which yielded a large quantity of silver ore. The produce of its mines was applied by the advice of Themistocles to the formation of the Athenian fleet: in Strabo's time the mine was nearly exhausted. Sunium was important on another account—viz., as commanding the passage of vessels coming from Eubœa and the north. The promontory, now *Cape Colonna,* was crowned with a beautiful temple of Minerva: the town lay on the eastern side of the promontory. Proceeding northwards from Sunium we meet with Thorĭcus, *Theriko,* on the eastern coast; the island of Helĕna, or Macris, *Macronisi,* stretched along opposite to it, and afforded a safe roadstead. Prasiæ, with an excellent harbour, *Port Rafti,* was farther up the coast: and yet farther Brauron, *Vronna,* celebrated for the worship of Diana; it stood a short distance from the sea. On the western coast the towns were more numerous, but not so important. Anaphlystus, *Anafyso,* corresponded in position to Thoricus; it stood on a river, by which it communicated with the inlet that formed its harbour. The road from Laurium to Athens, known as the ' Sphettian way,' ran parallel to the sea-coast.

It only remains to describe two islands, intimately connected with Attica, Salămis and Ægīna. The former, now *Koulouri,* lies in the northern angle of the Saronic Gulf, between Athens, Eleusis, and Megara. It is mountainous and of very irregular shape, being nearly divided in half by an inlet from its western side. The passage between Salamis and the Attic coast, where Mount Ægaleus declines, is very narrow; its entrance was guarded on the western side by the projecting headland of Cynosura, and by the small island of Psyttaleia, *Lipsokutuli.* It was in this strait that the Persians sustained their humiliating defeat, B.C. 480. The old town of Salamis was situated on the south side of the island; the later town of historical times, on the eastern coast, opposite Ægaleus, at *Ambelakia.* This town appears to have fallen into decay after its occupation by the Macedonians, B.C. 317. On the western side of the island, the projecting headland of Budōrum fronted Nisæa, three miles distant.

Ægina, *Egina*, is situated in the centre of the Saronic Gulf, nearly equidistant from Athens, Argolis, and Corinth. In shape it is an irregular triangle, the base fronting the coast of Argolis; in size about twenty-two miles round; in character mountainous, and for the most part, unproductive. The highest point, Mons Panhellenius, on the south-eastern side, was crowned by a celebrated temple of Jupiter. The navigation about its shores was impeded by numerous rocks and shoals. The position of Ægina adapted it most admirably for the purposes of maritime ascendancy. It raised itself to an early independence, and enriched itself at the expense of the neighbouring shores on the main land. It was too important a post to escape the notice of the Athenians; when not in their own possession it was the 'eyesore of the Piræus.' They held it in their own hands from the time of the Persian war until the battle of Ægospotami. It possessed two harbours, one on its eastern coast, the other on the western, where the chief city, Ægina, stood facing Epidaurus.

13 The small state of MEGARIS lay at the entrance of the Isthmus of Corinth. It consisted of a plain, enclosed on two of its sides by the Corinthian and Saronic gulfs, and elsewhere by mountain ranges. Cithæron separated it from Bœotia; a southern branch from that range, which terminates in two horned peaks, named the Kerăta, near Eleusis, formed its eastern boundary; and on the south the lofty Oneian mountains, *Macriplayi*, culminating in Mons Geranēa, *Palæovouni*, severed it from Southern Greece. Two roads led southwards; the one surmounted the precipitous Scironian rocks, which skirt the base of the Oneian range where it overhangs the Saronic Gulf; the other crossed the Oneian range, midway between the seas, by the pass of *Derbenivouni*, which the modern road follows; the central portion of the range, as well as the highest peak, is generally denominated Geranea. The road from Megara to Attica followed the coast, and was commanded by the heights of Kerata.

The plain of Megara is watered by numerous small streams flowing into the Saronic Gulf; in the centre of it stood Tripodiscus, where the various roads met for the pass of Geroneia. The capital, Megara, was built about two miles distant from the Saronic Gulf, opposite Salamis; two hills, Alkathoo and Caria, rose behind the town, each crowned with a citadel. It was connected by long walls, with its port, Nisæa, to the south-east, the entrance to which was protected by an island, Minōa, lying immediately in front of the town, and joined to the main land by a causeway. This island was incorporated with the main land as early as Strabo's time; the site of Nisæa is at *Dodeka Ecclesiæ.* The coast has changed so much, that the description of this locality given by Thucydides cannot be identified. Megara possessed also a port on the Halcyonian bay, Pagæ, *Psatho,* which the Athenians once occupied as a naval station.

14 CORINTH and its territory stood in the same relative position to Peloponnesus, as Megaris to Northern Greece; but there were differences in the geographical features of the country, which made the former by far the most important of the two districts. The Oneian range, which separated Megaris from Corinthia, crosses the neck of land between the Saronic and Corinthian gulfs, and runs out westward into a high peninsula, which divides the eastern coast of the latter into the Lechæan and Halcyonian bays, terminating in the promontories of Olmiæ and Heræum or Junonis, which face respectively towards Bœotia and Sicyon. On the south side the range declines gradually to a small plain, and allows the seas to approach within

three and a half miles of each other at the Isthmus of Corinth. The ground between the seas is sufficiently level to admit of vessels being dragged across, and the line which they followed was called the Diolcus; it is not, however, a *dead* level, as the ground rises towards the Saronic Gulf, and there breaks off into a low cliff. A canal was frequently projected, and even attempted by Nero; the results may yet be seen in a trench about one thousand yards long from the Lechæan side. There was also a wall drawn across the isthmus, about half a mile south of the Diolcus, but by whom erected is uncertain; it appears that temporary fortifications were several times erected there. The southern side of the isthmus is closed in by another range, named Onea, and by the rock Acrocorinthus. A narrow ravine separates these two, along which the road to Peloponnesus ran, immediately under the rock. The only other entrance southwards was at the other extremity of Onēa, where it left a narrow pass close by the sea, which was commanded by the port of Cenchreæ. The territory of Corinthia stretched southwards about ten miles from the Isthmus.

Corinth itself was most happily situated for purposes both of war and commerce; immediately behind the town, and at a distance of two miles from the sea, rose the impregnable rock which formed its citadel, one thousand nine hundred feet high, with an area of two miles in circumference on its summit, and well supplied with water by the spring Peirēne. The walls of Corinth enclosed a circumference of ten miles, exclusive of those which connected it with its harbour of Lechæum. The town was well supplied with water by natural springs, two of which, beside that in the citadel, were called Peirene; it was further accommodated with a fine aqueduct, constructed by Hadrian. Corinth was taken and sacked by Mummius, B.C. 146, and restored by Julius Cæsar, B.C. 44. Besides the port of Lechæum, it possessed another on the Saronic Gulf, Cenchreæ, *Kekhries,* five miles distant; and this double port made Corinth an entrepôt for the interchange of European and Asiatic productions. Having command also of the two passes into Peloponnesus, it was naturally adapted to exercise great influence in the military affairs of Greece; but intestine divisions, and perhaps the very extent of its walls, prevented it from doing as much as we should have expected.

The Isthmus itself was the scene of annual games, which were celebrated at a spot near the Saronic Gulf, and not far from Schœnus, *Kalamaki,* the port whence vessels made the Diolcus.

15 SICYONIA AND PHLIASIA.—Westward from Corinth, a narrow but fertile plain stretches along the sea coast; inland the country is broken up into confined valleys, bounded by high hills. Three such valleys open into the plain, and the streams which flow down them were known as the river of Cleōnæ, the Nemea, and the Asōpus. The ridge that separates the two first was called Apĕsas, *Mount Fuka,* and that between the Nemea and Asopus, Trikarānon, *St. George.* The Nemea, in its lower course, formed the boundary between Corinthia and Sicyonia.

The territory of Sicyon, *Vasilika,* extended along the coast nine miles, and about the same distance inland. The town itself was situated two miles from the sea, with its acropolis and other public buildings on a fortified hill of considerable area; the base of the hill is washed on the east by the Asopus, and on the west by a brook supposed to be the Helisson. It was connected with its port by long walls; these and the maritime quarter of the city were destroyed by Demetrius, B.C. 303.

The small district of Phliasia consisted of the upper valley of the Asopus, which, above the town of Phlius, turns at right angles to its future course, and has its rise in the western mountains that border on Arcadia. Phliasia was enclosed by mountains on all sides, except towards Sicyon; Lyrcēum separated it from the plain of Argos, Trikaranon from the valley of Nemea, and Celossa from Arcadia: each of these ranges, however, had roads across. Phlius itself stood at the angle where the Asopus begins to flow towards the north.

Eastward of Phliasia, the small state of Cleōnæ occupied the upper valleys of the Nemea, and of the stream on which its town stood. The hills about Nemea are perforated with caverns; and hence this was selected as the fittest scene for Hercules' contest with the lion. At Nemea, which was situated on a small plain, games were celebrated every three years; the stadium and theatre may yet be traced near the remains of the temple of Jupiter. Cleonæ, *Kurtesi*, was situated on the left bank of the river, and on the high road between Argos and Corinth, built on an eminence and strongly fortified. There were two routes across the mountain to Mycenæ; a footpath called Contoporcia, and a more circuitous but easier road called Tretus, or *bored*, from the numerous caverns along it.

16 ACHAIA occupied the whole of the northern coast of Peloponnesus, westward of Sicyonia; its boundary on this side was the river Sythas; and at its other extremity the Larissus, which disembogues south of Prom. Araxus, separating it from Elis. It consists of a narrow plain, confined on the south by the high wall of mountains which enclosed Arcadia: and here its boundary was irregular, according as the mountains recede from, or approach to the sea. The line which it followed was (starting from the east) Stymphălus, *Ghymno Vuni*, Cyllēne, *Zyria*, then the advancing Chelydorēa, *Mavrioro*, Cerynēa behind Ægium, then the lofty and wild chain of Erymanthus, *Olenos*, and lastly, a western offset from that named Scollis, which some have supposed to be identical with the Petra Olenia of Homer.

These mountains rise for the most part abruptly, presenting a lofty wall on the side of Achaia, furrowed here and there with the courses of the mountain streams. The rivers are necessarily short, the mountains seldom being distant more than fifteen miles from the shore; and, as we might expect, they vary very much in their depth at various seasons, being almost dry in summer, and coming down with violence in winter. There is only one range wholly in Achaia, and hence called Panachaiicum, *Voidhia:* it is a northern spur of Erymanthus, running out towards the neck of the Corinthian Gulf. The sea coast is regular; the most northern point is Prom. Drepănum, *Dhrepano:* the coast curves slightly inward on the western side of that cape, forming the harbour of Panormus, and protrudes again in Prom. Rhium, the nearest spot to the coast of Ætolia. It then trends southward, sweeping round in a fine bay, now the bay of *Patras*, to the opposite promontory of Araxum, *C. Papa*.

The maritime district of Achaia was eminently fertile: it produced flax, in addition to grain of every description; the currant, now the staple export of the district, is comparatively a modern introduction.

The geographical character of this province, separated as it was from its neighbours, but accessible in all parts to its own inhabitants, exercised a marked influence on its political institutions. From the earliest times, we hear of a confederacy of twelve cities, which, with a slight interruption, and with a variation in the number, was maintained until the extinction of Grecian independence. The names of the cities are differently stated by writers of different ages; probably because, as one city fell into ruin, its place was supplied by another. Their names as given by Herodotus were as follow:—Pellēne, on the eastern border, situated on a steep hill, seven miles from the sea; Ægīra, earlier Hyperesia, *Palæo-kastro*, a mile and a half from the sea; Ægæ, on the Crathis, *Akrata*, which had disappeared as early as Strabo's time; Bura, *Trupia*, five miles inland; Helīce, at the mouth of the Selinus, the original capital of Achaia; it was destroyed by an inroad of the sea, B.C. 373, at the same time that Bura was destroyed by an earthquake; Ægium, *Vostitza*, which succeeded Helice as the spot of congress: it was situated on the sea shore, west of the Selinus, possessed the best port on this coast, and was much beautified with temples and public buildings: Rhypæ, said to have been ruined by Augustus, who removed its inhabitants to Patræ: Patræ, the third capital of Achaia, which still retains its ancient name and pre-eminence: it stands on an eminence about half a mile from the sea, with level ground intervening; a rich plain extends southward, bounded by Mons Panachaiicus: Olĕnus, *Kato*, at the mouth of the river Peirus or Melas, *Kamenitza;* higher up that stream, Pharæ on its left bank; Dyme, near *Karavostasi*, between Olenus and Prom. Araxus; and lastly, Tritæa, *Kastritza*, the inmost town of Achaia, under Erymanthus, in the highest valley of the Selinus. Most of these towns fell into decay at the time of the Roman conquest.

17 Elis, or Elea, occupied the northern half of the west coast of Peloponnesus, from the river Larissus, which separated it from Achaia, to the Neda, *Buzi*, on the side of Messenia. These limits included four districts, differing essentially from each other in character, and for a long period politically distinct. Firstly, a very rich alluvial plain intervened between the base of the range of Scollis and the sea, reaching from the Larissus in the north, to the promontory of Ichthys, *Katakolo*, in the south, and attaining a considerable breadth by the projecting headlands of Chelonātas, *Clarentza*, and Hyrmīna, *Tornese;* this was called Cœile Elis — i. e., the *hollow* Elis; it was watered by the Peneus, *Gastuni*, and its tributary, the Ladon. Secondly, there was the highland district of Acrorēa in the north-east, consisting of the ranges of Scollis, *Sandameri*, and the southern limbs of Erymanthus—viz., Lampēa, *Astra*, and Pholoe, which form the boundary between Elis and Arcadia. A range of high ground striking off westward from Pholoe, and named Amphidŏlis, separates the water basins of the Peneus and the Alpheus; and this high ground formed the northern boundary of the third division of Elis, named Pisātis, which consisted of a series of small valleys running southwards, and conveying tributaries to the Alpheus. To the south of this river, the mountains and the sea approximate so closely as to leave but a strip of coast-land: and among the western offsets of these mountains lay, lastly, the district of Triphylia.

In the Homeric poems we hear of the Epeans in Hollow Elis, and the Pylians* southward, the Eleans appearing only as a subdivision of the Epeans. Ephyra is represented as the capital of the Epeans, situated on the river Selleeis. Whether these were identical with the town Elis and the river Peneus, or whether (as some suppose) both the town and river must be sought more to the south, near the promontory of Ichthys, is a question not yet decided. At all events, Elis—which, if not existing under an earlier name, was founded soon after the Trojan war—rose to be the chief town in the north; Pisatis became a separate political district in consequence of the importance which the Olympian games conferred on the town of Pisa. The contests for the supremacy between Elis and Pisa ended in the subjugation of the latter about 770 B.C. Triphylia, which owes its name, we are told, to the mixed character of its population, consisting of the three tribes, Epei, Minyæ, and Elei, formed at all times a distinct district, sometimes subject to the supremacy of Elis, at other times independent or allied with the Arcadians.

Elis was remarkable for its fertility, possessing a rich soil, abundance of water, and level plains. The chief towns were as follow:—In Hollow Elis—Buprasium, on the borders of Achaia; Cyllēne, *Clarentza*, north of the promontory of Chelonatas, the harbour of Elis: Elis, *Palæopoli*, on the left bank of the Peneus: it was just on the borders of the plain, with its citadel on a prominent rock called *Kaloscopi;* and Pylus, surnamed, for distinction's sake, Eliacus, on the left bank of the Ladon, and about ten miles from Elis. In the Acrorea—the fortress of Opus, at the confluence of the Ladon and Peneus; Eupagium and Thalamæ, higher up the course of the latter; and Thraustus, *Dhomoko*, near the sources of the Ladon. In Pisatis—Olympia, the central spot to which the roads converged, and the scene of the most celebrated games in Greece: it was situated on the right bank of the Alpheus,

---

* Homer describes the Alpheus as flowing through the land of the Pylii, which implies that the kingdom of Pylus included the later district of Pisatis.

on a small plain about three miles long and one broad, bounded on the north by the hill of Cronium, and on the west by the Cladeus, a small tributary to the Alpheus. The Altis, or sacred enclosure, containing the Temple of Jupiter and other sacred buildings, occupied a slightly elevated platform near the confluence of the Cladeus. The Stadium was on the eastern side of the Altis, and the Hippodrome a little beyond it. The place is now called *Andilalo.* At the eastern end of the plain stood Pisa, which seems to have fallen into decay soon after its defeat by Elis. Two roads led from Olympia to Elis, one of which descended the Alpheus and took the plain, passing through the towns Dyspontium and Letrīni, *Phyrgo,* and near Pheia, which was probably situated at the neck of the singular promontory of Ichthys; the other crossed the mountains by Heraclea, *Strefi,* Salmōne, on the river Enipeus, *Floka,* and Pylus: Cycesium lay to the north of Olympia. In Triphylia—along the valley of the Alpheus, Epitalium, *Agulenitza,* the same as Homer's Thryon or Thryoessa, not far from the mouth of the river; Scillus, the abode of Xenophon, on the Selinus, which joined the Alpheus a short distance below Olympia; and Phrixa, or Phæstus, higher up the river. An immense lagoon stretched along the coast south of the Alpheus, near the termination of which stood the old town of Samia, and later the fortress of Samicum, *Khaiaffa:* the Anīgros, *Mavro-potamo,* discharges itself a little below; Pylos Triphylicus was on the south side of this river, and distant nearly four miles from the sea.

18 MESSENIA occupied the lower half of Western Peloponnesus from the river Neda. In the north it bordered upon Arcadia, from which it was separated by the range of heights, now called *Makryplai,* that connect Lycæum with Taygetus: the highest of these hills was Cerausium, *Tetrazi.* The same series of heights descending southwards formed also the boundary between Messenia and Laconia, as far as the sources of the Pamīsus, *Pirnatza,* or *Dhipotamo,* which thence formed the line of separation to the sea coast. Towards the south, the land ran out into an extensive peninsula, ending in the promontory of Acrītas, *C. Gallo.*

Messenia contains a larger extent of plain and a richer soil than any other province of Peloponnesus. The valley of the Pamisus is divided into an upper and lower plain: the former called after its chief town, Stenyclārus, to the north-east of Ithome; the latter lying along the sea-coast, and so famed for its fertility as to attain the appellation of *Macaria.* The southern and western parts of Messenia also possess a very great proportion of level ground capable of cultivation. The hills which penetrate into the interior attain no very great height; their sides were clothed with forests, and their summits were generally free from snow. The fertility of this province, resulting from the combined causes of rich soil and favourable temperature, made it an important adjunct to the comparatively barren country of the Spartans. The most remarkable hill was Ithōme, *Vurkano.* the last of a series of heights which project westward from the *Makryplai,* separating the two plains already referred to. It is situated on the right bank of the river Balyra, extending in a slightly curved form from north to south, and connected at the latter point with a similar hill of inferior height, named Mount Evan. Ithome was an inaccessible post, and on that account selected as the citadel of the old Messenians, and in later times as the protection of their capital of Messene, which was erected under its western declivity.

The chief rivers are, the Neda, on the northern boundary, flowing between precipitous banks with a deep and rapid stream; and the Pamisus, *Dhipotamo,* with its tributaries. The Pamisus itself has but a short course: it takes its rise in swampy ground, south-east of Ithome, and flows with a full stream to the south; it is joined near its source by a river of much greater length, which drains the plain of Stenyclarus, named Balȳra, *Vasiliko,* and again, near its mouth, by a tributary on its left bank—the Aris, *Pidhima.*

The topographical notices of Messenia belong for the most part to its earliest history. Homer mentions towns which had no existence in later times, and many of the most interesting scenes of his poems are laid in this district. Pylus, the capital of Nestor, is identified with the well-known spot of that name on the promontory of Coryphasium: the honour was in old times contested by the other towns of this name in Triphylia and Elea. Andania, the ancient capital, stood on the Charadrus, an eastern tributary of the Balyra; Œchalia, a little eastward, on the site of the more modern Carnasium; Anthēa is supposed to correspond with Thuria, on the Aris; and Æpēa with Corone. Dorium lay to the north-east of Cyparissia. Pheræ and Cardamyle existed in historical times, but were not then included in Messenia.

The history of the Messenian wars introduces us to some localities in the north-eastern angle of the country, which seems to have been the point of ingress to the Spartans, and consequently the chief scene of operations. Amphēa was probably situated on the upper course of the Amphitus; Stenyclarus, on the eastern border of the plain named after it; and the fortress of Eira, on the heights of Cerausium, overhanging the Neda. Ithome has been already mentioned.

During the three centuries that followed the conquest of Messenia, we have only occasional mention of places on the coast. Between the border of Elis and Pylos there was but one town, Cyparissia, *Arkadhia*, which gave its name to the extensive bay on this part of the coast, and to the promontory that terminated it to the south. South of this, the island of Prote lies off the coast. The promontory of Coryphasium follows, the supposed site of Pylos, and the northern inclosure of the *Bay of Navarino*. The bay is semicircular, two miles and a half in breadth. An island, *Sphagia*, generally identified with the ancient Sphacteria, stretches across the mouth of the bay, leaving an entrance 1400 yards in width at its southern, and another of 150 yards at its northern extremity, opposite to which is the projecting headland of Coryphasium. On the inside of the promontory there is a lake or lagoon, now called *Osmyn Aga*,—of which there is no mention in ancient writers,—having an inlet from the harbour. The modern town of *Navarino* stands at the southern outlet of the bay, and some conjecture that this was the site of Nestor's capital. The scene of the operations in the Peloponnesian war was at the northern extremity of the bay now called *Paleo-castro*. Methōne, *Mothoni*, south of Pylos, possessed a good port, protected on the west by the tongue of land on which the town was situated, as well as by a rock at its mouth. The Œnussæ Insulæ, *Sapienza* and *Kabrera*, lie a short distance off the coast. On the eastern coast of the peninsula there were two ports, Asĭne and Corōne, which occasionally gave name to the large bay between the coasts of Messenia and Laconia, Sinus Asinæus or Coronæus, *Gulf of Koroni*. The former was situated about five miles from the promontory of Acritas, and was chiefly remarkable as a settlement of the old Dryopian stock: Corone was higher up—not on the site of *Coron*, but at *Petalidhi*. The town of Messēne, *Mavromati*, the later capital of the province when the Messenians were restored to independence, was founded B.C. 370, and built under the supervision of Epaminondas: it was situated on the western side of Ithome, and the fortifications enclosed the summit of the hill. Limnæ, on the borders of Laconia, and so often a source of contention between the two countries, was probably the swampy ground about the sources of the Pamisus.

19 LACONIA.—The western boundary of Laconia has been already stated as the river Pamisus, and the northern continuation of Taygetus, *Macryplai*. Towards the north it was separated from Arcadia by the high ground which forms the watershed between the Alpheus and the Eurotas; near the eastern coast it was contiguous to the small district of Cynuria, and in this direction had no strongly marked natural limit; in other parts it was bounded by the sea. The two highest ridges of Peloponnesus, Taygetus and Parnon, traverse this region in a southerly direction, and occupy almost the whole of the province with their extensive ramifications; they sink towards the head of the Laconian bay, but reappear more to the south in the high peninsular ridges which end in the promontories Tænărum, *Cape Matapan*, and Malēa,

St. Angelo. These ranges seem to lie wide apart from each other; but in reality they almost meet at the course of the Eurotas, by means of secondary ranges, which, after a long interval of high broken ground, descend sharply into the valley from a height of about five hundred feet. the highest points* of Taygetus are Talĕtum, *St. Elias*, and Evŏras, to the south-east of Sparta. The Eurŏtas, *Iri*, is the only river of importance in Laconia, receiving numerous tributaries from both the mountain ranges: it has its source in the north-western angle of the province, on the borders of Arcadia: it receives, a little above Sparta, a considerable stream from the north-east, the Œnus, *Kelefina;* then traverses the plain of Sparta, and afterwards the broader plain of Helos, and discharges itself at the head of the Laconian bay. The routes to the northward followed the course of the Eurotas and Œnus; the former leading to Megalopolis, and the upper parts of Messenia, the latter to Cynuria and Argos. The high country between the upper valleys of the rivers was named Sciritis, and across this there was a mountain road, that struck off from the valley of the Œnus, near Sellavia, and went direct to Tegea: on the western side, the only communication across Taygetus was from Sparta to Pheræ, by a track which followed the course of the river Tiasa, *Pandeleimona.* As these roads ran over high ground, and were defensible at certain points, Laconia was justly described as δυσείσβολος,† 'difficult of access to an invading army.'

A glance at the map will show that Laconia possessed an immense extent of sea-coast; it was not however available for maritime purposes, partly on account of the deficiency of harbours, and the dangers of the southern promontories—partly from the character of the country inland, and its remote position in reference to other provinces. On the eastern coast there was only one seaport, Epidaurus Limĕra, *Palæa Nomenvasia*, which was protected on the south by the projecting headland (formerly an island) of Minoa. In the Laconian bay, there was Gythēum on the western coast, which served as the arsenal of Sparta; and lower down, Teuthrōne, *Scopopoli;* but neither of these appear to have had any great commerce. Nor was Laconia well favoured in respect to internal resources. The mountain ridges of Taygetus and Parnon were bleak and barren. The high plain that intervenes to the secondary ridge is described as 'a poor mixture of white clay and stones, difficult to plough, and better suited to olives than corn.'‡ The only fertile spots were the valley of the Eurotas, and the plains of Helos and Leuce.

The most important towns lay in the valley of the Eurotas. The defile at its source was commanded by the forts of Ios and Eutæa, the former lying on the Laconian, the latter on the Arcadian side of the border. Sellasia, *Krevata*, was situated at the junction of the roads to Sciros and Cynuria, and just at the spot where the valley of the Œnus is narrowed to a defile by the close approach of two hills, named Evas and Olympus: it was thus the key to the valley of the Eurotas; and as such was occupied by Epaminondas and Antigonus in their invasions of Laconia. Sparta, or Lacedæmon, was on the right bank of the Eurotas, not far below the junction of the Œnus: it was built on a cluster of low hills, fronting the river for a mile and a half, but with a narrow plain intervening. The walls enclosed a circumference of six miles, and the Acropolis was erected on the highest of the hills: the town was divided into five districts. Immediately below the town, the valley of the Eurotas was narrowed on its left bank by the hill of Menelæum. This pass, which was commanded by the position of Sparta, was the entrance to the lower valley of the Eurotas, and the plain of Helos. The villages *Magula* and *Psykiko*, about two miles eastward of *Mistra*, stand on the site of Sparta. Therapne, *Amphisu*, was a suburb of Sparta, on the opposite bank of the river, two miles distant. Amyclæ, the second town in

* There are in all *five* peaks, whence the modern name, *Pente-dactylon.*

† Euripides. Diodor.

‡ Leake's *Morea*, i. 143.

Laconia, stood on the right bank, about two miles and a half below Sparta, on a tributary named the Phellia; it was beautified with numerous temples. Helos was on the sea-coast, at the southern edge of the plain, near the mouth of the Eurotas.

Off the promontory of Malea lay Cythēra, *Cerigo,* an island of the utmost importance to the Lacedæmonians. It was twice occupied with effect by the Athenians, in the Peloponnesian war, and after the battle of Cnidus. The town of Cythera stood on the eastern coast, about a mile and a quarter distant from the principal harbour, Scandea.

20 ARGOLIS.—This division of Greece embraced several independent states, connected together only by geographical contiguity, and not by any political bond. These states were Argos, Epidaurus, Trœzēne, Hermiŏne, and the southern district of Cynuria, which was at some periods a portion of the Argive territory, but more frequently independent. Phliasia is generally included in Argolis; but as it is separated from the plain of Argos by natural boundaries, and belongs physically to the district that borders on the Corinthian Gulf, it has had a separate place assigned to it.

Argŏlis consisted of the maritime district that lies eastward of the high chain of the Arcadian mountains—Artemisium, *Turniki,* and Parthenium, *Partheni.* On the north it was separated from Phliasia by a branch of Lyrceum, and by the range of high ground proceeding eastward from it, which forms the watershed between the rivers flowing northward to the Corinthian Gulf, and those which water the plain of Argos. On these two sides its boundary is tolerably regular, but not so the line of its coast. An extensive peninsula runs out towards the south-east, formed by the high range of Arachnæus and its subordinate hills—Titthēum, Cynortium, and Coryphæum. This peninsula is washed on its northern side by the Saronic, and on its southern by the Argolic gulf. It terminates in the promontory of Scyllæum, *Skyli;* it has several projections, particularly that of Methāna on its northern coast; and it is fringed with numerous islands, such as Calauria, Hydrea, and others.

There is only one plain of any size, that namely, in which Argos was situated, and which stretches back from the head of the Argolic Gulf for a distance of nearly ten miles to Mycenæ. This *plain,* as well as the city, is called Argos by Homer and Euripides. It is watered by numerous streams, or rather torrents, (for they are dependent chiefly on storms and the melting of the winter snows,) the most important of which is the Inăchus, *Banitza,* with its tributary the Charadrus, *Xerias.* Argos itself stood on the right bank of the latter, about three miles distant from the sea: its citadel was built upon a steep rock that rises to the height of a thousand feet at the back of the town, named Larissa; in later times, there was a second citadel on a lower height, named Deiras, connected with Larissa: Argos retained its size and splendour down to the age of Strabo. The plain is swampy in the neighbourhood of Argos: higher up it becomes dry and parched. Mycēnæ, *Kharvati,* was situated at the head of the plain: it ranks as one of the oldest cities of Greece, having been founded by Perseus, B.C. 1400; some portions of its Cyclopian architecture still remain: it was wholly destroyed B.C. 468. South of Mycenæ, just at the foot of the range of hills that bound the plain, was the Heræum, the common temple of Argos and Mycenæ. Tiryns, *Paleo-anapli,* also celebrated for its Cyclopian remains, was situated in the plain south-east of Argos, about two miles from the sea, with its citadel on an oblong rock, elevated about fifty feet above the plain. Nauplia, the port of Argos, on a tongue of land south of Tiryns, had an excellent harbour, still called *Napoli.* The western side of the plain, south of Argos, was bounded by the hills Lycōne, Chaon, and Pontīnus: from the second issues the Erasinus, *Kephalari,* the outlet, as was supposed, of the Arcadian river Stymphalus. Between Pontinus and the sea was the celebrated marsh or lake of Lerna, the scene of Hercules' combat with the monster. It was probably identical with the still existing Halcyonian pool, of which we also hear in Grecian myths. The plain of Argos is bounded to the south by the hills which form the pass of Anigræa; on the other side of which comes the valley of the Tanus, and the district called Cynuria, or Thyreātis. This was the border-land of Laconia and Argolis, and the source of many bitter contests. During the Peloponnesian war, the expelled Æginetans were settled here by the Spartans, then in possession of it: they were in turn ejected by the Athenians, and the Argives were finally made masters of it. The chief town was Thyrea, distant a mile and a quarter from the sea, on a tributary of the Tanus: it gave its name to the bay, which served as its harbour, Thyreātes Sinus, *Gulf of Astro*. The other towns were—Anthēna, on the road from Thyrea to Sparta; and Eva, a border town in the same direction. The territory of Epidaurus extended chiefly along the north-eastern coast of Argolis; but it appears to have stretched also across the peninsula. It consisted of the valleys of the Arachnæan range. Epidaurus itself, *Pidhavro*, lay on the eastern coast opposite Ægina, on a promontory: the small plain that belonged to it for two miles along the sea-coast, produced, and still produces, the vine. Epidaurus possessed a fleet, and its position was favourable for maritime purposes: its chief celebrity, however, arose from the temple of Æsculapius, about five miles distant, which was visited from all parts of the world; it was situated in a thickly-wooded deep valley, under Mount Tittheum. Trœzene occupied the eastern, Hermione the western, extremity of the peninsula. The former town was situated opposite the peninsula of Methāna, and equi-distant (at an interval of two miles) from two bays on each side of it: its chief port, Pogon, so called from its resemblance to a *beard*, was protected by the island Calauria: the citadel was on a rugged hill, the base of which was washed by streams on either side; the site is called *Damala*. Methāna, or Methōne, was connected with the main land by a very narrow neck, which the Athenians walled across in the Peloponnesian war. The island Calauria is chiefly memorable for the death of Demosthenes, which took place at the asylum of Neptune: the channel between it and the coast is now so shallow as to be fordable, and hence called the Straits of *Poro*. Hermiŏne, *Kastri*, stood on a projecting tongue of the southern coast, with the hill Pron rising behind, and the island of Hydrea, *Hydra*, opposite to it: in its territory were some towns of little importance, as Halica westward, and Mases near the southern promontory, off which lay the island of Tiparēnus, *Spezzia*.

21 Arcadia.—It now only remains for us to describe the central district of Peloponnesus. Its boundaries have been already stated in the description of the contiguous countries. It consists of a highly elevated plateau, broken up by mountains and river courses, and in some few spots opening into plains of varied extent, the whole being encircled by a higher barrier of mountains. There is but one outlet for the waters of this large district—that, viz., by which the Alpheus passes into the maritime district of Elis. Nature has provided, however, an escape for the rivers which do not flow into the Alpheus, by subterraneous channels, *Katabothra*, worked through the limestone of which the rocks consist: they are found especially in the eastern part of Arcadia.

The most marked natural division of Arcadia is that which separates the water-basin of the Alpheus from the eastern plains of Mantinea and Tegea, consisting of a series of heights known from north to south as Aroania, Penteleum, Sciathis, Mænălus, and Borēum. Between these heights and those which form the eastern boundary of Arcadia—Artemisium and Parthenium—there extends a long valley or strip of plain, subdivided by lesser heights into portions, which formed the districts of separate towns. Along this valley ran the road that communicated between the Isthmus of Corinth and Laconia—the scene of so many encounters in the later history of Greece. The road entered Arcadia, by way of Stymphālus, at the north-eastern corner. The plain of Stymphalus, *Kionia*, was about six miles in length, bounded on the northern side by a spur of Cyllene of that name, on the southern by

Apelaurum; and on the western, by Oligyrtus. The waters thus enclosed collected in a lake, on the banks of which stood the town, and escaped by a subterraneous passage, emerging, as was believed, in the Argolic river of Erasinus. The plain of Caphyæ follows on the southern side of Oligyrtus, similarly surrounded, with the town situated at the western extremity of the Orchomenian lake: the Achæans were defeated near this place by the Ætolians. A hill called Trachys, projecting towards the lake from the east, bounds the plain of Orchomenus; the town itself, *Kalpaki*, was strongly posted in the ravine that connects the plains of Caphyæ and Orchomenus, through which the road passed, opposite Trachys. The plain extends southwards to the hill of Anchisia, *Armenia*, over which the road crossed to the plain of Mantinea: this was the most favourable spot for military operations, and no less than four important actions occurred here. Mantinēa itself was originally situated in the northern part of the plain, on a hill now called *Gurtzuli*: it was afterwards removed into the centre, near Mount Alesium, where it lay on both sides of the small stream Ophis, covering a large area, and altogether one of the most important towns of Greece. The scene of contest between the Bœotians under Epaminondas, and the Lacedæmonians and others, B.C. 362, lay in the southern part of the plain, under the wooded height of Scope. From Mantinea, roads led not only north and south, but eastward across Artemisium to Argolis, and westward to Methydrium. The plain of Tegea was separated from the Mantinean by the Pelagus Wood; it was about ten miles in length by five in breadth, bounded on the east by Parthenium, on the west by Mænalus, and on the south by Cresium. The town itself lay in the southern part of the plain, south-east of *Tripolitza*, and came next to Mantinea in size and importance: its proximity to Laconia brought the Tegeans into frequent collision with Sparta, though occasionally, as in the Peloponnesian war, it led to an alliance with that power. Tegea seems to have retained its importance down to the time of Pausanias. From Tegea, the road to Laconia began to ascend, by a stream reputed to be the upper course of the Alpheus, to the high land of Sciritis. There was also a pass thence to Argos across Parthenium, and a track by the course of Gareates to Thyrea. The western portion of the Tegean plain is half enclosed by the advancing height of Boreum: in the angle of it, and on the road that led to Megalopolis, was situated Pallantium, *Tripolitza*, after which the surrounding plain was named. The chief celebrity of Pallantium was derived from the tradition, that Evander, the founder of Rome, came from thence. A road crossed the Mænalian ridge thence to the upper valley of the Alpheus and Megalopolis.

The western portion of Arcadia, consisting of the water-basin of the Alpheus, is far larger than the eastern valley we have just described. The general course of the Alpheus is from south-east to north-west: the position of its sources was undecided; the common opinion of the ancients was, that the Alpheus and the Eurotas had a common source in the high ground of Sciritis, and that, after flowing together for a short distance, they were engulphed in a *katabothra*, and separating, reappeared on different sides of the mountain, the Alpheus at Pegæ, south-east of Megalopolis. Another account, however, represented the Alpheus as rising in the district of Tegea.

The valley of the Alpheus consists of an upper and a lower plain, connected by a long ravine: in the former Megalopolis was situated—Heræa formed the centre of the latter; the straits or narrow passage lay about Brenthe, where the advancing heights of Lycæum impended over the river. The plains possessed a rich soil, and the banks of the river were shaded with groves of plane-trees; most of the hills were covered with forests either of oak or fir, intermixed with pasture-ground, which adapted this province for pastoral pursuits; the temperature is considerably below that of the maritime districts of Peloponnesus. The most important tributaries of the Alpheus are from the north—i. e., on its *right* bank: they were—the Helisson, *Davia*, which receives the waters of the western declivities of Mænalus and crosses the plain of Megalopolis; the Gortȳnius, *Atzikolo*, in the centre of the province, which joins the Alpheus in the ravine below Brenthe; the Ladon, which flows through the plain of Heræa: this river exceeds the Alpheus in volume of water, and in modern times receives the name *Rufias*, by which the lower course of the Alpheus is distinguished; it drains the northern portion of Arcadia, receiving tributaries from the Aroanian mountains and from the valleys westward of Orchomenus; and lastly, the Erymanthus, *Dhimitzana*, which runs parallel to the range of the same name, near the border of Elis.

The most important town of this district was Megalopolis, *Sinano*, the later capital of Arcadia, erected by the advice of Epaminondas, B.C. 370: it was built on both banks of the Helisson, and in the centre of the plain which extended from the hills to the Alpheus: its size was so great that the population of many neighbouring towns was drawn off to fill it: in Strabo's time it was nearly deserted. Heræa, *Aianni*, on the right bank of the Alpheus, above the junction of the Ladon, was the chief town in the lower valley, and its proximity to the Elean frontier exposed it to frequent contests. Aliphēra, *Nerovitza*, stood south of Heræa, on a height commanding the plain; the Eleans occupied it before the Social war, as an excellent post for offensive operations. South of Aliphera, the ground rises to the hill of Cotylium, which separates the valley of the Neda from that of the Alpheus. The chief town on the Arcadian bank of this river was Phigalia, *Pavlista*, strongly posted on a precipitous rock overhanging the Neda; its position on the borders both of Elis and Messenia exposed it to frequent struggles: it possessed numerous handsome temples, the most celebrated being that of Apollo Epicurius at Bassæ, the remains of which are still very considerable. In the northern part of Arcadia we meet with Psophis, *Tripotamia*, on M. Erymanthus, an important post, as it commanded the road that led from Elis and Arcadia across Erymanthus to Achaia; Cleitor, near *Mazi*, at the junction of a small stream of its own name with the Aroanius, a northern tributary of the Ladon, surrounded by hills and strongly fortified; and Cynætha, *Kalavryta*, north of Cleitor, on the Achæan side of the mountain-barrier, and on the banks of the Erasinus which flows into the Corinthian Gulf. Between Cynætha and Pheneus the river Styx takes its rise, on the northern declivity of the Aroanian range. Pheneus, *Fonia*, lay under Mount Cyllene, situated in the midst of a plain like that of Stymphalus, with a lake in the centre, receiving the streams of the Olbius and Aroanius, and discharging them by a *katabothra:* occasionally the outlet filled up, in which case the waters burst forth into the Ladon, and caused an inundation. The remains of an embankment to restrain these inundations are still visible. The town of Pheneus stood at the north of the lake, with its citadel on a cliff.

II. *The Isles of the Ægæan Sea, and Cyprus.*

The Isles of the Ægæan Sea were ranged by Greek writers under two classes, the Cyclădes and the Sporădes. The former consisted of the group that surrounded the sacred isle of Delos, the numbers and the names of the islands being, however, very variously stated: the latter included all the remaining islands, which were termed Sporades, i. e., the '*scattered*,' from their irregular positions with respect to each other. Many of the Sporades have been already described in the account of Asia Minor, along whose coasts they chiefly lie: the Cyclades remain to be described. Andros, *Andro*, Tenos, *Tino*, and Myconos, *Mycono*, lie in a line with Eubœa, from which the first is distant only ten miles, stretching towards the south. Delos, *Delo*, follows, south of Myconos, held sacred as the birthplace of Apollo and Diana, and hence chosen by the Athenians as the place of congress, and as the treasury of their confederation; Mons Cynthus rises in the centre of the island. At a distance of half a mile lay Rhenēa, also sacred to Apollo, and at one time connected with Delos by a chain: it was, indeed, frequently called Delos, and shares with it the same modern name. After the decay of Corinth, Delos became, through its central position with respect to Europe and Asia, and through the excellence of its port, a place of commercial importance. Syros or Syra, *Syra*, the birthplace of Pherecydes; the barren rock of Gyărus, *Chiura*, used as a place of banishment by the Roman emperors; Cythnus, *Thermia*, the modern name indicating the existence of warm springs; and Ceos, *Zea*,—lie westward of Delos towards Attica, from the coast of which the last was distant twelve miles. Ceos was at one time the most important of the Cyclades, possessing four towns, two of which had disappeared before Strabo's time, while the other two, Iulis and Carthæa, were flourishing. Ceos gave birth to Simonides and Bacchylides. South of Cythnus was Seriphos, *Serpho*, about twelve miles in circumference, the scene of Perseus' exploits, and in later times used for the same purpose as Gyarus; then Siphnus, *Siphanto*, in the age of Herodotus one of the richest of these islands from its gold and silver mines, but in Strabo's time poor even to a proverb. Cimōlus, *Kimoli*, was celebrated for fuller's-earth; Melos, *Milo*, the most southerly of the group, was fertile and rich in all sorts of productions; lying opposite the coast of Laconia, it was colonized from Sparta, and its adherence to that state during the Peloponnesian war led to the capture of its chief town and the extermination of its inhabitants. South of Delos lie—Paros, *Paro*, with the celebrated marble quarries of Marpessa, and also famed for excellent figs; Oliărus, *Antiparo*, a small island about two miles to the south-west; and Naxos, *Naxia*, east of Paros, the largest of the Cyclades, being nearly eighty miles in circumference, celebrated for its wine, and, prior to the Persian war, the most powerful of the Cyclades; its town of the same name was taken in the expedition of Datis and Artaphernes.

Of the Sporades, there remain to be mentioned, Ios, *Nio*, south of Paros, the reputed burial-place of Homer; Thera, *Santorin*, also called Calliste, the most southerly of the group, occupied by Minyans from Laconia, who became in later times the founders of Cyrene; Amorgus, *Amorgo*, south-east of Naxos, known for its manufacture of linen; Astypalæa, *Stampalia*, of irregular shape, about ninety miles in circumference; Telos and Chalcia between Astypalæa and Rhodes; and Carpăthus, *Scarpanto*, midway between Rhodes and Crete.

The important island of Creta, *Candia*, closes the Ægæan Sea on the south, stretching across from east to west, in a length of about one hundred and forty miles. It is traversed by a lofty chain of mountains; the highest point is in the centre of the island, Mount Ida, *Psiloriti*, the summit of which, nearly 3000 feet above the sea, is covered with snow for the greater part of the year; in the western half the prominent range was called Leucos, *Asprovouna*, and in the eastern, Dicte, *Lasiti*. These mountains are for the most part well covered with forests; being of a calcareous formation, they abound in caves and grottoes.

In shape, Crete resembles an irregular parallelogram; the two western angles or promontories, were known as Kriu-metōpon, *Cape Crio*, in the south, and Corycus, *Cape Grabusa*, in the north. The corresponding promontories at the other extremity were Ampĕlus, *Cape Xacro*, and Samonium, the Salmōne of the 'Acts of the Apostles,' *Cape Salomo*.

The towns scattered along the coast were very numerous; we shall mention Cydonia, *Khania*, on the northern coast, at the neck of the peninsula of Cyamum, with a good harbour; Cnossus, or Gnossus, north-east of Ida, at a short distance from the coast, the ancient capital of Minos, and at all times the principal town of Crete; it possessed a port, Heraclēum, eastward of *Candia*; the site of Gnossus is now called *Macron-teichos*; Lebeu, *Leda*, the port of Gortyna, to the eastward of Prom. Leon; and westward of that promontory 'the Fair Havens,' Kaloi Limĕnes, at which St. Paul touched; Gortȳna, in a plain south of Mount Ida, in Roman times the capital of Crete; its ruins are visible at *Hagios dheka*; and Lyctus, *Lytto*, about fifteen miles south-east of Gnossus, and at the same distance from its port of Chersonesus; it was so considerable a town as at one time to rival Gnossus.

Cyprus, which still retains its name, lay equidistant from the coasts of

Asia Minor and Syria, in that part of the Mediterranean which was called the Pamphylium Mare. It was a Greek island in respect to population; the Phœnicians, who originally occupied it, were confined to the southern coast, while the Dorians held the northern, and the Ionians the eastern. The island is traversed from west to east by two ranges of mountains, the most southerly of which is the Mons Olympus of the ancients, *Mount St. Croce*: these ranges are so lofty as to retain the snow for many months, and their direction exposes the southern coast to extreme heat. Olympus terminates in the west, in Prom. Acămas, *St. Epiphanio*, and in the east, where it runs out into a horn, in Prom. Dinaretum, *Cape St. Andre*, with two insulated rocks beyond, named Kleides, '*The Keys*.' The length of the island is one hundred and forty miles, and its greatest breadth sixty. There is only one plain of any size—viz., that of Salămis on the eastern coast, watered by the river Pediæus; it is formed by the diverging chains of Olympus, the lower of which, Aous, ends in Prom. Thoni, *Pala*. The chief towns were—Soloe, *Aligora*, a seaport on the northern coast, famous for its corrupt Greek (whence the term *Solœcism*): on the east coast, Salamis, at the mouth of the Pediæus; after Constantine's reign it was called Constantia, probably having been rebuilt by him; it was the chief town in the island: on the southern coast, Amăthus, with copper-mines in its neighbourhood; and Paphus, a double town—the old distinguished as Palæpaphus, about a mile from the sea-coast at *Kukla;* and the new a seaport town, somewhat to the westward of Prom. Zephyrium at *Baffo*. The first was the celebrated seat of the worship of Venus.

III. *Illyricum, Illyris, or Illyria.*

This was the general name for the mountainous district that borders on the eastern shore of the Adriatic Sea, from Histria to Epirus. In the north it was contiguous to the province of Pannonia, from which it was separated by a line parallel to the valley of the Savus; eastward, the Bebii Montes and the chain that bounds the valley of the Drilo, named Barnus, separated it from Mœsia and Macedonia. Illyria was divided into two parts, Romana and Græca: the first, the Roman province of Illyria; the second, annexed by Philip II. to Macedonia, and included in the Roman province of that name. The lower course of the Drilo, *Drin*, which joins the Adriatic just where the coast takes a due southerly direction, forms the separation between them.

This country was little known to the writers of Greece and Rome. The high mountains that shut it off from its eastern neighbours, the wild character of its inhabitants, the intricate navigation of its coasts, and the comparatively short and easy transit to Italy by the neck of the Adriatic Sea, led to its being little frequented. In later times, indeed, Epidamnus became the port for the overland route from Italy to Byzantium; and this conduced to a better acquaintance with the southern portion.

1 Illyria Romana, or Barbara, was the northern division. Ranges of mountains running parallel to the sea, traverse it from north-west to south-east, under the names Albius, or Albanus, and Ardius. The only river of importance is the Drilo, which takes its rise in Lake Lychnitis. The province was occupied by three dominant tribes—the Iapŏdes, in the north, on the boundaries of Pannonia, who were subdued by Augustus; the Liburni, who occupied the upper half of the sea-coast, a seafaring people, who early submitted to the Romans, and rendered them good service: and the Dalmătæ, who occupied the lower half of the coast, and were subdued by Statilius Taurus, B.C. 23. After the subjugation of these, Augustus made Illyria into a province. In the later division of the empire, Illyria Romana, together with Pannonia and Noricum, constituted a diocese of the Italian prefecture.

The chief towns were—Scardona, *Scardin*, on the estuary of the river Titius, the seat of the conventus juridicus for Liburnia; Salŏna, on a gulf which still retains the name, the native place of the Emperor Diocletian, who erected a splendid palace, part of which yet remains, at Spalătum, *Spalatro;* Epidaurus, at the western entrance of the *Gulf of Cattaro*, a Roman colony, which retained its importance until the irruption of the Sclavonians; Lissus, *Alessio*, on the left bank of the Drilo, founded by Dionysius, tyrant of Syracuse; its Acropolis was situated on an inaccessible rock; and Narōna, *Vido*, on the river Naro, the seat of a conventus juridicus.

Off the coast of Illyria Barbara lay a number of islands, known as the Liburnĭcæ Insulæ, of which we shall mention—Issa, *Lissa*, one of the smallest, but yet most important from the Greek settlement established there; it was famous for its wine and for its light vessels, 'lembi Issæi;' Pharus, *Lesina*, between Issa and the main land, colonized by inhabitants of Paros; and Melĭta, *Melida*, the most southerly, which has been by some identified with the Melita on which St. Paul was shipwrecked.

2 Illyria Græca extended from the river Drilo to the neighbourhood of the Acro-Ceraunian Promontory. The coast was fertile, and well populated: the interior mountainous, and only adapted for sheep feeding. Parallel to the mountain range of Barnus, which formed the eastern boundary, runs another called Candavius Mons, and between them was situated the large lake Lychnitis, *Lake of Ochrida*, in which the Drilo has its rise. The river Aous, *Boiussa*, enters the southern portion of this province: and there were two other important rivers, the Apsus, *Beratino*, which takes its rise in the Candavian range, and the Genusus, *Skombi*, somewhat higher up the coast.

The inhabitants of Illyria Græca were divided into a number of tribes, of whom the Taulantii seem to have been the most important, occupying the whole extent of the sea-coast: the Parthīni lived northward of Lake Lychnitis, in the valley of the Drilo. The most important towns were Epidamnus, *Durazzo*, founded by Corcyræans, and well known in connexion with the commencement of the Peloponnesian war; the Romans, considering the latter part of the name ominous, changed it to Dyrrachium; under them it became the most important place on this coast, being the commencement of the Via Egnatia; Apollonia, *Polina*, also a Corcyræan colony, and under the Roman supremacy the seat of a famous university: and Lychnĭdus, *Ochrida*, the ancient capital of the Dassaretæ, on the northern shore of the lake of the same name.

CHAPTER VII.

I. ITALIA.—II. SICILIA, SARDINIA, AND CORSICA.

I. *Italia.*

§ 1. General description. — 2. Political divisions. — 3. Liguria. — 4. Gallia Cisalpina. — 5. Venetia, Carnia, and Histria. — 6. Umbria. — 7. Etruria. — 8. Picenum. — 9. Sabini, Marsi, Peligni, Vestini, and Marrucini. — 10. Latium. — 11. Campania. — 12. Samnium. — 13. Apulia. — 14. Lucania. — 15. Bruttium. — 16. The Roman Roads.

THE name Italia was originally applied only to the southern point of the peninsula below the Lametic and Scylacean bays. The Greeks who settled on the south coast extended its application northwards to Pæstum and Tarentum. In the third century B.C. the Romans included under it the country as far north as the Arnus and Rubico. Lastly, Augustus gave the name its widest acceptation by adding Gallia Cisalpina and Histria. Its boundaries at this period were—the Alps, in the N. and N.W.; the Varus and the Mare Inferum, on the W.; the Arsia and the Mare Adriaticum, on the E.; and the Mediterranean on the S.

The geographical features of Italy are strongly marked; the Alps sweep round in a semicircular form from sea to sea, and interpose a barrier between it and the rest of Europe. They were divided into the following distinct ranges, the names of which are preserved in modern geography—Maritimæ, from the shores of the Mediterranean to M. Vesŭlus, *Monte Viso;* Cottiæ (named after Cottius, who maintained his independency in this part of the range,) about the head-waters of the Duria Minor, including M. Matrŏna, *Mont Genèvre;* Graiæ, northwards to Cremōnis Jugum, *Cramont;* Pennīnæ, about the *Great St. Bernard*, across which was a much frequented pass, with a temple sacred to Jupiter Penninus at the highest point; Rhæticæ, eastward to the Atagis, *Adige*, with M. Adūla, *St. Gothard;* Venĕtæ and Carnicæ, from the Atagis to M. Tullus, *Terglou;* and lastly, Juliæ, to the borders of Illyria.

From the western extremity of the Alps emanates the subordinate range of Mons Apenninus, which forms the backbone of Italy; it commences near *Genoa*, and following for a while the line of the sea-coast, gradually diverges into the heart of the country, and traverses in a south-easterly direction the whole length of the peninsula, crossing over finally into the island of Sicily. It attains its greatest height in Samnium, where it emits an important offset to the eastward, which, passing through Apulia and Calabria, terminates in Prom. Salentinum. The Apennines occupy with their lateral ridges a very considerable portion of southern Italy, and form an important feature in the political geography of that country. The high grounds supplied summer pasturage to the flocks of the Apulian and Campanian plains; the declivities were clothed with valuable forests, and the valleys were adapted by their varying altitude to every sort of agricultural produce, and at the same time afforded numerous sites for towns and villages, peculiarly suitable for a rude and insecure state of society.

Northern and Southern Italy differ widely in their general aspects: the former consists of an immense plain, lying between the Alps and the northern Apennines, and watered by the Padus, *Po*, and its numerous tributaries; the latter is broken up in all directions by the lateral ridges of the Apennines, which, in some provinces—as in Etruria, Umbria, Lucania, and Bruttium—penetrate to the sea-coast, while in others they decline at a greater or less distance from it, and leave remarkably fertile plains, as in Campania and Apulia. The rivers in this part are necessarily short: the most important are—the Arnus, *Arno*, in Etruria; the Tibĕris, *Tiber*, which has gained a world-wide celebrity from the mighty city which stood on its banks; the Vulturnus, *Voltorno*, which rises in Samnium and joins the sea in Campania; the Aufĭdus, *Ofanto*, in Apulia; and the Aternus, *Pescara*, higher up the eastern coast.

The coasts of the Adriatic and Tyrrhenian seas present a marked contrast; the former is comparatively very regular, the only noticeable feature in it being the cluster of hills named M. Gargānus, *Gargano*, which projects into the sea and forms a rounded peninsula: the upper part of this coast has been much influenced by the quantities of soil deposited by the *Po*. The coast of the Tyrrhenian sea, on the other hand, abounds with bays and promontories; commencing from the north, the most important are—Sinus Ligusticus, *G. of Genoa;* Prom. Circæi, *M. Circello*, in Latium; Sinus Cumanus, or Crater, *Bay of Naples*, bounded by Prom. Misēnum, *C. Miseno*, in the N., and Prom. Minervæ, *C. Campanella*, in the S.; Sinus Pæstanus, *G. of Salerno*, bounded on the S. by Prom. Posidium; Sinus Lameticus, *G. of Eufemia*, also known by the names Terinæus, Hipponiates, and Vibonensis; and Prom. Scyllæum, formed by the prominent cliff of Scylla at the northern entrance of the Sicilian Straits. The southern coast is also irregular; the peninsula terminates in a double promontory, Leucopetra, *C. dell' Armi*, and Prom. Herculis, *C. Spartivento:* northwards, there is the Sinus Scylaceus, *G. di Squillace*, opposite to the Lameticus, bounded by Prom. Cocynthum, *P. di Stilo*, on the S., and Prom. Lacinium, *C. Colonne*, on the N.; and higher up, the Sinus Tarentīnus, *G. of Taranto*, enclosed on the E. by the Calabrian peninsula, which ends in Prom. Iapygium or Salentinum, *C. di Leuca*.

2 The earliest political divisions of Italy, and the periods at which the changes of population and dominion took place, are questions still involved in great obscurity. All that will be here attempted will be to state as concisely as possible the prevailing opinions on this subject, as far as they bear upon the geographical description of this country.

The Greeks mention certain territorial divisions named after the dominant tribes, viz., Œnotria, or Italia, in the south; Ausonia, or Opica, central Italy; Iapygia, along the eastern coast, from Garganus southwards to Prom. Iapygium; and Tyrrhenia, the western coast, from the Liris northward: they also mention the Ombrici, or Umbri. These names represent the aboriginal tribes, who attained importance before the foundation of Rome. They were in number five:

1. The Osci, Opĭci, or Ausŏnes. This tribe seems to have advanced from the southward, and to have occupied the western coast from the Silarus to the Tiber, and inland to the central range of the Apennines. In historical times they were subdivided into the Æqui, who held the high ground that bounds the plain of Latium, from Tibur to Præneste; the Volsci, who held a similar position from Præneste to Tarracina; and the Aurunci, on the borders of Campania, about Suessa Pometia. The Latini were probably a mixed race, formed by a conquest of the Osci over the Tyrrheni.

2. The Umbri or Ombrĭci. In historical times, this tribe was confined to a district north of the Apennines; but in an earlier age, they possessed Etruria (where a trace of them remained in the river Umbro, and the district Umbria about its mouth) and the upper coast of the Adriatic to the mouth of the Po. The advance of the Tusci on the west, and the Gauls on the north, drove them into the fastnesses of the Apennines.

3. The Tusci. The indigenous name of this important tribe was Rasena: by the Greeks they were improperly called Tyrrheni, which in reality designates the Pelasgic element of the population; by the Latins Tusci or Etrusci, and their country Etruria. The extent of their settlements was once far beyond what they held in historical times; they owned the country north of the Po, between the Ticinus and the Athesis—the interior of Gallia Cispa-

dana—their later country of Etruria, whence they had ejected the Umbri—and lastly, a confederacy of towns as far south as Campania, which, however, at an early period gave way before the advancing power of the Osci.

4. The Sabīni or Sabelli. This tribe occupied the high valleys of the Apennines on both sides of the mountains, from the borders of the Umbri southwards. At the time of the foundation of Rome, they had descended into the *Campagna*, and in later times we find a branch of them, the Hernici, settled in the valley of the Trerus, a tributary to the Liris. The Samnites, and a variety of tribes on the eastern coast, the Hirpini, Frentani, Picentes, Peligni, Marsi, and Lucani, were all members of the Sabine race.

5. The Tyrrheno-Pelasgi. This may be deemed an immigrant tribe from Greece; it formed, however, a most important element in the population of Italy. At the era of the foundation of Rome, the Pelasgi were scattered along the sea-coasts of Campania, Latium, and Etruria, rather as settlers than as possessors of the country: they were also found on the northern coast of the Adriatic, in the towns of Hadria, Truentum, Numana, &c.: the kindred races of the Henĕti in Venetia, and Istri in the peninsula of Histria, formed a connecting link between the Pelasgians of Italy, and the Illyrian and Epirote tribes of the eastern coast. In the south they were found in still greater numbers: from the headland of Garganus to the Iapygian promontory that were known as Iapyges, subdivided into three clans, Daunii, Peucetii, and Messapii. The Choni of the eastern, and the Œnotri of the western coast of Lucania and Bruttium, were also members of the Pelasgian race.

It now only remains to notice those who were decidedly of foreign extraction; (1) the Ligŭres, Ligyes, or Ligustici, occupied Gallia Cisalpina westward of the Ticinus, and the maritime province of Liguria; they were probably connected with the Celtæ, and were found not only in Italy, but westward of the Alps to the Rhone, and even at one time to the Pyrenees; (2) the Ibēres, also a Celtic race, were found in the islands of Corsica and Sardinia, and the kindred tribe of the Sicāni or Sicŭli in Sicily; and (3) the Phœnicians had settlements both on the northern and southern coasts of Sicily, and in Sardinia.

The two centuries after the foundation of Rome witnessed an important change in the population of southern Italy, from the numerous and flourishing colonies planted by the Greeks. The part of the coast along which they were settled, from Tarentum to Rhegium, was named Græcia Magna.

In the north, the entrance of the Gauls effected a permanent revolution in the position of the Italian races, and established a new territorial division. As early as the sixth century they are said to have crossed the Alps, and, ejecting the Etruscans, settled themselves in the rich plains of *Lombardy*. About B.C. 500, fresh tribes appeared, the Boii and Senones, and occupied the district between the Po and the Apennines, thrusting the Umbrians back into the mountains, and altogether restricting the Etruscans to their territories south of the Apennines. The Ligurians were also dislodged from their possessions north of the Po. The extensive district which the Gauls thus occupied was called Gallia Cisalpina.

The periodical migrations of the Samnites from the central range of the Apennines, also gave rise to new geographical divisions. The precise dates of these migrations are not known, but they may be considered as having taken place in the fourth century B.C. The Lucani, in Lucania; the Bruttii, in Bruttium; the Vestini, Frentani, and others on the eastern coast, are all off-shoots of the Sabellian stock.

The settlements of the forementioned tribes, who, with one or two exceptions, communicated their names to their territories, became the foundation of the political divisions of Italy. In the time of Augustus, when the Roman supremacy was established over the whole peninsula, it was divided into the following eleven regions:—1. Latium and Campania; 2. Apulia, Calabria, and the Hirpini; 3. Lucania and Bruttium; 4. Samnium, the Frentani, Marrucini, Peligni, Marsi, Vestini, and Sabini; 5. Picenum; 6. Umbria;

7. Etruria; 8. Gallia Cispadana; 9. Liguria; 10. The eastern half of Gallia Transpadana; 11. The western half of Gallia Transpadana. These we shall proceed to describe, commencing with the northern districts.

3 LIGURIA was bounded by the Sinus Ligusticus on the S., the river Varus, *Var*, on the W., the Macra on the S.E., separating it from Etruria, and the Padus on the N.: it thus comprehended *Genoa, Piedmont* south of the *Po*, and part of *Parma*.

The Apennines and Maritime Alps traverse it in close proximity to the Mediterranean Sea, leaving but a narrow strip of coast land, along which ran the important route to Gaul, named the Via Aurelia. The northern declivities of these ranges slope down towards a spacious plain, crossed in this province by numerous tributaries to the *Po*, of which the most important was the Tanărus, *Tanaro*. The Ligurians were divided into numerous tribes, classed under two divisions as Alpīni and Montāni; the former occupying the Alps, the latter the Apennines: the most important were—the Taurīni, between the Padus and the Tanarus; the Vagienni, in the mountainous region, which contained the sources of these rivers; the Intemelii, on the coast near the western border; and the Inganni, to the eastward.

The most important towns were—Genua, *Genoa*, a much-frequented seaport at the head of the Sinus Ligusticus; Alba Pompeia, *Alba*, on the Tanarus, surnamed after Pompeius Strabo; Asta, *Asti*, farther down the same river; and Dortōna, *Tortona*, to the eastward.

4 GALLIA CISALPINA.—The northern part of Italy was called in historical times Gallia, from the race who occupied it, and, to distinguish it from the other country of that name across the Alps, the names Cisalpīna, Citerior, and sometimes Togāta, were added, the last indicating the use of the Roman *toga*, in contradistinction to the Celtic dress which prevailed in Gallia Braccata. This large district was bounded on the W. and N. by the chain of the Alps, as far as the valley of the Athĕsis, *Adige;* on the E. by that river to its junction with the *Po*, and southward of the *Po* by the Adriatic Sea; and on the S. by the chain of the Apennines and the course of the Rubĭco, *Fiumicino;* it thus comprised the greater part of *Piedmont*, *Lombardy*, and the districts of *Parma*, *Modena*, *Bologna*, and *Ferrara*. The *Po* divided it unequally into Transpadana, the northern, and Cispadana, the southern portion. The course of the Padus, which was called by the Greeks Eridănus, and by the Ligurians Bodencus, has been already noticed; it was navigable for light craft as high up as Augusta Taurinorum, *Turin;* frequent inundations occurred during the summer months from the melting of the Alpine snows. Its lower course has undergone material alterations, in consequence of the flatness of the surrounding country: in ancient times it divided near *Ferrara* into two main streams; the southern of which was named Olana and still *Volano;* the northern, which retained the general direction of the river, Padoa: the latter was subdivided before reaching the sea into seven channels, which at an early period were improved by artificial embankments. The tributaries of the Po, in Gallia Cisalpina, were—on the left bank, the Duria Major, *Dora*, which rises in the *Little St. Bernard*, and waters the valley of the Salassi; the Ticīnus, *Tessino*, which rises in M. Adula, and flows through Lacus Verbanus, *Lago Maggiore*, famed in history for the engagement between the Carthaginians and Romans, B.C. 218, which took place near *Pavia;* the Addua, *Adda*, flowing through Lacus Larius, *Lago di Como*, and joining between Placentia and Cremona; the Ollius, *Oglio*, flowing through Lacus Sebīnus, *L. d'Isco;* the Mincius, *Mincio*, which carries off the waters of Lacus Benăcus, *L. di Garda*, and flows in a sluggish stream by Mantua; and the Tartărus or Atrianus, *Tartaro*, which forms a connecting link between the Padus and Athesis in their lower courses: on the right bank—the Tanarus, *Tanaro*, rising in the Maritime Alps; the small river Trebia, *Trebbia*, rising in the Apennines and joining the Po a little above Placentia, celebrated for the engagement between Hannibal and the Romans, B.C. 218; and the Rhenus, *Reno*, which flows past Bononia, and discharges itself

into the large lagoon formed by the Po: the celebrated meeting between the Triumvirs—Octavianus, Lepidus, and Antony—took place on a small island either in the Rhenus or in its tributary the Lavinius.

The principal tribes and cities in Gallia Transpadana were as follow. The Taurīni, whom we have already mentioned as living in Liguria, were found also to the north of the *Po;* their chief town lay on the left bank of the river, and after the time of Augustus, who made it a Roman colony, was named Augusta Taurinorum, *Turin:* Hannibal found it the most important place in those parts: a road led thence across the Cottian Alps by the present pass of *Mont Genèvre,* following the courses of the Duria Minor and of the Druentia, and passing by Segusio, *Susa,* the capital of the Alpine sovereignty of Cottius. The Salassi lived northwards, chiefly in the valley of the Duria Major, and on the southern declivities of the Alps; they were troublesome neighbours to the Romans until subdued by Terentius Varro, who placed a fortified camp in their territory: Augustus afterwards erected a town in this spot for the protection of the road across Mons Penninus, and called it Augusta Prætoria, *Aosta:* Eporedia, *Ivrea,* was erected for a similar purpose lower down the course of the Duria. The Libicii lived in the plain of the *Po,* below the Taurini, with the town Vercellæ, *Vercelli:* then the Lævi and Marici, with the town Ticīnum, *Pavia,* on the left bank of that river, near its junction with the *Po.* The Insubres were a powerful tribe, between the Ticinus and the Addua, with Mediolānum, *Milan,* for their capital; this town was taken by the Romans B.C. 222, and rose to great eminence, both as a central point of communication and as the seat of a flourishing university; Laus Pompeii, near *Lodi,* also in their territory, was named after Pompeius Strabo, who planted a colony there. North of the Insubres were the Orobii, in the lake district, with the towns Comum, *Como,* the birthplace of the younger Pliny, at the extremity of Lacus Larius, and Bergŏmum, *Bergamo:* from Comum a road led across the Alps by Curia, *Coire,* to Rhætia. The Cenomāni (whose original seats were about the *Maine*) occupied the plain between the Addua and the Athesis: in this district the Romans erected the important town of Cremōna, *Cremona,* on the *Po,* as a defence against Hannibal; it was fortified and possessed many handsome buildings; Vespasian's army sacked it, A.D. 70, and it never afterwards recovered its prosperity. Verōna, *Verona,* on the right bank of the Athesis, was founded by the Euganei, and afterwards occupied by the Cenomani: it was the birthplace of Catullus, Vitruvius, and the elder Pliny, and one of the finest towns of northern Italy. Brixia, *Brescia,* between the lakes Sebinus and Benacus, is one of the few old Etruscan towns which existed in historical times. Mantua, *Mantua,* was built on a small island in the river Mincius: Virgil was born at the neighbouring village of Andes.

Gallia Cispadana consisted of the numerous valleys into which the Apennines break up on their northern side, together with the plain south of the *Po,* from the Trebia to the Adriatic. There was no easy point of access to this country across the Apennines: the Romans entered it usually at its south-eastern extremity, from Ariminum, whence the Via Æmilia, constructed, B.C. 186, by Æmilius Lepidus, led across to Placentia, following generally a line parallel to the hills.

The chief Gallic tribes in this district were—the Anamares, between the *Po* and the Apennines, south of Placentia; the Boii, in the central district about Parma and Modena; the Lingŏnes, in the angle formed by the lower course of the Po and the Adriatic; and the Senŏnes, along the Adriatic south of Ravenna.

Most of the towns owe their origin to the Gauls, but their prosperity to the Romans. Placentia, *Piacenza,* was built at the same time as Cremona, B.C. 219, as a military post for the defence of the border; its importance, as such, was proved after the battles of the Ticinus and Trebia, when the Roman generals effected their retreat thither: after the construction of the Via Æmilia it rose to great importance. Parma, *Parma,* came next on the Via

Æmilia; originally built by the Gauls, it was insignificant until the Romans sent a colony thither, B.C. 183; it suffered much in the civil wars, but was restored by Augustus, with the name Col. Julia Augusta. Regium Lepidum, *Reggio*, was colonized probably by M. Æmilius Lepidus. Mutĭna, *Modena*, colonized by the Romans, B.C. 183, sustained a long siege in the civil wars; it attained a high state of prosperity, being described by Cicero as 'firmissima et splendidissima populi Romani colonia.' Bononia, *Bologna*, was colonized B.C. 190. Ravenna, *Ravenna*, on the coast of the Adriatic, owed its prosperity to its being selected by Augustus as the station for his fleet on that sea; he built a walled harbour, named Classes, which he connected by a canal with the *Po;* the marshes by which Ravenna was surrounded rendered it impregnable. By the advance of the coast, the modern town stands several miles from the sea.

5 1. VENETIA was bounded on the W. by the Athesis, on the E. by the small river Timāvus, on the S. by the Adriatic, and on the N. by the Alpes Carnicæ: it comprehends the eastern part of *Lombardy.* This country derived its name from the Veneti, or Heneti, who settled in it, and who were believed by the ancients to be allied to the tribes of the same name in Paphlagonia and Gallia. No part of Italy was more highly favoured than this; the soil was very productive, and the people pacific both in their temper and pursuits. The Romans annexed it to their empire B.C. 183, chiefly for the purpose of restraining the Gauls: the precise date when it was formally constituted a province does not appear.

The chief rivers were—the Athĕsis, Atesia, or Atagis, *Adige,* on the western boundary, which has its sources in the Rhætian Alps, and flows southwards as far as Verona, thence bends round to the east, and discharges itself into the Adriatic, north of the *Po;* the Medoăcus, *Brenta,* consisting of two united streams, Major and Minor; the Plavis, *Piave,* more to the eastward; and the Tilaventus, *Tagliamento.*

The chief towns were—Patavium, *Padua,* the capital, and the birthplace of Livy, on the Medoacus Minor, which carried on a considerable trade in woollen stuffs; Altĭnum, *Altino,* on the river Silis, near the sea, a depôt for the commerce of northern Europe; and Aquileia, *Aquileia,* founded by the Romans B.C. 181, about seven miles from the sea; it was strongly fortified, and carried on a considerable trade. The roads from Dalmatia, Histria, and Pannonia joined at this point.

2. CARNIA, or Carniola, was the mountainous district to the north of Venetia and Histria. Its inhabitants were a Celtic race, of whose history we know very little. The Romans planted some military colonies at the entrance of the mountain passes, for the protection of the frontier: such as Julium Carnicum, on the upper course of the Tilaventus; and Forum Julii, *Cividale,* north of Aquileia.

3. HISTRIA, which still retains its name, was considered, before the time of Augustus, as a part of Illyria; it was subdued by Claudius Pulcher, B.C. 177. It consisted of the peninsula formed by the diverging horns of the Adriatic, viz., the Sinus Tergestĭnus, *Gulf of Trieste,* and the Sinus Flanatĭcus, *Gulf of Fiume.* The Timavus separated it from Venetia, and the Arsia from Illyria. The only large towns were—Tergeste, *Trieste,* at the head of the western gulf, elevated by Vespasian to the rank of a Roman colony, and thenceforward a place of much importance; and Pola, or Pietas Julia, *Pola,* at the southern point of the peninsula.

6 UMBRIA.—Descending southwards from Gallia Transpadana, we come to the territory of the ancient and once extensive tribe of the Umbri. It has been already observed that the Rubico separated it from Gallia; it thence occupied the sea-coast southward to the river Æsis, *Æsino,* where it adjoined Picenum. The maritime district is but narrow, the spurs of the Apennines protruding to the immediate neighbourhood of the sea. The interior is divided into numerous valleys, ascending to the central range of the Apennines; the Umbri occupied these, from the sources of the Tiber to those of the Nera, as

well as the country on the western side of the range between these rivers down to and even below their junction; it thus comprehended the provinces of *Urbino, Perugia,* and parts of *Romagna* and *Umbria.*

The streams that descend from the eastern declivities of the Apennines attain no great length; one of them, the Metaurus, *Metauro,* is well known from the engagement in which Hasdrubal lost his life, and which took place on the left bank of the river, near *Fossombrone.* On the other side of the mountains, the Tiber and its tributaries have their sources. The Nera, or Nar, *Nera,* rises in Mons Fiscellus, and descends to the south-west, receiving on its left bank the Velīnus and other Sabine streams, and discharging itself into the Tiber: the small Tinia, *Timia,* rises near Spoletium, receives the sacred Clitumnus, and flows north-west, joining the Tiber below Perusia.

The towns of Umbria were—Arimĭnum, *Rimini,* a flourishing seaport, where the Æmilian and Flaminian roads met; Fanum Fortunæ, *Fano,* on the banks of the Metaurus, originally only a temple (as the name implies), but afterwards made a Roman colony, with the name Col. Julia Fanestris; Sentīnum, on the Æsis, the scene of a battle between the Romans and the Samnites; Mevania, *Bevagna,* on the Tinia, in a most fruitful district; Spoletium, *Spoleto,* founded by the Romans B.C. 241, on the Flaminia Via; Narnia, *Narni,* on the left bank of the Nar, strongly posted on a rock, built by the Romans B.C. 300, on the site of the ancient Nequīnum; Interamna, *Terni,* higher up the Nar, and surrounded by it; and Tuder, *Todi,* an old Umbrian town, on the left bank of the Tiber.

7 ETRURIA bordered on the Mare Inferum from the Tiber in the S. to the Macra in the N. The central chain of the Apennines to the sources of the Tiber, and the course of that river thence to the sea, formed its eastern and southern boundaries; on this side it was contiguous to Umbria, the Sabini, and Latium. It corresponds generally with the modern state of *Tuscany.*

Etruria consists of the following districts, widely different in character and climate: (1) the sea-coast, which is marshy and unhealthy; (2) the rich valleys of the Arnus, Umbro, and Tiber, productive of every species of grain; and (3) the wooded heights of the Apennines, and the numerous off-sets that branch from them. These secondary ranges are very irregular in their courses, and produce a corresponding irregularity in the direction of the valleys: in the interior they run rather parallel to the central chain, from N. to S.; nearer the sea, however, their direction is from E. to W.

The lakes form a remarkable feature in the geography of this province; they are for the most part environed with hills, having but one approach, and in some cases no visible outlet: such are the Lacus Trasymēnus, *L. di Perugia,* south of Cortona, which was approachable only on the northern side, the scene of Hannibal's victory, B.C. 217; L. Volsiniensis, *L. di Bolsena,* near Volsinii, which had an outlet by the river Marta; the small L. Vadimōnis, near *Bassano,* now filled up with reeds and peat, between Ciminius Mons and the Tiber, the scene of the defeat of the Etrurians, B.C. 310: L. Ciminius, *L. di Ranciglione;* and L. Sabatīnus, *L. di. Bracciano,* north of Veii, whence an aqueduct conveyed a supply of water to Rome.

The chief rivers of Etruria were the Arnus, *Arno,* in the north, rising in the Apennines, and flowing with a general direction to the west; near its mouth it receives a tributary, the Auser, from the north; the Umbro, *Ombrone,* of much shorter course that the Arnus; the Clanis, a tributary to the Tiber, which rises westward of the Trasymene Lake, and runs in a valley which seems to belong equally to the basins of the Arnus and the Tiber, forming a long marsh or lake, the Palus Clusīna, which had an outlet into both rivers, but chiefly by the Clanis into the Tiber; and lastly, the small but celebrated Cremĕra, *La Valca,* which rises near Veii, and joins the Tiber north of Rome.

Etruria abounded in wealthy and strong towns, the remains of which at this day are very extensive. They were situated almost without exception on hills or cliffs overhanging a stream, and sometimes at the junction of two streams. The walls were of a Cyclopian character, but of a more advanced style than the Pelasgic walls of Tiryns and Mycenæ; the stones being hewn, and fitted in horizontal courses. Twelve of the chief towns formed a confederacy: the names are stated variously, changes probably having occurred by the decay of some, and the introduction of others in their place. The generally received list includes Cortona, Perusia, Arretium, Volsinii, Tarquinii, Clusium, Volaterræ, Rusellæ, Vetulonia, Veii, Cære, and Falerii.

The most important towns in Etruria were—Luna, on the left bank of the Macra, with a spacious natural harbour at the mouth of the river; its walls were built of solid marble, taken from the famous *Carrara* quarries; Luca, *Lucca,* on the river Auser, made a Roman colony B.C. 177; Pisæ, *Pisa,* at the confluence of the Auser and Arnus, with a harbour at the mouth of the latter, whence a considerable trade with Sardinia and Gaul was carried on; Fæsŭlæ, *Fiesole,* situated at the entrance of a pass across the Apennines, on the line of the modern road from *Florence* to *Modena;* Florentia, *Florence,* on the right bank of the Arnus; Arretium, *Arrezzo,* in the upper valley of the Arnus, celebrated for its manufacture of arms and terra-cotta vases, as well as for its vineyards, and important in a military point of view, as commanding the southern route to the valley of the Clanis; Cortōna, *Cortona,* about fourteen miles south of Arretium, and to the north of the Trasymene Lake; Volaterræ, *Volterra,* called also Velathri, strongly posted on the flat summit of a hill overlooking the maritime plain; its walls were seven miles in circumference, and the town ranked as the largest and strongest in Etruria; it withstood Sylla for two years; Vetulonia to the south, on the small river Lynceus, not far distant from the sea; Populonium, *Porto Baratto,* the port and arsenal of the Etruscans, just opposite *Elba;* Rusellæ, in the valley of the Umbro; Clusium, the ancient Camers, at the southern extremity of the Palus Clusina, the capital of Porsenna; Perusia, *Perugia,* between the Trasymene Lake and the Tiber, celebrated for the long siege it sustained against Augustus; Volsinii, *Bolsena,* on the lake named after it, the most wealthy and luxurious of the Etruscan cities; Cosa, on the sea-coast, one of the naval stations of the Romans; Tarquinii, on the Marta, the birthplace of Tarquinius Priscus, and in his time probably the metropolis of the Etruscan confederacy; Falerii, *Civita Castellana,* the capital of the Falisci, which was besieged by Camillus, B.C. 395; Capena, *Civitucula,* a colony from Veii, about five miles from the Tiber; Veii, *L'Isola Farnese,* a fortified town on a cliff overhanging the Cremera, which was taken by Camillus, B.C. 395; Cære, called by the Greeks Agylla, a Tyrrhenian settlement near the coast, well known for the hospitality with which its inhabitants received the Romans at the time of the Gallic invasion; and Centumcellæ, *Civita Vecchia,* where Trajan constructed a magnificent harbour.

Off the coast of Etruria lies the island of Æthalia or Ilva, *Elba,* the iron mines of which were known to the ancients.

8 PICENUM adjoined Umbria, along the coast of the Adriatic, extending southwards to the river Matrīnus, *Piomba;* inland it was bounded by the territories of the Sabini and Marsi: it is now a portion of *Abruzzo Ultra.* In general character it resembles Umbria, being broken up into numerous small valleys, and possessing a fertile soil. The Via Salaria formed the line of communication with Rome.

The most important towns were—Ancōna, *Ancona,* a seaport, which was founded by Syracusans, B.C. 359, and so named from its position on an *elbow* or promontory; Firmum, *Fermo,* about five miles from the sea, which possessed a fortified harbour, named Castellum Firmanum; Ascŭlum, *Ascoli,* a strongly fortified town on the Truentus, which sustained a severe siege against Pompey in the Social War; and Auxĭmum, *Osimo,* on the Miscus, also strongly fortified.

9 The SABINI, MARSI, PELIGNI, VESTINI, and MARRUCINI. These tribes are grouped together, as being allied in race, and contiguous in abode: they

occupied the districts on both sides of the Apennines, from the borders of Etruria, Umbria, and Picenum in the N., to Latium, Samnium, and Apulia in the S.

1. The district of the SABINI was bounded on the N.W. by the Nera, on the S.W. by the Tiber, on the S. by the Anio, and on the E. by the central chain of the Apennines: it is still called *Sabina*.

The chief river is the Velīnus, *Velino*, which rises in the high Apennines, receives a considerable tributary, now called the *Salto*, from the district of the Marsi, and empties itself into the Nera: the lower valley about Reate was liable to inundations, until Curius Dentatus formed an artificial course, which terminates in the celebrated falls of *Terni*. This valley was the original seat of the Sabines: their metropolis was the town abovementioned, Reăte, *Rieti*, which was surrounded by a most fertile country. The Via Salaria passed through it, and the sulphureous springs in its neighbourhood led to its being much frequented by the wealthy Romans. There were many other towns in this and the adjacent valleys in the days of Sabine independency, which disappeared at an early period.

The part of the country best known to us lies in the vicinity of Rome, and abounds with spots of historical interest: here were situated the Mons Sacer, a low range at the junction of the Anio and Tiber, whither the Roman plebs seceded; Fidēnæ, on the Tiber, an early opponent of Rome; the brook Allia, on whose banks the Romans were defeated by the Gauls, B.C. 389; Nomentum, *Lamentana Vecchia*, on the Via Salaria, with excellent vineyards about it; Cures, *Corresse*, the birthplace of Numa Pompilius; and many other places mentioned in the early history of Rome.

The only towns of interest in the eastern part of this province were—Nursia, situated on a spur of the Apennines, near the valley of the Nera; and Amiternum, near *Aquila*, on the eastern side of the main ridge of the Apennines, in the valley of the Aternus.

2. The MARSI dwelt about the Lacus Fucīnus, *Lago di Celano*, and in the high mountain district which contains the sources of the Liris and the *Salto*. The barren and wild character of this small province contributed to the formation of the character of its inhabitants; they were brave, hardy, and independent, and offered a stout resistance to the arms of Rome; they were also much given to superstitious practices, and were adepts in the art of charming serpents, a practice still in vogue among the occupants of this region.

The Lacus Fucinus is surrounded by the highest peaks of the Apennines, the bases of which protrude for the most part to the very edge of the lake, but in some few spots leave a narrow plain: it is about thirty miles in circumference; occasionally its waters rose so high as to inundate the shores; to prevent this, an emissary was constructed by Claudius, which carried the superfluous waters to the Liris. The towns of the Marsi were—Marrubium, *St. Benedetto*, on the eastern shore of the lake; and Alba Fucentia, made a Roman colony B.C. 303, and from the strength of its position selected as the site of a state-prison. The celebrated Lucus Angitiæ has left a trace of its name in the village of *Luco*, on the south-western shore.

3. The VESTINI are sometimes included in Picenum: they did not, however, come within the limits we have assigned to that province, but lived adjacent to it, occupying the sea-coast from the Matrinus to the Aternus, and inland to the chain of the Apennines. The general character of this district is mountainous; but the gradually declining ridges leave a maritime plain of about ten miles width, remarkably fertile in grain and fruit. The chief river is the Aternus, *Pescara*, which rises near the Sabine town of Amiternum, and descends first towards the south-east and then to the north-east, falling into the Adriatic near a town of the same name, Aternum, *Pescara*. The chief town was Pinna, *Civita di Penna*, in the centre of the district, which was besieged by the Romans in the Social War.

4. The PELIGNI held a small mountainous district, adjoining the Marsi,

and south of the Aternus. A valley which supplies a tributary to that river contained their towns of Corfinium, *St. Pelino,* and Sulmo, *Sulmona.* The former stood near the Aternus, and commanded the road which crossed the Apennines from the Marsi to the Adriatic; from its own strength and its favourable position, it was selected as the head-quarters of the allies in the Social War. Sulmo, higher up the valley, is chiefly known as the birthplace of the poet Ovid; it suffered severely from a siege by Sylla.

5. The MARRUCINI occupied a narrow district on the right bank of the Aternus from the Peligni to the sea. The only town of importance was Teāte, *Chieti,* on the bank of the river, a large and prosperous place: the valley produced a superior kind of fig.

10 LATIUM.—The earliest notices that we have of Latium apply the name only to a small portion of the plain which stretches southwards from Rome. In the time of the later kings, it was co-extensive with the Roman dominion, embracing the whole of the plain to Antium and the Volscian hills; and this was afterwards known as Latium Antiquum. When the Romans advanced their conquests beyond the hills, they included the territories of the Volsci, Æqui, Hernici, and Aurunci under that name, or, as it was more properly termed, Latium Novum or Adjectum.

In its widest extent, then, Latium was bounded on the N. by the Tiber and the Anio, on the E. by the districts of the Marsi and Samnites, on the S. by Campania, and on the W. by the Mare Inferum: it corresponds with the modern province of *Campagna di Roma,* with part of *Terra di Lavoro.* It consists of two districts widely differing in appearance and character—the undulating plain which stretches from the Tiber southwards along the coast of the Mediterranean to Circeii; and the hilly country which bounds that plain, and contains the valleys of the Liris, the Trerus, and the Anio. The range which separates these districts extends from Tibur on the Anio, to the sea near Tarracina, and is interrupted only in one spot, near Præneste, where access is given to the valley of the Trerus. The Æqui occupied the northern half of this range, and the Volsci the southern half, with the plain adjacent to it; the Hernici lived behind the range in the valley of the Trerus. These districts we shall now describe more minutely, with the towns belonging to them.

1. The LATINI held the undulating plain from the Tiber and the sea to the hills just described. This plain is broken by the Alban hills, which rise in an isolated group at a distance of about fourteen miles from Rome; they are volcanic in their formation; the loftiest was called Mons Albānus, *Monte Cavo,* and possessed a temple sacred to Jupiter Latiaris; the Feriæ Latinæ were celebrated on it. Under this hill is a lake, Albanus Lacus, in the crater of an extinct volcano; to check the inundations which were caused by the overflow of its waters into the plain, an emissary was constructed, B.C. 397, to the Tiber. There is another smaller lake to the south. the modern name of which, *Nemi,* is derived from the sacred grove, Nemus Dianæ, on its banks.

In this district was Roma, *Rome,* the capital of Italy and of the ancient world, situated on the left bank of the Tiber, about sixteen miles from the sea. The city of Romulus stood on the Palatine hill; under the early kings it extended to the neighbouring heights of Velia, Cermalus, Cælius, Fagutal, Oppius, and Cispius, which, with the Palatine, made up the original seven hills (Septimontium) of Rome. Another city meanwhile, inhabited by Sabines, was erected on the Capitoline, Quirinal, and Viminal hills, and the union of these two cities by Servius Tullius brought Rome to its full extent. The relative position of the seven well-known hills on which the enlarged city stood, is the most important feature in the topography of ancient Rome. Three of them, the Quirinal, Viminal, and Esquiline, are grouped together, being in fact projections from the same high back-ground; the Esquiline is the most southerly of the three, parallel to which, with a shallow valley intervening, rises the Cælian, an oblong hill curving slightly inwards. The Palatine is, as it were, the *focus* to which these several hills point, while two detached heights, the Capitoline and the Aventine, are situated respectively north and south of it, occupying the ground that intervenes between the group and the river Tiber. The highest of these hills, the Esquiline, is about one hundred and sixty feet above the level of the river. The Tiber has a serpentine course, bending inwards, so as to touch the bases of the Aventine and Capitoline, and then outwards with a considerable sweep, enclosing the Campus Martius.

We shall briefly describe these hills, with the position of the most remarkable buildings and streets. The Capitoline has a double summit, the southern of which is the famous Tarpeian rock, on which the temple of Jupiter Capitolinus stood; the northern is the site of the ancient Capitol; the dip between the extremities, called Intermontium, contained the Asylum of Romulus, the Tabularium, or Record Office, and other public buildings. The Forum, now *Campo Vaccino*, was situated between the Capitoline and Palatine; from its low position it was originally swampy, but it was drained by Tarquinius Superbus, who constructed the Cloaca Maxima for the purpose: it was rectangular in shape, and surrounded by temples and statues. Along the eastern side of the Forum, the Via Sacra conducted in one direction to the Capitoline, in the other, along the valley between the Esquiline and Palatine, to the Flavian Amphitheatre, more commonly known as the Colossēum, and thence to the Porta Capena. The Via Sacra was lined with official residences, chapels, and statues, and constituted the most frequented promenade; near the Colosseum was the fashionable quarter called Carinæ, now *Pantani*. The Vicus Cyprius led from Carinæ to Subūra, the most crowded quarter of the whole town, lying in the hollow between the Quirinal and Esquiline. The Esquiline was crowned with the Baths of Titus; beyond which, outside the walls of Servius, were the Gardens of Mæcenas. The Quirinal was similarly occupied by the Baths of Diocletian and the Gardens of Sallust, both of which were within the walls, adjoining the Porta Collina. Collis Hortorum, so called from the number of gardens about it, is now the *Pincian* hill. The Campus Martius was for a long period a vacant space outside the walls, used for public amusement and exercise; the emperors, however, and particularly Augustus, erected numerous public buildings on it, among which the Pantheon, built after the battle of Actium; the Mausoleum Augusti, in which Marcellus and others were interred; the Septa Julia, in which the centuries gave their votes; and the Circusses of Domitian and Flaminius, were conspicuous. Returning into the city, the summit of the Palatine is remarkable as the favourite residence of the emperors Augustus, Tiberius, Caligula, and Domitian; as also of many illustrious citizens, Cicero, Mark Antony, Hortensius, and the Gracchi. Between the Palatine and Aventine lay the Circus Maximus, originally erected by Tarquinius Priscus, and enlarged at various times by Cæsar, Augustus, Claudius, and Trajan; it was an oblong building, rounded at its southern extremity, and large enough to accommodate 385,000 spectators. A series of porticoes surrounded it, with shops under the arcades. Outside the Porta Capena stood the splendid Baths of Antonine; and a little farther on, the Monument of the Scipios. Here too was the valley of Egeria, with the small stream Crabra, *Aqua Santa*.

The other important towns of the Latini were—Ostia, the port of Rome, at the mouth of the Tiber, with salt marshes in its neighbourhood; Laurentum, *Paterno*, the capital of Latinus, about sixteen miles to the eastward of Ostia; Lavinium, *Pratica*, which fell early into decay; Ardea, *Ardea*, the capital of the Rutuli, on an eminence near the sea; Lanuvium, *Lavigna*, on the most southerly of the Alban hills, the native place of the Antonines and many other famous Romans; Aricia, *La Riccia*, at the foot of Mons Albanus, which retained its importance under the Roman empire, partly through its beauty and fertility, partly through the celebrated grove and lake of Diana in its immediate neighbourhood; Alba Longa, on a spur of the Mons Albanus, and on the north-eastern edge of the lake; Tuscŭlum, *Frascati*, on the most northern of the hills, the residence of many celebrated men, particularly Cicero, Mæcenas, and Lucullus; Gabii, about twelve miles from Rome, a colony from Alba: Præneste, *Palestrina,* an important post, commanding the entrance to the valley of the Trerus, and possessing a celebrated temple, sacred to Fortune, with an asylum; and Tibur, *Tivoli,* on the Anio, renowned for its beauty, which attracted thither Mæcenas, the emperor Hadrian, and other illustrious men; it is further interesting as the abode of Syphax and Zenobia.

2. The Æqui or Æquicŏli occupied the upper valley of the Anio, with the hilly country adjacent to it, between the territories of the Latini on the W., the Sabini on the N., the Marsi on the E., and the Hernici on the S. They were the constant foes of the Romans down to their subjugation, B.C. 303. The only town of importance was Carseŏli, on the Via Valeria, where the Romans were in the habit of placing hostages and state-prisoners.

3. The Hernici lived between the Æqui and the Volsci, in the valley of the Trerus and on the hills to the north of it. The Trerus is a tributary to the Liris, rising near Præneste and flowing towards the S.E. The chief town of the Hernici was Anagnia, *Anagni,* well situated on a spur of the hills which bound the valley on the N. The Via Latina passed through it, which led to its being frequently attacked by the enemies of the Romans. Ferentīnum, *Ferentino,* and Frusĭno, *Frosinone,* were towns of less importance, similarly situated on the Via Latina.

4. The Volsci occupied a larger portion of Latium than any of the tribes already mentioned. On the W. they held the sea-coast from Antium to Tarracina; on the E. their territory advanced to the border of Samnium; they occupied the valley of the Liris northwards to the country of the Marsi; and on the side of the Latini they held the mountain district that bounds the Latin plain.

The chief river was the Liris, *Garigliano,* which rises near the Lacus Fucinus, and reaches the sea at Minturnæ: the Trerus is its chief tributary. Several small streams descended from the Volscian hills into the maritime plain, and were there absorbed in a large marsh, well known under the name of Pomptīnæ Palūdes. In the days of Volscian independence, this plain had been carefully drained, but after the destruction of the towns on it, the rivers stagnated there. Many attempts were made by the Romans to remedy this evil, particularly by Corn. Cethegus and Julius Cæsar. Augustus succeeded to great extent by the construction of a canal, which served the double purpose of drainage and navigation: it ran parallel to the Via Appia from Appii Forum to Tarracina.

The chief town of the Volsci was Antium, *Porto d'Anzo,* situated on a rocky promontory near the border of the Latini, with a port named Ceno close by; in the time of the Roman kings it possessed great maritime power, and did the Volscians good service with its fleet; it was finally conquered B.C. 338, and the beaks of its vessels were carried to Rome and placed in the Forum. The other places of interest were—Velĭtræ, *Velletri,* just below the Alban hills, the birthplace of Augustus; Astŭra, on the coast below Antium, the country residence of Cicero; Circeii, on a high peninsular rock overhanging the sea, named M. Circæus, *Monte Circello,* frequently mentioned in the early wars of Rome; Anxur or Tarracīna, *Terracina,* on the summit of a hill, which commanded the Appia Via on one side, and overlooked the sea on the other; Aquīnum, *Aquino,* the birthplace of Juvenal, in the valley of the Liris; and Arpīnum, *Arpino,* higher up the same valley, the native place of C. Marius and of Cicero, who possessed an estate in the neighbourhood.

5. The territory of the Aurunci extended along the sea-coast from near Anxur to the border of Campania; inland it was separated from the Volscian district by a chain of hills, which terminated at the valley of the Liris. On the western boundary these hills approach the sea-coast, and formed a narrow pass near Lautŭlæ, through which the Appia Via went; this pass was occupied by Fabius Maximus in the second Punic war. The territory of the Aurunci, particularly the Ager Cæcubus, yielded excellent wine.

The chief towns were—Fundi, *Fondi*, near a lake of the same name; Cajēta, *Gaeta*, on a promontory which enclosed on the W. the gulf named after it, Sinus Cajetanus, *Gulf of Gaeta;* Formiæ, *Mola*, on the shores of the gulf, where Cicero possessed a villa, in which he was put to death; and Minturnæ, near the mouth of the Liris, with considerable marshes about it, in which Marius took refuge.

11 CAMPANIA was bounded by the Mare Inferum on the W., the river Silarus on the S., Samnium on the E. and N.E., and Latium on the N.W. Mons Massicus, *Montedragone*, celebrated for its vineyards, separated it from the latter; and a line of isolated heights, Tifāti Montes, *Maddaloni*, Taburnus, *Taburno*, and others, separated it from Samnium: it corresponds with the province of *Terra di Lavoro*, with a part of *Principatro Citra*.

Besides the hills already mentioned, there are others of greater importance: such as Lactarius, on the southern side of the Sinus Cumanus; Gaurus, a volcanic range, on the opposite side of the bay, between Cumæ and Neapolis; and particularly the celebrated Vesuvius, which rises not far from the centre of the bay: the frequent eruptions of this mountain have altered its own form as well as the line of the neighbouring coast: Strabo describes it as having a level summit, and there is little doubt that the ridge now called *Somma* is the ancient top, the conical elevation above that being of comparatively modern formation: the changes on the coast are marked by the position of Herculaneum and Pompeii, which formerly stood by the sea, as well as by the altered course of the river Sarnus. To the north of Mons Gaurus there is a considerable plain, stretching as far as the Vulturnus, to which, in all probability, the name Campania (from *campus*) was originally applied; the southern part of this, near Cumæ, was of a volcanic character, and was thence named by the ancients Phlegræi Campi (the *burning* fields), Laborinus Campus (whence the modern name, *Lavoro*, is derived), or Area Vulcani. The effects of volcanic agency are particularly visible in this neighbourhood: near Cumæ was the Lacus Avernus, in an extinct crater, deemed the entrance to the volcanic regions from the mephitic exhalations that rose from its surface; close by was the Lacus Lucrinus, which has been almost filled up by a volcanic mountain, *Monte Nuovo*, which suddenly rose up A.D. 1538: Agrippa connected these lakes with each other and the sea by opening channels between them, and thus constructed a double harbour, which he named Portus Julius.

The rivers of Campania were — the Vulturnus, *Volturno*, which rises in Samnium, and, in its upper course, flows towards the S.E., but, after its junction with the Calor, turns abruptly to the W., and having skirted the base of the Tifati Montes, crosses the plain to the sea; the Sarnus, *Sarno*, which rises in Mons Taburnus, and discharges itself into the Sinus Cumanus, near Pompeii; and the border stream of Silărus, *Sele*, the upper course of which belongs to Lucania.

The beauty of Campania, the luxuriousness of its climate, and the fertility of its soil, rendered it the favourite residence of the wealthy citizens of Rome.

The coast of Campania abounded with prosperous towns. Cumæ was the most ancient, and, at one time, the most powerful city in these parts: it was founded by Æolians, B.C. 1030, and, in turn, it founded Puteoli, Messana, and Neapolis: its chief celebrity arose from the oracle of the Sibyl; Baiæ, *Baia*, near Prom. Misenum, was much frequented for its mineral waters; Putĕŏli, *Pozzuoli*, on the opposite side of a small bay, possessed a good port, whence a considerable trade with the East was carried on: sulphureous springs were common in this neighbourhood, and are said to have given rise to the name of Puteoli, the place having originally been called Dicæarchia: eastward of Puteoli, a spur of Gaurus, named Colles Leucogæi, approaches so close to the shore as to intercept the road: a tunnel was made through this by the command of M. Agrippa, and still exists under the title of the *Grotto of Posilyppo*, which it derives from the celebrated villa of Pausilȳpon, erected by Augustus near it: over the tunnel is the building reputed to be Virgil's tomb; Neapolis, *Naples*, stood at the north-eastern angle of the Sinus Cumanus: it was originally named Parthenŏpe, and probably derived its more modern name from some additions that were made to it after the Samnite conquest of Campania; Herculaneum and Pompeii were farther down the coast: they were overwhelmed by an eruption of Vesuvius, A.D. 79, which proved fatal to the elder Pliny; Salernum, *Salerno*, was the last town of importance on the coast: it was colonized by the Romans, B.C. 194, and was the chief town in the territory of the Picentini, who were settled in the southern part of Campania. The chief towns in the interior were—Teānum, *Teano*, surnamed Sidicinum, from its being the capital of the Sidicini, in the northern part of the province; Casilīnum, *Capua*, on the Vulturnus; and Capua, *S. Maria di Capua*, a short distance from the left bank of that river, the chief town of northern Campania, and historically famous for the fatal influence which its luxurious climate had upon the Carthaginian army.

Off the coast of Campania lie the islands of Prochȳta, *Procida*, Pithecūsa, *Ischia*, and Capreæ, *Capri*, the last of which has obtained an unfortunate celebrity as the scene of Tiberius' debauchery.

12 SAMNIUM was an irregularly shaped province, lying on both sides of the Apennines, and bounded by Latium and Campania on the W., Apulia and the Frentani on the E., Lucania on the S., and the Marsi and Peligni on the N.; it comprehended *Principato Ultra*, *Sanneo*, and part of *Abruzzo Citra*.

The Apennines attain their greatest extent and elevation in this province, and present the appearance of a solid wall of rock, rising out of the plain; their lower regions are clothed with belts of forest, while the uplands afford excellent pasturage during the summer months. The valleys on the western side of the central range are watered by the Vulturnus, *Voltorno*, and its numerous tributaries, the chief of which is the Calor, *Calore*; those on the eastern side by the upper courses of the Sagrus, *Sangro*, Tifernus, *Biferno*, Frento, *Fortore*, and Aufĭdus, *Ofanto*, which flow into the Adriatic. The inhabitants of Samnium were brave and warlike, and for a long period withstood the Roman power; they were divided into three clans, the Caraceni in the N., the Pentri in the centre, and the Hirpīni in the S.; to these a fourth is sometimes added, the Caudīni, who are more properly regarded as a subdivision of the Pentri.

The chief towns were—Aufidēna, *Alfidena*, the metropolis of the Caraceni; Æsernia, *Isernia*, near the source of the Vulturnus; Venāfrum, *Venafro*, celebrated for its oil, on the right bank of that river; Boviānum, *Boiano*, near the source of the Tifernus; Beneventum, *Benevento*, in the valley of the Calor, one of the oldest towns of Italy, and of importance from its position on the Appia Via; it received a colony from Rome B.C. 268, when its former ill-omened title of Maleventum was abolished; and Caudium, *Costa Cauda*, between Beneventum and Capua, situated near a defile (Furculæ Caudinæ) of Mons Taburnus, in which the Romans were ignominiously defeated B.C. 321; the defile has been identified with the valley of *Arpaia*. The celebrated sulphureous lake of Amsanctus lay in a valley of the same name, eastward of Beneventum.

13 APULIA, in its widest extent, was bounded on the N. by the Frento, on the W. by the Apennines, and on the E. and S. by the Adriatic Sea: it thus included the whole of the Iapygian peninsula, and comprehended *Capitanata*, *Bari*, and *Otranto*. More strictly, however, Apulia applied only to the northern portion of this district, from the Frento to the spot where the Apennines approach the sea in the neighbourhood of Egnatia, the peninsula itself being distinguished as Calabria or Iapygia.

Apulia proper consists of an extensive plain, extending from the mountains to the sea, and crossed by numerous streams, of which the Aufidus is the most important. The coast is low and regular, with the exception of the remarkable promontory or cluster of hills named Garganus. The southern district on the other hand is mountainous, being traversed by an offshoot of the Apennine range, which emanates from the central chain near Venusia, and as it approaches the sea gradually expands, and covers the whole of the peninsula: this high ground terminates in Prom. Iapygium, *C. di Leuca.* The population was of a mixed character, Illyrians and Greeks having settled among the old Ausonians. The territorial divisions were named after the inhabitants, Apŭli being retained as the general title: these divisions were four in number—Daunia from the Frento to the Aufidus, Peucetia thence to Egnatia, Calabria along the eastern coast of the peninsula, and Messapia along the western, including the district of the Salentini near Prom. Iapygium.

The chief towns were—Sipontum, *Siponto,* a sea-port, south of M. Garganus; Salapia, *Salpi,* on a large lagoon more to the south; Arpi, *Arpi,* said to have been founded by Diomedes, whose memory was retained in the name given to the surrounding plain, Campus Diomedis; Canusium, *Canosa,* on the right bank of the Aufidus, where the Romans took refuge after their defeat at Cannæ, which lay about five miles lower down the river; Venusia, *Venosa,* the birthplace of Horace, close under the Apennines; Barium, *Bari,* a fishing station, and the chief town in Peucetia; Egnatia, *Agnazzo,* in Calabria, where the Via Egnatina came upon the sea-coast; Brundusium, *Brindisi,* the well-known port whence the Romans crossed over to Greece, and the terminus of the Appia Via; Hydruntum, *Otranto,* more to the south, also possessing a good harbour; and Tarentum, *Taranto,* at the head of the fine gulf which was named after it, originally founded by Iapygians, but occupied by a Lacedæmonian colony B.C. 707, and afterwards the most powerful city in Magna Græcia: it possessed a small but eminently productive plain.

Two roads connected Apulia with Rome—the Via Appia, which entered the province near Venusia, and crossed the Apennines to Tarentum, whence it was continued to Brundusium; and the Via Egnatina, which parted from the Via Appia at Beneventum, and crossed the plain by Æcæ and Canusium to Barium and Egnatia, and so on to Brundusium.

14 LUCANIA, which is supposed to derive its name from the Greek word λευκὸς, 'white,' in reference to the limestone rocks common in that province, was bounded on the E. by the Sinus Tarentinus, from the Bradanus, *Brandano,* to the Crathis, *Crati;* on the W. by the Mare Inferum from the Silarus, *Sele,* to the Laüs, *Lao;* on the N. by Samnium and Apulia; and on the S. by Bruttium: it comprehended *Basilicata,* the greater part of *Principato Citra,* and a part of *Calabria Citra.*

The Apennines intersect it in all directions, and approach very near the coasts, only leaving small maritime plains about the mouths of the rivers; they do not, however, obtain the height of the Samnite mountains. On the borders of Apulia rises the lofty hill named Vultur, whence the south-east wind was called Vulturnus. The rivers are necessarily of short course; the Silarus, on the border of Campania, receives two tributaries from Lucania—the Tanăger, *Negro,* remarkable for having a subterraneous course for some miles, and the Calor, *Calore;* on the eastern coast, the Acĭris, *Agri,* flowing into the Tarentine Gulf, is the most important; the Siris, *Sinno,* lower down the coast, is known from the battle which took place on its banks between Pyrrhus and the Romans; the Crathis, on the frontier of Bruttium, receives on its left bank the Sybaris, *Sibari,* and higher up, near Consentia, the Acheron, *Mucone,* on the banks of which Alexander of Epirus perished.

The most flourishing towns of Lucania were the colonies planted by the Greeks along the sea-coast. Metapontum, at the mouth of the Casuentus, is said to have been founded by Pylians on their return from Troy; it attained considerable prosperity, but sunk after the Punic wars. Heraclēa, *Polycoro,* on the Aciris, was founded by Tarentines, and was the place where the Greek colonists held their congress. Sybăris, at the junction of the Crathis and Sybaris, was founded B.C. 720, by Achæans and Trœzenians, and speedily became a most powerful and luxurious place; it perished B.C. 510, in a war with the neighbouring city Crotona; near its site Thurii was erected, B.C. 446, by the remains of the Sybarite population, reinforced by new colonists from

Greece, and speedily rose to eminence; it was plundered by Hannibal, and restored by the Romans B.C. 190, with the name Copiæ. On the western coast there were—Buxentum, *Policastro*, a colony from Messana B.C. 467; Elea, or Velia, from Phocæa B.C. 553, the birth-place of Parmenides, and the seat of the Eleatic school of philosophy; and Posidonia, better known by the later name of Pæstum, *Pesto*, founded by the Sybarites B.C. 582, famed for its roses, and for the remains of its temples.

15 BRUTTIUM occupied the southern extremity of the peninsula, from the rivers Laüs and Sybaris, comprehending the modern divisions of *Calabria Citra* and *Ultra*.

It is throughout mountainous; there is, however, a remarkable interruption in the Apennine range between the Sinus Lameticus and S. Scylaceus, which approach within twenty miles of each other, with low ground intervening: the ridge to the south of this was named Mons Sila. The streams are short and unimportant.

The chief towns of Bruttium were Greek colonies. Crotōna, *Cortrone*, situated on the eastern coast, was the most flourishing: it was founded by Achæans, B.C. 710, and attained great celebrity as the seat of the Pythagorean school: it suffered severely in a contest with the Locri, and sunk into insignificance about the time of the Punic wars. Scylacium, *Squillace*, a short distance from the bay named after it, was founded by Athenians; Caulonia, *Castel Vetere*, lower down the coast, by Crotonians; both were destroyed by Dionysius the Elder, and afterwards restored, but without regaining their former prosperity. Locri, *Pagliapoli*, the capital of the Locri Epizephyrii (so called from the neighbouring Prom. Zephyrium), was founded by Opuntian Locrians, B.C. 683; though it did not possess a harbour, it nevertheless attained considerable prosperity before its capture by Dionysius the Younger. Rhegium, *Reggio*, founded by a mixed colony of Chalcidians and Messenians, B.C. 688, owed its chief importance to its position in reference to Sicily, as being the usual point for the passage from Italy to that island; it was taken and plundered by Dionysius the Elder, after a siege of eleven months; and though afterwards restored, its former prosperity never returned; it suffered from frequent earthquakes, as well as from the effects of the civil war. Hipponium, Vibo, or Valentia, *Bivona*, was the only Greek town of importance on the western coast; it was founded by Locrians, and destroyed by Dionysius the Elder, who transported its inhabitants to Syracuse. Pandosia, the ancient capital of the Œnotrians, was situated on the river Acheron, probably at *Castel Franco*. Consentia, *Cosenza*, the capital of the Bruttii, stood on a height near the source of the Crathis.

16 The Roman roads form an important feature in the geography of ancient Italy, and therefore deserve particular notice. The Via Latina led southwards from Rome, by Anagnia and Ferentinum, to Casilinum, where it joined the Via Appia. The Via Appia, formed by Appius, B.C. 312, crossed the plain of Latium by the Alban hills to Tarracina, thence followed the line of the sea-coast to Sinuessa, and there struck inland to Casilinum and Capua, which formed the original terminus. Augustus afterwards continued it to Brundusium, by Beneventum, Venusia, and Tarentum. From Beneventum, a branch struck off to the eastward, by Æquum Tuticum and Canusium, to Egnatia, and along the coast to Brundusium; this was called Via Egnatina, or, as some suppose, Via Trajana, from its having been restored by the emperor Trajan. The Via Ardeatina led to Ardea; the Via Ostiensis, along the left bank of the Tiber, to Ostia; the Via Labicana to Labicum, and onward to the station Ad Pictas on the Via Latina; the Via Prænestina through Gabii to Præneste; the Via Tiburtina to Tibur, whence the Via Valeria was constructed to Carseoli, Alba Fucentia, Corfinium, and the shores of the Adriatic; and the Via Nomentana to Nomentum and Eretum. The Via Salaria followed the course of the Tiber to Eretum; thence it struck into the interior to Reate, crossed the Apennines to Asculum in Picenum, and joined the coast road, which led in one direction to Ancona, in the other to Hadria.

The Via Flaminia was the great northern road, which communicated with Gallia Cisalpina; it was constructed, B.C. 221, by Flaminius the Censor; it crossed the Tiber by the Milvian bridge into Etruria, and recrossed it at Ocriculum, and led thence by Narnia and Spoletium across the Apennines to the valley of the Metaurus, by which it descended to Fanum Fortunæ. The Via Æmilia, starting from the latter place, and following the coast to Ariminum, struck across Gallia Cispadana to Placentia. The Via Cassia and the Via Claudia were connected with the Via Flaminia as far as the Milvian bridge, and about six miles from Rome they branched off,—the former to Sutrium, Volsinii, Clusium, Arretium, and Florentia; the latter to Sabate, Sena Julia, and Luca. Lastly, the Via Aurelia followed the coast of the Mare Inferum by Centumcellæ, Pisæ, Luna, and Genua to Gaul.

II. *Sicilia, Sardinia, and Corsica.*

1 SICILIA, *Sicily*, one of the most important islands in the ancient world, was separated from Italy by the Fretum Siculum, *Straits of Messina.* Its historical names, Sicania and Sicilia, were derived from its original inhabitants, the Sicani and Siculi; the poetical appellations, Trinacria and Triquetra, are supposed to refer to its triangular shape.

The Fretum Siculum is about two miles and a half across at its northern entrance, but gradually expands as it advances southward. The navigation of these straits was supposed to be dangerous in consequence of the proximity of Scylla and Charybdis. The former is a precipitous rock, about 350 feet high, standing out from the mainland of Italy, opposite Prom. Pelorus; the latter is a strong eddy, now called *Galofaro*, caused by the meeting of the currents, and is strongest near Messana: a distance of several miles intervenes between them. Sicily is generally mountainous; three main ridges form the framework of the island—Nebrōdes, *Madonia*, which runs from the centre towards the eastern angle, and there terminates in Prom. Pelōrus, *C. di Faro;* Heræi Montes, *Monti Sori*, which run towards the south-eastern promontory of Pachȳnus, *C. Passaro;* and Crathas, which traverses the north-western district, and may be considered to terminate in the heights of Eryx, *St. Giuliano;* the name of the western promontory was Lilybæum, *C. Boco.* The most celebrated of the Sicilian mountains, Ætna, is unconnected with these ranges; it rises out of a plain on the eastern coast in an isolated mass: numerous eruptions are mentioned in classical writers. The plains are few, and of no great extent; the largest is that on which Catana stood, to the south of Ætna, anciently called Læstrygŏnum Campus, and now *Piano di Catania.* The soil of Sicily was, with the exception of the high ground in the centre, eminently fertile; the abundance of grain which it produced rendered it a most important acquisition to the Romans, and obtained for it the appellation of the 'granary of Italy.'

The earliest inhabitants of this island were the Celtic tribe of the Sicani or Siculi—in all probability, the same people under different titles. The Phœnicians established depôts for commercial purposes along the western coasts, and attained considerable power; but their fame and influence were eclipsed by the flourishing colonies planted by the Greeks, along the eastern and southern coasts especially, which became the seats of powerful states, and extended their authority over the whole island. The Romans invaded it in the second Punic war, and reduced it to a province B.C. 241.

Of the numerous towns of Sicily, we can only mention the most illustrious. Messāna, *Messina*, once called Zancle from its *sickle-shaped* harbour, was situated on the Fretum Siculum, opposite Rhegium; it derived its later name from the Messenians, who settled there. Naxus, on the eastern coast, was founded by Chalcidians, B.C. 736, and destroyed by Dionysius B.C. 403; its inhabitants shortly after settled at Tauromenium, *Taormina.* Catăna, *Catania*, was founded by Naxians, B.C. 730; it lay in the rich plain south of Ætna. Not far south was Leontini, *Lentini*, founded by Chalcidians in the same year. Syracūsæ, *Syracusa*, which ranked as the capital, was founded by Dorian colonists under Archias, B.C. 735. The town was originally built on the small island Ortygia, and thence spread to the mainland, with which the island was connected by a mole. The great harbour lay on the southern side of the island, the little harbour on the northern; a stream called the Anāpus discharged itself into the former. The town was situated on gently rising ground, which terminated abruptly towards the plain at the back; the walls enclosed an area twenty-two miles in circumference. It was divided into five districts: Ortygia, on which the citadel stood; Acradĭna, facing the sea; Tyche, the most densely-populated, behind it; Epipŏlæ, the highest part of the town, overlooking the plain; and Neapolis, near the Anapus. Syracuse was taken by the Romans, B.C. 212. On the southern coast were—Camarīna, *Torre Camarina,* a colony from Syracuse, B.C. 598; Gela, *Terra Nova,* founded by Rhodians and Cretans, B.C. 688, on a river of the same name; Agrigentum, or Acragas, *Girgenti,* a colony from Gela, B.C. 580, the most flourishing of the Sicilian towns after Syracuse, its ruins still attesting its former magnificence; Heraclea Minōa, westward of the mouth of the Halycus, successively in the hands of Cretans, Selinuntians, Spartans, and Carthaginians; Selīnus, *Castel-vetrano,* founded by Megarians, B.C. 626, in the midst of a very fertile district; and Lilybæum, *Marsala,* a Carthaginian settlement on the promontory of the same name. On the northern coast were—Drepănum, *Trapani,* and Eryx, on the western declivity of the hill so named, both of them Carthaginian towns; Egesta, or Segesta, at the junction of two streams named Scamander and Simois, reputed to be a Trojan colony, and historically famous for its hostility to its neighbour Selinus; Panormus, *Palermo,* celebrated for its spacious harbour; and Himĕra, *Termini,* founded by Chalcidians from Messana, B.C. 639, destroyed by the Carthaginians B.C. 409, and replaced by a town on the other side of the river, named Thermæ Himerenses, from hot springs about it. In the interior, the chief towns were—Centurĭpa, *Centorbi,* an old Siculan town, south-west of Ætna, the most important corn-market in the island; and Enna, *Castro Giovanni,* strongly situated in the central mountains, and hence selected as the stronghold of the slaves in the second Servile war.

To the north of Sicily lies a group of islands, variously called Æoliæ, Vulcaniæ from their *volcanic* character, or Lipareæ after the largest of them, Lipara, *Lipari;* the most northerly, Strongy̆la, corresponds with the modern *Stromboli;* Hiĕra, *Vulcano,* was the most active in ancient times. Off the western extremity of Sicily are the Ægātes Insulæ, chiefly known from the naval contest in which the Carthaginians were defeated, B.C. 242.

2 SARDINIA, or Sardo, as the Greeks called it, and CORSICA, or Cyrnus, were situated due south of Genua, and parallel, the second to Etruria, the first to Campania. They are both very mountainous: the main ridge in Sardinia was called Insani Montes, in Corsica Aureus Mons. The first was the most productive, but also the most unhealthy; the latter yielded cattle and timber.

The population of Sardinia was originally Iberian, but soon mixed with Carthaginians, who planted colonies along its coasts and obtained a supremacy over the whole island. It fell into the hands of the Romans at the conclusion of the first Punic war, and was united with Corsica as a province. The chief towns were—Olbia, *Terra Nuova,* in the north, the spot of embarkation for Rome; Carălis, *Cagliari,* on the south coast, the seat of government; and Cornus, on the western coast, the capital of the native population.

Corsica was similarly occupied by a variety of races—Iberians, Ligurians, and Carthaginians; the Phocæans also settled here, but soon deserted it. The chief towns were Mariāna, a Roman colony, planted by Marius; and Aleria, probably identical with Alalia where the Phocæans settled, also colonized from Rome: they were both on the eastern coast.

CHAPTER VIII.

I. HISPANIA. — II. GALLIA. — III. BRITANNICÆ INSULÆ. — IV. GERMANIA. V. RHÆTIA, NORICUM, PANNONIA.—VI. DACIA.—VII. SARMATIA EUROPÆA.

I. *Hispania.*

HISPANIA, *Spain* and *Portugal*, was bounded by the Mare Cantabricum, *Bay of Biscay*, on the N., the Pyrenæi Montes on the N.E., the Mare Internum on the E. and S.E., and the Oceanus Atlanticus on the W. and S.W. The name Hispania is supposed to have been introduced by the Carthaginians: the Greeks named it Iberia, probably because the coast about the river Iberus first became known to them. It was occasionally called Hesperia by the Latin poets, from its westerly position in reference to Italy.

The peninsula of Hispania is severed from the rest of Europe by the Pyrenæi Montes, which commence near the Mediterranean, and run across to the Bay of Biscay. The ramifications of this chain extend over the whole country; the western continuation, which runs parallel to the northern coast, was named Mons Vindius, or Vinnius; Idubĕda was the southern offset which forms the western boundary of the valley of the Iberus, with which M. Caunus, *Moncayo*, and Saltus Manlianus, were connected; Orospĕda commences about the mid-course of Idubeda, and diverges towards the south, containing the sources of the Bætis; a western offset from it, named M. Marianus, *Sierra Morena*, divides the water-basins of the Anas and the Bætis; a second and parallel ridge, M. Ilipŭla, skirts the coast of the Mediterranean, terminating near the *Straits of Gibraltar*.

Among the numerous rivers of Spain six are pre-eminent—the Ibērus, *Ebro*, which drains nearly the whole eastern angle of the peninsula between M. Idubĕda and the Pyrenees; the Bætis, *Guadalquivir*, which falls into the Atlantic west of Gades; the Anas, *Guadiana*, which has a parallel course to the north of the Bætis; the Tagus, *Tagus*, which rises in M. Idubeda, and traverses the central provinces in a westerly direction; the Durius, *Douro*, more to the north; and the Minius, or Bænis, *Minho*, which rises in M Vindius, and flows towards the S.W. into the Atlantic.

The most remarkable promontories are—Prom. Pyrenæum, *C. de Creux*, on the borders of Gaul; Artemisium, or Ferraria, *C. de St. Martin*, opposite the Insulæ Pityusæ; Scombraria, *C. de Palos;* Prom. Charidēmi, *C. de Gata*, which forms the south-eastern angle; Calpe, *Gibraltar*, one of the celebrated Columnæ Herculis; Prom. Junōnis, *C. Trafalgar*, outside the Fretum Gaditanum, *Straits of Gibraltar;* Prom. Sacrum, *C. St. Vincent*, the south-western angle; Prom. Barbarium, *C. Espichel;* Prom. Magnum, *C. de Roca*, north of the mouth of the Tagus; Prom. Nerium, *C. Finisterre;* and Prom. Trileucum, *C. Ortegal*, at the north-western corner.

Of the various races which tenanted Spain, the Ibēri are generally held to be the aborigines; at an early period, however, a Celtic tribe crossed from Gaul, and coalescing with the Iberians, formed the mixed race of the Celtiberi. In some districts these races remained distinct; the Iberians, the progenitors of the modern *Basques*, occupied the Pyrenees and the sea-coasts; the Celts were found about the Anas and in Gallæcia; while the Celtiberi held the central plains, and particularly the high land where the tributaries of the *Ebro* and *Tagus* take their rise. The Greeks visited the coast and planted some few colonies, of which Barcino, Tarraco, Zacynthus, afterwards Saguntum, and Emporiæ, may be mentioned; they also penetrated outside the *Straits of Gibraltar*, to Gades and Tartessus, the latter of which is in all probability identical with the Tarshish of Scripture. The Carthaginians, from their greater proximity, traded more regularly with it, and established their stations along the coast. The foundation of Carthago Nova, B.C. 228, led to hostilities with Rome, and for a time the *Ebro* formed the boundary of their respective dominions. At the end of the second Punic war, however, the Carthaginians were expelled, and the Romans divided Spain into two parts, Citerior and Ulterior, the *Ebro* separating them. When the native tribes had been subdued after a series of wars, Augustus divided the country into three provinces—Tarraconensis, Bætica, and Lusitania; to which Constantine afterwards added a subdivision of the first, Gallæcia, and three provinces which did not, strictly speaking, belong to Spain—viz., Baleares, Carthaginiensis, and Mauretania Tingitana.

1 LUSITANIA, the most westerly of the divisions of Spain, was bounded on the W. and S., by the Atlantic Ocean, on the N. by the Durius, and on the E. by the Anas and Tarraconensis. It comprehended *Portugal* and the Spanish provinces of *Estremadura* and *Salamanca*. The southern angle was called Cuneus, from its resemblance to a *wedge;* a similarity in the name has led some to assign it as the residence of the Cynetes mentioned by Herodotus.

TRIBES.*	TOWNS.
Lusitāni, in *Portuguese Estremadura* and *Beira*	Scalăbis, *Santarem.*
Vettōnes, in *Spanish Estremadura* and *Salamanca*	Augusta Emerĭta, *Merida.*
Celtĭci, in *Alentejo* and *Algarve*	Pax Julia, *Beia,* Ebŏra, *Evora.*

2 BÆTICA derived its name from the river Bætis, which flowed through the centre of the province. It was bounded on the N. and W. by the Anas, and on the S. by the Atlantic and the Mediterranean; on the E. it was contiguous to Tarraconensis. It corresponds with *Andalusia* and part of *Spanish Estremadura.*

TRIBES.	TOWNS.
Turdetāni, in *Seville*	Hispălis, *Seville,* Gades, *Cadiz.*
Turdŭli, in *Cordova*	Cordŭba, *Cordova,* Astigi, *Ecija.*
Bastŭli, in *Granada*	Munda, *Monda.*
Celtici, in *Estremadura*	Pax Augusta, *Badajoz.*

3 TARRACONENSIS embraced all the remaining northern, central, and eastern provinces of Spain. It derived its name from its capital town, Tarraco.

TRIES.	TOWNS.
Contestāni, in *Murcia*	Carthago Nova, *Cartagena.*
Edetāni, in *Valencia* and *Arragon*	Turium, *Valencia,* Cæsar Augusta, *Saragossa,* Saguntum, *Murviedro.*
Ilercaŏnes, in *Eastern Valencia.*	Dertōsa, *Tortosa.*
Cosetāni, Læetāni, Ausetāni, Indigĕtes, Cerretāni, in *Catalonia*	Tarrăco, *Tarragona.* Barcĭno, *Barcelona.* Ausa, *Vique.* Emporiæ, *Ampurias.* in the district still called *Cerdagne.*
Lacetāni, Jaccetāni, Ilergĕtes, Vescitāni, in *Arragon,* north of the *Ebro*	Ilerda, *Lerida.* Osca, *Huesca.*

* The position of the tribes in Spain is most easily and clearly defined by a reference to the modern divisions of the country, and to the chief towns about which they lived. These are therefore given in a tabular form; the places of particular interest will be noticed presently.

TRIBES.	TOWNS.
Vascōnes, Vardŭli, in *Navarre*	Pompēlon, *Pampeluna*, Calagurris, *Calahorra*. Menosca, *St. Sebastian*.
Caristi, Autrigŏnes, in *Biscay*.	
Cantăbri. in *Santander*, and the eastern parts of *Asturias*.	
Astŭres, in *Asturias* and *Leon*	Asturĭca, *Astorga*.
Gallæci, in *Gallicia* and *Northern Portugal*	Lucus Augusti, *Lugo*, Augusta Bracăra, *Braga*.
Vaccæi, in *Old Castile*	Pallantia, *Palentia*, Pintia, *Valladolid*.
Arevăcæ, in *Burgos*	Cluuia, *Corunna del Conde*.
Carpetāni, in *Madrid* and *Toledo*	Tolētum, *Toledo*.
Oretāni, in *Mancha*	Castŭlo, *Cazlona*.
Celtibēri, in *Soria* and *Cuenca*	Bilbĭlis, *Calatayud*.

The places that have obtained any historical celebrity are the following:—Gades, or Gadeira, *Cadiz*, a flourishing port ou the southern coast, built on an island adjacent to the main-land,—in later times celebrated for its wealth and luxury; Carteia, *Rocadillo*, near Prom. Calpe, also an important port; Corduba, ou the Bætis, the birthplace of the Senecas and Lucau, and besieged by Cæsar in the Civil war; Italica, *Sevilla la Vieja*, on the same river, the birthplace of the emperors Trajan and Hadrian; Illiturgis, *Andujar*, high up the Bætis, taken and destroyed by Scipio, B.C. 210; Munda, *Monda*, near the southern coast, celebrated for the victory of Scipio over the Carthagiuians, B.C. 216, aud of Cæsar over the sons of Pompey, B.C. 45; Carthago Nova, a sea-port, built by the Carthaginians under Asdrubal, and afterwards taken and colonized by the Romans; Valentia, higher up the coast, destroyed by Pompey in the Sertorian war; Saguntum, on the coast opposite *Majorca*, besieged by the Carthaginians B.C. 219, against whom it held out for eight months; and lastly, Numautia, near the source of the Durius, taken, after a siege of several years, by Scipio Africanus Minor, B.C. 133.

Two groups of islands lie off the eastern coast of Spaiu—the Baleāres, or Gymnesiæ, and the Pityūsæ. The former consisted of Major, *Majorca*, Minor, *Minorca*, and some few others of insignificant size; the latter of Ebūsus, *Ivica*, and Ophiūsa, *Formentaria*. The Baleāres were occupied by a mixed population of Phœnicians, Rhodians, and Spaniards, who were subdued by the Romans B.C. 123. They were chiefly celebrated for their skill in slinging, which adapted them for acting as mercenaries. The name Baleares has been commonly, though improperly, derived from the Greek word βάλλω, 'to cast'—a derivation to which both the spelling of the name, and the fact that the Greeks called them Gymnesiæ, are objections.

II. *Gallia.*

GALLIA was bounded on the W. by the Atlantic Ocean, on the S. by the Pyrenees and the Mediterranean Sea, on the E. by the Rhine and the Alps, and on the N. by the Fretum Gallicum, *Straits of Dover*, and the Oceanus Britannicus, *British Channel*. It comprehended *France*, *Belgium*, *Switzerland*, with parts of *Holland* and *Germany*. The Greeks described it by the names Celtica, Galatia, or Celto-Galatia; the Romans named it Gallia Transalpina, or Ulterior, in order to distinguish it from Gallia Cisalpina.

The chief mountain ranges are—the Alps, which have been already described; M. Cebenna, *Cevennes*, a northern continuation of the Pyrenees; M. Jura, *Jura*, north of Lacus Lemanus, *Lake of Geneva*; and M. Vosĕgus, or Vogesus, *Vosges*, which runs parallel to the Rhine, in *Alsace*. A wild and mountainous tract of forest-land, in the N.E., was named Arduenna Silva, *Ardennes*. The chief rivers are—the Rhodănus, *Rhone*, which rises in the Alps, passes through Lacus Lemanus in a westerly course, and after its junction with the Arar, *Saone*, turns towards the south, and flows into the Mediterranean; the Garumna, *Garonne,* which rises in the Pyrenees and flows into the *Bay of Biscay;* the Liger, *Loire,* which has by far the longest course, rising in M. Cebenna, and traversing the central districts of *France,* discharging itself into the *Bay of Biscay;* the Sequăna, *Seine,* which flows into the British Channel; the Mosa, *Meuse,* which flows towards the north, and connects with the Rhine near the sea; and lastly, the Rhenus, *Rhine,* which formed the boundary between Gaul and Germany from the Alps to the German Ocean; it formerly discharged itself by two channels, of which the most northerly retained the name of the river, while the other, uniting with the Mosa, was called Vahălis, *Waal.* Mention is made of a third mouth, named Flevum Ostium; this was probably an artificial channel, constructed by Drusus, in order to check the inundations to which the country about the lower course of the river was liable: it connected the Rhine with the *Yssel,* and so with the *Zuyder-Zee.* The chief tributaries of the Rhine in Gaul were the Nava, *Nahe,* and the Mosella, *Moselle,* which rises in M. Vogesus, and joins it at Confluentes, *Coblentz.*

The southern coasts of Gaul were, from an early period, frequented by the Carthaginians; and it is not improbable that an active trade was carried on with Britain and the north, by the *Rhone* and the *Seine.* The Greeks were not much acquainted with it, though Massilia, *Marseilles,* was founded by the Phocæans. The Romans first obtained a footing B.C. 128, by an expedition sent to aid the Massilians against the Salyans; they extended their conquests northwards to the Isara, and, B.C. 121, formed the province of Gallia, afterwards called Narbonensis. The campaigns of Cæsar, B.C. 58—50, first opened the interior. He met with three dominant races, the Aquitani, the Celtæ, and the Belgæ, which suggested a threefold division of the conquered districts, Aquitania, Celtica, and Belgica: this was adopted by Augustus, with some variation in the boundaries, and with the substitution of the name Lugdunensis for Celtica. In the later division of the Roman Empire, Gaul was a diocese of the Præfectura Galliarum, and was subdivided into seventeen provinces.

1 AQUITANIA was bounded on the W. by the *Atlantic,* on the S. by the *Pyrenees,* on the E. by M. Cebenna, and on the N. by the Liger. In the later division, it formed three provinces—viz., Novempopulana, *Gascony;* Aquitania Prima, *Auvergne, Limosin,* and *Vellai;* and Aquitania Secunda, *Guienne, Poitou,* and the intervening districts. The inhabitants of this province consisted of two totally distinct races—the Aquitani, properly so called, who were found only in the south-western angle, in the district afterwards called Novempopulana; and the Celtæ, who occupied the remainder of the province. The former were connected with the Iberi of Spain, and were, in all probability, the aborigines of Gaul.

TRIBES.		TOWNS.
Tarbelli,	in *Gascony*	Lapurdum, *Bayonne,* Aquæ Augustæ, *Dax.*
Cocossātes,		Cocossa, *Chalosse.*
Convĕnæ,		Lugdūnum, *St. Bertrand.*
Ausci,		Augusta, *Auch.*
Vocātes,		
Tarusātes,		near *Aire.*
Elusātes,		Elūsa, *Eause.*
Bitурĭges Vivisci,	in *Guienne*	Burdigăla, *Bourdeaux.*
Vasātes,		Cossio, *Bazas.*
Petrocorii,		Vesumna, *Perigueux.*
Nitiobrĭges,		Aginnum, *Agen.*
Cadurci,		Divŏna, *Cahors.*
Rutēni,		Segodūnum, *Rodez.*
Gabăli, in *Gevaudan*		Anderĭtum, *Javols.*

TRIBES.	TOWNS.
Vellāvi,* in *Vellai*	Ruesium, *St. Paullien.*
Arverni, in *Auvergne*	Nemossus, *Clermont.*
Lemovīces, in *Limosin*	Augustorītum, *Limoges.*
Santŏnes, in *Saintogne*	Mediolānum, *Saintes.*
Pictŏnes, in *Poitou*	Pictāvi, *Poictiers.*
Bituriges Cubi, in *Berri*	Avarīcum, *Bourges.*

2 NARBONENSIS was bounded on the W. by M. Cebenna, on the E. by the Alps, on the N. by the Rhodanus, and on the S. by the Mediterranean. Towards the S.W. it extended to the *Pyrenees*, and embraced *Languedoc.* It was subsequently subdivided into five provinces—viz., Narbonensis Prima, *Languedoc;* Secunda, *Provence;* Alpes Maritimæ, the eastern parts of *Dauphiny* and *Provence;* Viennensis, *Dauphiny;* and Alpes Graiæ et Penninæ, the northern and eastern parts of *Savoy.* This portion of Gaul was well known to the Romans, and contains many places of classical interest; among which we may mention Massilia, *Marseilles*, founded B.C. 539, by Phocæans, for a long period the seat of a most extensive commerce, and, when this ceased through the destruction of its fleet by Cæsar, equally famous as a place of fashionable resort; Arelāte, *Arles*, on the Rhone, which ranked as the most beautiful city of Gaul, having been adorned by Constantine and various other Roman emperors; and Aquæ Sextiæ, *Aix*, known as the oldest Roman colony in Gaul, and as a favourite watering-place: near it, Marius gained his victory over the Cimbri.

TRIBES.	TOWNS.
Volcæ Tectosăges, Volcæ Arecomĭci, } in *Languedoc*	Tolōsa, *Toulouse.* Narbo, *Narbonne*, Nemausus, *Nismes.*
Sardŏnes, in *Roussillon*	Ruscĭno, near *Perpignan.*
Salyes, in *Provence*	Arelāte, *Arles*, Aquæ Sextiæ, *Aix*, Massilia, *Marseilles.*
Cavări, in *Comtat*	Avenio, *Avignon.*
Vocontii, in *Southern Dauphiny*	Dea, *Die.*
Helvii, in *Northern Languedoc*	Alba, *Alps.*
Tricastīni, Allobrŏges, } in *Dauphiny*	Augusta, *Aouste.* Vienna, *Vienne*, Gratianopolis, *Grenoble.*
Centrŏnes,† about the *little St. Bernard.*	

3 LUGDUNENSIS—so called after its metropolis, Lugdunum—corresponds with the Gallia Celtica of Cæsar. It was bounded on the S. by the Liger, M. Cebenna, and the Rhodanus; on the E. by the Arar, and a line drawn from its source to the *British Channel*, somewhat east of the *Seine;* and on the N. and W. by the Ocean. In the later division it formed four provinces—viz., Lugdunensis Prima, *Burgundy*, *Lyonnois*, and *Nivornois;* Secunda, *Normandy;* Tertia, *Brittany*, *Touraine*, *Maine*, and *Anjou;* and Quarta, parts of *Champagne*, *Isle of France*, and *Orleanois.*

The most famous tribes of this province were the Senones, Lingones, and

* The reader cannot fail to remark the frequent identity of the modern with the classical names of places in Gaul.

† The course of Hannibal across the Alps was directed through the district of the Centrones, but not, as was formerly supposed, across the pass of the *Little St. Bernard.* Having crossed the Rhone in the neighbourhood of Nemausus, not far from its mouth, he followed up the left bank of the river through the district of the Cavari, as far as the junction of the Isara, *Isère;* thence along the left or southern bank of that river to *Montmèlian*, crossing in his route a stream named Druentia, (not to be confounded with the Druentia, *Durance*, in the neighbourhood of *Aix*, but probably the *Romanche*, near *Grenoble:*) leaving the *Isère* in the neighbourhood of *Montmèlian*, he followed the course of the *Arc* by *St Jean de Maurienne*, to the summit of *Mont Cenis*, and thence to Segusio, *Susa*

Ædui: the two first were among the tribes who crossed the Alps under Brennus; the latter was remarkable for its steady adherence to the Romans. The only town worthy of especial mention is Lugdūnum, *Lyons*, which was advantageously situated at the confluence of the *Rhone* and *Saone*, and hence was elevated to the dignity of a Roman colony, and made the capital of the province. The present capital of France is represented by Lutetia, which was built on the island of *La Cité*.

TRIBES.		TOWNS.
Segusiāni,	in *Lyonnois*	Lugdūnum, *Lyons*.
Ædui,	in *Burgundy*	Augustodūnum, *Autun*, Matisco, *Maçon*.
Boii,		Gergovia, perhaps *Charlieu*.
Mandubii,		Alesia, near *Flavigny*.
Lingŏnes,	in *Champagne*	Andomatūnum, *Langres*.
Tricassi,		Augustobŏna, *Troyes*.
Meldi,		Iatinum, *Meaux*.
Senŏnes,		Agendĭcum, *Sens*.
Parisii,	in *Isle of France*	Lutetia, *Paris*.
Veliocasses,	in *Normandy**	Rotomăgus, *Rouen*.
Calĕti,		Juliobŏna, *Lillebonne*.
Eburovīces,		Mediclānum, *Evreux*.
Lexovii,		Noviomăgus, *Lisieux*.
Viducasses,		Argĕnus, *Vieux*.
Baiocasses,		Augustodūrum, *Bayeux*.
Unelli,		Constantia, *Coutances*.
Abrincatui,		Ingĕna, *Avranches*.
Curiosolītes,	in *Brittany**	Alētum, *St. Servan*.
Osismii,		Vorginum, *Carhaix*.
Venĕti,		Venetæ, *Vannes*.
Redŏnes,		Condāte, *Rennes*.
Namnētes,		Condivicnum, *Nantes*.
Diablintes,	in *Maine*	Neodūnum, *Jublains*.
Arvii,		Vagorĭtum, *Cité Erve*.
Cenomāni,		Suindinum, *Le Mans*.
Andecăvi,	in *Anjou*	Juliomăgus, *Angers*.
Turŏnes,	in *Touraine*	Cæsarodūnum, *Tours*.
Carnūtes,	in *Orleanois*	Genăbum, *Orleans*.
	in *Chartrain*	Autrĭcum, *Chartres*.

Off the coast of Armorica lay the islands Cæsarea, *Jersey;* Sarnia, *Guernsey;* Ridūna, *Alderney;* Uxantis, *Ushant;* and Venetorum Insulæ, *Bellisle*, *Quiberon*, &c.

4 Belgica was bounded by Lugdunensis on the W., the Alps on the S., the Rhine on the E., and the German Ocean on the N.; it embraced the north-eastern provinces of *France*, and *Belgium*, with parts of *Germany* and *Switzerland*. It was subdivided into five provinces—viz., Belgica Prima, *Lorraine* and *Luxembourg;* Secunda, *Picardy*, *Artois*, and *Flanders;* Germania Prima, the northern part of *Alsace* and the *Rhine Provinces*, down to *Andernach;* G. Secunda, the *Lower Rhine Provinces* and the *Netherlands;* and Maxima Sequanorum, southern *Alsace* and a large part of *Switzerland*.

The inhabitants of this province were partly Celts, partly Germans, partly a mixture of the two. The Sequani and Helvetii belonged to the former race; the Ubii and Batavi, with other tribes on the banks of the Rhine, to the latter; while the mass of the people, the Treviri, Remi, &c., known collectively as the Belgæ, were the descendants of a German race who had

* These provinces were known by the name Armorĭca, derived from two Celtic words, signifying a *maritime* district.

coalesced with the older Celtic population. The Romans were unacquainted with this province until the time of Cæsar's expeditions, which spread over a term of eight years, B.C. 58—50, and which ended in the successive defeat of the Helvetii, Belgæ, and Aquitani. Roman colonies were planted in different localities, in order to retain the submission of the conquered people. Generally the chief towns of the native tribes were selected for this purpose, which, with a Roman name, were also romanized in appearance and character, and were not unworthy progenitors of the towns which now stand on their sites. The most important colonies, however, were those which were established at a later period, to check the incursions of the Germanic tribes. The wars of Drusus, B.C. 12—9, and of Germanicus, A.D. 14—16, led to the erection of no less than fifty forts along the banks of the Rhine. Some of these became most important towns: Argentoratum, *Strasbourg*, was both a garrison town and an arsenal, where arms were manufactured and stored for the use of the troops in the northern wars; Mogontiacum, *Mayence*, was fortified by Drusus, and became afterwards the capital of Germania Prima; Augusta Trevirorum, *Trères*, was also a fortified Roman colony, and from its advantageous position the usual residence of the Roman generals: it became the capital of Belgica Prima; Bonna, *Bonn*, was an important post, as Drusus had thrown a bridge across the Rhine at this point; Antonaeum, *Andernach*, Gesonia, *Zons*, Novesium, *Neuss*, were also military fortresses, though of less importance. But the most flourishing of all the colonies was that which Claudius established, A.D. 51, at the previously existing town of the Ubii (Oppidum, or Ara Ubiorum), and which he named, in honour of his wife, Colonia Agrippina, *Cologne*, afterwards the capital of Germania Secunda. The Ubii were a German tribe, who had been transplanted to the left bank of the river by Agrippa, B.C. 37. Lower down the river, Castra Vetera was an intrenched camp, on the site of the modern *Xanten;* in the district of the Batavi, called Insula Batavorum, which lay between the *Rhine, Waal, Meuse,* and the sea, there were a number of insulated forts, the position of which is uncertain. At the mouth of the Rhine, Caligula erected a lighthouse, the remains of which yet exist under the name of *Calla-Thurm*.

TRIBES.	TOWNS.
Helvetii, in *Switzerland*	Aventĭcum, *Aveneche*.
Raurăci, Tribocci, } in *Alsace*	Augusta, *Augst*. Argentorătum, *Strasbourg*.
Sequăni, in *Franche Compté* . . .	Visontio, *Besançon*.
Leuci, Mediomatrĭci, } in *Lorraine* . . .	Tullum, *Toul*. Divodūrum, *Metz*.
Nemētes, Vangiŏnes, with the Caracates. } on the *Rhine* .	Noviomăgus, *Spire*. Borbetomăgus, *Worms*. Mogontiăcum, *Mayence*.
Trevĭri, in *Luxembourg* and along the *Moselle*	Augusta, *Trèves*. Confluentes, *Coblentz*.
Ubii, on the *Rhine*	Antonacum, *Andernach*, Colonia Agrippīna, *Cologne*.
Cæresii, Pæmāni, Segni, Condrusii, } in the *Ardennes* and *Eifelgebirge*.	
Tungri, in *Liège*	Aduatĭca, *Tongres*.
Eburŏnes, Aduatŭci, } in *South Brabant*.	
Gugerni, on the *Rhine*	Vetera Castra, *Xanten*.
Batāvi, in *Utrecht* and *Zealand* . .	Lugdunum, *Leyden*.
Menapii, in *Anvers* & *North Brabant*	Castellum Menapiorum, *Kessel*.
Toxandri, in *Limbourg*.	
Nervii, in *Hainault* and *Namur* . .	Bagănum, *Bavai*.

TRIBES.	TOWNS.
Morĭni, in *Flanders*	Gesoriăcum, *Boulogne.* Portus Iccius,* *Sangatte.*
Ambiāni, in *Picardy*	Samarobrīva, *Amiens.*
Bellovăci, in *Isle of France*	Cæsaromăgus, *Beauvais.*
Suessiŏnes, in *Isle of France*	Augusta,† *Soissons.*
Veromandui, in *Vermandois*	Augusta, *St. Quentin.*
Atrebătes, in *Artois*	Nemetăcum, *Arras.*
Remi, in *Northern Champagne*	Durocortŏrum, *Reims.*

III. *Britannicæ Insulæ.*

The name Britannia was applied in ancient geography, as *Great Britain* is in modern, to *England* and *Scotland* exclusively; *Ireland*, however, was included in the term Britannicæ Insulæ. The name Albion was used synonymously with Britannia. The Carthaginians were the earliest nation that became acquainted with these islands; but the description they gave of them, as related by the Greek geographers, was very vague. The name Cassiterĭdes is generally supposed to apply to the *Scilly Isles*, but there are strong reasons for understanding by it *Cornwall* and *Devonshire*. Little or nothing was known of the interior of the country until Cæsar's invasions in the years 55 and 54 B.C.; he penetrated northward of the Thames, without making any permanent conquests. It was not until nearly a century after this that the Romans undertook the subjugation of Britain. Claudius, A.D. 43, sent Aulus Plautius with forces for this purpose, who succeeded in subduing the southern and eastern tribes. Ostorius, his successor, carried his arms into *Wales* and *Shropshire*. Mona, *Anglesea*, was subdued by Paulinus Suetonius. Petilius Cerealis, in the reign of Vespasian, completed the conquest of the Brigantes in *Yorkshire*, and Julius Frontinus that of the Silures in *South Wales*. Finally, Agricola (A.D. 78—84) advanced the Roman boundary to the *Firths of Forth* and *Clyde*, and established a line of forts between these two. From this, however, the Romans were soon obliged to withdraw; and Hadrian, in A.D. 121, constructed a new line of defence, Hadriani Vallum, *Picts' Wall*, between *Solway Firth* and the *Tyne*. In the reign of Antoninus Pius, the boundary was again pushed forward to its former position, and a regular rampart, Vallum Antonini, *Graham's Dyke*, was established from sea to sea. The Caledonians again forced a withdrawal, and the limit of the Roman dominion was finally fixed at the *Solway Firth* and *Tyne*, between which Severus, A.D. 209, built a wall parallel to that of Hadrian.

Until the reign of Severus, Britannia had been governed as a single province by a Prætor; he divided it into two, Superior and Inferior, separated by the *Thames* and the *Bristol Channel*. By Constantine it was subdivided into four—viz., Britannia Prima, south of the *Thames;* Secunda, *Wales;* Flavia Cæsariensis, between the *Thames*, *Severn*, and *Humber;* and Maxima Cæsariensis, between the *Humber* and the *Tyne*. The district between the walls of Hadrian and Antonine was named Valentia; the country still more north, Vespasiana; and the northern part of Scotland, Caledonia, or Britannia Barbara.

The prominent features of the coasts — the promontories, rivers, and estuaries—are described by the ancients; but the mountain ranges are not noticed. On the eastern coast, the most important promontories are — Cantium Prom., *North Foreland;* Ocellum Prom., *Spurn-head;* Tæzalum

---

* It was from this spot that Cæsar crossed over to Britain. In his history he distinguishes three ports in this neighbourhood: P. Iccius or Itius, P. Superior, and P. Inferior; the two latter are probably identical with *Gravelines* and *Wissant*.

† The numerous towns named Augusta by the Romans, were distinguished by the addition of the name of the tribe in whose territory they stood; as Augusta Trevirorum, *Trèves*, A. Suessionum, *Soissons*, &c.

Prom., *Kinnaird's Head;* and Verubium Prom., *Duncansby Head,* the north-east point of Scotland; the rivers and estuaries — the Tamĕsis, *Thames;* Metăris Æstuarium, *The Wash;* Abus, *Humber;* Boderia or Bodotria Æst., *Firth of Forth;* Tava, *Tay;* Deva, *Dee;* Tuæsis Æst., *Murray Firth;* and Varar, *Dornoch Firth.* On the southern coast, the promontories are—Damnonium or Ocrinum, *Lizard Point,* and Antivestæum, or Bolerium, *Land's End;* and the rivers—Trisanton, *Arun;* Alaunus, *Avon;* and Tamărus, *Tamar.* On the western coast, the promontories are—Herculis Prom., *Hartland Point;* Octopitarum Prom., *St. David's Head;* Canganorum Prom., *Braich-y-pwll;* Novantum Prom., *Mull of Galloway;* Epidium Prom., *Mull of Cantire;* and Tarvĕdum or Orcas Prom., *C. Wrath;* the rivers and estuaries—Sabrīna, *Severn,* flowing into Sabriana Æst., *Bristol Channel;* Seteia Æst., the mouth of the *Dee:* Belisāma Æst., the mouth of the *Mersey;* Moricambe Æst., *Morecambe Bay;* Itūna Æst., *Solway Firth;* and Clota Æst., *Firth of Clyde.*

The disposition of the native tribes at the time when the Romans became acquainted with them, was as follows:

In Britannia Prima: — Cantii, in *Kent;* the Regni, in *Surrey* and *Sussex;* the Belgæ, in *Hampshire, Wiltshire,* and *Somersetshire;* the Atrebatii, in *Berkshire;* the Durotrīges, in *Dorsetshire;* and the Damnonii, in *Devonshire* and *Cornwall.*

In Britannia Secunda:—the Demĕtæ, in *Pembrokeshire* and *Cardiganshire;* the Silūres, in the remainder of *South Wales* and *Monmouthshire;* the Ordovīces, in *North Wales* and *Shropshire;* and the Cangi, in *Carnarvonshire.*

In Flavia Cæsariensis: — the Trinobantes, in *Essex* and *Middlesex;* the Cenimagni, in *Suffolk;* the Icĕni, in *Norfolk;* the Catuvellauni, in the counties of *Hertford, Northampton, Buckingham, Cambridge,* and *Bedford;* the Dobūni, in *Gloucestershire* and *Oxfordshire;* the Cornavii, in *Warwickshire* and *Staffordshire;* and the Coritāni, in *Lincolnshire* and *Leicestershire.*

In Maxima Cæsariensis:—the Brigantes, and an insignificant tribe, the Parisi, near Prom. Ocellum.

In Valentia:—the Elgŏvæ, in *Dumfriesshire* and *Kirkcudbrightshire;* the Novantæ, in *Wigtownshire;* the Otodĕni, along the eastern coast; and the Damnii, south of Antonine's wall.

In Romana Barbara:—the Caledonii, subdivided into various unimportant tribes.

The details of the ancient geography of our native island are for the most part interesting only from local associations. Few historical events are mentioned in connexion with special localities; more, indeed, can be learnt from the materials which are supplied by excavations of the old Roman sites, than from any literary records. The positions of the various tribes have been already noticed; it remains now to state some few particulars with respect to the most important towns. Rutŭpiæ, *Richborough,* in *Kent,* was the usual port of transit to Gaul. Dubræ, *Dover,* Lemanus Portus, *Lymne,* and Reculbium, *Reculver,* were also frequented. Londinium, *London,* was a considerable town when Cæsar visited Britain. Ptolemy places it on the right bank of the Thames; but the main town was on the site of 'the City.' It was destroyed in Boadicea's war, but restored and surrounded by fortifications by Constantine; though only in the rank of a colonia, it became the capital of the country, with the name Augusta Trinobantum. The southern counties, together with *Gloucestershire* and *Oxfordshire,* seem to have been the favourite district of the wealthy Romans. Aquæ Solis, *Bath,* was frequented for its waters. Corinium, *Cirencester,* Venta Belgarum, *Winchester,* Moridūnum, *Dorchester,* were considerable towns, and adorned with various public buildings. Isca Silurum, *Caerleon,* was one of the three great military stations of Britain; it was selected for the purpose of restraining the attacks of the Welsh tribes. The other two posts were Deva, *Chester,* and Eborăcum, *York:* the former checked the inroads of the Irish, the latter served as the head-quarters for all expeditions against the Caledonians; its importance in this respect raised it to the dignity of a Roman municipium, and made it the frequent residence of the emperors, two of whom, Severus and Constantius Chlorus, died there. The wall of Hadrian was defended by a series of military stations, to the number of twenty-three, which became regular towns; and between these were intermediate forts. The wall of Antoninus was similarly defended by eighteen forts, which, however, were not tenanted sufficiently long to become towns. North of this wall, the name Alata Castra indicates the existence of an entrenched camp, supposed to have been near *Inverness.* In the eastern counties we meet with the important towns of Lindum, *Lincoln*, a colony and station on the road between *London* and *York;* Venta Icenorum, near *Norwich;* Durobrīvæ, *Castor*, in *Northamptonshire*, where a considerable manufacture of pottery was carried on; Verulamium, *St. Albans*, the old capital of Cassivellaunus, and a Roman municipium; and Camalodūnum, *Colchester*, the first Roman colony, having been selected for that purpose by the emperor Claudius. There were in all thirty-three privileged Roman towns in Britain, of which two, Eboracum and Verulamium, possessed the full rights of citizenship; nine ranked as Coloniæ, and the remainder as Stipendiariæ, with various but uncertain privileges.

Hibernia, *Ireland*, was not visited by the Romans; their acquaintance with it was limited to the accounts gleaned from the natives in their commercial visits to Britain. The names by which it was described, Hibernia, Ierne, Juverna, have the same common root as the modern names *Erin* and *Ireland* with the addition of a prefix *Hi* or *I*, indicating a *people*. There was also a tribe of the same name—or more probably a number of tribes sharing the collective name—the Ivernii, who occupied *Munster*, with a town, likewise called Ivernis, on the *Shannon*. Various other tribes are mentioned by Ptolemy, whose names are so far important as they aid the ethnologist in establishing an affinity between the ancient inhabitants of Ireland and other Celtic races; thus we hear of a tribe—the Menapii, in *Wexford*—cognominous with a Belgic tribe in the *Netherlands:* again of the Brigantes, in the same neighbourhood, a branch of the same race we have already met with in *Yorkshire:* and again of a town, Dunum, which appears so frequently in the terminations of Celtic names, as Lugdunum, &c. An early connexion probably existed between Spain and Ireland.

The *Isle of Man* received the names Monarīna, and Monapia, evidently containing the same root as the name Mona, *Anglesea*. The *Hebrides* were called Ebūdæ; the *Orkneys*, Orcădes; the *Scilly Isles*, Cassiterides, Silurum, or Sylinæ Insulæ; and the *Isle of Wight*, Vectis. Diodorus relates that the Massilians traded on the latter island with the native Britons for tin, which was brought in wagons from the main-land across the channel (the *Solent*), when it was dry at the ebb of the tide. We have, lastly, to mention the island of Thule, which was discovered by Pytheas of Marseilles, and which, according to his account, would correspond with *Iceland:* subsequent descriptions of its position vary exceedingly. Ptolemy's Thule would correspond rather with the largest of the *Shetlands;* in fact, Thule became a proverbial expression for the most northerly point of the known world.

IV. *Germania.*

Germania was bounded by the Rhine on the W., the Danube on the S., the Vistula on the E., and the Mare Germanicum and Mare Suevicum, *Baltic Sea*, on the N. It was occasionally called Magna, or Barbara, in distinction to the Roman provinces, Germania Prima and Secunda, on the left bank of the Rhine; it embraced *Germany*, with the exception of the countries south of the Danube, together with what little was known of *Denmark*, *Sweden*, and *Norway*.

The mountains of *Germany* were in ancient times clothed with forests, and are hence described by the Romans under the name Silvæ. The largest of these, Hercynia Silva, included all the great ranges, commencing near the borders of the Helvetii in the S., and extending parallel to the Danube as far as Dacia eastward, and along the Rhine northward. The name yet survives in the modern *Hartz* in *Hanover*. In addition to this general title, the chief ranges received specific names, of which we may mention Mons Abnŏba, *the Black Forest*; Bacenis Silva, *Thüringer-wald;* Melibŏcus Mons, *Hartz;* Sudēti Montes, *Erz-gebirge*, and Vandalĭci Montes, *Riesen-gebirge*, which inclose *Bohemia* on the north; and Gabrēta Silva, *Böhmer-wald*, which forms the southern boundary of that country; Asciburgicus Mons, *the Western Carpathians*, and Sarmatici Montes, *the Eastern Carpathians*, to the north ot *Hungary;* Taunus Mons, *Taunus*, on the right bank of the Rhine, in *Nassau;* and Silva Teutoburgiensis, *Teutoberger Wald*, between the rivers *Ems* and *Weser*, near *Osnabrück*.

Of the rivers of Germany, the Danubius or Ister, *Danube*, is the largest; its course has been already noticed. The Rhenus, which comes next, and which also has been noticed, receives several important tributaries on its right bank, such as the Nicer, *Neckar*, the Mœnus, *Maine*, and the Luppia, *Lippe*. The Amisia, *Ems*, the Visurgis, *Weser*, and the Albis, *Elbe*, flow into the Mare Germanicum; the Vistŭla, *Vistula*, into the Mare Suevicum.

The Romans were little acquainted with the interior of Germany. Cæsar crossed the Rhine twice, but did not advance far from its banks. Drusus (B.C. 12) advanced as far as the *Weser*, and subdued the tribes in and about *Westphalia*. The revolt under Arminius, and the defeat of Varus, in the *Teutoburger Wald*, led to the war in the same quarter which was conducted by Germanicus, A.D. 14—16. The Romans did not, however, succeed in establishing a permanent supremacy in the north of Germany: they were obliged to confine themselves to a district between the upper courses of the Danube and the Rhine, named Agri Decumātes, which they inclosed in a wall between the two rivers, commencing near *Coblentz*, and terminating near *Ratisbon*. This wall remained the limit of the Roman empire until the Marcomannic wars, A.D. 167—180, when it was withdrawn to the Danube.

The positions of the German tribes are with difficulty ascertained, partly from the indefiniteness of the statements concerning them, partly from the constant migrations that took place. Tacitus mentions three great families, the Ingævŏnes along the northern coast, the Hermiŏnes in the centre, and the Istævŏnes in the eastern and southern regions. Pliny adds to these the Vindĭli, and the Peucīni with the Bastarnæ, thus making a five-fold division. The inhabitants of Scandia, *Denmark*, are named by the latter Hilleviŏnes, by the former, Suiŏnes and Sitŏnes. It is difficult to reconcile these divisions of Tacitus and Pliny, or to classify the various tribes in their proper families. In all probability, the division of Tacitus applies only to the tribes westward of the *Elbe*, and not to the whole of Germany; the Ingævones occupying the coast from the *Rhine* to the *Elbe;* the Istævones the banks of the *Rhine*, from Mons Taunus to the Isala, *Yssel*, and inland to Teutoburgiensis Silva; and the Hermiones, the districts to the eastward which belonged to the tribes of the Cherusci and Chatti. According to another view, the Hermiones included the Vindili, who lived along the shores of the Baltic, the Peucini and Bastarnæ, and all the tribes of central and southern Germany.

In this uncertainty it appears best to omit any attempt at classification, and merely to mark the locality of each tribe separately. The Frisii lived along the coast from Flevo Lacus, *Zuyder-zee*, to the *Ems*, in *Friesland* and *Gröningen;* the Chauci between the *Ems* and the *Elbe*, in *Oldenburg* and *Hanover*, the Visurgis, *Weser*, dividing them into two clans, Majores on the east, and Minores on the west; eastward of the *Elbe*, the Saxŏnes (first mentioned by Ptolemy) in *Holstein*, a sea-faring tribe; the Angli in *Schleswig;* north of them the Cimbri, in *Denmark*, named after them Cimbrica Chersonesus. Along the coast of the *Baltic Sea*, the Vindĭli, subdivided into numerous tribes, of which the Burgundiones, in *Posen*, was the most important.

Returning westward, we meet with the following tribes between the *Rhine* and *Elbe*—the Usipĕtes, on the banks of the former, between the *Lippe* and the

Yssel; the Bructĕri, in *Westphalia,* divided into Majores and Minores; the Sicambri, to the south of the Bructeri; the Teuctĕri, along the Rhine, opposite *Cologne;* the Chatti, a very powerful tribe, in *Hesse Cassel;* the Cherusci, who took the lead in the revolt under Arminius, in *Saxony;* the Angrivarii, about the middle course of the *Weser;* the Langobardi, the ancestors of the *Lombards,* along the *Elbe,* in *Luneburg* and *Altmark;* and the Mattiăci, in *Nassau,* probably a subdivision of the Chatti.

The Agri Decumates, supposed to be so called because the inhabitants were obliged to give the Romans a tenth of their produce, were occupied by several unimportant tribes, who were afterwards incorporated in the confederacy of the Alemanni.

The tribes of *Central* and *Eastern Germany* were chiefly subdivisions of the Suevic race; the most important were—the Hermundūri, in *Bavaria* and part of *Saxony;* the Marcomanni, in *Bohemia,* the former residence of the Boii, after whom it was called Boiohemum; the Quadi, in *Moravia* and part of *Hungary;* the Semnōnes, on the *Elbe,* in *Brandenburg;* the Rugii, in *Pomerania;* the Gothōnes, about the mouth of the Vistula; and the Lygii, in *Poland* and *Posen.*

The Romans reckoned the Scandinavian peninsula as part of Germania, but their notions of it were very indistinct. Mention is made of the Scandiæ Insulæ, four in number, one of which, from its superior size, was named Scandia; the latter may very possibly represent *Sweden,* and the other islands the *Danish* group. Pliny speaks of another large island named Nerigos, which, from the similarity of name, is identified with *Norway.* The *Great* and *Little Belts* are called in ancient geography, Sinus Lagnus, and the *Kattegat* Sinus Codanus.

V. *Vindelicia, Rhætia, Noricum, and Pannonia.*

The districts south of the Danube, which are now included in the Germanic empire, were reckoned by ancient writers as belonging to Illyria rather than to Germania. They were conquered by the Romans B.C. 15, and henceforward formed separate countries, having been divided by Augustus into four provinces.

1 VINDELICIA was bounded on the N. by the *Danube,* on the W. by the territory of the Helvetii, on the south by the Rhætian Alps, and on the E. by the Œnus, *Inn.* It was incorporated with Rhætia about 100 A.D., with the title Rhætia Secunda; it corresponds with parts of *Bavaria* and the adjacent states. The northern district is tolerably level, the southern mountainous: it is watered by the Licus, *Lech,* Isarus, *Isar,* and Œnus, all of them tributaries to the *Danube.* The Lacus Venetus, *L. of Constance,* fell within its limits.

The tribes of Vindelicia were—the Brigantii, with the town Brigantium, *Bregentz,* at the eastern extremity of the L. Venetus; the Licates, about the *Lech,* with the capital Augusta Vindelicorum, *Augsburg,* made a Roman colony B.C. 14; and the Runicates, with the town Regīnum, *Ratisbon,* on the *Danube.*

2 RHÆTIA lay S. of Vindelicia, in the *Grisons* and *Tyrol.* The highest chain of the Alps separated it from Italy, and it was watered by the upper courses of the Athesis and the Œnus: the chains of the Rhætic Alps intersect it in all directions.

The inhabitants of Rhætia were of Celtic extraction; the chief tribes were—the Lepontii, on the southern declivities of the Alps, in *Tessino;* the Brixentes, about *Brixen;* the Tridentini, with the capital town Tridentum, *Trent,* on the Athesis; and the Breuni, in the north. It has been supposed that some Tuscan tribes took refuge in the valleys of the *Grisons* at the time of the Gallic invasion under Brennus, and that traces of their language yet survive in some places.

3 NORICUM was bounded on the N. by the *Danube;* on the E. by M. Cetius, *Kahlenberg,* and Pannonia; on the S. by the Alpes Carnicæ; and on the W. by Rhætia and Vindelicia; it corresponds with *Styria* and parts of *Austria.* It is highly mountainous, the various ranges which traverse it

receiving the general name of Alpes Noricæ: the southern districts are watered by the upper courses of the Savus, *Save,* and Dravus, *Drave.* The chief tribes at the time of the Roman conquest were—the Taurisci, who appear to have been the original inhabitants, and who occupied the south-eastern portion of the province; and the Boii, an immigrant tribe, who settled along the banks of the *Danube.* The towns were — Noreia, *Neumarkt,* the ancient capital of the Taurisci, from which the province derived its name; Virūnum, near *Klagenfurt,* in the valley of the Dravus; Juvavia, *Saltzburg,* on a tributary of the Œnus, colonized by Hadrian; and various border towns erected by the Romans along the course of the Danube, such as Laureacum, *Lorch,* Boiodurum, *Innstadt,* Lentia, *Lintz,* &c.

4 Pannonia was bounded on the N. and E. by the *Danube;* on the S. by the valley of the Savus; and on the W. by Noricum and Venetia; it thus comprised western *Hungary, Sclavonia,* and parts of *Styria* and *Croatia.* The Romans originally divided it into two provinces, Superior the western, and Inferior the eastern half. In the fourth century Galerius formed the eastern part of the latter into a separate province, called Valeria; and Constantine the Great equalized the two old divisions, by adding the southern part of Superior to Inferior. Pannonia is watered by the lower courses of the Savus and Dravus, and by the Arrabo, *Raab,* flowing northwards to the *Danube;* a large lake, Pelso, *Platten-see,* lies in the centre of the province.

The towns of Pannonia rose into importance in the wars which the Romans had to sustain against the northern hordes; the most important were—Vindobōna, *Vienna,* a Roman municipium on the Danube; Carnuntum, lower down that river, an important post in the Marcomannic war; Aquincum, *Buda,* where the Romans had a manufactory of arms; Taurunum, *Semlin,* at the junction of the Savus; Cibalis, the birthplace of Valentinian, and the scene of Constantine's victory over Licinianus, between the Savus and Dravus; Mursa, *Esseck,* on the right bank of the latter, the residence of the Roman governors; Siscia, *Sisseck,* a strong post in the upper valley of the Savus, the head-quarters of the Romans in the Illyrian and Pannonian campaigns; Pœtovium, *Pettau,* on the Dravus, with a palace of the Roman emperors; and Sabaria, westward of the Arrabo, where Ovid was buried.

VI. *Dacia.*

The Roman province of Dacia was bounded on the N. by M. Carpates; on the S. by the Danube; on the E. by the Tyras, *Dniester,* and the Euxine; and on the W. by the Tibiscus, *Theiss;* it thus comprised part of *Hungary, Moldavia,* and *Bessarabia.* The name Dacia does not appear before the commencement of the Christian era; the Daci were, however, doubtless the same people as the Getæ, whom we find in the time of Herodotus living south of the Danube, and who were pressed northwards by the Macedonians. The Daci became formidable opponents to the Roman power in the first century after Christ; Trajan subdued them after a contest of five years, A.D. 100—105, and reduced their country to the condition of a Roman province.

The chief mountain range is M. Carpātes, *Carpathians,* which descends from the northern frontier towards the *Danube,* and occupies the centre of the province with its numerous ramifications. The chief rivers were the Ister, and the Pathissus, or Tibiscus, *Theiss,* which formed the western boundary; the other large tributaries of the *Danube* have been already noticed in Herodotus's account of that river. Trajan threw a bridge across the Danube, probably at *Tchernetz,* below *Orsova.* The chief town of Dacia was Tibiscum, *Temesvar,* in the western part of the province.

The district westward of Dacia, between the *Theiss* and the *Danube,* was occupied by a Sarmatian tribe, the Iazyges, surnamed Metanastæ, from their having been *transplanted* thither from their original quarters about the Palus Mæotis: they settled here in the first century of the Christian era, and remained until they were driven out by the Goths. The ancients had very little acquaintance with this district.

VII. *Sarmatia Europæa.*

The vast regions of northern and eastern Europe are described by Herodotus and the earlier geographers under the name Scythia, and by later writers, commencing with Mela, under the name Sarmatia.

The mountain ranges are—Montes Rhipæi or Hyperborei, under which the *Ural* range is included; M. Carpates, and M. Sarmaticus, the *Carpathian* ranges, on the southern border; M. Peuce, in *Gallicia;* and the Venedici Montes, eastward of the *Vistula.* The most important rivers are—the Tanais, *Don,* which is described as rising in the Rhipæi Montes, and after a long course, first towards the S. E., and finally towards the S. W., discharging itself into the Palus Mæotis; the Borysthĕnes, *Dnieper,* which takes a parallel course to the Tanais, and joins the Euxine westward of it; it was navigated for a distance of four days' sail; the Hypănis, *Bog,* a less important stream to the westward; and the Tyras, *Dniester,* which rises on the northern declivities of M. Carpates, and also flows into the Euxine.

The principal tribes of this vast district, as described by Ptolemy, were—the Venĕdæ, on the shores of the *Baltic Sea,* from the *Vistula* to the *Gulf of Finland;* the Peucĭni and Bastarnæ, along the upper course of the *Vistula,* and among the northern ridges of the Carpathians; the Alauni, in *Central Russia;* the Sarmatæ or Sauromatæ, on the shores of the Euxine, between the *Dniester* and *Dnieper;* the Iazyges and Roxolani, between the *Dnieper* and *Don;* the Tauri, in Chersonesus Taurica, *Crimea;* the Tauroscythæ, outside the neck of the peninsula, and on the tongue of land called Dromos Achilleos, *Cosa Tendra;* and the Hamaxobii, about the middle course of the *Dnieper.*

The only towns deserving of notice were the Greek settlements on the shores of the Euxine—viz., Chersonesus, a Megarian colony in the south of the Tauric peninsula; Theodosia, *Kefa,* a Milesian colony on the eastern coast; Panticapæum, *Kertch,* at the neck of the Bosporus Cimmerius—the strait which connects the Palus Mæotis, *Sea of Azov,* with the Euxine; Carcina, at the neck of the Chersonese; Olbia, at the mouth of the Hypanis; Tyras, at the mouth of the Tyras; and Tanais, named after the river on which it stood.

CHAPTER IX.

I. AFRICA.—II. ÆGYPTUS.—III. ÆTHIOPIA.—IV. MARMARICA.
V. CYRENAICA.—VI. SYRTICA.—VII. AFRICA PROPRIA.—VIII. NUMIDIA.
IX. MAURETANIA.—X. LIBYA INTERIOR.—XI. THE ROMAN EMPIRE.

I. *Africa.*

THE continent which we, after the Romans, call Africa, was known to the Greeks by the name Libya. The etymology of these names is doubtful; but it appears certain that they were originally applied to *districts,* and thence extended to the *continent.* Libya designated that part of the upper coast of Africa which lay between the greater Syrtis and Egypt; and it has been conjectured that at the time when the Greeks first became acquainted with this region, a wandering tribe, named *Lebeta,* now living in the interior, were settled on the sea-coast, and that from them the name Libya had its origin. As this part of the coast was the first which the Greeks visited, it is not surprising that they should have adopted the name for the whole continent. Africa, again, was originally applied to a district in the neighbourhood of Carthage. This was the point with which the Romans first came in contact; they named their first province from it, and by degrees extended the name over the whole continent.

Africa was frequently treated as a portion of Asia, and occasionally as part of Europe; but the general opinion of antiquity granted it the dignity of being a separate continent. In this sense, it was bounded on the N. by the Mare Internum, or, as the Greeks would have described it, the Mare Libycum; on the W. by the Mare Atlanticum; on the E. by the Sinus Arabicus; and on the S. by the Oceanus Æthiopicus. With the exception of the north coast, little was known of the geography of Africa; the eastern and western coasts had been explored—the former, to ten degrees south of the equator, the latter to about five degrees north; but the portion with which the ancients were really acquainted may be described as a triangle, formed by the Red Sea, the Mediterranean, and an imaginary line drawn from the Straits of Gibraltar to those of *Babel-mandeb.*

Herodotus divided this continent into three provinces—Ægypt, Æthiopia, and Libya: Ægypt to the east, bordering on Asia; Libya, the remaining coast-land westward: and Æthiopia, the interior. The political division of the continent most suitable for a manual of Ancient Geography is that which the Roman writers have adopted—viz., Ægypt, Æthiopia, Marmarica, Cyrenaica, Syrtica, Numidia, and Mauretania.

II. *Ægyptus.*

ÆGYPTUS is the classical name for the country which the Hebrews called Mizraim, and the Arabs still call Mesr. It consists of a narrow valley, about 500 miles long, bounded by the Red Sea and the Isthmus of Arsinoe, *Suez,* on the E.; by a low chain of hills, separating it from the Desert, on the W.; by the Mediterranean, on the N.; and on the S. by a line drawn just below Elephantine.

Two ranges of hills bound the valley of the Nile—M. Arabicus on the E., and M. Libycus on the W.—leaving an interval of plain varying considerably in extent, but on an average nine miles broad. The only other hill worthy of notice is M. Casius, *El Katieh,* in the neighbourhood of the Mediterranean, on the border of Arabia Petræa.

Egypt was justly designated by Herodotus the 'gift of the Nile,' and a description of this river embraces almost all that is noticeable in the physical geography of the country. In Scripture it is called Sihor (Jer. ii. 18; Isa. xxiii. 3), 'black,' from the colour of the mud which it deposited: the name Nilus is said to be derived from a Sanscrit word of the same signification. Its source was one of the great problems of geography in ancient as in modern times. The opinion of Herodotus has already been noticed. Later geographers, as Strabo and Ptolemy, were aware of the division of the stream in its upper course, and stated that the springs were in the Mountains of the Moon. Nero sent out an expedition of discovery, which succeeded in reaching the sources of the eastern branch, now known as the *Blue* River. Before entering Egypt, it formed two cataracts; and thence, from the borders of Æthiopia, it flowed in one unbroken stream from Syene to Cercasorus. There it divided into two main streams; and these, breaking up again, discharged their waters through seven channels into the Mediterranean Sea. The ancients regarded the two outside channels—the Pelusiac towards the E., and Canopic towards the W.—as the most important. At the present day, the Bolbitine, or *Rosetta* branch, and the Phatnitic, by *Damietta,* have the supremacy; while the other mouths have disappeared in lagoons, or are become insignificant. Besides the four already mentioned, the ancients distinguished the Sebennytic, *Lake Bourlos,* the Mendesian, *Lake Menzaleh,* and the Tanitic, or Saitic, somewhat to the eastward.

Next to the Nile, the canals and lakes form the most important feature. The Canal of Trajan or Ptolemy connected the Nile in the neighbourhood of *Cairo* with the western arm of the Red Sea. The Lake of Mœris, *Birket-el-Karun,* to the south-west of Memphis, though of natural formation, was adapted by artificial means to receive the superfluous waters of the Nile, and dispense them in the dry season over the neighbouring lands. The Lake of

Sirbo, *Sabakat Bardowal,* was situated in the neighbourhood of the Mediterranean and Mons Casius. The Lacus Amārus, a connecting link between the Nile and the Red Sea—the Lake of Tanis, *Menzaleh,* at the mouth of the Nile—the Butic Lake, *Burlos*—and the Mareotic, *El Khreit,* in the neighbourhood of Alexandria, are also worthy of notice.

Egypt was divided by the Greeks and Romans into three parts—Lower Egypt, or the Delta, *Bahari;* Middle Egypt, also called Heptanŏmis, *Vostani;* and Upper Egypt, or Thebāis, *Said.* A further subdivision was established by the Egyptians into nomes, of which there were, according to Strabo, thirty-six. Middle Egypt derived its name, Heptanomis, from its containing seven of these nomes.

The most important towns and places in the Delta were—Alexandria, which still retains its name, on a narrow tongue of land between Lake Mareotis and the Mediterranean, built by Alexander, B.C. 332, and elevated to be the capital of Egypt; it possessed five harbours; the island of Pharos, surmounted with a lighthouse, lay about a thousand yards distant from the main-land, with which it was connected by a mole: Canŏpus, about fifteen miles to the north-east, on the Canopic outlet of the Nile, celebrated for its licentiousness: Butos, *Kom Kasir,* on the southern shore of the lake named after it: it was the chief town of the nome Chemmītes, so called after the island Chemmis, in the lake: Naucrătis, on the right bank of the Canopic channel, founded by Milesians, and much frequented by the Greeks, who in the time of Herodotus were confined to this spot: Sais, on the left bank of the Sebennytic channel, east of Naucratis, the ancient capital of Lower Egypt: Tanis, the Zoan of the Old Testament, *San,* on the south side of the Tanitic Lake, capital of a nome, and, before the time of Psammetichus, the residence of an independent royal dynasty: Bubastus, the Pi-beseth of Ezek. xxx. 17, *Tel-Basta,* on the eastern bank of the Bubastic channel: and Babylon, *Babel,* at the entrance of the great canal from the Red Sea, the border town of the Delta.

To the east of the Delta, properly so called—Heliopolis, in the Old Testament, On (Gen. xli. 45), and Bethshemesh (Jer. xliii. 13), *Matarieh,* capital of a nome, and seat of the famous temple of the Sun; it was situated to the north-east of Babylon, and about six miles from *Cairo:* Arsinoe, or Cleopātris, near *Suez,* at the head of the Red Sea (Baalzephon, if not identical with it, was in its immediate neighbourhood); Pi-hahiroth, probably on the site of *Ajeroud,* to the westward of Arsinoe: Magdŏlum, in the Old Testament Migdol, between Pelusium and Heroopolis: Heroopolis, or Abaris, *Abukeeheid,* on the canal to the north of the Lacus Amarus; it is either identical with the Rameses of the Old Testament, or else lay in the district of Rameses: in this neighbourhood undoubtedly lay Goshen, stretching from the Pelusiac arm of the Nile to the border of Arabia Petræa; in a later age we hear of the existence of a place called Vicus Judæorum, and of Castra Judæorum, and there are still some hillocks named *Tell el Jhud,* 'Jews' hills:' whether these are to be referred to the first residence of the Israelites in Egypt, or to the time of the Ptolemies, remains doubtful: Pelusium, the Sin of Ezek. xxx. 15, on the eastern arm of the Nile, about two miles and a half from the sea, between morasses and lagoons; it was strongly fortified, and deemed the key of Egypt; its ancient as its modern name, *Tineh,* signifies its swampy position.

In Heptanomis, or Middle Egypt—Memphis, called in the Old Testament, Noph, on the left bank of the Nile, some miles above the head of the Delta, the metropolis of Egypt after the fall of Thebes, and prior to the rise of Alexandria; near it stood several groups of pyramids, and particularly the three largest in Egypt, known as the Pyramids of Cheops, Chephren, and Mycerinus; the spot is now called *Jizeh:* south-west of Memphis, Crocodilopolis or Arsinoe, *Medinet Faioum,* between the Nile and the lake Mœris: near it stood the celebrated Labyrinth, a vast building partly below, partly above ground.

In Thebais, or Upper Egypt—Lycopolis, *Siout,* on the left bank of the

Nile: Coptos, *Koft*, an entrepôt for Indian and Arabian wares, which were brought hither from Berenice and Myos Hormos: Thebæ, in later times Diospolis, in the Old Testament No and No-Ammon, built on both sides of the Nile, the oldest capital of Egypt, far-famed for its size and for the splendour of its temples; its site is now occupied by four villages—*Luxor, Karnac, Medinet-Abu,* and *Kurnu:* and Syēne, *Assouan,* the southern fortress of Egypt, on the right bank; the old geographers drew their chief meridian through this spot. A few miles south, the Nile divided and formed an island, Elephantīne, on which was situated a city of the same name; this island was occupied by a garrison under the Persians and Romans. The island Philæ was the last spot in Egypt.

The ports on the Red Sea were—Myos Hormos, *Cosseir*, built by Ptolemy Philadelphus, to the north-east of Coptos; and Berenīce, in the parallel of Syene, also built by the same monarch.

To Egypt belonged two Oases, lying in the Desert, to the westward of the Nile; the Great or First Oasis, *El Khargeh*, in the parallel of Thebes, from which it was distant about five days' journey: and the Lesser or Second, *Wah el Bahryeh*, to the south-west of the lake Mœris. They were used as places of banishment by the Romans.

III. *Æthiopia.*

ÆTHIOPIA, or Æthiopia super Ægyptum, as it was more specifically called, the Cush of the Old Testament, lay to the south of Egypt, and corresponds with *Nubia, Sennaar, Abyssinia,* &c. Its southern boundary is not well defined: on the E. it embraced the coast as far south as Prom. Zingis, below *Cape Gardafui;* westward it was bounded by the Great Desert. It is for the most part a mountainous district, rising gradually to the southward, and ending in the snow-capped Mountains of the Moon.

The Nile divided into two branches, in about 16° of north latitude—viz., the Astăpus, or *Blue Nile*, and the *White Nile*. It also received the Astabŏras, *Takazze*, which with the Nile enclosed the kingdom of Meroe.

Æthiopia was tenanted by a vast number of independent tribes, distinguished by the ancient geographers by names indicative of their food or manner of living, but of whom we have for the most part no further information. The places, or tribes, worthy of particular notice are these,—the Macrobii of Herodotus, who are supposed to have occupied the territory of the *Somauli*, between the Straits of *Babelmandeb* and *Cape Guardafui:* the Auxumitæ, with the town Axūme, *Axoum* in *Tigre*, between the Astaboras and the Red Sea; the town is supposed to have been founded by the warrior caste expelled by Psammetichus from Egypt, B.C. 650; after the fall of Meroe, it became the seat of an independent and powerful kingdom: Adūle, a flourishing seaport town on the Red Sea, probably in the neighbourhood of *Annesley Bay*: and the Isle of Meroe, the district that lay between the Astaboras and the Nile, about the modern *Schendy, Halfay*, and *Atbar;* it is said to have received the name Meroe from Cambyses in honour of his sister, its former name being Saba or Seba; in which case it might be identified with Seba (Is. xliii. 3; Ps. lxxii. 10), the country of the Sabæans, (Is. xlv. 14) and the residence of the son of Cush (Gen. x. 7); the town lay at the junction of the rivers: it was governed by a priesthood, and through the importance of its position as a place of trade, it obtained the supremacy of the whole of North Æthiopia. North of it lived the Nubæ, with the town Napăta, probably the residence of Candace (Acts, viii. 27), though some suppose her to have lived in Meroe. The northern district, bordering on Egypt from the Isle Tachompso to Syene, was named Dodeca-schœnus, the distance between the two spots being twelve schœni. The Romans added it to Egypt, with the title, Æthiopia Ægypti. The Isle Tachompso is probably the same as *Derar*.

IV. *Marmarica.*

Marmarica was the name of the coast district from the border of Egypt westward to Cyrenaica. It was seldom treated as a distinct country: by some of the ancient geographers it was considered a part of Egypt, by others as part of Cyrene. Though now desolate, it is evident that at one time the land was in a high state of cultivation: there are remains of habitations, enclosures, water-courses, and cisterns, which show that no slight pains have been taken to make it fruitful. A low range of hill runs parallel to the sea-coast, which in one spot slopes off from the sea and forms a rising valley, the Catabathmus Major, *Akabah-al-Kebir*, which is the most remarkable feature in the outward appearance of this district. The Catabathmus Minor was a similar declivity of less extent, on the border of Egypt.

The towns on the coast were—Paraetonium, *El Boreton*, the asylum of Antony and Cleopatra: Apis, twelve miles to the westward: and Menelai Portus, *Marsa Toubrouk*, where Menelaus touched in his wanderings.

Two Oases, well known to the ancients, lay south of Marmarica—viz., Ammonia or Ammonis Oraculum, *Wady Sywah*, in the east, and Augĭla, *Aujilah*, in the west. The former of these is in the parallel of Memphis, at a distance of twelve days' journey. It was famous for the temple and oracle of Jupiter Ammon, and for the expeditions of Cambyses, and Alexander. Cambyses started his from Thebes with a vast army, which perished after a seven days' journey in the desert. Alexander followed the northern coast from the Delta, as far as Paraetonium, whence he struck southwards, and in eight days reached a city of the Ammonians, *Gárah*, and in one day more, the principal Oasis, *Sywah*, on which stood the temple of Ammon, *Oum Beydah*. This Oasis was and still is a great commercial mart for African productions: the caravans to Egypt follow very nearly Alexander's route.

V. *Cyrenaica.*

Cyrenaica, or the territory of Cyrēne, lay in the deep curvature formed by the Syrtis Major, and corresponds with the district now called *Dernah*. After the time of the Ptolemies, it was named Pentapolis, from the associated five cities which flourished there. Its early importance is due partly to its geographical position, being the nearest point to Greece and midway between Syria and Carthage, and partly to its extreme fertility: it was occupied in Herodotus' time by the following native tribes: the Asbystae, in the east; the Auschīsae to the westward; and in the interior, the Nasamōnes.

Cyrene, the metropolis of this district, was founded by a colony of Theraeans, B.C. 631, and soon became a place of importance. It stood about eight miles distant from the sea, with numerous ornamental buildings and catacombs; it is now named *Grennah*. Under the dominion of a branch of the Egyptian Ptolemies, from B.C. 321 to 96, it was the head of a confederacy of five cities—viz., 1. Apollonia, *Marsa Susa*, its port; 2. Ptolemāis, *Tolmeita*, the harbour of Barce, the ruins of which cover a circumference of four miles; 3. Arsinoe, or Tauchīra, *Taukra*, to the south-west of Ptolemais, a fortified town on the sea-coast, but not adapted for a port; 4. Berenīce, earlier Hespĕris, *Bengazi*, in the deepest recess of the Syrtis; near which lay the celebrated gardens of the Hesperides; the nature of the country gave rise to this fable: the ground breaks up into small ravines or chasms, the sides of which are clothed with shrubs, while a level space at the bottom studded with trees gives all the appearance of an artificial garden; and 5. Cyrene. In the interior, to the south-west of Cyrene, stood Barce, *Merjeh*, in the midst of a fine plain, about ten miles from the sea; it sunk after its conquest by the Persians in 510, having gained a high state of prosperity during the half century preceding its fall.

Under the Romans, Cyrenaica formed a portion of the province of Crete.

VI. *Syrtica.*

SYRTICA was the name given to the coast district lying between the Syrtis Major, *Gulf of Sidra,* and the Syrtis Minor, *Gulf of Khabs.* The name is derived from an Arab word meaning *desert,* and was applied to the barren and marshy region about these gulfs. The only rivers in it are the Cinyps, *Cinifo,* and the Triton, *Khabs,* which originally flowed through the series of lakes on the western border—Libyæ Palus, Pallas, and Tritonītis, *Sibkah*—but now discharges itself immediately into the Syrtis Minor, to the eastward of them.

Syrtica belonged originally to the Cyrenians, afterwards to the Carthaginians, and finally to the Romans. In the 3rd century of our era, it obtained the name Tripolitana (whence *Tripoli*), from its three chief towns, which were—Leptis Magna, *Lebdah,* founded by Sidonians, and, under the Romans, a place of commercial importance, as the entrepôt for the inland trade; Œa, probably on the site of *Tripoli,* also a flourishing town under the Romans; and Sabrăta, *Tripoli-vecchia,* a Phœnician town, increased and beautified by Justinian.

VII. *Africa Propria.*

The Roman province of AFRICA, in its most extensive sense, embraced all that lay between the border of Pentapolis in the E. and the river Ampsaga in the W.—that is to say, Syrtica, Africa Propria, and Numidia. The original province of Africa was co-extensive only with the Carthaginian territory, and was bounded on the S. by the river Triton, on the W. by the Tusca, and on the N. and E. by the Mediterranean Sea; it nearly corresponds with the *Pashalic* of *Tunis.*

From the point where the river Triton enters the sea, the coast turns sharply towards the N., and continues in this direction to the neighbourhood of Carthage, where it again returns to its westerly course. The projection thus formed is filled with the ranges of Atlas, which decline towards the sea, forming the promontories, Mercurii, *C. Bon,* in the extreme N.E.; Pulchrum or Apollinis, *C. Farina,* on the western side of the Bay of Carthage; and Candidum, *C. Bianco,* still more to the westward. The only rivers worthy of notice are the Bagrădas, *Mejerdah,* which rises in the back country of Numidia, and, after a devious course, reaches the sea near Prom. Apollinis; and the Tusca, *Wady Zain,* on the western border. The whole of the province is remarkable for its fertility; it is, however, liable to occasional droughts.

Africa Propria was divided into two portions, Zeugitāna the northern, and Byzacēna the southern half. The chief towns in Byzacena were—Thapsus, *Demas,* the scene of a contest between Cæsar and Juba; Leptis Minor, *Lempta,* a short distance from the coast; Hadrumētum, *Hercla,* a Phœnician colony, with a harbour named Cothon; Justinian restored its walls, and named it Justiniana; it afterwards received the name Heraclea; Tysdrus, *Al Jemm,* south of Hadrumetum, a flourishing town under the Romans; and Capsa, *Ghafsah,* in the S., a stronghold selected by Jugurtha for his treasury. In Zeugitana—Neapolis, *Nabal,* a Phœnician colony, on the Sinus Neapolitanus, *Gulf of Hammamet;* Aspis, or Clypea as the Romans translated the name, *Klibiah,* on a tongue of land south of *C. Bon;* Tunes, *Tunis,* on the innermost point of the Sinus Carthaginiensis; Carthāgo, situated upon a peninsula of about thirty miles in circumference, formed on one side by the inner gulf on which Tunes stood, and on the other by a large marsh or lagoon; the ground rises towards the sea, and breaks off precipitously in that direction; and here stood the oldest and strongest quarter of the city, named Byrsa; a magnificent aqueduct supplied the town with water from a distance of above fifty miles; Carthage was originally founded by Phœnicians B.C. 878, and destroyed by Scipio Africanus B.C. 146; Augustus erected a new town on its site, which rivalled its predecessor in size, and lasted into the middle ages: westward of Carthage, Utĭca, *Bou-Shatter,* at the mouth of the Bagradas, which, however, has changed its lower course considerably; after the fall of Carthage, it became the metropolis of the province; it is interesting as the place where Cato ended his life; lastly, Hippo, surnamed Zarÿtus, *Benzart*, westward of Prom. Candidum; also a Phœnician colony, and a place of importance under the Romans.

VIII. *Numidia.*

Numidia was contiguous to Africa Propria; it extended along the shore of the Mediterranean, originally as far as the river Mulŭcha, but was limited by Augustus to the Ampsaga: it corresponds with the eastern part of *Algeria.* The name Numidia—i. e., the land of the *Nomads*—indicates the character of its population; the chief tribe was named Massylii, and their mode of life, as described by Sallust, might, with a little variation, be applied to the *Kabyles,* who now occupy it.

The ranges of Atlas traverse Numidia in a direction parallel to the sea-coast, leaving an interval of plain from 40 to 150 miles in width. The chief rivers are the Rubricătus, *Seibous,* which rises in M. Thambres, and discharges itself near Hippo Regius; and the Ampsăga, *Wad-al-Kabir,* on the western border.

The chief towns were—Hippo Regius, *Bona,* west of the Rubricatus, a Roman colony, but chiefly interesting as the residence of St. Augustine; Vacca, later Theodorias, *Bajjah,* an important place of commerce on the eastern border; Zama, *Zowarin,* the residence of Juba, and famous for the battle between Hannibal and Scipio, B.C. 201; and Cirta, *Constantineh,* the capital of the old Numidian kings, situated on a high hill about ninety miles south of Hippo, and surrounded by a very fertile district.

IX. *Mauretania.*

Mauretania was bounded by the Ampsaga in the E., M. Atlas in the S., the Mediterranean in the N., and the Atlantic in the W.; it corresponds with *Morocco, Fez,* and western *Algeria.*

The ranges of Atlas form the prominent physical feature in this country. The main ridge, Atlas Major or Dyrin, *Daran,* rises from the shores of the Atlantic, and traverses the western half of the continent in an easterly direction, forming the boundary between the kingdoms of northern Africa and the Great Desert. In Mauretania, it throws off some important limbs to the northward, M. Phocra and Diur, which form the connecting link between Atlas Major and Atlas Minor; the latter—a range of inferior heights—skirts the northern shore, and runs up into a horn opposite *Spain,* forming the promontories of Abÿla, *Ximiera,* one of the celebrated Pillars of Hercules, and Cotes or Ampelusia, *C. Spartel.* The whole line of coast abounds in promontories, to none of which, however, does any historical interest attach. The chief rivers are—the Chinnălaf, *Shelif,* which rises in M. Cinnaba; the Mulŭcha, *Muluia,* which formed the boundary between the eastern and western divisions of the province; and the Lixus, mentioned in the account of Hanno's voyage, probably the *Tensift.*

The inhabitants of Mauretania received the general name of Mauri. The tribes had their distinctive titles; the most important were the Massæsÿli in the western, and the Musōnes in the eastern part of Cæsariensis. The Romans first became acquainted with this district in the Jugurthine war; it was incorporated in the empire by Claudius, who formed two provinces, Cæsariensis to the E., and Tingitana to the W. of the river Mulucha.

The chief towns were—Cæsarēa, formerly Jol, *Tennez,* on the sea-coast, the capital of Bocchus and Juba II., and afterwards of the eastern province; Sitifis, *Setif,* in the interior, westward of the Ampsaga; Tingis, *Tangier,* the capital of the western province, near Prom. Ampelusia; and Lixus, *El Araisch,* on the western coast, the chief emporium in those parts.

X. *Libya Interior.*

It remains for us briefly to mention the tribes and places in the interior of Africa, with which the ancients had any acquaintance. South of Mauretania dwelt the Gætūli, in three subdivisions—viz., the Autolales, with the town Autolala, *Agoulou*, on the Atlantic; the Phaurusii, southward, about the 25th degree of north latitude; and the Melano-Gætuli, a mixed race of negroes and Gætulians, to the S.E., in the district now occupied by the *Touaricks.* Eastward of the Gætulians lived the important tribe of the Garamantes, whose chief settlement was the Oasis of Phazania, *Fezzan,* south of Syrtica; they also occupied the southern district, where the tribes of the *Tibboos* now live. The towns of Garama, *Gherma,* Saba, *Sebha,* and Cillaba, *Zuela,* in *Fezzan,* are mentioned. The Garamantes were the most active traders of Central Africa; caravan routes are known to have existed from *Fezzan* to *Bornou* southward, to Leptis and Carthage northward, and to Thebes in Egypt eastward. South of the Gætuli, in *Soudan,* lived the Nigrītæ. Two rivers are placed in their district—the Nigir and the Gir: the former is the most westerly, and forms the lake Nigritis, perhaps *L. Debo,* west of *Timbuctoo;* the latter also forms a lake in its mid-course, named Chelonides, and discharges itself into Nuba Lacus, perhaps *L. Tchad.* It is, however, impossible to identify these rivers with any degree of certainty. Some of the towns of the Nigritæ are mentioned, as Pesside, probably *Timbuctoo,* Nigira, perhaps *Jenneh,* and Thamondacana.

Two groups of islands lie off the western coast of Africa: Fortunatæ Insulæ, one of which was named Canaria, whence the modern name *Canaries;* and Purpurariæ Insulæ, *Madeira* and the islands about it, which derived their ancient name from a manufacture of purple dye established on them.

XI. *The Roman Empire.*

It now only remains for us to sketch briefly the rise and extent of that mighty empire which at one time embraced almost all the countries described in the foregoing pages, and became co-extensive with the whole civilized world. Our view will be confined to the Roman provinces in the proper sense of the term, as applied to the conquered countries beyond the limits of Italy.

The island of Sicily was the earliest acquisition, B.C. 241, which was soon followed by the conquest of Sardinia and Corsica, B.C. 238. Hispania was partially subdued B.C. 206, and divided into Citerior and Ulterior; but the subjugation of the north-western tribes was not completed until B.C. 19, after which the threefold division, Lusitania, Bætica, and Tarraconensis, was established. The conquest of Gallia was effected at two distinct periods: the southern district B.C. 121; the remainder by Cæsar in the years B.C. 58—50. It formed four provinces—Narbonensis, which corresponded with the original province, Aquitania, Belgica, and Lugdunensis. Eastward of Italy, Illyricum was partly conquered B.C. 228, and more completely B.C. 168; the Dalmatæ and Iapodes alone retaining their independence until a later period, B.C. 33. Macedonia was conquered B.C. 168, and constituted a province B.C. 148; Epirus in 146; and in the same year, the remainder of Greece, under the title of Achaia. The foundation of the Roman sway in northern Africa was laid after the third Punic war, B.C. 146, when the greater portion of the Carthaginian possessions were incorporated in the province of Africa. The adjoining country, Numidia, was added by Cæsar B.C. 46; Cyrene, B.C. 96; and Egypt, B.C. 30. The island of Crete, which was united with Cyrene in one province, was subdued B.C. 67. In the remaining continent, the first province of Asia was formed, B.C. 129, out of the kingdom of Pergamus, comprising the western provinces of Asia Minor. Bithynia came into their possession B.C. 74; Cilicia, B.C. 66; Pontus and Paphlagonia, B.C. 65; Syria, under which Palæstina was included, B.C. 64; and Cyprus, B.C. 58.

Thus, at the dissolution of the republic, the Roman empire was bounded, in Europe, by the Atlantic Ocean, the British Channel, the Rhine, the Illyrian ranges, and the ranges that bounded Macedonia on the north; in Asia, by the Euxine Sea, the Euphrates, and the Arabian Desert; and in Africa, by the Great Desert southwards, and the border of Mauretania westwards. In addition to this, certain countries had been subdued, but were not yet incorporated in the empire, such as the Pannonians, the Thracians, the Colchians, and Iberians.

Under the early emperors the limits of the empire were considerably advanced. Augustus subdued Mœsia, Vindelicia, Rhætia, and Noricum, B.C. 15, and completed the conquest of Hispania. Tiberius added Cappadocia and Commagene A.D. 17, and reduced Pannonia to a province; Galatia and Lycaonia also became part of the Roman empire, A.D. 25. Claudius conquered Mauretania A.D. 42, and Britain A.D. 43; placed Judæa, A.D. 44, under Roman governors, and made Lycia and Thracia provinces. Vespasian incorporated the islands of Lesbos, Samos, Chios, and Rhodes, in a province named Provincia Insularum. Lastly, Trajan carried the boundaries of the empire to their greatest extent, by the conquest of northern Arabia A.D. 105; Dacia, A.D. 106; Assyria, Mesopotamia, and Armenia, A.D. 114.

Thus all that lies between the Atlantic and the Tigris on the E. and W., between the wall of Antonine in Britain and the Atlas range in Africa, and further eastward between the Carpathians and the Great Desert, and between Caucasus and the Persian Gulf, was subjected to the sway of Rome. The permanent boundaries, however, subsequent to Trajan's reign, were the Euphrates on the E., and the Danube on the N., the provinces beyond these rivers having been soon given up. The division into provinces remained until the time of Constantine the Great, who established a new and more systematic system. The empire was divided in four Præfectures, which were subdivided into Dioceses, and these again into Provinces:—I. Præfectura Orientis comprehended the following five dioceses, subdivided into forty-eight provinces: 1. Orientis; 2. Ægypti; 3. Asiæ; 4. Ponti; 5. Thraciæ. II. Præfectura Illyrici contained two dioceses: 1. Macedoniæ; 2. Daciæ; subdivided into eleven provinces. III. Præfectura Italiæ contained three dioceses: 1. Italiæ; 2. Illyrici; 3. Africæ; subdivided into twenty-nine provinces. IV. Præfectura Galliarum contained three dioceses: 1. Galliæ; 2. Hispaniæ; 3. Britanniæ; subdivided into twenty-eight provinces. In the division of the empire A.D. 395, the two first præfectures formed the Eastern, and the two last the Western Empire.

The recent discoveries of Colonel Rawlinson, in his translations of Assyrian and Babylonian inscriptions, are of great geographical interest, for though they are not as yet sufficiently classified and arranged to afford a complete topography of the countries about the rivers Euphrates and Tigris, yet they confirm and elucidate the accounts of the older geographers, especially of Herodotus, and the Jewish writers, and give sufficient evidence of the advanced civilization, large population, and extensive commerce of those districts, as well as the connexion of Assyria with Egypt and Arabia.

These inscriptions consist principally of records of the conquests of the Assyrian kings, and the divisions of their empire. The former extended over Media, Armenia, Mesopotamia, and Syria, as well as the countries bordering the Tigris and the Euphrates, to the east and west, and on the shores of the Persian Gulph.

The accounts of the northern countries, especially Armenia, are the more full and explicit, 276 towns being reckoned in that and the adjacent districts, while in the country of Tubal, twenty-four kings are enumerated. The expeditions of the Assyrian kings appear generally to have been directed first to the N.W., where the country was more exposed to their attacks, and then by the N. to N.E., E., and even S., as more or less success attended them. In the catalogues of the towns conquered by them, some are identified not only in Babylonia, or Shinar, as it is called, and Assyria, but in Persia, Armenia, Media, Syria, Palestine, Egypt, and the country at the mouth of the Euphrates.

Besides the general geographical interest attaching to those inscriptions, they throw considerable light on some important points of history: for example, Assur is always opposed to the Chaldeans; we have the limits of the empire of Darius defined by authority; and the locality of the tomb of Cyrus fixed at Pasargadæ in the plain of Morghaub; the correctness of the Persian account of his death being thus fully confirmed.

Babylonia is only known in the inscriptions as Shinar, which may possibly be the same as the Singara, or Sinjar, of Histiæus, a name preserved in the hills between the Euphrates and Khabour to the west of Mosul and the village below them; it is also written Sinkar,or Senkerah, and was, Colonel Rawlinson supposes, probably the Lancherah of Berosus; and afterwards the Athra or Otiris of Pliny; its inhabitants were Chaldees; its chief city, after the accession of Nebuchadnezzar to the throne was Babylon, "the glory of the Chaldees' excellency;" Babel, the Gate of God; indeed almost all the principal cities of the Babylonian Empire seem to have been built by Nebuchadnezzar; the name of that king being found on the bricks of which they were composed. Among the localities especially pointed out by Colonel Rawlinson are—1. On the Iskalah Canal, 15 miles N. of Bagdad. 2. On the right bank of the river at Bagdad. 3. At Nearkan Kabya, on the road to Hillah. 4. At Akerkerf, called by Arabs Palace of Nimrod. 5. Near Khan-i-said. 6. Zaleh on the River Euphrates, near Musaib. 7. The City of Cutha, Lat. 32° 41′ 36″, Long. 44° 42′ 26″, apparently almost equalling Babylon in extent; also at Kalwadha, Hymar, Birs Nimroud, Beth Digla, Beth Sida, or Beth Djehda, and others, the latter being one of the most famous cities of Babylonia.

It should, however, be noted that Mr. Layard and others consider the ruins at Nimroud, Karamless, Khursabad, and Kuyunjik, to be palaces at the angles of one great city, they forming, according to Colonel Jones' survey, an exact parallelogram. The word 'Nimrod' appears as the passive form of a verb, and may mean 'the settlers.' Chaldea appears identical with Calah or Halah, Halah, forming Caldi or Haldi, and cognate with Phut and Phutiza; the Assyrian name of Calah was Levekh, i. e., Larissa, probably the Lachisa of the Samaritan Pentateuch. Colonel Rawlinson appears to identify this city with the ruins at Sirpul Shah, with the Halus of Tacitus, and with Holman, as he does the sister city, Resen or Dasen with Yassen Tappeh in the plain of Shah Rigor, the seat of the Dassen Khurds. These, however, ought to belong to Assyria.

The city named in the Book of Genesis, next to Babel, Erech, Colonel Rawlinson identifies with the Ur of the Chaldees, named in the history of Abram, and the Warka of the inscriptions; he supposes it to be the Camarina of Eupolemus, and the Orchæ of the Greeks. The ruins are of stupendous magnitude, and being under examination, may be expected to yield much information to the explorers; but it should be observed that Warka is elsewhere placed by him in Hyrcania, and that Mr. Layard sees no reason whatever to suppose Ur to have been in that locality. The chief cities of the Chaldees were, however, to the south.

The country about the mouth of the Euphrates was called Beth Jakinah; there were seven kings of the Jakanatsi in the land of Yatnan, near Taha Dunis, which, with Beth Takarah and Beth Eden, were the chief cities. The ruins at Mugheir or Nunwaweis, will probably prove to be those of one of these three cities. Yetenira, a name not dissimilar to Yatnan, is named as a dependency of Susiana. Zazana is named as a city near Babylon, and Dobana as a district appertaining to that city. Pekodh is also named as a town in Shinar. It may be noted that in Babylonian, the Euphrates is called Euperatah, in Assyrian Berat or Pherat, which approaches nearer the Jewish word, and is also the name or title of the monarch, and of which the Babylonian appears the corruption.

Of Assyria itself less information is obtained from this source; it appears however to have been named from the god Assarac, which name may have some preconnexion with that of Assur; it is also called Zahiri. The plains of the city of Assaramineh below Nineveh, as well as those of Lambinal, are mentioned in connexion with the country of Dagini, as the latter is with Ararat, which would lead to the supposition of an error, either in the inscription or the reading. Khursabad is identified by Colonel Rawlinson with Sargina, the city of Sargon, Kuyunjik with Mespilah, and Nebbi Yunus with Nineveh, on the Tigris, opposite Mossul, called also Beth Arkstonia, and said to have been built after the manner of Egypt; Niffer, or Tel Anu, the city of the moon, appears to have been the residence of the Assyrian kings, before Nineveh was built; it is situated near the mouth of the Kercha; reference to this is, Colonel Rawlinson thinks, probably made by Isaiah c. xxiii. v. 13. Chage also was between the Tigris and Kercha, and according to Dicæarchus, Babylon was built by Emigrants from that place, but, as Mr. Layard well observes, the crowding so many large cities so closely together is warranted neither by history nor analogy.

The catalogue on the bulls in the plain of Nimroud, commemorates the conquests of Temenbar II., son of Sardanapalus or Asaradonpul from W. to N. and by E. to S. in the following order:—the Nahiri, Khamana, and Sheta, the countries watered by the Tigris and Euphrates from Belats to Hakim, and thence to Melinda, to Dagani, to Arzekan, to Latsan, to Hubiska, the Arians and tribes of Chaldees on the coast.

The limits of the dominions of the Khursabad kings are thus stated. Assyria, Babylon, the Sahiri, and Hekti, from Yetnan, as far as Misr and Mesek—i. e., lower Egypt, Maratha, and Saccan, on the sea coast of Phœnicia. The land of the Sheta, Media, Vakania, (possibly the same as Veklanya, the land of the Vakki,) Ellenbi, Sasi, Susiana, and numerous cities on the Tigris, Passitigris, and Eulæus. In the eleventh century, before the Christian era, the limits of the Assyrian empire were from the Persian Gulph to the Mediterranean, but did not include Syria or Asia Minor.

Of Persia, also, the information obtained is rather historical than geographical. We have, however, the divisions of the empire of Darius given as twenty-one, thus—

1. Persia; 2. Susiana; 3. Babylonia; 4. Assyria; 5. Arabia; 6. Egypt; 7. Those of the sea; 8. Sparta, probably the Dorian colonies; but in the time of the Maccabees, the Jews claimed kindred with the Spartans; 9. Ionia; 10. Armenia; 11. Cappadocia; 12. Parthia; 13. Zangaria; 14. Asia; 15. Chorasmia; 16. Bactria; Sogdiana; 18. the Sacæ; 19. Sattagydes; 20. Arachosia; 21. The Medians; and, in addition, Cyganaca and Racha, are named as cities of Persia; on crossing from Persia through Media, Katsir is reached, then Kharkkar, the cities of Kakhidra, Tarzanem, and Isleban, which must therefore have been in or near Armenia. In Media we have the district of Kapuda named, and Gedrosia as a city: Rhages is identified with Margiana; Gadytia is named as a district of Arachosia, and Capyscutia and Arshada forts in the same.

Of Armenia, which was evidently the debateable land of Western Asia, we have more details. The wars of the Assyrian monarchs being chiefly in that country, hence the number and variety of names preserved. On the north of this the country of Ararat is placed, and to the west that of the Sheta, to the South Aram Bedan, probably Padan Aram.

Of Ararat we have the following notices:—The capital was Arkarkhan, and while eighty-seven cities are said to have been situate in the land between Armenia and Ararat, in the latter one hundred are named; Habbaril, of Ararat, is said to have received tribute of the King of Shetinah, gold, silver, horses, sheep, oxen, &c.; the Hekdi and Shesha are there located; to the east is the land of Kharka, probably the modern Khorkhor or Van. Nukatseri, or Nuzatserie, appears to have been another name for this country, the cities in which, after its conquest by the Assyrians, received the names of their Gods, as Taha Nebu, Taha Bel, Taha Ashteroth. This is also the country where the Ark of Xixuthrus is supposed to have rested, according to Alexander Polyhistor, quoting Berosus; from Assyria it lies across the Zab, and in the same direction we have the cities of Hubiska, Mela, and Minni, probably the Ararat Minni of Scripture, (see Jeremiah li., 27), with its chief city Tchikarta, given in order, and in the account of the raid or predatory excursion, in which they are enumerated, they are followed by Mesarta with its capital, Kharta, the country of Sardera and Persia.

The Askenaz of Scripture, mentioned in connexion with Ararat Minni, is probably Arzeskan. Beyond the river Zab the plains of Larri and Ladsan are said to extend as far as the cities Tel Abtan and Tel Zaledan. In the account of another raid, commencing again with Hubiska, Bagatsiri is mentioned as a district having thirty-six towns, besides its capital, Anseri—fifty cities are also named in Armenia. Ladsan, Barrianæ, and Kharran, or Sharran, are mentioned as districts in connexion with Minni, and beyond them the cities of Biharia and Litiharia. In Persia the cities of Bairet and Shel Khamana, of course, on the east side of the Tigris, while the district Khamana appears to have been on the west. Akarinia. supposed to be Kharta, is mentioned on the sea coast, and Mesek, in other inscriptions, meaning Lower Egypt, is in one named as in Armenia. The return was through the country of Kharets, descending into the plains of Eones above the country of Umen. In this 250 cities were despoiled. Lasan evidently joined Armenia, and may possibly be the same as Laz or Lazisthan. The similarity of names, however, makes localization dangerous, as in another raid, commencing more to the west in the country of the Nahiri, (between which country and Ararat Isibarta, possibly the same as Hiritissa, is named), the Khamana and Sheta, the route is through the countries watered by the Euphrates and Tigris, from Belats to Shakem, by Melinda, Dagain, (this place paid tribute in horses,) Arsekan, Latsam, and return by Hubiska, the Arians, and tribes of Chaldees on the coast. The city of Hindara is elsewhere named as the stronghold of Ellula or Melinda. Across the upper Euphrates, Kanala is mentioned as capital city of the Shetinah; Lek, not of course the modern Lek or Ladak, is named as a mountainous district to the north, and in connexion with the city of Shenala, or Shenaba. Beyond the Upper Euphrates the lands of Khamana and Malar are named the city of Tel Barabra, Bithen, between that river and Arteri, and Sitrat on the Euphrates; in the same direction we have also the plains of Elets, Dagini, and Enem; to the south of these Lerzan and Hubiska, the country of Shelar, or Kelar, the district of Zoba, and city of Yedi, and beyond, the city of Erri, in the district of Abvarri.

The Bilikh, an affluent of the Euphrates, above the Khaboor, is named as Belak, and beyond it the cities of Tel Alask, Habareiny, and on the opposite side of the Euphrates the country of the Sheta and the city of Muen, which, from the other catalogues, would appear to have been on the east of the Tigris; in continuation of this route we have Barbara, the country of Atesh, a name also found in Syria, the country of Telati towards the east, the city of Taha Dunis and land of Beth Takara, and still further east or south the land of Shinar.

Towards the north-west, beyond Khamana, we find the country of Berbini, the city of Bahura and Tanakem the stronghold of Ettak, Leman beyond Tanakem, and Nethels beyond Leman. These belong to the mountain districts of Lebanon, as appears from Colonel Rawlinson's identification of names on the monolith of Sardanapalus at Calah, on which the names Lemenen, Hamana, Lebanon, Shenir, are mentioned together, and from the same authority he classes the following names:—Atesh Hems, or Emessa, supposed, from St. Jerome, to be the same as Edessa, Husubrian, Sidon, the greater and the less, Beth Zitta the City of Olives, Sarepat Sareptah, Mahallat tne ascent, Tyre, Kksip Eksippa, Akkia or Akkra Acco, or Acre, Khazitis Cadytis, Gaza Rhinocorura, Alakis Lachish, the Larissa of the Greeks, the scene of Pompey's death, the name of which was transferred to Assyria; between the last-named towns Asuda Arvad, Gubal Byblos, Ashdod, Beth Ammon, Ascalon, Ekron, Hudemiah Yatunan Ethnan Edom, Sela Petra, Lubanah Libnah. Near Ashdod the city of Shenakti, probably Askelon, is named as given to the Yavanah, who the Colonel thinks may possibly be the Ionians, and their leader Methati of Atheni, Melanthus of Athens.

Misr appears identical with the Persian Mudrayah, *i.e.*, Egypt, Mirhuka with Meröe. To the north of Palestine we have Atesh, and beyond the country of Telati towards the head-waters of the Tigris, in the country of Khumana, Yeri the city of Esdinak is named, and near Hamath, eighty-nine independent towns. Khamana is of course the Amana of the Greeks. Near Atesh are also placed the countries of Lemnan, Berabin, and Tubal, with twenty-four kings; beyond Alta and the gold country of Belin.

The following names, mentioned in Scripture, besides those already noticed, Colonel Rawlinson considers as identified:—Gozan, Haran, Rezeph, Eden, Thelasar, Calno, Carchemish, on the Euphrates, Arphad, Arvad and Aroer, as well as the Arab tribes of Kedar, Hazor, Sheba, Teman, Nebaioth, Dedan, and the Hagarenes; the Tigris, the Euphrates, the two Zabs, Hermas and Khaboor rivers. To these Mr. Layard adds the names of Elam, which he identifies with Sardiana, Shusan, Meshek, Tubal, Pethor, Samaria, Harran, and Ur, Khasri, the Chauser river, and the plain of Dura. The native forms of Cilicia, Comagene, Sophene, Gazarene, and most provinces named by Grecian geographers, are also found.

Ethnological facts of much value are to be obtained from these inscriptions. Akkadimi, 'the East,' is the term applied to the country of the Chaldeans, Armenia, and Babylonia; but Assur, as already noted, is always opposed to the Babylonians. The most important race in these countries were the Scythæ, called also Sacæ, Saci, Saccan, Tzimri; they dwelt on the Tigris, in Babylonia, Assyria, as well as the north and west towards Syria, in Khamana, Beth Hebra, and Tubal, and are distinguished as warlike Nomad horsemen, from the located and resident agriculturists whom they subdued. They appear to have been divided into two tribes, the Humarga—the Amurgiri of Herodotus—and the Tigrak-Huda, or bowmen. to them the tablets, called Median, are inscribed, and, Colonel Rawlinson thinks, the Cymri, Celts, Sclavonians, and Teutons, as well as the Finns, Turks, and Magyars, were included in their families.

The Assyrians are mentioned as a colonizing race, and as forming settlements in all their conquests.

The Arians are located below the Persians, and again across the Zab, and the Sheta next to them, near the coast. This tribe, or people, as has been shown, were also located with the Khamana on the west of the Euphrates, above the Khaboor; these are supposed to be identical with the Katti or Hittites. The Nahiri about the head waters of the two rivers, their country the Naharaim of Scripture, are named in connexion with Hamath, as is also the tribe Yehuda. Rabek, the principal city of the tribe of Khulban, is identical with Heliopolis. The Sattagydis and Medians have already been named as the nineteenth and twenty-first divisions of the Persian Empire under Darius.

Several Arab tribes on the banks of the Tigris are named the Yetah, Rebiah, Keril, Lemdod, Khemoran (Kamarina of Eupolemus, near Ur of the Chaldees), Hichil, Ruhna, Luhti, on the rivers of Susiana the Tebilu, Akindara, Bilder, and Sati.

The character of the different races is discernible from the tribute paid by them, the northern nations gold and cattle, the western, as the Dagini, horses, the commerce of the Chaldees to the south is represented by gold, silver, gems, and pearls.

MARITIME DISCOVERY.

INTRODUCTION.

COMMERCE is the daughter of peace and the bond of unity between nations. It was therefore reserved for the period of the dispensation of peace and good-will among men to spread commerce over the globe, and link together in her golden chains those before separate and unknown to each other. Commercial relations must have their origin in interest, and the origination of them must offer large profits as its inducement. Yet the intimacy of these relations tends to equalize the condition of all men—makes known to all their universal brotherhood and common origin; and though at first the savage may receive for the valuable natural productions of his country what to the civilized man may seem a trifle, it must be remembered that it is to him, nevertheless, a sufficient return, and that he is further rewarded by his introduction to the arts and sciences of civilized life, as well as to that religion of which civilization is the accompaniment.

Commerce does not, however, often recognise her true mission; yet the eternal law of nature remains, and she fulfils it, though imperfectly, and, as it were, in spite of herself; and in its fulfilment, she thus brings into intimate communion the inhabitants of the world. The History of Discovery is therefore, in some sort, the History of Commerce; and as the greatest commercial power on the globe, or, indeed, that the world has ever yet seen, is Great Britain, every Englishman must take a personal interest in its narrations; nor will he have reason to be ashamed at the perusal. If not the first, her sons are certainly the most numerous in the ranks of those who have opened to Europe the knowledge of the rest of the world. If we cannot claim as our own Columbus, De Gama or Magelhaens, Polo or Balboa, we have names enough and to spare, and neither the glory of the Spaniards nor Portuguese need excite our envy; for if to them be allotted the first place in discovery, to us must be conceded the first in colonization; for while the empire conquered by them has passed or is passing into other hands, that established by us has extended far wider than theirs ever did, and seems to promise the subjugation of the greater part of the world to our descendants.

The honour of maritime discovery has passed from nation to nation with the empire of the sea. At first historically confined to the Mediterranean, it was in turn possessed by the Phœnicians, Carthaginians, Greeks, and Romans; and again, by the Venetians and Genoese; and under their direction, the Portuguese and Spaniards extended it beyond the narrow limits of that inland sea, but not until indications of the route to be pursued had been obtained from the labours and travail of those who had endeavoured to extend their commercial relations by land. We may, indeed, safely assume that the progress of discovery has been by gentle degrees, although they have been forgotten in the fame of those more extended and daring adventures which resulted from them. In the account of geographical discoveries, Europeans must of course start from their own earliest knowledge; but preceding and parallel with its advance, other discoveries were necessarily going on, by which mankind had been spread over the globe; still the maritime power possessed by them has been at all times so much greater than that of any other people, that the world may be considered as indebted to them for its personal knowledge of itself and its relations.

But although, both with respect to Europeans generally, and the rest of the world more particularly, we are indebted to commerce for our geographical knowledge, there is one exception to this rule. The Northmen, whose discoveries on the continent of North America were unobserved or unrecorded by the other nations of Europe, seem to have been led to foreign lands almost entirely by their love of wandering and habit of living by plunder; and it is a problem well worthy the attention of the ethnologist, how far the infusion of northern blood may have influenced the discoveries of other nations. To them, however, we are only indirectly indebted for geographical information; it has been the endeavour to open a passage by sea for the trade of the east, that has extended the knowledge of the surface of the globe, the monopoly of that trade by the Venetians leading to the discovery of the route by the Cape of Good Hope and of the New World, and to the full tide of discovery by the Spaniards and Portuguese, the Dutch, French, and English, in the 15th and 16th centuries.

CHAPTER I.

§ 1. Commercial intercourse of the middle ages.—2. Missions to the Tartars.—3. Causes of the extension of discovery: the mariner's compass.—4. The conquests of the Moors; Portuguese discoveries in Africa.—5. Columbus.—6. Discoveries of the Northmen.—7. Character of Columbus.—8. Discoveries of the Spaniards.—9. Successors of Columbus.—10. Era of conquest.—11. Vasco de Gama.—12. Conquests of Portuguese.—13. Magelhaens, his circumnavigation.—14. Pope Alexander's division of the world; its consequences.—15. Consequences of discovery to Science.

COMMERCIAL Intercourse of the Middle Ages.—After the irruption of the barbarians into Southern and Western Europe, and the consequent dismemberment and suppression of the Roman empire, the knowledge which the Romans had acquired of distant countries by their relations with other nations, was for a time partially obscured, until, rising out of the commercial chaos that followed, the republic of Venice secured, and for a long period monopolized, the commerce of the East.

The principal channels of trade had been Constantinople and Alexandria, until the conquest of Africa by the Arabs and their encroachment on the territories of the Eastern Empire aroused Western Europe, and excited the Crusades. To those wars is to be attributed the maritime power of the Italians, as well as the English; for while the former were the carriers of Europe, the latter from her isolated position was obliged to be dependent on her own resources; nor did these prove insufficient. The same necessity had maintained her marine for the purposes of commerce from the time of the Romans. The descents and ravages of the Danes on her coasts had, from the time of the great Alfred, inured her children to maritime warfare, as her fisheries had to a maritime life; so that the fleet with which Richard her Lion King, sailed to the Crusades, was the admiration even of the Sicilians. Her sailors signalised their nautical skill and courage by conquest over the galleys of the Saracens, and the Isle of Cyprus rewarded by its submission the boldness of their leader.

The customary channels of commercial intercourse with the East being closed by the Saracens, the Venetians and the Genoese re-opened the older routes across the continent. By one of these merchandize was transmitted from Bassorah on the Tigris, and by that river to Tabriz, near the Caspian, and from thence across Georgia, by the Black Sea, to the mouth of the Don; while from Tabriz light goods were also conveyed to Aias or Ajazzo, in the Gulf of Iskenderoon, at the north-east angle of the Mediterranean. By the other route, merchandize was brought from the river Indus, across Bokhara, to the Caspian, and from Astrachan, along the base of Caucasus, to Azov.

Caravans from China also followed this route; but in 1260 the Genoese restored the Greek emperors to the throne of Constantinople, and having obtained from them the monopoly of the trade of the Black Sea, the Venetians entered into a commercial treaty with the Sultan of Egypt, and Alexandria became once more the emporium of the commerce of the East. The countries through which commercial intercourse had been previously carried on, were of course sufficiently well known to those who traversed them; but these had been principally Asiatic merchants, those of Europe being, for the most part, limited in their personal labours to the shores of the Mediterranean and Black Seas; but the rise of the power of the Monguls under Zenghis Khan, at the commencement of the thirteenth century, the ravages of his lieutenants, and the fears of the petty princes and governors of Western Asia and Eastern Europe, soon made the interior of Tartary better known than it is even now, from their frequent embassies to her capital, Carracorum; for before the middle of that century, the successors of that monarch had extended his kingdom from Hungary to China. Subsequently, the conquest of Georgia and Armenia brought the Monguls into collision with the Saracens and Turks, and Christendom began to hope that her own advantage, and even extension, might arise from the contest between her enemies. Traditions, probably relating to the Nestorian Christians and to Abyssinia, becoming current in the West, raised the hope, if not the belief, that Christian kingdoms would be found beyond those countries occupied by the Saracens; and this, confirmed by reports brought to Europe at a later period, both of the character of the Tartars, their difference from the Saracens, of the kingdom of Prester or Presbyter John, the Christian king and priest in India, originated and sustained schemes for uniting the Tartars and the Christians against the Mahometan conquerors of Western Asia, and led Pope Innocent IV. to send missionaries to convert the Khan and his subjects to the Christian faith, and bring them into submission to the authority of the successor of St. Peter.

2 *Missions to the Tartars.*—The Pope and the Tartar chief were, indeed, at that time the most important persons in the world; for though their power was limited by that of the Christian kings on the West, and the Mahometan empire on the east, yet their union, in opposition to the latter, if successful, as it could not but have proved, would, no doubt, have given the Empire of the West to the one, and that of the East to the other. This, however, the hierarchical pride of the missionaries prevented; and when, afterwards, through geographical discovery, the Pope thought to enlarge his dominion both in the West and in the East, Providence, in the presence and domination of the Anglo-Saxon race, ultimately frustrated his intentions, and established in both a Protestant power equal to any in Europe. The Franciscan Ascelin, whom he sent southward through Persia, met only with insult and contumely; nor did the more prudent Minorite Carpini fare much better. He had, however, an audience with the Great Khan, at his court in Bokhara; and having travelled to that country overland through Poland and Russia, he has transmitted to posterity an account of his journey and of the Tartar nation. He, moreover, gave a fabulous relation respecting Prester John; and to him may probably be attributed the first particular account of that prelate.

While the French king, St. Louis, was engaged in his crusade against the Saracens in Egypt, he received an embassy from a Tartar chief, named Erkaltay, who was then engaged in war with the Saracens in Persia. This induced him to send one William de Rubruquis, or Von Ruysbeck, a Belgian friar, as ambassador to that prince. De Rubruquis followed the same track as Carpini, confirming and enlarging his accounts of the Tartars and Prester John, as well as giving further indications of the existence of rich and powerful kingdoms in India. He found numerous Europeans at the court of the Khan, and from him we learn that Italian merchants had farmed from the Mahometans the monopoly of the alum works in Asia Minor, which, until the fifteenth century, supplied all Europe.

As the Arabians, being themselves a commercial people, had, on their conquest of the west of Asia, closed the Alexandrian and Syrian routes against Europeans, the journeys of Carpini and De Rubruquis, by opening new channels for commerce, excited to new adventures the merchants of Italy; and, accordingly, in 1254, two noble Venetians, Maffeo and Nicolo Polo, crossed the Black Sea, and after various adventures, arrived at the court of the Khan, from whence they were sent back with an ambassador to the Pope, who dying on the journey, they reached home after an absence of fifteen years. In 1271, taking with them Marco, a son of Nicolo, who had been born and grown to manhood during their first absence, they returned, with letters from Pope Gregory X. to the Great Khan, whom they found in China. He received them with great honour, and young Marco was adopted into the household of the Tartar monarch, where he acquired a knowledge of the languages of the East. He was afterwards made governor of the imperial city, Yang-tchou-fou.

Seventeen years did the brothers Poli remain at the Tartar court, and were then sent as ambassadors to Persia, with a princess betrothed to the Mongul ruler of that country. Obliged to return, in consequence of the disturbed state of the frontiers, they proposed to convey her to her future home by sea, in consequence of the report given by Marco of the ease with which the Indian seas might be navigated, he having then returned from a voyage to the Indian islands. They accordingly sailed with fourteen ships, some having as many as 250 men on board, laden with presents from the Khan, and arrived safely at Ormuz; but finding a revolution had taken place in Persia, they left the expedition to return back, and passing through Armenia, arrived at Venice, by way of Trebizond and Constantinople, after an absence of twenty-four years. Subsequently, Marco, having been taken in a naval engagement with the Genoese, and detained prisoner at Genoa, wrote there those accounts which stimulated the spirit of discovery and commerce in the middle ages, and which, bringing to the knowledge of Europeans the western shores of the Pacific, may be considered as the exciting cause to the discovery of the New World.

The natural riches of the countries in the east of Asia, though doubtless exaggerated in the accounts of these and other travellers, were sufficient to give great stimulus to the eastern trade of Europe. The fisheries of the north opened commercial relations between the cities of the Hanseatic league and the republics of Italy. The Moors introduced the luxuries of the East into Spain, and thus the spirit of commerce pervaded Europe.

At the present time, when every one who travels, even into countries already well known, presents the world with his experiences, the facility with which the caravan-trade through Tartary to India was carried on during the 14th century, can, in the paucity of accounts, be scarcely appreciated; and yet the Itinerary of Pegoletti of the route 'from Tana to Cathay with merchandize and back again' is sufficient to show that this trade was regularly organized and carried on without difficulty. By this route, for the purposes of commerce, the East was visited by Europeans from all parts of the West and South; and among those who have left accounts of their travels, Oderic of Portenau and Sir John Mandeville ought to be noted as exercising no inconsiderable influence. The former was canonized so late as the 18th century; and as the religious marvels for which he received that now very questionable honour are sufficiently mendacious, it would have excited no astonishment had the other portions of his narrative proved equally unworthy belief. He appears, however, from certain minute facts which he has recorded, to have passed into India and China. The latter probably never went beyond Palestine, but derived his accounts from the Arabian travellers, and the romances of the Scandinavian and Arabian writers. Notwithstanding this there is no doubt that many of his accounts were believed; and his description of the court of Prester John, at which he says he was received, confirmed and increased the general faith, not only in the riches but the Christianity of a large portion of the people of the East; and the jewels brought home by the Poli were sufficiently numerous and valuable to excite cupidity and admiration, and afford to ardent minds a satisfactory evidence of the truth of stories such as those of Mandeville, of tables of emeralds and of carbuncles a foot long, the radiance of which illuminated the palace at night. The narrative of the Spaniard, Ruy Gonzalez de Clavijo, who, in consequence of the favourable reception of a previous embassy, was sent, in the year 1403, by Henry III. of Castile, to the court of Timur, then held at Samarcand, is of far more value, enlarging the accounts of former travellers; and from this time Spain and Portugal entered with spirit into the great commercial contest for the monopoly of the trade of the East.

3 *Causes of the Extension of Discovery: the Mariner's Compass.*—The conquests of the Moors had attracted to Spain the ardent spirits of all nations, even the extreme north of Europe; they brought with them whatever knowledge of other countries their own possessed. The Moors had introduced into the Peninsula the luxury and love of splendour proverbially Eastern, which the Spaniards and Portuguese were not slow to adopt: they had also made the Arabian language and Arabian learning common in Western Europe, and thus facilitated the transmission of the commerce of the East from their own hands into that of their enemies.

In preparation, too, for more extended discoveries, science, which the Moors had introduced into Spain, had not failed to contribute. The properties of the magnet had, indeed, been known for centuries, a Provençal poet at the court of Frederic Barbarossa having in 1181, described it as useful to guide the mariner at sea; its use, however, now became general in the West, as the Arabians had already made it in the East; indeed, so early as 1269, it was known, even in its variation, to the Germans, as we learn from the physician, Peter Adsiger, though its introduction is usually attributed to Gioja of Amalfi, in 1302.

4 *The Conquest of the Moors; Portuguese Discoveries in Africa.*—The conquest of the Moors in the West was, so to speak, the first step to the conquest of the world; in this, Portugal led the way by carrying the war into Africa. King John, in 1415, took Ceuta, and gave the government of his conquest to his son, Don Henry, who, three years before had shown his desire for maritime discovery by despatching ships to the west coast of Africa: and from that time till his death he never intermitted his exertions. Until 1418, however, the Portuguese mariners had not passed Cape Bojador, when the attempt of Joham Gonzalvez Zarco and Tristam Vaz Texeira to double that Promontory, led to the discovery and colonization of the Canary, and the occupation of the Madeira Islands, by them and Bartholomew Perestrelo; both of which had, however, been previously known to the Spaniards, the English, and even the Normans, who had probably extended their voyages beyond Cape Bojador, although the perseverance of the Portuguese has justly secured to them the honour of permanent discovery on that coast; and in 1433, it was rewarded by the return of Gil Eannez, or Gilianez, as he is usually called, after doubling that cape, with satisfactory accounts of the coast beyond, and the facility with which it might be reached by sea.

The knowledge of the previous expeditions of the Normans no doubt induced Don Henry to apply to Pope Martin V. for a grant of all the countries he might discover in that direction. If his predecessors had required the submission of the Great Khan to their authority as the vicegerents of God upon earth, it was but a small thing that he should grant to a Christian prince the dominion of unknown lands peopled by Mahometans or Pagans, especially as it presupposed their being brought under the rule of the Holy See; and the application was a recognition on the part of the King of Portugal of the universal extent of his own authority; and accordingly the perpetual donation of all lands or islands between Cape Bojador and the East Indies was made by him to that crown. This places beyond doubt the object of Prince Henry to have been the attainment of the commerce of the East by circumnavigating Africa. The Arabs had brought into Spain and Portugal the literature of Greece; and the voyage of Nearchus and reported voyages of the Phœnicians and Egyptians round Africa, could scarcely have been unknown to him. Thus, one discovery leads to another—the knowledge of one fact to that of another. Mankind is always advancing—always accumulating—laying up in store for generations to come. But to commercial, religious ardour and enthusiasm were—as in the East, so now in the West—made auxiliary. The wars against the Moors had been esteemed religious wars; plenary indulgence had been granted to those engaged in them, as in the Crusades; and it was now extended to those who should rescue the unknown regions of Africa from the hands of the infidels and pagans, and enlarge the dominions of the Holy See; and thus the spirit which had crowned with success the Spanish and Portuguese arms in the Peninsula and in Africa, was now invoked in aid of maritime discovery.

In 1441, Antonio Gonzalvez and Nuno Tristan reached Cape Blanco, and having taken some Moors prisoners, obtained for them the next year, as ransom, gold dust and negroes; and then commenced that trade which has been the disgrace of Christendom and the curse of Africa until this day. To these navigators is by some attributed the discovery of the Cape de Verd Islands—an honour usually conferred on Antonio Noli, in 1450, but which were visited by Cada Mosto in 1456. In 1445, Dinis Dyaz, or Fernandez, as he is more usually called, passed the Senegal river, and reached Cape Verd; and in 1449, the Portuguese had colonized the Azores, which had been previously discovered by the Flemings. These successes having attracted Venetian navigators to the court of Portugal, Prince Henry availed himself of their scientific knowledge, and had his recent discoveries more accurately examined. One of these navigators, Aloisio de Cada Mosto, a Genoese by birth, published an account of these countries, to which, by Don Henry's permission, he sailed in 1454; from this it appears that the Portuguese obtained from their inhabitants a knowledge of Timbuctoo, of the Great Sahara, and of Lake Tchad. It is remarkable that he supposed the Senegal to be connected not only with the Niger, but with the Nile, and that generally the great rivers and lakes have been supposed to intersect the continental masses and unite opposite oceans. Such an opinion led Alexander the Great to survey the Caspian—possibly to the circumnavigation of Africa—certainly to our knowledge of the western and northern coasts of America.

In 1456, Cada Mosto again visited the river Gambia; and about six years after, Pedro de Cintra gave the name Sierra Leone to the mountains which now bear it: but to the death of Don Henry, in 1463, a temporary suspension of maritime discovery succeeded. It is marvellous that, with such clear views, such extensive means, and such devotion to one object, as are expressed in the life of that prince, the discoveries of the Portuguese during half a century under his direction should not have reached the equator; yet it does not appear that there was any want of energy or perseverance. The development of all great things is slow: we must not despise the day of small things.

The knowledge of the existence of gold has always been among the greatest incitements to extended discovery. In the middle of the fifteenth century, gold had been imported in considerable quantities from the coast of Guinea, and in 1469 the monopoly of the trade was given to Fernando Gomez; but to this, as to every similar grant in those times, was attached the obligation of extending discovery, and in consequence the islands on the coast, as far as Anabon, in lat. 1° 24′ south of the equator were discovered; and the knowledge of the coast of the main-land extended as far as the northern limits of Congo. The accession of John II. gave a fresh impulse to the spirit which Don Henry had evoked in the breasts of the Portuguese, and in 1471 the Gold Coast was discovered by Juan de Santarem and Pedro de Escobar; and on the accession of John II. in 1481, though not without difficulty, a fort was erected by Diego de Ambuza, called S. George del Mina, afterwards popularly El Mina, on the coast of Ashantee; the king, upon this, assumed the title Lord of the Gold Coast, and obtained from the pope a confirmation of the grants made to Don Henry, accompanied by a strict prohibition against the intrusion, within the limits conceded to him, by any other Christian king. Nor was this caution inoperative, for it proved sufficient to induce Edward IV. of England to discourage the enterprise of his subjects in that quarter.

In 1484, Diego Cam discovered the river Zaire, or Congo; and extending his voyage to the south, returned with ambassadors from the negro sovereigns of that country, who, being baptized in Portugal, missionaries were afterwards sent back with them to Africa; from some of these the king received accounts of a monarch, whose territories were to the east of Congo, so similar in some respects to those given by De Rubruquis and others, of Prester John, as to convince him that the kingdom of that monarch might be reached by circumnavigating Africa. That this king was the king of Abyssinia, and the account substantially correct, can now scarcely be doubted; its influence on the extension of discovery by the Portuguese was most important. In 1444, Don Pedro, then Regent of Portugal, had proposed to send ambassadors to Prester John; and though at that time the intention was not prosecuted, yet it was approved by his councillors, and shows that the desires of the Portuguese had been turned in that direction. The accounts of the negroes now induced the king to send expeditions, both by sea and land. Pedro de Covilham, who was already well acquainted with the Arabs by residence in Africa, was sent in 1486 by the ordinary route, from Fez to Arabia, and thence proceeded to India. On his return he visited Sofala, and received there accounts of Madagascar. On his arrival at Cairo, he found that Alfonzo de Paiva, who had accompanied him so far, having directions to search for the kingdom of Prester John to the south, had been treacherously murdered; and he therefore proceeded himself to Abyssinia, having sent home to the king all the information he had been able to collect.

On his arrival in Abyssinia, although admitted to the highest offices of the state, he was detained a prisoner, and spent the rest of his life there; and Roderiquez de Lima, when sent as ambassador to that country in 1525, found him still alive. It should seem that he found means to keep up a correspondence with his own country, and there can be no doubt that his accounts confirmed the opinion which had already obtained among them, that India could be reached by the south of Africa.

In the meantime, an expedition, under Bartholomew Diaz, was despatched to prosecute discovery by sea. He having pursued the customary route along the coast until he had passed the tropic of Capricorn, then stood due south; and having lost sight of land, and being driven to the eastward by heavy gales, passed the southern point of Africa without knowing it, reached De la Goa Bay, and discovered Great Fish River; and returning, found he had accomplished the object of his voyage. He named it the Cape of Tempests, a name which the king judiciously changed for that of Good Hope.

Few navigators of that time deserve greater fame than Bartholomew Diaz, either for boldness or the success it merits and generally secures; for though he did not proceed far beyond the southern point of Africa, yet the easterly trending of the coast could have left no doubt on the mind of the navigator, or indeed of his nation, especially when compared with the accounts of Covilham, and the knowledge that the longitude of Alexandria had been reached so far to the south, that the route to India by sea had been opened. But before the Portuguese availed themselves of this knowledge, a fresh era in the history of discovery, and of the world, had commenced; — indeed, the discovery of the New World may well be considered as the commencement of Modern Geographical Science, for from that period until now nothing has remained to the navigator or traveller but to work out and develop its consequences.

5. *Columbus.*—Of Columbus himself little need be said; few names are better known to history than his, nor has the mistaken appellation given to the new world which he discovered robbed him of his due honour, or placed Amerigo Vespucci beside him in the sanctuary of the temple of Fame.

It is, however, important to remark, that Christoforo Colombo was by birth a noble, by education a scholar, by necessity, perhaps, a navigator. His magnanimity, his perseverance, his knowledge, are due to his antecedents. Yet does this in no degree detract from his merit. The accidents of life, in the providence of God, most frequently determine our position; our actions are our own, and those which changed the Genoese navigator into Christoval Colon, the Spanish grandee and admiral of the Indies, were worthy greater eminence than he enjoyed—placing the country of his adoption first among the nations of the world, and adding one of the most brilliant to the illuminated pages in which the learning and genius of the country of his birth, at that period, are enshrined.

Born in 1441, he was, in 1473, in the service of the king of Naples, and subsequently commanded a squadron of Genoese galleys. He then went to Lisbon, and found employment in making maps and globes, and may in this manner have contributed not a little to the success of the Portuguese navigators. At this period of his life he appears to have made a voyage to the north, and reached the seventy-third degree of latitude in that direction; and to have acquired a knowledge of land to the westward, beyond the limits of the maps constructed after Ptolemy. He also resided some time at the Azores, and heard there of land to the west, and of tokens of the existence of man brought by the sea from that quarter. He married the daughter of Pedro de Perestrelo, who had been governor of Puerto Santo, and thus acquired the inheritance of his experience and knowledge. We learn also that he had visited the coast of Africa, as far south as the fort El Mina. Availing himself of the proposals of Martin Behaim, and other philosophers, for the use of the astrolabe at sea, he distinguished himself in the paths of science, and prepared the way for his own future discoveries by framing rules for the calculation of longitude and latitude, and for thus ascertaining the position of a vessel at sea when out of sight of land, enabling navigators to traverse with certainty the pathless regions of the ocean—which, indeed, he himself was the first to explore.

The knowledge of an ocean to the east of Asia, acquired by Marco Polo; of another, extending far to the south and west of Africa, by the Portuguese; his own experience of a coast far to the west of Europe; would be sufficient to account for the decision to which the well-stored mind of Columbus was directed by his native genius; but there are not wanting evidences that others had, before him, arrived at the conclusion that the Western Ocean alone divided Europe from the Cathay and Zipango of the eastern travellers. From the middle of the fourteenth century, the Spanish and other maps, constructed no doubt from Italian originals, if not by Italians, had included islands in the Western Ocean. The Azores and Madeira were thus laid down many years previous to the usual date of their discovery; and in the map of Andrea Bianco, constructed in 1436, and now preserved in Venice, an island called Antilia is placed far to the west. On the globe constructed by Martin Behaim, probably towards the close of the same century, certainly previous to the discoveries of Columbus, an island of the same name also occurs, in the latitude of the tropic of Cancer; and one still larger a few degrees north of the equator, against which it is noted, 'in 585, Sir Brandran came here with his ships.' The countries of India, Cathay, and Zipango, appear further to the west; while to the north, Iceland, and some islands,—indicating, no doubt, the discoveries of the northmen,—are delineated.

6 *Discoveries of the Northmen.*—The researches of the Danish archæologists have placed beyond all doubt the discovery, not only of Greenland, but the northern parts of North America, by the Northmen: these were partially colonized before the end of the tenth century. In the seventh century, they had extended their piratical expeditions to Ireland; in the ninth, they had conquered the Hebrides, and levied tribute on the coasts of Ireland; before the tenth, they had discovered and sent colonies to Greenland; and at the commencement of the eleventh, an Icelander named Biorn, sailing to Greenland to see his father, was

driven to the south-west, where he found a beautiful country. After reaching his original destination, he returned with Lief, son of Eric the Red, the original colonizer of Greenland. Delighted with the place, they passed the winter there; and, by their estimation of the length of the shortest day, should have been in about the forty-ninth degree of north latitude. It is, however, uncertain whether they did not reach a more southern limit. The vines found by them induced them to name the country Vinland, to which the appellation 'the good' is usually given by the northern writers. But as the island of Montreal, in latitude 46°, was called by the French the Island of Bacchus for the same reason, this affords no evidence of their having been in a lower latitude. The description given of the portion of their discoveries which they called Markland, agrees well with the western coast of Newfound land, Prince Edward's Island, and the parts of Nova Scotia, Cape Breton Island, and New Brunswick, surrounding the Gulf of St. Lawrence; while the north and east coast of Newfoundland agree with their description of the land first seen by them, which they named Helleland, and which they say was a rocky island. It does not appear that any colony was established by them; but, in 1121, Vinland was visited by Eric, bishop of Greenland, as a missionary, and a lucrative traffic in furs afterwards carried on from Greenland with the natives. These discoveries were brought to the general knowledge of the rest of the world by the two brothers Zeni, Venetians, who, in the service of a chief of the Feroe Islands, revisited those countries, and to the information given by their precursors added more, both novel and singular.

As in the case of so many of the early travellers, their accounts are distorted and obscured, by being mixed with fabulous matter; but there is no reason to doubt that they reached Newfoundland, which they termed Estotiland or Eastoutland, and Nova Scotia, which they termed Droceo. These countries are placed in their map more than a thousand miles west of the Feroe Islands, which they term Friesland. One of the party who had been taken prisoner, was carried by the natives far to the south, and found there a civilized people, possessed of the precious metals, living in large cities, with temples. This account would, no doubt, be connected in the minds of the cosmographers of the fifteenth century with countries adjoining to India and Cathay; for, like Columbus himself, no one seems to have doubted that the coasts and islands of the western continent were those of eastern Asia; nor is this error in distance difficult to account for. The descriptions of Ptolemy had extended Asia, on the maps of the middle ages, far to the eastward of its proper position; the discovery of countries beyond the India known to him had, of course, brought the eastern coasts of Asia, as described by Marco Polo, still further eastward of their real longitude; and so on Behaim's globe, the east coast of 'Cipangi' is placed within seventy degrees of the Azores, and 'India extra Gangem' within ninety, instead of more than double that distance, as they really are. We cannot, therefore, wonder that Columbus, expecting first to meet with islands, should think it was possible to reach land 750 leagues beyond the Canaries, though connecting that land with India; more especially as Marco Polo had represented Zipangu to be 1500 miles distant from the main-land, and that in the Sea of China to the south there were 7440 islands; for, as he places Cochin China the same distance to the west that he does Zipangu from the main-land, the conclusion that some of these islands must stretch far to the eastward seems inevitable, and could not have escaped the sagacity of Columbus.

7 *Character of Columbus.*—These considerations justify the opinion already expressed, that the discoveries of Columbus are to be attributed as much to his knowledge as to his genius, as well as the decision of Malte-Brun, that he was more learned and less rash than his panegyrists have described him, and may serve to stimulate all generous minds to the cultivation of knowledge, as that which opens to genius the path to fame.

It should be also noted, that the same scientific spirit which animated Columbus was not absent from the breasts of many of his contemporaries.

The knowledge of the circular form of the earth seems to have been the basis of all their calculations. We know, from his own account, that it was this which induced John Cabot to seek a north-west passage to India as the shortest route from England; and there is no reason to doubt that, had the great Genoese not discovered the New World, some other of the enterprising navigators of that period would have done so. Indeed, John Cabot rediscovered Newfoundland during the second voyage of Columbus, and his son Sebastian discovered Florida the year previous to that in which Columbus reached the main-land of the Western Continent. If it be the summit of human greatness to appear a giant among dwarfs, then do these things detract from the fame of Columbus; but if it be greater to be a giant among giants—and surely there were giants in the earth in those days—then do they rather add to and increase it. It was science that led the great admiral to the west, even if the immediate incitement to follow its leading was derived from physical causes, the effects of the winds and currents of the ocean.

It is well known how Columbus first opened his project to the Portuguese king, and how that monarch failed in the endeavour to rob him of the honour which must attend its success; how, to prevent similar treachery, he made proposals at the courts of Spain and England at the same time; and how the former through the noble-mindedness of its queen, Isabella, was honoured to be instrumental to the discovery of a new world. Columbus left Portugal in 1484, and more than seven years of doubt and uncertainty were ended by the agreement made between the great navigator and the king and queen of Spain, in April, 1492. On the third of August, in the same year, with three small vessels, and at the most 120 men, his confidence in himself and God to aid him, Columbus sailed from Palos. On the 6th of September, he left the Canary Isles; and, on the 11th of October, after a voyage of thirty-five days, he chanted 'Te Deum' on the island of San Salvador. Let his biographers record his trials both before and after—his triumph on that day was a full recompence for both.

8 *Discoveries of the Spaniards.*—Columbus having further discovered Cuba, Hispaniola, the Haiti of the natives, and built the fort of La Navidad, sailed for Spain; where, after dangers which would no doubt have frustrated the purposes of his outward voyage, had they then occurred, he arrived on the 15th March, 1493. The same year he sailed on his second voyage, from Cadiz; and, in 1494, John Cabot sailed from Bristol, and rediscovered Newfoundland. From this time two parallel series of discoveries were carried on in the New World, the one the result of the voyages of Columbus, the other of those of Cabot; both those navigators owed their success to the light of science; both reasoned, as their countrymen are used to do, from abstract principles: but, in the endeavour to extend and make available the results of their discoveries, these were soon forgotten. At the present time, however, when the whole globe has been mapped out, and commerce is seeking the shortest routes and readiest channels between the different countries of the world, it is worth while to remember that these two Italian navigators. at the close of the fifteenth century, acted on their knowledge of the sphere, and calculated the effect of great circle sailing. The discoveries of the English and French to the north of the New World, must occupy a separate chapter in the history of discovery, more especially as modern discovery in the Pacific has in a great measure resulted from them.

The admiral, as Columbus now delighted to be called, soon prepared for his second voyage. Success dissipated the clouds which had obscured the prospects of his first. Instead of three small vessels which the little port of Palos had with difficulty furnished, a fleet of seventeen vessels, manned by 1500 persons full of ardent hope, left the bay of Cadiz on the 25th of September. Taking a more southerly course than in his first voyage, on the 2nd of November he discovered Dominica, passed from that island to Guadaloupe, and from thence to Hispaniola, where he arrived at the end of the same month. The fort La Navidad having been destroyed, the admiral chose another locality, and laid the foundation of the city Isabella; and having left his brother Diego as his deputy, set sail on the 24th April, 1494, with three small caravels, to examine the coast of Cuba. Directed by the natives to the south to search for gold, he discovered the island of Jamaica; but on his return towards the coast of Cuba, becoming embarrassed among small islands, he thought, and his crew, desirous to return, gladly encouraged the error, that he had reached the main-land; he therefore returned to Hispaniola by the south of Jamaica. The factious spirit of the Spaniards soon made a voyage to Spain necessary, and his enemies found means to detain him there till the year 1498. He left Spain on his third voyage, the 30th of May, with six vessels, and taking a yet more southerly course, was rewarded by the discovery of Trinidad on the 31st July. Entering the Gulf of Paria, he discovered the river Orinoco, and working through the Dragon's Mouth between the island and the main, extended his discoveries to the island of Margarita, and sailed from thence direct for Hispaniola. Here, again, faction had been the parent of strife and dissension, nor could the presence of the admiral himself restore order; and at length an officer, Francisco Bobadilla, was sent out from Spain with provisional authority, of which he commenced the exercise by sending Columbus home in irons; and though ultimately well received by the king and queen, who at his representation recalled Bobadilla, yet was he not allowed to return himself, but Nicolas de Ovando was appointed to the government.

The return of Vasco de Gama from India, by the Cape of Good Hope, happening at this juncture, and the admiral having declared his belief that the passage westward to the Indies lay between the lands discovered by him in his second and third voyages, cupidity achieved what justice could not obtain, and Columbus was permitted to depart in search of this route. He sailed from Cadiz with four small vessels, none of which exceeded seventy tons burden, the 9th of May, 1502, and made Martinique the 15th of June. Proceeding by Hispaniola and Cuba, he reached the shores of Honduras, and from thence navigated his little squadron to the Gulf of Darien; but so unfit were the vessels for the voyage, that he was obliged to seek means of refitting, and they were only saved from foundering by being run ashore on Jamaica; and here his discoveries ended, though not his troubles. Posterity, uninfluenced by envy, has done to his memory that justice which he failed to receive from his contemporaries.

9 *Successors of Columbus.*—The great admiral was not without worthy successors. Alonzo de Ojeda, a cavalier of distinction, had accompanied him in his second voyage. In 1499, Ojeda sailed from Spain with four ships, taking with him, as one of his pilots, a Florentine navigator, Amerigo Vespucci. He explored the coasts of Venezuela, and returned to Spain. This voyage is remarkable, not only on account of its connexion with the name subsequently given to the New World, but also because Ojeda met Englishmen in the Gulf of Maracaybo. Vespucci afterwards entered the service of the king of Portugal, but soon returned to Spain, where, on the death of Columbus, in 1506, he was made chief pilot. In 1507, he published an account of his voyages, in which he claims to himself the discovery of the continent which has since borne his name.

It is, however, proved beyond doubt, by the evidence of Ojeda and other eminent navigators, taken on the trial of the suit of Don Diego Columbus against the royal fiscal, that the first visit of Vespucci was made, as narrated, with Ojeda, in 1499; indeed, it does not appear that he made any independent discoveries, and he can claim no honour on that account. Impudence often attracts the attention which modest merit fails to secure.

It appears probable that Columbus gave no name to the continent, from the persuasion that it formed part of Asia, and was in the neighbourhood of India and Cathay, confirmed in this by the character of the climate, and productions of the country—the gold and pearls which he obtained from the inhabitants.

In the same year, 1499, Vincent Yanez Pinzon, who had, with his brother, accompanied the admiral in his first voyage, sailed from Palos in December, with four caravels, pursuing his voyage south until he lost sight of the Pole Star, on the 20th of January, 1500. He made land 8° south of the equator, and 2° north of where the Portuguese admiral, De Cabral, arrived three months later. Both took possession of the new country, in the name of their respective sovereigns. Pinzon followed the coast northward until he was rewarded by the discovery of the gigantic Maranon, from whence he steered through the Dragon's Mouth to Hispaniola, and thence to Spain, where he arrived in September.

The same year, (1500), Roderigo Bastidas, taking with him Juan de la Cosa, who had been, like Vespucci, one of the pilots of Ojeda's expeditions, sailed from Cadiz with two small vessels. He prosecuted his discoveries on the coast from the most westerly point of Ojeda to the most southerly and easterly of Columbus.

In the year 1508, Pinzon, now associated with Juan de Solis, sailed again for the south. They prosecuted their voyage 40° south of the equator, but not agreeing, returned home; and, subsequently, De Solis, who, on the death of Vespucci, had been made chief pilot, sailed again for the south in 1514. He surveyed the coast with such accuracy as the science of that time permitted, discovered the river La Plata, and having been killed by the natives, his companions returned to Spain.

10 *Era of Conquest.*—The era of discovery was now to be succeeded by the era of conquest. Spain allotted out her new dominions among those who had gained them for her, on condition of their founding colonies. In the colonization of his portion, Ojeda had been anticipated by a wealthy merchant, named Nicuessa, who fitted out an expedition from Hispaniola; it had for its pilot, De la Cosa. Nunez de Balboa and Francesco Pizarro sailed in it, and Hernando Cortez was only prevented from joining them by illness. Success did not, however, attend it, though Balboa established a small colony on the Isthmus of Darien, and making incursions into the interior, in September, 1513, discovered the Pacific Ocean. The Spanish king rewarded him by appointing Pedrarias Davila governor of Darien, who put Balboa to death four years after his discovery had proved that Columbus had in reality given a new world to Spain.

The injustice of the court of Spain to the great admiral was acknowledged, and in some sort compensated, by the investment of his son Diego with his honours and offices. This gave a fresh impulse to discovery, and in 1512, Juan Diaz de Solis discovered the river La Plata, the knowledge of which was further extended by Sebastian Cabot, in 1527, and by the colonists under Pedro de Mendoza, while Juan Ponce de Leon, sailing to the north, discovered Florida and the Bahama channel, where he noticed the north-easterly current, and thus opened a new and advantageous route to Europe. This discovery was followed up, in 1519, by Francesco Garay, then governor of Jamaica, who despatched Pineda to survey the coast. He completed the survey of the Gulf of Mexico, Hernando de Cordova having, two years before, examined the coast of Yucatan, and brought back accounts of the civilization and wealth of the inhabitants; and Juan de Grijalva, following him, had landed on the coast of Campeachy, to which he gave the name of New Spain, and he more than confirmed the accounts of Cordova. In 1520, the discovery of De Leon was extended to Cape Hatteras, by Vasquez de Aillon, who thus passed into the limits of the previous discoveries of Cabot.

The conquest of Mexico by Cortez, in 1521, and the subsequent extension of his power over Honduras, led to discoveries in that ocean which Balboa had first seen. The ambition of Cortez was not contented with these limits: the Indies, Cathay, and Zipango were the ultimate object of his desires, as they were of Columbus himself; and on the discovery of the Strait of Magelhaens, he determined to bring the trade of the East to Europe through the countries which he had conquered. In 1526, he despatched Alvaro de Saavedra across the Pacific, thus originating those schemes which the jealous policy of the court of Spain has reserved to be carried into execution by the

British colonists of North America at the present time, more than three centuries after. He subsequently despatched a fleet to the north-west, under Hurtado de Mendoza; but this returning unsuccessful in 1536, he took the command of another expedition himself, discovered the peninsula of California, and the Gulf, which he named the Vermilion Sea, afterwards called the Sea of Cortez. He sailed northwards as far as 40°. Cortez, who may be esteemed second only to Columbus in the greatness of his views, not only extended by his own conquests the dominions of Spain in the New World, but rendered assistance to Pizarro in the conquest of Peru; indeed, the successes of the Spaniards in South America must be mainly attributed to him. These now proceeded rapidly. On the east, Orellana had descended the Maranon, to which, from his fabulous accounts, the name Amazon was given; and Valdivia reached the 40° south latitude on the coast of Chili, and thus, in less than fifty years the Spanish discoveries in the New World had been extended over 80° of latitude, equally distributed on either side of the equator, and on both coasts of the continent.

11 *Vasco de Gama.*—The discovery of the Cape of Good Hope by Bartholomew Diaz had not been followed up by the Portuguese with the spirit they had previously displayed. It was not until 1497, when Covilham, by his reports of the knowledge of the Arabs of the Indian Ocean and eastern coasts of Africa, had fully prepared the way for the passage by that route to India, that Vasco de Gama was sent to explore it. He pursued the course taken by Diaz until the coast trended northward, and thus had the honour to be the first European who had reached the Indian ocean by sea. He touched at Natal, and discovered Mozambique, just two months before Columbus set out on his third voyage. Here he found civilized communities of Moors and Mahometan Arabs, carrying on a lucrative trade with India; and from this point the opposition of the Mahometans was the most serious impediment he had to encounter. Proceeding northward, he reached Mombaz and Melinda, and from the latter port steered direct to India, arriving at Calicut in twenty-three days. He had taken, as his pilot, a native of Guzzerat, whom he found acquainted with the astrolabe, and who told him it was in common use among the Arabian navigators of those seas.

By his prudent conduct, De Gama frustrated the machinations of the Mahometans, obtained the favour of the Zamorin of Calicut, and on his return took with him an ambassador from Melinda to Portugal, where he arrived in September, 1499, rather more than two years after his departure. The success of De Gama stimulated the court of Portugal to new exertions. In the same year another expedition was fitted out, the command of which was given to Pedro Alvarez Cabral. It consisted of thirteen ships, and had on board 1200 soldiers.

The course taken by Cabral differed from that hitherto pursued by the Portuguese, and led to the discovery by him of the coast of Brazil, in 17° south latitude. Writers have differed in opinion as to the motive which induced Cabral to this course; some have attributed his discovery to necessity, some to accident, some to storms, others to the endeavour to avoid them; but it seems probable that, like Cabot, from his knowledge of the properties of a sphere he shaped his course the shortest way. It has already appeared, that the great navigators of this age depended much on their mathematical knowledge. Mercator's projection had not as yet distorted the surface of the globe, and altered the apparent relations of countries to each other. The course necessary to clear the western point of Africa would be the shortest route to Brazil; Cabral took that course, and arrived there. The claim of Portugal to this country was not disputed by Spain, and she retained possession of that which the science of her navigators had discovered for her.

In the passage of the Cape, Cabral experienced severe weather, and lost four of his ships, in one of which was Bartholomew Diaz, who thus perished in the endeavour to extend and complete his own discovery. Cabral, however, reached Calicut with six ships, established a factory there, examined the coast of Cochin, and nearly as far south as Cape Comorin; and having taken ambassadors from the principal chiefs of that coast, returned to Portugal. In the interim Juan de Nova had been despatched with four ships to join him, and had discovered the Island of Ascension, and reaching India, engaged and defeated the fleet of the Zamorin, returning with rich cargoes. De Nova discovered St. Helena, which from that period has been a place of refreshment to those engaged in the India trade.

In the spring of 1502, De Gama, whose reception had not been most gratifying on his return from his first voyage, was placed in command of a fleet of twenty ships, and proceeding direct to Quiloa, on the east coast of Africa, he compelled the king to pay tribute to the crown of Portugal. Passing from that port to India, he discovered the Seychelles, and at the request of the Christians whom he found in Malabar, he left some ships for their protection, and returned with great treasure obtained by the defeat of the fleet of Calicut. Vincent Soarez, whom he left in command in his absence, neglecting the orders he had received, cruised off the coast of Arabia for prizes, discovered the Island of Socotra, but was ultimately lost in a monsoon.

12 *Conquests of Portuguese.*—In 1503, Francisco de Albuquerque sailed with nine ships for India. He found the king of Cochin driven from his country by the Zamorin, who had after their first visit been hostile to the Portuguese, in consequence of the bad conduct of those left by De Gama at his factory. Albuquerque restored the king of Cochin, and obtained from him permission to build a fort in his dominions. Footing having been thus obtained, the era of conquest in India commenced. Albuquerque returning to Portugal was lost, but his nephew Alfonzo afterwards termed the Great by the Portuguese, arrived safely with much treasure.

From the first, discovery in Africa and Asia had been carried on by the court of Portugal as a national affair, and now, as a further step towards permanent possession and empire in the East, Francisco de Almeyda was sent out with the title of Viceroy and Governor-General of the Indies. He sailed, in 1507, with a powerful armament, reduced Mombaz, and after defeating the combined fleets of Egypt, Cambay, and Calicut, and subduing the whole coast from Diu to Cochin, he returned, and was succeeded by Alfonzo de Albuquerque, who established his government at Goa, and from thence, in 1509, sent Lopez Sequiera to make discoveries in the East. Sequiera reached Malacca, and, in 1511, Albuquerque followed him, reduced that place, and sailed to Sumatra, where he established a fort; and having afterwards taken Ormuz, secured the supremacy in those seas to the Portuguese. Thus conquest and discovery proceeded hand in hand. In 1506, Tristan d'Acunha discovered the island which still bears his name. Soarez and Simon d'Andrada discovered the Maldives, and Lorenzo d'Almeyda took possession of Ceylon. In 1511, Francesco Serrano and Diego d'Abrecy, under the orders of Albuquerque, reached respectively, Ternate and Amboyna. In 1521, the Portuguese took possession of the Spice Islands, built a fort at Ternate, and here Antonio de Britto met the companions of Magelhaens. In 1517, Soarez had sent Andrada to open the trade with China.

13 *Magelhaens, his Circumnavigation.*—The discoveries of Diaz and Columbus, De Gama and Magelhaens, of Balboa and Cortez, had now brought the Spaniards and Portuguese into collision among the eastern islands of Asia.

The voyage of Magelhaens was the natural result of previous discoveries, and of the antagonism of Spain and Portugal. The Portuguese had penetrated to the islands of the China Sea. Balboa had proved the discoveries of Columbus to be in a New World. Both the admiral and Cortez had aimed at reaching India by a westward route. It remained to ascertain the limits of the new continent, and whether a passage through it or round it was to be found. This Cabot had endeavoured to do towards the north, and Magelhaens, more fortunate, succeeded in effecting to the south.

Fernando Magelhaens had attained to some note among the Portuguese commanders in the Indian seas; but, disgusted with the treatment he received from those in power, readily embraced offers made him by the king of Spain. The service of Spain was at this time more tempting than that of Portugal, inasmuch as it offered a better field for individual exertion; the subjects of the one being permitted to undertake expeditions on their own account, while the discoveries and conquests of the other were carried on under the direction and at the expense of the government.

14 *Pope Alexander's Division of the World; its Consequences.*—When Pope Alexander VI., in the plenitude of his vicegerency over the world, had divided the globe by a line drawn from north to south, 100 leagues westward of the Azores, and conferred all countries discovered within 180 degrees to the west upon the crown of Spain, and all within the same distance east upon that of Portugal, he laid, as ignorance commonly does when it assumes the office of arbitrator, the foundation of future disputes.

The dimensions of the world were not at that time accurately determined, Asia being supposed to extend far to the east of its just limit. The Spaniards and the Portuguese, having now occupied opposite sides of the globe, began to question how far their rights under the papal grants extended. The recent discoveries of the latter, opening the commerce not only of the Spice Islands, but of China and Japan, were regarded as of more than ordinary importance—as, indeed, the fulfilment of the main object of both nations. According to the globe of Martin Behaim, the Moluccas would fall within the limits of Spain; moreover in 1494, a convention had been held, at which the two governments agreed to remove the line 370 leagues west of the Azores. Portugal by this established, indeed, her right to Brazil, but endangered the loss of it in the islands of Eastern Asia.

Magelhaens, with the ardour of a new convert, maintained the right of Spain to the Moluccas, and undertook to conduct a fleet to them by a westerly route. He sailed with five vessels, the largest of which did not exceed 120 tons burden, and only 260 men under his command, on the 20th September, 1519, made Brazil, and proceeding south discovered a harbour, which he named St. Julian, in latitude 50°. Here he determined to winter, but a mutiny breaking out, he assassinated one, executed another, and abandoned a third of his lieutenants, and by these severe measures brought his crews to obedience. Here he met with the Patagonians, and sailing from thence in October, 1520, soon entered the strait which bears his name. In the moment of success, one of his ships deserted him, and another having been wrecked previously, he entered with only three vessels the South Sea, which, seven years before, Balboa had first seen from the mountains of Darien. He crossed the vast expanse of ocean without discovering more than two of its numerous groups of islands—it is uncertain which these were—and reached the Philippines in March, 1521, nearly four months after he left the land. Here he was well received by the king of Zebu, but engaging in the quarrels of the natives, he was killed in battle, and many of his men afterwards massacred. On his death, the Spaniards destroyed one of their ships, and with the two remaining went in search of the Moluccas. Touching at Celebes and Borneo, they arrived at Tidor, and were joyfully received by its king, who was then at war with the king of Ternate, who was supported by the Portuguese. Sailing from thence, one of the vessels, obliged to put back, was captured by the Portuguese; the last remaining one, the Vittoria, now commanded by Sebastian del Cano, having doubled the Cape of Good Hope, reached San Lucar on the 6th of September, 1522, having circumnavigated the globe for the first time, and been absent from that port about three years and fourteen days.

In 1525 Sebastian sailed again, in a fleet commanded by Garcia de Loyasa, from Corunna, passed the Straits of Magelhaens without accident, but, on reaching the ocean one of the vessels was detached from the squadron in a storm, and with much difficulty reached the coast of Mexico. In the passage Loyasa died, and Sebastian survived him but a few days. Now under the command of Solazor, passing the Ladrone islands, the fleet reached the

Moluccas; and here, in contest with the Portuguese, many were killed and taken prisoners, and Fernando de la Torre, with the remnant, reached Spain in 1534. From this time, discovery in the Pacific, as the Spaniards of Peru and Chili had, from their experience of its character, named the new ocean, must occupy a separate place in history.

15 *Consequences of Discovery to Science.*—The immediate consequences of the remarkable voyages of Magelhaens, and the fleet of Loyasa, were not so great as might have been expected, although that of Saavedra must be considered as a result of the former; nevertheless few have been really more important, and no country has derived more benefit from them, or availed herself of the road thus opened, more readily than England.

The consequences to science were great, though not, perhaps, so apparent. It was not necessary, indeed, that the rotundity of the earth should be thus proved; but they afforded a means of estimating, approximately, its proper size, and obtaining more accurate ideas of the true length of a degree of longitude. The difference of time consequent on the rotation of the earth was also noticed, and must have exercised much influence on the astronomical speculations of that period. In 1543, Copernicus published his system of the motions of the heavenly bodies. The discoveries of Magelhaens and del Cano may have formed the basis of his theory.

CHAPTER II.

§ 1. Discovery in Newfoundland: John and Sebastian Cabot.—2. The French in Canada: Cartier.—3. Voyages to the North-East: Chancellor.—4. The English in the Pacific; Drake.—5. Discovery to the North-West resumed; Davis, Hudson, Baffin.—6. Junction of the two oceans: Juan de Fuca.—7. Discovery in the South Sea: the East India Companies.—8. The Buccaneers: Dampier.—9. The Hudson's Bay Company: Dobbs and Middleton.—10. Russian discovery to the North-East: Behring.

DISCOVERY of Newfoundland: John and Sebastian Cabot. — The extremity of the New World had now been discovered to the south, and in this Magelhaens was much facilitated by its compact form. Those who had followed the Northmen to the west had not been less diligent or less enterprising, though less successful, the irregularity of the coast detaining them of necessity for a much longer period—nay, in connexion with the rigour of the climate towards the north, has detained them till now.

If the Spaniards and Portuguese claim the honour of southern discovery, to the English and French belongs that of extending our knowledge towards the north; but it should be remarked, that in either case the leaders were Italians,—in the one, the great Genoese, and in the other, the scarcely less eminent, though less fortunate Venetian.

The voyages of the Northmen were not followed up until a century after. This is easily accounted for by the political circumstances of the time, leading men rather to the conquest and consolidation of kingdoms already known, than to the discovery of new worlds abroad; nor would it, in all probability, have been then attempted, but for the hope of arriving at Cathay by a shorter route, and thus securing a monopoly of its commercial treasures. The words of Sebastian Cabot—'Understanding, by reason of the sphere, that if I should sail by way of the north-west, I should by a shorter track come into India'—are most worthy of constant recollection, because they show that the voyages made by him and his father were not merely consequences of the first voyage of Columbus, but the result of independent deductions from known mathematical truths.

Henry VII. had received the propositions of Bartholomew Columbus favourably, and it is not impossible that he might have ultimately closed with them.

When, therefore, John Cabot laid his plans and demonstrations before him, confirmed by the success of the great admiral in his first voyage, it is not surprising that he should have readily adopted them. John Cabot, as his real name, Giovanni Cabotto, was Englished, by birth a Venetian, had been residing in the city of Bristol, then the first maritime port of England, prior to 1475. To him and his three sons Henry granted letters patent, dated the 5th March, 'in the 11th year of our reign'—i.e. 1496—'To sail under the flag of England, and take, subdue, and occupy, as lieutenant of the king, such towns, cities, castles, and isles, as they might discover.' But the projected voyage was not only to be one of discovery, conquest, and occupation; trade was to be a principal object. The monopoly of the trade of the countries was given to the adventurers, who were to fit out five vessels at their own 'costs and charges.' The merchandise brought back was to be free from customs duty, and one-fifth of the profit was to accrue to the king. The expedition set sail early in the year 1497, and on the 24th of June land was discovered. This, as first seen, was called 'Prima Vista;' and according to the then usual custom of navigators, an island lying out from the land was named St. John's, being discovered on the feast of St. John the Baptist.

In the year following the king granted a second patent, in which the recent discovery of land and isles by 'the said John Kabotto' is recited, and in which it is expressly provided that he may act by deputy, and of course superseding the first, which was granted to him and to his sons, being given to him and in his name only. It does not, therefore, appear strange that the next voyage should have been undertaken, not by John, but by his second son, Sebastian, who had accompanied him in the first. John Cabot must, at this time, have been probably fifty years old, and having pointed out the road, future discoveries were wisely committed to the son, who, though then only twenty-three years old, had the experience of one voyage, and the benefit of his father's advice, to temper the ardour of youth. Indeed, as appears to have been the case with all the great navigators of that era, his education seems to have peculiarly fitted him for the service in which he was to engage. Born in Bristol, he had been, when very young, taken by his father to Venice, where he had the opportunity of acquiring the highest mathematical and nautical knowledge of the time. In his after life he was justly esteemed as one of the greatest navigators in the world, and it is probable his early youth was not without promises of his future greatness.

Sebastian sailed in the summer of the year 1498, and, according to Peter Martyr, with two ships and three hundred men. He directed his course so far to the North Pole, that he found continual daylight; and even in the month of July, his progress was impeded by ice. Finding the land to the north of 56° still continent, he turned to the east, and having sailed probably as far as 76° 30′ north, he turned to the south, and followed the coast, which he found trending towards the west, until he reached the latitude of the Strait of Gibraltar, and thence until he had the Island of Cuba on his left in nearly the same longitude. Whatever latitude may be conceded to this account, even if with Gomara we limit it to 38°, there seems no reason to doubt that Sebastian Cabot must have sailed far down the coast of North America, and possibly anticipated the discovery of Florida by Ponce de Leon by twenty years; for he noticed the gulf stream and its westerly direction. From the number of fish which were found on these coasts, and which, on his first voyage, the natives had called Baccalhaos, he gave that name to the coast he had discovered; and to the fishery thus brought into notice must be ascribed the subsequent further knowledge and colonization of the more northern portion of it.

Sebastian returned at the close of the same year, and in the following year, 1499, probably made a third voyage, and sailed still farther south. This was the same year that Ojeda was on the coast of Guiana, and reported to have found Englishmen in the bay of Maracaybo; and though there is no evidence that they belonged to the expedition of Cabot, and we know that others were at the same time engaged in prosecuting discovery in those seas, it should not be without notice, because it is the fate of nations which, like the northern, have for the most part left to individual enterprise what the southern have undertaken as national, that much of their labour and the knowledge consequent upon it has been left unchronicled.

2 *The French in Canada: Cartier.*—Of Sebastian Cabot we hear nothing more until 1512, when he entered the service of Spain. In the interim, Gaspar Cortereal, a noble Portuguese, fitted out two ships to prosecute discovery to the north-west, to which his father, John Vaz Costa Cortereal, had, as it is said, sailed in 1463, and discovered the land of Baccalhaos. Sailing in the year 1500, he found a country distant from Europe two thousand miles, and stretching west and north-west; and coasting it for six or seven hundred miles without reaching its termination, concluded it to be part of the main-land which had been discovered the year before. If this account may in the least be depended upon—and from its inaccuracies in date, as well as from other causes, it appears far from indisputable—the description of the inhabitants would accord with those of New England, Nova Scotia, and Newfoundland; while that of the country and climate would agree better with a more northerly latitude; and accordingly it is usually supposed that Cortereal coasted along Labrador. He reached Portugal, on his return, on the 8th October, 1501. It is said that Cortereal sailed on a second voyage, and reaching Hudson's Strait, was never afterwards heard of. There is, however, a discrepancy in the date, which is fixed at 15th May, 1501. It is scarcely possible that his first voyage should have occupied more than a year, or that he should have spent a winter on the coast. His brother Michael also perished the following year in an endeavour to recover him.

During the life of Ferdinand of Spain, Sebastian Cabot remained at his court, and in 1515 was a member of the Council of the Indies; in 1516, a voyage to the north-west, projected by him, was prevented by the death of the king, and afterwards Sebastian returned to England, and the following year sailed in an expedition fitted out by Henry VIII., under the command of Sir Thomas Pert, in which, having reached latitude 67° 30′, the unfitness of the commander for his office led to the return of the expedition. It is usually supposed that Pert and Sebastian Cabot proceeded southward to Porto Rico. It is, however, more probable that the English vessel seen there by the captain of the caravel Navarro was one of the expedition despatched from Bristol in the year 1527, by Mr. Thomas Thorne. It consisted of two vessels, one of which was lost on the coast of Newfoundland; the other, it seems probable, from the account of John Rut, who commanded it, proceeded southwards.

From the period of the discovery of Newfoundland, the value of the fisheries had attracted yearly more visitors from Europe. The French, under Denys and Aubert, made voyages there in 1506 and 1508. It was not, however, till 1524, that the French fairly entered on the field of discovery. In that year, a Florentine, Giovanni Verrazzano, sailed in command of four French vessels, coasted the continent of America from 34° to 50°, and returned the same year. Nothing further was done by them until 1534, when Jacques Cartier, at the suggestion of Philip Chabot, then Admiral of France, sailed from St. Malo in April, and having circumnavigated Newfoundland, returned to France in September. The next year, he sailed again in May, with three ships, and examined the Gulf of St. Lawrence, which he had discovered in the previous voyage, named the Bay des Chaleurs, and the Peninsula of Gaspé, and passing the Island of Anticosti, he entered the River St. Lawrence, giving to the northern channel between that island and Labrador the name since extended to the whole river and the gulf into which it flows. He ascended the river as far as the island now called Montreal, to the hill in the centre of which Cartier had given the name Mont Royale. Here he found the Indian town Hochelaga. Returning to France, he arrived at St. Malo, July 6th, 1536.

In the year 1540, Jean François de la Roque, Lord of Roberval in Picardy, sailed in command of a fleet, as viceroy of the French monarch in his newly-discovered kingdom. Cartier had been sent to prepare for his reception, and proceeding past Hochelaga, built two forts; but finding the Indians, before so friendly, now violently hostile, in consequence of the death of their chief, whom Cartier had in his second voyage carried to France, he sailed down the river, and met the viceroy on the coast of Newfoundland; but, notwithstanding his arrival, returned to France, and died shortly after. Roberval explored the River Saguenay, which Cartier had discovered, and returned also to France. In the year 1549, he, in conjunction with his brother, fitted out another expedition, of which the fate has never been ascertained. These voyages, however unsuccessful, led to the knowledge that a profitable trade in furs and sea ivory might be carried on in those countries, and to their ultimate settlement by the French.

3 *Voyages to the North-East: Chancellor.*—The scientific spirit which had animated Columbus, Cabral, and Cabot, was not in England diverted from its original purpose by success. The endeavours to reach the Indies by the shortest route had led them to the discovery of the northern portions of the New World. The last voyage in that direction had, however, been made in 1536 by one Thomas Hore, of London, 'a man of goodly stature and great courage, and given to the study of cosmography.' This had been lamentably disastrous, and for a time the efforts of the English in that direction languished; but the return of Sebastian Cabot revived the spirit of discovery, and directed it into a new channel.

The shortest route from England to Cathay he knew must be by the north-east, and accordingly, having been appointed grand pilot by Edward VI., and governor of a company of merchants associated for the purposes of discovery, under his direction, a fleet of three ships, the command of which was given to Sir Hugh Willoughby, was despatched to the east in 1553. Two of these vessels were lost on the coast of Lapland, and their commander with their crews perished miserably; but the third, under the command of Richard Chancellor, pilot-major to the expedition, taking a more northerly course, arrived safely in the White Sea; and he, travelling over-land from thence to Moscow, opened those commercial relations with Russia which led to the establishment of the Muscovy Company, and which have been continued with so much advantage to both nations until now. Returning from a second expedition with an embassy from Russia, Chancellor was wrecked, and lost his life, on the coast of Scotland. In 1556, Stephen Burroughs, who had been with Chancellor, saw Nova Zembla, and subsequently, under the direction of Cabot, reached the River Pechora.

The English were followed in this direction by the Dutch. In 1594, four vessels left the Texel under the command of William Barentz. One division of this fleet, under Barentz, reached the northernmost point of Nova Zembla; the other, under Corneliz Nay, the Sea of Kara. This led to a second voyage, which was altogether unsuccessful; notwithstanding which, the merchants of Holland, stimulated to exertion, perhaps, by the offer of a large reward for the discovery of a North-East passage, again sent out Barentz, and with him Cornelius Rijp. Barentz reached Spitzbergen, and returning, was caught in the ice to the east of Nova Zembla, and being forced to winter in that island, died there.

4 *The English in the Pacific: Drake.*—It was not, however, only to the north that England was now prosecuting naval adventure; the progress of the Portuguese and Spaniards in the South Sea soon excited the enterprising spirit of her children.

In 1534, Alcazava had sought to reach Peru by the Strait of Magelhaens. Although his expedition was disastrous, yet it increased our knowledge of the south-eastern part of the New World. In 1539, Camargo followed him with scarcely better success, although he succeeded in reaching Peru. In 1557, Ladrillero surveyed the strait. In 1542, Villalobos made a settlement on the island discovered by Magelhaens, and extended the knowledge of the ocean and some of the islands of the Pacific, to the group named by him the Philippines. He, however, failed in the object of his voyage viz. to make a settlement on those islands, was compelled to submit himself to the Portuguese, and died at Amboyna.

The discoveries of the Portuguese among the islands of the Eastern Archipelago, and their knowledge of a portion of the island since called Australia, had led to the conclusion that a great southern continent existed in that direction. One of the vessels of Villalobos, endeavouring to return to Spain by the east had touched at New Guinea, to which that name was then given, and which was supposed to form part of this southern continent. In 1564, an expedition was fitted out to establish a colony at the Philippines, and placed under the command of Miguel Lopez de Legaspi With him was sent Andres Urdaneta, who had been with Loyasa; and when the first object of the voyage had been accomplished, and Manilla made the capital of the Spanish possessions in the Indian seas, Urdaneta endeavoured to return across the Pacific to New Spain, which hitherto no navigator had done. Acting, doubtless, on the same rules of abstract science which had guided Columbus, Cabral, and Cabot, Urdaneta steered a northerly course, and succeeded in reaching the Spanish possessions in America without difficulty, and from that time the Manilla fleet made its annual voyage across the North Pacific. At this period the discoveries of the Spaniards in the South Sea were carried on with much boldness. Juan Fernandez, seeking a course from north to south along the coast of Peru, steered westward, and discovered the island which still bears his name; he also ascertained the regular direction of the winds in those latitudes. He appears to have discovered other islands far to the westward, possibly New Zealand. In 1567, Alvarez de Mendana sailed from Callao, discovered the Salomon and other islands; and, on his second voyage, thirty years after, he further discovered the Marquesas, and some minor groups, but failed to find the Salamon islands. Such were the consequences of the imperfect reckoning which, in the infancy of nautical science, navigators were able to make.

In the interim, however, a new era had opened upon the history of maritime discovery, by the appearance of the English in the Pacific. The misfortunes of Alcazava, and those who followed him, had invested the Straits of Magelhaens with terrors to the minds of the Spaniards; and though Legaspi had traversed them without difficulty, yet the success of Urdaneta had opened what seemed a more desirable route, and realized the aspirations of Cortez. But this very success was to be the cause of the danger they afterwards experienced from Drake and his followers. The voyages of the Manilla fleet had become known in Europe; already the plunder of the Spaniards in the Gulf of Mexico was looked on by the English as the easiest means of acquiring wealth, and it was believed that treasure was transported across the isthmus of Central America. To intercept this, Sir John Hawkins had, in 1567, made a voyage to the Spanish Main, and sailed as far south as the Falkland Islands, which he named after himself and his queen, Hawkins' Maiden Land; and, in 1573, Francis Drake, who had accompanied him, sailed with two ships, and, landing on the isthmus, was the first Englishman who saw the Pacific Ocean. From thence he returned with great treasure, and was followed, in 1575, by John Oxenham or Oxnam, who crossed the isthmus, built a small vessel on the opposite coast, and took two wealthy prizes from the Spaniards. He was, however, taken prisoner, and, with his men, put to death; but these two voyages, doubtless, animated the English people with the desire to extend their expeditions against the Spaniards along the western coasts of the New World.

Drake, like most of the leading English navigators of that time, was from the West of England. He was born at Tavistock, in Devonshire, and brought up to the sea. Having dissipated, in profuse liberality, the riches he had acquired in his second voyage, a fleet of five vessels was fitted out for him;

the largest of which was, however, of only 100 tons burden, and the whole only carried 164 men. He sailed on the 13th of December, 1577, from Plymouth. He reached the La Plata on the 14th of April following, and was there obliged to abandon one of his vessels. In June, he made Port St. Julian, and remained there two months; sailing from thence on August 17th, 1578, now with only three vessels, he passed through the Strait of Magelhaens, and discovered that the western portion of the land was not continuous, but an archipelago of islands. Driven by a violent gale far to the south and west, one of his vessels parted company, and was never heard of afterwards. Drake, again driven to sea by the violence of the weather, was separated from his only remaining companion, which, returning by the strait, reached England safely; he, running still further south, 'fell in with the uttermost part of the land to the South Pole,' and was the first to discover the Cape, 'without which there is no land to be seen to the south—but the Atlantic and South Sea meet in full scope.' This he places in latitude 56°, the exact position southward of Cape Horn. The Archipelago he named the Elizabethides, in honour of his queen. Proceeding northward, and amassing great treasure by the way, he reached Callao on the 15th of February; there having plundered the vessels in the harbour, and learnt that the Cacafuego, a large vessel, had recently sailed, laden with treasure to Panama, he made all sail in pursuit, and soon overtook and captured her. The booty taken was estimated at £150,000 sterling.

Having now succeeded in the main object of his voyage, Drake was anxious, as well as his men, to return home, and he determined to attempt this by the most direct route. Accordingly, having refitted, and guided, no doubt, in some measure, by charts which he had recently taken from a Spanish vessel, Drake stood directly to the north-west, and sailing 1400 leagues, without seeing land, reached the 42° north latitude. Here he found the cold intense, but proceeding still north he made land in latitude 48°; when finding the cold increasing, and the land trending to the north-west, he renounced his intention, and turned his course to the south, passing along the coasts, already probably known to the Spaniards, of which, however, he took possession, and to which he gave the name of New Albion. From hence he determined to sail westward, and having discovered some islands, at length reached the Moluccas, and from thence, by the Cape of Good Hope, sailed to England, where he arrived, September 26th, 1580, after an absence of nearly three years.*

It has been made a matter of dispute, how high a latitude Drake succeeded in attaining. It appears probable, that instead of reaching only 48°, he in reality sailed past that parallel, for from Vancouver's Island, in 49°, the coast very apparently trends westward. His correct observation of latitude towards the south is, indeed, the only thing that makes against this hypothesis; but in any case the easterly variation of the compass, if as great then as now, would give that impression of the direction of the land observed by him, and it is so delineated in the early Spanish charts. The true direction of the coast from Cape St. Lucas to Cape Mendocino is N.W. ½-N., while that of Vancouver's Island trends N.W. by W. If Drake was wrong in his reckoning six degrees, he still must have gone as far north as Cape Mendocino, but if, as appears more likely, he reached the island afterwards named from Vancouver and Quadra, the description of the coast will appear more consonant with our present knowledge. In any case the name San Francisco may well remind Englishmen of this voyage of their great sea captain.

5. *Discovery to the North-West resumed: Davis, Hudson, Baffin.*—Martin Frobisher, the worthy comrade of Drake and Hawkins, by the support of the

---

* The voyage of Magelhaens had occupied three years and thirty-seven days; that of Drake only two years and ten months.

Earl of Warwick, was enabled, in 1576, to fit out a fleet of three vessels for further discovery in the north-west. He left Yarmouth on the 19th of June, and on the 11th July made the southern point of Greenland; here one of his ships left him, and returned to England. Sailing from thence south-west, he made land in 62°, which was shut in by an impenetrable barrier of ice. This must either have been the northern coast of Labrador, or the eastern shore of Hudson's Bay, or Southampton Island; from the time taken in sailing, the latter is not improbable, and if so, Frobisher penetrated into Fox's Channel. Here he met the Esquimaux, and returning with some of these 'strange infidells,' reached home the 2nd of November.

It is probable that this discovery would not have been followed up, although he was highly commended 'for the great hope he brought of finding a passage to Cathay,' had not there been among the specimens of the productions of the new country which he brought home, a piece of black stone like coal, which probably contained pyrites, led to the belief that gold existed in that region; and, in consequence, with a 'royal ship' added to his former little squadron, Frobisher sailed again from Blackwall in May, 1577. On the 16th of July, he again entered the strait which he had discovered, loaded his vessels with 'ore,' and returned. Whether from want of knowledge or any other cause cannot now be ascertained, but the report of those who were appointed by the queen to examine the ore was favourable, as was the opinion of all men respecting the probable discovery of a north-west passage. Another expedition was therefore prepared, and in 1578, fifteen vessels, fully appointed, assembled at Harwich; in August, after having passed through the greatest dangers from the ice and fogs, and wandered to the north-westward far from their intended track, they reached the place of their destination. The losses experienced marred the prospects of the expedition, and Frobisher reluctantly returned home. It is said that he subsequently made another voyage, of which, however, no particulars are known.

In 1583, Sir Humphry Gilbert, half-brother to Sir Walter Raleigh, made three voyages to take possession of Newfoundland, of which, and other countries in America, he had obtained the gift from Queen Elizabeth. Unsuccessful in all, he in the third, after surveying some portion of the coast of that island, returning home, perished. These abortive efforts were followed by those of Sir Walter himself, of De la Roche, Chauvin and Pontgravé, and of Champlain, which led to the accurate knowledge of the entire coast from Virginia to the Gulf of St. Lawrence. This, however, belongs rather to the history of colonization than discovery.

Discovery to the north-west was resumed in 1585, when two vessels, equipped at the expense of some merchants in London, solely for that purpose, sailed from Dartmouth, under the command of John Davis, on the 7th June, and on the 19th July reached the shores of Greenland. Coasting towards the south, in the latitude 60°, he found the land trending towards the west, 'and after fifty or sixty leagues, it failed, and lay directly north.' He followed the coast for thirty leagues, and then steered north-west, and found land in 60° 40′, which he coasted for five days, and entered a strait, or sound, some twenty or thirty leagues wide, in which, sailing in open water for eighty leagues, he at length determined to return home, where he arrived on the 30th September. He subsequently made two more voyages, but without further success than tracing the outline of the land as far as Hudson's Strait. In 1602, George Weymouth was sent out, but returned without effecting anything. In 1605, the King of Denmark sent an expedition, under English commanders, Cunningham and Hall; and in 1606, the Indian merchants another, under John Knight; both were unfortunate and unsuccessful. But in 1607, Henry Hudson sailed, with only one small vessel, to find a passage, if possible, directly across the pole. He made land in latitude 70°, and still further northward, in 73°, he named a bold headland Hold-with Hope; this, probably, was not again seen till Scoresby's voyage in 1822. Having passed the latitude of the north of Spitzbergen—viz., 81° 30', and his provisions failing, he returned home. In 1608, he set out on another voyage, which, being like the first, under the patronage of the Muscovy Company, had in their minds an Eastern direction. Hudson, however, soon gave up his attempt towards the east, and returned. He was again sent out in the service of the Dutch East India Company, and having apparently determined that if a passage was to be found, it would be to the north-west, he again abandoned the search towards the east, after reaching Wardhuys. The result of this voyage was the discovery of the river which bears his name. In 1610, he was again in the service of Englishmen. Sir John Wolstenholme and Sir Dudley Digges were the chief promoters of this enterprise, in which Hudson made the discovery which has most tended to immortalize his name. He followed the track of Davis, reached the island now known as Resolution Island, and entered the strait which was destined to be called after him, where he observed the same westerly current which Davis had before noticed; from whence, proceeding westward, he entered the sea or bay since so well known by his name, and by the Company which subsequently adopted it, and which has exercised so powerful an influence over the northern parts of North America. Hudson named the capes at the entrance of the bay after his patrons, and that to the south still bears the name of Wolstenholme, as do the islands near it that of Digges. Having made this discovery, he went in search of a fitting place to winter. On the breaking up of the ice, he weighed anchor to return home; but shortly a mutiny broke out, and Hudson was set adrift with eight of his men, and left to perish.

In the course of discovery to the north-west, Hudson emulated, if he did not exceed, the services rendered by Frobisher and Davis. In 1612, Hudson was followed by Captain Thomas Button, in vessels fitted out by the same adventurers. He discovered Nelson River, and wintered there, and in the spring, having reached latitude 65°, returned home.

The subsequent voyages of Hall, Gibbons, and Fotherby, produced no results; but in 1615, the Muscovy Company sent out Robert Bylot, who took with him, as pilot, William Baffin, the fourth great name in north-western discovery. Having reached Greenland, Bylot sailed through Hudson's Strait, by Salisbury Island, into the channel afterwards called Fox's Channel, and there made land to the west, in the same latitude as Button had done. This he named Cape Comfort. He was prevented, however, from proceeding westward, by the set of the current out of Frozen Channel; but discovered the islands to the north to which Parry afterwards gave the name of Baffin, and the northern extremity of Southampton Island; from hence, at Baffin's suggestion, they returned to Nottingham Island, and from thence home, anchoring on the 8th of September in Plymouth Sound, after an absence of scarce four months.

The next year they sailed again; and the instructions given to Baffin, as pilot, by the adventurers, amount to this: That he was to enter Davis Strait, and sail as nearly as might be on the arc of a great circle to Japan. They anticipated his reaching 80° of latitude, on the west coast of Greenland. Baffin sailed on the 26th March, 1616; and after considerable difficulty, reached latitude 77° 35', and thence followed the trending of the coast to the north-west, naming the different inlets they passed after Sir Thomas Wolstenholme, Rich, and Hackluyt, the historian of maritime discovery, Sir Thomas Smith, and Alderman Jones. Following the coast now to the south, they passed Sir James Lancaster's Sound; and, finding their farther passage obstructed by ice, returned home, where they arrived on the 30th of August. Baffin was subsequently killed in battle in the East Indies. Baffin discovered Lancaster Sound the 12th July, 1616; Parry entered it the 30th of the same month, 200 years after.

North-west discovery was continued by the Danes in 1619, and Jens Munk having sailed up Davis Strait, was forced by the ice to return, and wintered in Chesterfield Inlet. This voyage led to no further discoveries, but is remarkable for the death of all the crew but three, the result of superstition and want of discipline.

In 1610, Luke Fox, or, as he called himself, North-west Fox, who had been longing for many years to make an attempt at discovery in that direction, sailed from Deptford in a vessel of eighty tons, provided by the king, and fully furnished at the expense of merchants of London, among whom Sir John Roe and Sir Thomas Wolstenholme were most forward; and, on the same day, Thomas James sailed from Bristol in a vessel of seventy tons, built for the purpose by the merchants of that city, and fitted out at their expense. Fox reached Hudson's Bay, and coasting Southampton Islands in latitude 64° 10′, entered the strait to which has been extended the name of Sir Thomas Roe's Welcome, which he gave to an island at the entrance; here turning to the west, he followed the coast of Hudson's Bay to Nelson River, and thence proceeding southward, on the 29th August he fell in with James; subsequently, finding the coast trending south-east, he abandoned the search, and returned home. James, less energetic, or less fortunate, only reached Port Nelson on the 16th August, in direct course from England, and proceeding southward, wintered at the bottom of the bay to which his name has been given; where, having suffered much from cold and scurvy, he was detained by the ice till the 1st of July, when, in consideration for the state of his ship and crew, he returned to England.

6 *Junction of the two oceans: Juan de Fuca.*—There is a very close connexion between the voyages of discovery made on the north-eastern coast of America and those on the north-western. The former had been undertaken with a view to the discovery of a north-western passage to India; and even in later times, Baffin's Bay and Hudson's Bay, although not satisfying this expectation, rather encouraged, by their depth and extent, the idea that a passage was to be found in that direction. The result of the voyage of Urdaneta had of course the same tendency. There was a great expanse of water to the north-east of China, and the conclusion, confirmed by experience, that the east and the west were connected by it, was soon confidently arrived at. The practicability of the passage was, of course, quite another matter; and, indeed, still remains to be ascertained. The account of Gaspar Cortereal seems to justify the conclusion that a tradition was then extant of such a connexion, and that it was named the Strait of Anian; and the endeavours of subsequent navigators, till the time of Vancouver, were directed to the finding that strait.

The idea of a junction of the two great oceans had influenced the mind of Columbus, and was not absent from that of Cortez. It led to the attempt of Drake to return home by the north-east; doubtless to the prosecution of the discoveries of the Spaniards on the north-west coast of America. The Vermilion Sea, discovered by Cortez, promised at first to realize this notion. In 1539, Juan de Ulloa sailed round it, and ascertained its limits; and Fernando Alarcon explored the Colorado River in 1540.

In 1542, Cabrillo coasted California as far as Cape Blanco and Cape Mendocino, estimating the latitude of the former at 43°, which is too far north. In 1547, Urdaneta is said to have discovered this strait. In 1584, Gali, returning from Japan, the coasts of which he had examined, described those coasts along which Drake had sailed, and is said to have first made land in 57° 30′ north latitude, which, admitting an error of trifling moment, is not improbable, for he observed a current from the north, which led him to suppose that the strait in question was in that direction.

Cabrillo and Urdaneta might have preceded Drake in their voyages along this coast as far as Cape Mendocino, latitude 42° N., but Drake, in all probability, went much further north, and certainly landed, remained on the coast some time, and received the cession of it from the natives, taking formal possession. The title of the English, therefore, to it would be as good as that of the Spaniards or Portuguese to many of their possessions. It is now in the hands of their descendants. Alarmed at the boldness of the English, the Spaniards dispatched two vessels from Lima, under Pedro de Sarmiento, in 1570, to survey the Strait of Magelhaens. He discovered the archipelago which lies on the south-west coast of South America. The reports carried by him to Spain induced the sending out a large fleet to fortify the strait, and establish a colony, the fate of which was as disastrous as its origin was foolish.

In 1604, Sebastian Viscaino examined the coast as far as Cape Mendocino, discovered the harbour of Monterey, and one vessel reaching the forty-third parallel, reported an opening, which, if seen, could only have been the mouth of the Columbia, which is, however, in latitude 46° 20′.

In the interim between the voyages of Galli and Viscaino, some discoveries are reported, which, if true, are of the first importance; and which, indeed, if only in the report, had much influence on the future.

The voyage of Drake was not likely to remain long unimitated. In 1587, Thomas Cavendish, or Cand'sh, had followed him into the North Pacific. Near the southern point of California he captured the Santa Anna, a Spanish galleon, to which, so the story runs, he set fire, after putting the crew on shore. The vessel, however, having been driven on shore by the wind, was refitted by the Spaniards, who thus succeeded in reaching New Spain. Among them were Sebastian Viscaino and Juan de Fuca. The former is said to have made voyages on that coast in the years 1596 and 1602; and the latter to have been sent by the Viceroy of Mexico immediately after his escape. He made two voyages, and in the second, 'finding the land trending north and north-east, with a broad inlet of the sea between 47° and 48° of latitude, he entered thereinto, and sailed therein twenty days, and found that land still trending sometimes north-west and north-east and north, and also south and south-east, and very much broader sea than was at the said entrance; and passed divers islands in that sailing. Being entered thus far into the said strait, and being come into the Northern Sea already, and finding the sea wide enough everywhere, and to be about thirty or forty leagues wide at the mouth of the straits where he entered, he thought he had well discharged his office, and returned to Acapulco.'

Juan de Fuca was a Cephalonian by birth, and not receiving further encouragement from the Spaniards in the New World, returned to Europe, where he met at Venice an English merchant of note, named Lok, who endeavoured, through Sir W. Raleigh, to interest the English government in the matter, but without success; and it was not till the middle of the next century that discovery on this coast was resumed.

Of the reputed voyages of Maldonado and De Fonte, of Ladrillero and Chack, nothing need be said, but that of De Fuca appears worthy of notice. On the presumption that he passed through the straits which bear his name, through the Gulf of Georgia and Johnstone's Straits to the Pacific, his description of the Strait of Anian, which he professed to have discovered, is not altogether inaccurate.

The strait is in latitude 48° 30′. The breadth, indeed, does not exceed twenty miles, but its measurement where the Gulf of Georgia and Puget's Inlet meet may be indefinitely extended; and the number of islands and various trending of the coast are stated with sufficient accuracy. The westing made in the progress through Johnstone's Strait might, in so intricate a navigation, be easily lost sight of, especially if the variation of the compass is allowed for; and the Pacific, when re-entered, would appear to be the Northern Ocean which the Greek pilot had been seeking. But the court of Spain had its object in keeping all discovery on this coast from the knowledge of the rest of the world; and so far as it was concerned, this object was secured. The truth, however, would have been less dangerous to Spain than the uncertain accounts of De Fuca, or the fables of Maldonado and De Fonte, for these tinged the accounts of Dixon and Meares, brought Cook and Vancouver to the coast, led Alexander Mackenzie across the continent, and transferred the dominion of the north-eastern coast of the Pacific from the Spanish to the English race.

7 *Discovery in the South Sea: the East India Companies.*—The voyage of Drake is, among English navigators, without parallel until the time of Cook, in 1778. During these two centuries, however, something had been done towards discovery in the Pacific Ocean. Cavendish, who had returned by the Philippines and Moluccas and the Cape of Good Hope, and had made more accurate observations than those who preceded him, enabled geographers to lay down with greater accuracy the position of the islands of the Pacific and the coasts of Asia, by reducing the distance across the Indian Ocean, and increasing that across the Pacific. His voyage was also remarkable for its rapidity, having accomplished the circumnavigation of the globe in eight months less than Drake. His want of success in his second voyage damped the ardour for maritime discovery in England; while the political state of Europe aroused the energies of the Dutch. The union of the crowns of Spain and Portugal under the jealous Philip II. had directed the energies of those kingdoms rather to the subjugation of Europe than the extension of the trade of the world. But the emancipation of Holland brought unexpected rivals into the utmost limits of the wide-extended empire of that monarch. To this they were moved by the example of the English, and in its prosecution they made use of an English pilot. In 1598, four ships were sent, under the command of Oliver van Noort, which, passing through the Strait of Magelhaens, arrived, after a voyage of about one year and eight months, at the Ladrones, and returned by the Cape of Good Hope, reaching Rotterdam, after circumnavigating the globe in less than three years. Synchronous with this was the disastrous voyage of James Mahu, which is remarkable for the re-discovery of the Falkland Islands by Sebald de Weert on his return home, and for the residence of the pilot, William Adams, in Japan, who with one of the ships succeeded in reaching that island, where he gained the favour of the emperor; but not being permitted to depart, he obtained for the remnant of the Dutch who had landed with him the permission which was not accorded to himself; by this means the trade of Japan was opened to the Dutch and the English—for Adams was an Englishman, and in his letters had invited both to trade in his new country. The first English trader arrived at Japan in 1613; but after the death of Adams, in 1631, the trade was unaccountably discontinued, and when, afterwards, in 1673, an attempt was made to resume it, permission was refused, in consequence of the marriage of the king of England to the daughter of the king of Portugal—Adams, no doubt, having inspired the Japanese with a true protestant dread of the Portuguese and Spaniards, and the consequences of their admission into any country, and hatred of the Jesuits and priests.

The attempts to reach India by the north having failed, and the last unsuccessful voyage of Cavendish having deterred other Englishmen from following him by the Strait of Magelhaens into the Southern Ocean, in 1591 a fleet of three ships was fitted out to cruise against the Portuguese in the Indian Seas. Of these vessels one only, that commanded by James Lancaster, succeeded in reaching its destination by the Cape of Good Hope, and was subsequently lost on its return. But notwithstanding this, having obtained a charter from Queen Elizabeth, in the year 1600, some merchants of London, under the style of the 'Governor and Company of Merchants of London trading to the East Indies,' despatched Lancaster again with five ships, the following year, who returned with large profits on the adventure, having established a factory on the island of Java. He was followed by Sir Henry Middleton in 1604, and by Keeling in 1607, when amicable relations were entered into with the Great Mogul.

While the Dutch and English were thus seeking a share in the trade of the East, the French were not altogether idle. The Normans had laid claim to have been among the earliest discoverers on the coast of Africa—so early, indeed, as the middle of the fourteenth century; but with whatever truth this may be affirmed, the eastern trade was not opened by France till the formation of the East India Company in 1604, though, in 1601, Francis Pirard de Laval had, in the endeavour, been cast away on the Maldives, from whence he did not escape till 1607; nor, indeed, was anything seriously attempted until after the re-formation of the company in 1611.

In the meantime, the colonies of New Spain recommenced the endeavour to acquire a knowledge of the South Sea, and Pedro Fernandez de Quiros, who had been with Mendana in 1595, when he attempted in vain to plant a colony on the island Santa Cruz, which he had discovered, sailed from Callao, in 1606, for this purpose. Quiros discovered several islands, and among them, probably, Otaheite; and subsequently arrived at a great country, described by the natives of the neighbouring islands as without end. Here anchoring in a spacious bay, which he named De la Vera Cruz, he supposed he had discovered the southern continent—Australia del Espiritu Santo, as he called it, and returning to Spain, obtained permission to colonize it, but died on his passage out, at Panama. Luis Vaz de Torres, his second in command, who had been separated from him in a storm, proceeded southward having ascertained 'Australia' to be an island, though what island is still uncertain. He also saw New Guinea and the islands near it, and probably discovered the great island to which the name Australia is now given.

In 1614, the Dutch again equipped a large fleet, which, under the command of George Spilbergen, sailed through the Strait of Magelhaens, defeated the Spanish on the coast of Peru, assisted in the reduction of the Spice Islands, and returned without loss in less than three years, having established the supremacy of the Dutch in those seas. Although this navigator did not increase geographical knowledge, his voyage led to the confirmation of the discovery of Drake.

The difference between discoveries carried on under the jealous system of the Portuguese, and the more liberal system of the Spaniards, has been already noticed. The contrast is even greater when made with the English and Dutch, especially after the accession of Philip II. to the united crowns of those kingdoms had assimilated the policy of both. It is also to be remarked that the genius of the Protestant religion favoured private enterprise, and thus the expeditions of the Protestant nations are marked with a boldness to which the Roman-catholic had long been strangers. The fashion, however, of forming commercial companies passed from the one to the other; and although they have seldom maintained their monopolies against the spirited attacks of individuals, yet great loss to trade and violent contests have resulted, to the great detriment, indeed, of all. A singular limitation roused the spirit of enterprise among the Dutch merchants. The charter of the Dutch East India Company gave it an exclusive right to the trade carried on through the Strait of Magelhaens. Pilots who had sailed with Cavendish could hardly have been ignorant of the discovery of Drake; and in 1615, Isaac le Maire and William Cornelisen Shouten, of Hoorn, set sail in two vessels, accompanied by two Englishmen, to double the point which Drake had discovered. Arriving at the southern part of America, they made Statenland, and, passing through the strait which separates it from Terra del Fuego, gave it the name Le Maire; and at length reaching the most southern point, they named it Horn or Hoorn, from the native town of Shouten, as well as his ship, which bore it. Having lost that vessel by fire, they were unable to prosecute further discoveries; but refreshing themselves at Juan Fernandez, they sailed for Java, where the remaining vessel, the Unity, was confiscated by the East India Company.

The Spaniards, alarmed at this voyage, as they had been before at that of Drake, sent Bartholomeo and Gonzalez Nodal, with Dutch pilots, to survey the southern extremity of the New World, who completed what the English and Dutch had begun.

The discovery of Torres was in the same year (1606) rivalled by the crew of a Dutch vessel, who reached Australia, but supposed that land to be part of New Guinea. Subsequently, Dirk Hertoge gave the name of his vessel, the Eendracht, to the north-western portion of Australia. In 1618, Zëachen discovered the northern coast; and the year following, Jan Edels pursued his discoveries on the western. In 1627, De Nuitz, and in the succeeding year De Witt, surveyed the southern coast, and Carpenter gave his name to Carpentaria. In 1642, Abel Jansen Tasman was sent in two ships from Batavia, to ascertain the extent of the south land. On the 24th November he discovered land, to which he gave the name of Van Diemen's Land, in honour of the governor of Batavia. Having circumnavigated Australia, Tasman sailed eastward, and discovered land, which he called Statenland, supposing it might form part of the southern continent; this was New Zealand. From thence Tasman passed to the Friendly Islands, where the conduct of the natives justified the name subsequently given them by Cook; and from thence through the Archipelago to New Guinea, and returned to Batavia. From the Dutch surveys of the coast, Australia received the name of New Holland.

8 *The Buccaneers: Dampier.*—While the Dutch and Portuguese were contending for the commerce of the east, and the French and English were colonizing North America, the riches of the Spanish Main tempted individuals, principally of these latter nations, to unite for piratical adventures, and to follow, if not in the steps of Drake, at least in those of Oxenham. By the names of Buccaneers or Flibustiers, they carried on their piracies, under different leaders; but at last, having received a severe check from the Spaniards, who surprised the island Tortuga, which they had made their home, they organized their forces and elected a commander. From this period their proceedings were on a formidable scale, and marked by unparalleled daring, prowess, and ferocity. The history of maritime discovery need not record the storming of cities or the massacre of their inhabitants; but it was the capture of Panama by Morgan, and the sight of the great expanse of the southern ocean, in 1664, that opened a new field for the ambition and rapacity of the buccaneers. In 1680, a party numbering 331, principally English, crossed the Isthmus of Darien, embarked on the South Sea in canoes, seized the first vessels they fell in with, steered to the south, and returned to the West Indies by Cape Horn.

The success of this voyage provoked another in 1683. Some of the same party, having captured a ship of eighteen guns, left the Chesapeake, and sailed for the coast of Guinea, where, having taken a Danish vessel of thirty-six guns, they burnt the first, and in their new prize sailed for the Strait of Magelhaens. Here they met another English vessel bound on the same voyage as themselves, and heard report of a third; others, therefore, there might have been, and probably were. From thence they sailed to Juan Fernandez, where, on the former voyage, they had left an Indian whom they had brought from the Mosquito coast, and whom they found again, after an absence of three years. At the Galapagos, the three vessels, having united, established a depôt; one vessel returned home by the East Indies, another by Cape Horn, while the third, after an extended cruise of several years, sank, worn out, at her anchors. These voyages added little, indeed, to geographical knowledge, but they gave fresh stimulus to maritime enterprise, and Davis and Dampier acquired in them their knowledge of the South Seas, which they carried to England; and in 1699, the latter, now in command of a vessel belonging to the royal navy, was sent by King William to examine the coasts of New Holland and New Guinea. Dampier reached the former island after a voyage of six months, and after getting embarrassed with the Archipelago on the eastern coast, sailed for New Guinea, which he reached on New Year's Day, 1700; and after coasting that island, made land to the east, which, having circumnavigated and found separate from it, he named New Britain. On his return home, his ship was wrecked on the Island of Ascension. Subsequently, Dampier made two voyages to the Pacific on privateering expeditions; in the former of which Alexander Selkirk was left on the island of Juan Fernandez; and in the latter he was discovered there, having lived alone on the island for four years and three months. This last voyage was eminently successful as a speculation, and led to another, in which Captain Clipperton traversed the Pacific in a boat of only ten tons burden. In 1718, and in 1739, a squadron was sent under Commodore Anson to attack the Spaniards in what they fondly deemed their own waters. The French also had followed the example of the English, and now frequently traversed the Pacific; in 1721, one of their vessels had crossed that ocean in fifty days; and in the same year, Jacob Roggeween, with a fleet of three Dutch vessels, sailed to the Falkland Islands,—which had received that name in 1690 from an English privateer captain, but were named by Roggeween Belgia Austral,—sailed through the Strait of Magelhaens, and, passing from Juan Fernandez, threaded the Archipelago of the Southern Ocean, and reached Batavia.

In all these voyages the identification of the lands seen is difficult. Each voyager, being desirous of appropriating to himself what, perhaps, others had before discovered, gave a new name to what he saw, and thus almost inextricable confusion bewilders those who attempt to follow their tracks minutely. It was reserved to later times to obtain an intimate knowledge of the Pacific; but these daring sailors opened those paths which were afterwards surveyed and delineated by the skill, courage, and science of Cook and his contemporaries.

9 *The Hudson's Bay Company: Dobbs and Middleton.* — While the Buccaneers were successfully marauding in the South Seas, the spirit of enterprise in England was seeking other spheres of action, even in the frozen north, and the attempt was made which was to result in the knowledge of the interior of the northern parts of America. On the proposition of a French Canadian, named Grosseliez, who had made a journey by land to Hudson's Bay, a company was formed for the further exploration and subsequent colonization of the country around it. At the head of this was Prince Rupert, and many noblemen and men of wealth joined in the undertaking. In 1668, Zachariah Gillam was sent to take Grosseliez out. They wintered in Rupert's River, and built a fort there, taking possession of the country, which, in honour of the Prince, was named Rupert's Land, and was granted to the company as a British colony, reserving to the adventurers the sole right of occupation and trade. The formation of this company had two important effects on the progress of discovery—at first in retarding it, and subsequently in forwarding it, especially towards the extreme north. There can be no doubt that the knowledge of the valuable furs to be obtained in these northern regions had its effect, not only on the formation of the company, but on several expeditions both before and after; indeed, we find Davis engaged in this traffic, but, like a true sailor, giving it up immediately that an opportunity was afforded for the further progress of his voyage; and it appears to have been, from the first, sufficiently profitable to prevent the desire for further discovery on the part of the company. The report, however, made by the governor of their fort at Nelson River, Mr. James Knight, that copper was to be found in great plenty to the north, induced the fitting out an expedition to discover it, which was placed under his direction, and proved most disastrous, being cast away on Marble Island, at the north-west extremity of Hudson's Bay, where all the crew perished from cold and hunger, some having prolonged a miserable existence through two years. Being so long without tidings of Knight, whom they, at first, hoped might have found the long-desired western passage, the company despatched John Scroggs to search for him, who probably passed the remnant of his crew on Marble Island, but returned without doing anything. The report, however, of the great rise of the tide in Sir Thomas Roe's Welcome, which he brought home, induced a Mr. Dobbs to solicit the company to make further efforts in that direction, to which at last it consented, and sent Christopher Middleton; who, proceeding up the Welcome, discovered Wager Inlet and Repulse Bay; and finding no further progress possible in that direction, returned. He also saw, from a high hill, the strait called Frozen Strait, communicating with Fox's Channel.

This voyage had remarkable effects on further discovery to the north-west. Dobbs, on private information afforded him, accused Middleton of having been paid by the Hudson's Bay Company to give a false account of his discoveries, or, at any rate, to mislead the public; and after much altercation, Dobbs's view of the case appears to have prevailed against Middleton's defence, for an act of Parliament was passed, offering a reward of £20,000 to the discoverers of a north-west passage; and, in 1746, William Moor and Thomas Smith were sent out. This voyage resulted only in the survey of Wager Strait.

10 *Russian Discovery to the North-East: Behring.*—So many disappointments checked the ardour for discovery in England; but, in the meantime, the knowledge of the northern coasts of Asia and America was being extended by the Russians. The Empress Catherine—almost as worthy the name Great, for the largeness of her views, as her husband Peter—followed up his projects by sending an officer of her navy, Captain Vitus Behring, overland to Okhotsk, where, having built two vessels, he sailed in 1728, examined the coast of Asia to the north-east, until, in lat. 67° 18′, finding it trended westward, he, returning, wintered at Okhotsk. The next year he sailed again, and made an ineffectual attempt to reach America. Martin Spangberg, ten years after, passed between the Kurile Islands, and reached Japan.

Behring sailed on his third voyage on the 4th of June, 1741, having passed the winter in the harbour which he named Petropaulowski, from his vessels the St. Peter and St. Paul, now the most important Russian station on that coast. Tchirikow, the second in command, having been parted from Behring, reached the American coast on the 15th July, in latitude 56°, probably on one of the islands forming the Archipelago now belonging to Russia, but two boats' crews having been massacred by the natives, he returned. Behring made land on the 18th, in latitude 58° or 60° and first discovered at a distance, which he estimated at about seventy-five English miles, a mountain, to which he gave the name of St. Elias. From thence he proceeded northward, and examined the coast till it trended southward, thus discovering the peninsula of Aliaska. Here he suffered from severe storms; and driven to the south-east, and then to the north-west, he at length reached an island, in latitude 54° 55′, about eighty miles only from Kamschatka. Here Behring died, and his companions, in the spring, built a small vessel from the wreck of the St. Peter, and returned to Kamschatka. From this voyage, so fatal to the commander, not only was important geographical knowledge obtained, but a trade in furs was opened by the Russians with North-west America, which has been continued to the present day, and on account of which they despatched expeditions in 1766 and 1768, and have established a factory at Sitka, not far from where Tchirikow first made the coast; and as, in a series of expeditions commencing 1598, the whole northern coast of Asia had become known to the Russians, the voyages of Behring and Spangberg completed that knowledge by the exploration of the straits which bear the name of the first, thus proving the separation of Asia from America; and by the second, of the Archipelago to the South of Kamschatka, connecting their discoveries with those of the Portuguese in China and Japan. The existence of a north-east passage was thus demonstrated.

Of the Russian expeditions in northern Asia a brief notice in this place will suffice. In 1598, Fedor Dzakow reached the Yenisei; in 1610 he descended that river, and reached Passina, or Piasina. In 1640, Cossacks, in the service of Russia, discovered the Lena. Between 1636 and 1640, Jellesei Busa discovered, in the interior, the rivers which flow between the Lena and the Indigirka; and Ivanow, the latter river. In 1647, two unsuccessful expeditions were made to the east of the Kolyma. In 1649, Semen Deshnew, with Fedot Alexiow, and Gerasim Ankudinow, discovered the river Anadir, and entered Behring's Strait. The two latter were wrecked, and perished miserably. In 1650, Semen Motora met Deshnew at the Anadir; and Michael Staduchin following him, passed that river, and reached the Pechena, where he perished. In 1711, Wagin and Permakow reached Liakow Islands, since named New Siberia, and were murdered by their crews. In 1712 and 1714, Staduchin, Markow, and Kruglakow, made unsuccessful voyages; and in 1724, Fedot Amossow, after two abortive attempts, discovered the Bear Islands, off the River Kolyma.

These voyages have been continued, with scarcely any intermission, until the present time; they had, however, ceased to be discoveries, and are rather to be considered examinations and surveys of the coast line. In 1736, Shuratow and Owzyn explored the Obi and Yenisei. In 1740, Sterlagow extended the knowledge of the coast to the north-east islands; and the same year Minin sailed north from the Passina to 75° 15′. In 1735, an expedition left the Lena to explore the coast to the Obi. It was commenced by Prontchichew; continued, first by Laptew, who was wrecked, and many of his companions perished; then Tchcliuiskin, who fell in with the survivors, but only reached and explored the Taimura. Laptew subsequently explored the coast from the Kolyma to the Chroma; in 1740, reached Bear Islands; and in 1741, explored the Anadir in boats. In 1735, Lassinius reached the Chiamlach, but only seven of the party survived the winter. In 1759, Eterikan reached the Liakhow Islands. In 1761, Scharalov surveyed part of the coast beyond the Kolyma; in 1763, Andrijew examined the Bear Islands, which were more particularly surveyed by Leontiew Lyssow and Puhkarew in 1767, and, in 1770, they received that name from Liakhow, who obtained the monopoly of the fossil remains found on them. In 1765, Vassili Tchitsagoff was sent to make discoveries to the north; he sailed from Archangel, and reached 78° 8′, and subsequently 80° 30′; his further progress being stopped by the ice. In 1787 and 1791, Billings explored to the east, and, in 1808, Hedenstrom the islands to the north. In 1819, Lagaref was sent to explore Nova Zemlia, but returned unsuccessful. In 1821, Lutké followed him with no better success, but in the two following years surveyed the coast of Lapland and the western coast of Nova Zemlia, and ascertained the division of the islands so named: his fourth voyage to survey the east coast was unsuccessful. It was, however, effected in 1832 by Pachtussof, though his companion, Krotoff, was lost in the attempt. In 1820, Lieutenants Von Wrangell and Angon explored the coast eastward of the Lena, and made expeditions on the ice to the Polar Sea, completing our knowledge of the northern coasts of Asia.

The outline of the eastern and northern shores of Asia being thus ascertained, nothing remained to the general correct delineation of the outline of the surface of the continental masses of land, but the ascertaining the position and character of the northern and north-western portions of America.

CHAPTER III.

§ 1. Discovery in the Pacific: Byron and Wallis.—2. Australia and New Zealand: Cook's first voyage.—3. The Southern continent: Cook's second voyage.—4. North-West discovery resumed: Hearne and Phipps.—5. North-East route through Behring's Strait: Cook's third voyage.—6. The French in the Pacific: Perouse and D'Entrecasteaux.—7. The fur traders on the North-West coast of America: Meares and others.—8. Survey of the North-West coast of America: Vancouver.—9. Russian voyages in the North Pacific: Krusenstern.

DISCOVERY in the Pacific Ocean: Byron and Wallis.—The discoveries which, in 1568, Mendana had commenced in the Pacific, were now to be completed, and our knowledge of that vast expanse of water extended to all its divisions, the dreams of enthusiasts exploded, and misrepresentations and errors of former navigators corrected. Two causes combined to produce the desirable result—the accession of George III. to the crown of England, and the loss of Canada by the French. Nothing can more redound to the glory of that monarch, than the ardour with which he encouraged scientific pursuits. How much our men of science owe their knowledge and position in society to his fostering care, when science was comparatively little thought of, and its professors still less, many have yet to learn. To him belongs the glory of having restored to discovery her scientific character, and to have planned and sent out expeditions without selfish or political considerations; nor was this unfelt or unresponded to, even by the nations which, during his reign, were hostile to this country, but the flag of England, on board the ships of Cook, was esteemed a neutral flag.

Discovery in the Pacific had, however, recommenced under more selfish auspices. France, having lost her province of Canada, and more especially the fisheries on the banks of Newfoundland, which had been, and which, since she has regained them, still are her principal reasons for attaching any value to her possessions in those parts, looked round for some spot where, if not beyond the reach of the arms of Great Britain, at least in comparative safety from the insignificance of the spot chosen, she might plant a colony, and carry on trade in furs and fish. No doubt in part also influenced by the then prevalent belief, so tenaciously held by many, and by Dalrymple in particular, of the existence of a southern continent, as delicious in its climate and luxurious in its productions, as the most favoured part of the New World, she selected the Falkland Islands, to which, in the uncertainty of the discovery, and their hitherto uninhabited state, she had as much claim, perhaps, as any other power; and in 1763, M. de Bougainville was sent to locate a settlement on them. This seems to have attracted the attention of England, and the following year, Commodore Byron was sent with two vessels. In his instructions, the Falkland Islands and Pepys Island, called 'his Majesty's,' thus asserting the authority of Great Britain over them, are the principal objects of his researches, and their first result was to ascertain that no such island as the latter was in existence. Byron then entered the Strait of Magelhaens, where he met the Patagonians, and sailing to the Falkland Islands, discovered Port Egmont, and took possession in the name of the king. Subsequently passing the strait, he entered the Pacific, and passing the Islands of Disappointment, so named by him as affording no shelter to shipping, reached a group of islands to which he gave the name of King George; from them, by Prince of Wales Island, and the island of Danger, he reached Tinian, and returned to England by way of Batavia.

Byron was followed, in 1766, by Captains Wallis and Cartaret. On reaching the Strait of Magelhaens, they were, however, separated, and never after joined company. Wallis sailing westward, reached the group named by Cook the Society Islands, and called Tahiti, King George the Third's Island; from thence, by Tinian and Batavia, he reached England in the following spring. Cartaret, in the meanwhile, was pursuing a more southern route across the Pacific. He saw and named Pitcairn's Island, and passing near the Salomon Islands without seeing them, proceeded to New Britain, discovered the strait which separates it from the island to which he gave the name New Ireland; and having determined the position of many islands in those seas, he returned to England.

In 1767, the French having resigned their claim to the Falkland Islands to Spain, in consideration of 500,000 crowns, Bougainville was sent to effect the transfer, and having done so, proceeded on a voyage across the Pacific, and passing in the track of English navigators, reached the Cape of Good Hope only a few days after Cartaret had passed it. Bougainville named one group, probably the Terra Australis of Quiros, Les Grandes Cyclades, another Louisiade, and gave his own name to another island.

These voyages, the result of mixed motives, were not completed before that of Cook, originated in singleness of mind for the advancement of science, had commenced.

2 *Australia and New Zealand: Cook's First Voyage.*—In maritime discovery, Cook stands second only to Drake in the estimation of his country-

men, and therefore only second as following him in the order of time. Among moderns, no name in the history of discovery deserves such honourable mention. Like his great fore-runner, he began life in the coasting trade, now, since the general use of coal, more important on the north-east than on the south-west coasts of England. Volunteering into a ship-of-war, he distinguished himself so much for nautical skill, courage, and discretion at the taking of Quebec, and the subsequent transactions of the war in Canada, and laid the foundation for scientific reputation, by a survey of the coast of Newfoundland, and astronomical calculation of the longitude by observing an eclipse of the sun, that when, in pursuance of the recommendation of Halley, it was determined to send an expedition to the South Sea, to observe a transit of Venus across the sun's disk, which was expected in the year 1769, the obstinacy of Dalrymple led to Cook's being appointed to the command, and he sailed from Plymouth on the 26th August, 1768, in the *Endeavour*, well supplied with all necessaries for the voyage, and accompanied by a naturalist and an astronomer of eminence. The presence of Mr., afterwards Sir Joseph Banks, with the expedition, showed that the spirit of Raleigh and Granville was not quenched in the latter part of the eighteenth century. Cook sailed round Cape Horn, and thence direct for Tahiti, which had been fixed, on the recommendation of Captain Wallace, as the place where the astronomical object of the voyage was to be secured, if possible. Favoured by the weather, three observations of the transit were obtained, and Cook proceeded to carry out his further instructions, by examining the group to which Tahiti belongs, and to which he gave the name Society; from thence he proceeded to the south-west, passed an island, named by a Tahitian he had taken with him, Ohiteroa, and reached New Zealand in October, which he circumnavigated; and having discovered the strait which still bears his name, proceeded to Australia, examined carefully the eastern coast, discovered the strait which separates it from New Guinea, to which he gave the name of his vessel, the *Endeavour*, and thence sailing to Batavia to refit, suffered the loss of his principal coadjutors and many of his crew, but reached England on the 10th June, 1771, after a voyage of two years and eleven months.

While Cook was occupied in this voyage, an expedition was fitted out by some French mercantile adventurers in Bombay, to trade with Peru, and placed under the command of M. de Surville. Having touched at the Bashee Isles, and passed the southern extremity of the Archipelago Louisiade of Bougainville, to which he gave, from the ferocity of the inhabitants, the name Arsacides, he reached New Zealand at the time Cook was examining that island. Here he destroyed some villages, in revenge for the loss of a boat, and to this atrocity may probably be traced the subsequent murders committed by the inhabitants on the European visitors.

3 *The Southern Continent: Cook's Second Voyage.*—The entire success of Cook's first voyage fully justified his selection to command another expedition. His discoveries on the coast of Australia and New Zealand had proved that the great southern continent, if it existed at all, was not to be found in that direction; and although, like the happy islands of the west, it seemed to fade away at the approach of man, still there were many, who, like Dalrymple, retained their faith in it to the last. The first object of Cook's second voyage was therefore to examine the southern ocean in high latitudes. Two vessels were selected of considerable tonnage; and as the only misfortune attendant on the first voyage had been the loss of men from sickness, every care was taken to prevent this in the second.

Cook sailed from Plymouth, July 13, 1772, and having crossed the meridian of Cape Circumcision, said to have been discovered by the French far to the south of the latitude assigned to it, and having thus still further reduced the dimensions of the great southern land, he proceeded to the south and east, and reached the ice on the 10th December. At first only islands and bergs were seen; but on the 17th January, in latitude 67° 15′, ice appeared, extending in a solid mass from east to south-west. Here his consort, with Captain

Furneaux, parted company in a fog, and Cook determined to repair at once to the appointed rendezvous in New Zealand, where he arrived on the 26th March, not having seen land during the whole time. In the interim, Captain Furneaux had examined the southern and eastern shores of Van Dieman's Land, and arrived at the conclusion that it formed part of Australia. This determined Cook not to make further surveys in that direction. Having hitherto preserved his own crew from disease, he determined during the winter to examine the southern Pacific within 46° of latitude, and passing the dangerous Archipelago of Bougainville, sailed to Tahiti for the benefit of Captain Furneaux's crew, who were suffering from scurvy; from thence sailing westward, he landed on the island named Middleburgh by Roggeween, and from thence proceeded to Amsterdam Island, from whence he returned to New Zealand, where having refitted his ships, he sailed on 26th November to the south. The first ice was seen on the 12th of December, and on the 30th of that month he arrived at the edge of the solid ice, in latitude 71°. Being thus stopped in his progress, Cook sailed eastward in search of the great southern land, and found the sea everywhere open, and his progress unopposed. He made Easter Island, for which his immediate predecessors had searched in vain, and from thence sailed to the Marquesas of Mendana. Proceeding from thence to Tahiti, he discovered a group to which he gave the name of Palliser's Islands; and having spent some time there and at Huaheine, returned to the group containing Amsterdam Island, to which he gave the name of the Friendly Islands, as descriptive of the character of their inhabitants. Sailing west, Cook fell in with a group of Islands, which he concluded to be the Terra Australis del Spiritu Santo of Quiros; these he found peopled with a race differing in every respect from that with which he had hitherto been acquainted in the South Seas. Cook having explored all the islands from thence to Tanna, named them the New Hebrides. On his voyage from them to New Zealand he further discovered New Caledonia and Norfolk Island. He reached New Zealand on the 18th October, and sailed again to the south on the 10th November, and made direct for Terra del Fuego, where he arrived on the 17th December; which having examined he proceeded to the east, and fell in with an island which he named New Georgia; and still further south he discovered land, to which he gave the name of his patron, Earl Sandwich. From hence he continued his voyage to the east, till on the meridian of the Cape of Good Hope, when he turned to the north, and arrived there on the 22nd of March, by his computation.

Cook had now circumnavigated the southern pole, and found land within 30° of latitude from it. He had arrived at the conclusion, since so fully justified, that a great mass of land did exist within that limit, but the quantity of ice, which was to him sufficient evidence of the fact, satisfied him also that the prosecution of discovery in that direction would be attended with great danger, and would be productive of no solid advantage. He left the Cape, and arrived at Portsmouth, 13th July, 1775, after a voyage of three years and eighteen days; and so perfect had been his arrangements for the health of his crew, that during that long period he only lost one man from sickness. Captain Furneaux had been less successful. Arriving at New Zealand after Cook left it, he lost a boat's crew, who were murdered by the natives. He sailed direct for the Cape of Good Hope, passing between New Georgia and Sandwich Land without discovering either, and arrived in England just one year before Cook.

In the same year in which Cook sailed on his second voyage, but some months earlier, Captain Marion du Fresne, incited by the success of Cook in his first voyage, proposed to take back to Otaheite from the Isle of France a native whom Bougainville had brought home with him. He sailed with the intention of examining the southern ocean. After having fulfilled the nominal object of his voyage, and the man having died on the passage, Du Fresne proceeded to New Zealand, where he and twenty-six of his companions were killed by the natives, and the expedition returned, without having effected anything, to the Mauritius. Kerguelen, however, who had been sent with Aotorroa to that island to meet Du Fresne, proceeded from thence on a voyage of discovery to the South Atlantic, and was rewarded by the discovery of the island which bears his name, and the importance of which, as lying in the best track from the Cape of Good Hope to Australia, must before long be generally recognised. On returning to France, however, his story was doubted, but the king, Louis XV., sent him out again the next year, when he examined the coast for eighty leagues; and here, for the present, researches to the south terminated.

4 *North-West Discovery resumed: Hearne and Phipps.*—Cook had solved the great geographical problems of his day. There remained, however, one which even hitherto has not been satisfactorily expounded, and to this the attention of the English government was soon directed. Thirty years had elapsed since the contest between Middleton and Dobbs had resulted in the offer of a reward of 20,000*l.* for the discovery of a north-west passage from Europe to Asia. Incited by the Honourable Danes Barrington, Lord Sandwich, then at the head of the Admiralty, determined on sending an expedition for that purpose, and accordingly Captain Phipps, afterwards Lord Mulgrave, with Captain Lutwidge, sailed on the 4th of June, 1773, and passing Spitzbergen, reached latitude 80° 37′ north; but becoming encompassed with ice, and escaping with difficulty, both ships returned to England. Two things make this expedition, otherwise unsuccessful, deserving of notice. Phipps attained the highest latitude as yet reached, and Horatio Nelson accompanied the expedition as a midshipman.

Some further progress towards north-west discovery was made by Samuel Hearne, in the employment of the Hudson's Bay Company, in the years 1769 and 1770. The object was the discovery of copper to the north; and in the last journey it was, so far as discovery was concerned, entirely successful. In 1771, Hearne traced the river to which he gave the name Coppermine, to its mouth, thus ascertaining the existence of a northern ocean, 25° to the westward of the extreme westerly point yet attained by sea. The western coast of North America was also further explored by the Spaniards, who had established settlements on the coast, as far north as San Francisco. In 1774, alarmed probably at the pertinacity of the English, and fearing lest, as subsequently happened, they might follow the example set by Drake, and seek a northerly passage round America by the west, Juan Perez and Estevan Martinez were sent to examine the coast to the north of Cape Mendocino. They discovered land in latitude 53° 53′, probably part of Queen Charlotte's Islands, and in 54° named a headland Santa Margarita, and the strait between that and the islands, subsequently named Prince of Wales' Islands, Entrada de Perez. Want of water compelled their return south, and in 49° 30′ they entered a bay called by them San Lorenzo, but since, it is thought, better known as Nootka Sound; but why the vessel should have been obliged, in such a secure haven, to cut her cables and stand to sea, seems inexplicable. Many years after, Martinez claimed the discovery of the Strait of De Fuca, and the headland at the entrance is named by the Spaniards after him.

Another expedition was despatched, in 1775, under Don Bruno Heceta, Juan Perez d'Ayala, and Juan Francisco de la Bodega e Quadra, the latter a name subsequently well known in the history of that coast. Heceta made land in 48° 26′, and returning observed the current of the Columbia river, but without ascertaining its real character. Bodega extended his voyage to 56° or 58°, discovered the mountain subsequently named Edgecumbe by Cook, and returned without making any discoveries worth noticing.

5 *North-East Route through Behring's Straits: Cook's Third Voyage.*—Lord Sandwich was not to be prevented from the prosecution of his great object by one failure. On consultation with the best authorities, it was determined that the next expedition should proceed by way of the Pacific Ocean and Behring's Strait, and an act of parliament was passed, by which the proffered reward was extended to success from that quarter; and Cook, although now

resting from his labours in the retirement of Greenwich Hospital, at once volunteered for the command. On the propriety of his appointment there could be no question, and he accordingly sailed on the 12th July, 1776; and when near the Cape of Good Hope, having been joined by his consort, in command of Captain Clerke, he sailed from thence on the 30th November, and passing two small islands which had been discovered by Marion du Fresne, named them after Prince Edward, and on the 24th reached Kerguelen's Land. Here he found the record left by the French of their discovery; and having ascertained its insular character, and that it did not form part of a southern continent, as Kerguelen had supposed, Cook sailed for Van Dieman's Land, where he arrived 26th January, 1777.

Depending on the correctness of Captain Furneaux's report, Cook missed the discovery of the strait between that island and Australia; touching at New Zealand, and proceeding from thence, he discovered the islands of Mangea and Waato, outliers from the group of the Society Islands. From thence he sailed to the Friendly Islands, where he remained until he had acquired an accurate general knowledge of their geography, when, leaving them, he sailed eastward, and arrived at Otaheite in August. In December, he sailed northward, and on the 18th January discovered land, which proved to be a group of islands, to which he gave the name of Sandwich, the steady patron of geographical discovery. Here he remained about a month, and then proceeding on the main object of his voyage, reached the coast of America in latitude 44° 33′. Following the coast northwards, he named a cape, since known to be at the mouth of the Columbia River, Flattery, because it had at first seemed to hold out promise of the harbourage he was seeking; and being baffled by strong west and north-west winds, he was kept at sea, and did not again reach the land till in latitude 49° 29′; where, between two widely separated headlands, he found the capacious sound to which he gave the name of King George, but which has retained in preference its native name of Nootka; and here his sailors commenced the traffic in furs which has, until lately, given so much commercial and political influence to the north-west coast of America.

It has been a cause of wonder to many that Cook should pass the Columbia River and the Strait of De Fuca without perceiving them. His dependence on Captain Furneaux's authority will show us that he was not unwilling to trust to the reports of others; but in the case of the narrative of De Fuca, followed as it was by the marvels of De Fonte, and unelucidated by the knowledge obtained by the Spaniards, in accordance with their usual selfish and short-sighted policy, it might have been justly matter of surprise if Cook had evinced any faith in it; but, in truth, he had no opportunity to discover the Strait of De Fuca without leaving the main object of his voyage, and returning to the south from Nootka; while the peculiar character of the mouth of the Columbia deceived not Cook only, but Vancouver; indeed, the fearful line of breakers which extends across it might well deter both from too near an approach, and lead to the conclusion that no practicable entrance for large vessels was to be found there.

Sailing from Nootka northward along the coast, he entered an extensive inlet under the 60th parallel, to which he gave the name of Prince William; and still further west, one deeper and more extensive still, to which, misapprehending its real character, the name of Cook's River was afterwards given by Lord Sandwich. Steering westward from thence, he passed between the Kodiak Islands and the main; from thence he passed to Oonalashka, where, being detained by bad weather, he gained some knowledge of that dreary country. Departing from thence, and following the coast to the northeast, he discovered Bristol River, and traced the shore of Bristol Bay, and thence followed the coast northward to latitude 60°. Here navigation became dangerous from the shallowness of the water, to avoid which, standing to sea, he discovered some islands in latitude 60° 17′, and about ten degrees of longitude to the westward; from whence, steering to the north and east, he passed another island, to which he gave the name of Anderson, after the surgeon of the Discovery, who was just deceased; and again made the continent, in latitude 64° 27′. From this point he followed the coast until he reached its most westerly point, which he named Cape Prince of Wales, and perceiving land in the distance, he sailed to the westward, passed a group of islands, and reached the shores of Asia. Here he made a short acquaintance with the inhabitants, and, favoured by a southerly wind, proceeded through Behring's Strait, which he estimated as fourteen leagues in breadth at its narrowest part. Keeping the American coast in view, he steered north and east, discovered and named Point Mulgrave in latitude 67° 45′, and at last, in latitude 70° 44′, arrived at the edge of the solid ice. Had he pursued his inquiry in this quarter further, he might have possibly ascertained the existence of the islands recently discovered by Captain Kellett; but the ice appeared to Cook, and possibly was then, impassable; and he turned to the south and east, where, in latitude 70° 29′, he discovered and named Icy Cape. From thence he again turned north, and was again stopped from further progress by the ice, when he again stood in for the American land, discovered and named Cape Lisburne, in latitude 69° 5′. Finding it impossible to proceed northward, he now stood to the west, and made the coast of Asia, in latitude 68° 56′; and finding the season too far advanced for further discovery in such high latitudes, he determined to steer southward for more temperate regions. Not, however, to leave his task more unfinished than he could help, he examined the coast of Asia until he had satisfied himself that he had reached the southern point of the promontory called by the Russians Tschutskotkoiness.

Finding his own discoveries to agree with those of Behring, but to differ from the more recently-constructed maps, especially with reference to the islands, Cook determined to satisfy himself on this head before leaving the coast, and accordingly stood over to the American shore. Here he examined and named Norton Sound, and having ascertained the continuity of the land from Cape Prince of Wales southward, was satisfied that it formed part of the American continent, and was not insular, as the charts had led him to suppose it might be. In following the coast to the southward, he found the water shoal so rapidly, that at a point, which on that occasion he named Shoal-Water, lying in latitude 63°, he was obliged to haul to the westward. Steering southward for the island which he had previously discovered under latitude 60°, he fell in with a large island, which he named after Captain Clerke, and from thence proceeded to Oonalashka, to obtain water and refresh his crews. Here he received a communication from Russians engaged in the fur trade, and ascertained that since the time of Behring it had been carried on with great advantage by them; his own crews also obtained valuable furs from the natives. He also ascertained from them the incorrectness in many essential particulars of the charts in use. Cook left this coast on the 31st October, 1778; and on the 26th November, made land, which proved to be a portion of the Sandwich Island group with which he was hitherto unacquainted. He examined these islands, and in the larger, Owhyhee, discovered a harbour on the southern side. From hence, sailing to make a complete survey of the islands, his vessels were damaged in a gale, and he was obliged to put back to repair and refit. Here the natives indulged to such an extent their propensity to theft, that Cook determined to seize their king as a hostage: in this attempt he failed, and brought on a collision in which he lost his life.

With Cook commenced a new era in the art of navigation—the application of sanitary measures for the preservation of his crews, the first step made by any navigator to a satisfactory system of naval economy. Unsurpassed by any in boldness or exactitude, the extent of his discoveries is unrivalled, and the correctness of his surveys universally acknowledged. He may be well named the father of modern discovery. Before his time, the result of a voyage depended much, if not entirely, on accident; since then, the longest voyages have become almost, if not altogether, matters of calculation.

On his death Captain Clerke took the command, and proceeded northward through Behring's Strait, reached latitude 70° 33′, was there stopped by a solid barrier of ice, endeavoured to make the Asiatic shore, but failed, from the same cause, and, in consequence, determined to return home by Japan, in order to obtain information respecting those islands, so little known; but before reaching Kamschatka, he died of decline, and Captain Gore succeeded him. Under that officer and Lieutenant King, the vessels proceeded to the south-east, but from tempestuous weather, failed in the intention to survey Japan, and reached Macao on the 3rd December, 1779. Here the value of the furs they had obtained on the north-west coast of America was discovered, and led to the opening a trade in furs between India and Nootka Sound, the consequences of which were most important, both geographically and politically. Sailing from thence, they reached England on the 4th October, 1780, after an absence of four years, two months, and twenty-two days, having lost only five men from sickness during the whole period. The loss of officers in this last expedition of Cook is as remarkable as in his first, embracing the two commanders and the surgeon. The results of the voyage may be briefly summed up thus:—the establishment of the fur trade in North-west America; the placing a colony at Port Jackson, in Australia; the ultimate settlement of New Zealand; the making the Sandwich Islands the central depôt of the Pacific; and, more important than all, the education of a body of scientific navigators, inferior to none who had preceded them, whose names must appear hereafter, and who, like Vancouver, the most worthy successor of the immortal Cook, each in his degree emulated the actions and shared the fame of that great commander, who had now raised Great Britain to an eminence in the history of geographical discovery, equal to that which had been before occupied either by Portugal or Spain. This fame the French were not long in attempting to rival, and accordingly fitted out, in 1773, an expedition of two ships, which they placed under the command of François-Galaupe de la Perouse, who had already distinguished himself, no less for his courage and nautical skill than for his generosity in an expedition to destroy the English settlements on Hudson's Bay. In the selection of the officers, crews, and vessels to be employed, as well as in their supply with everything requisite for the voyage, every care was taken to meet the exigencies of an exploration more extended and more particular than any yet made.

6 *The French in the Pacific: La Perouse and d'Entrecasteaux.*—On entering the Pacific Ocean, La Perouse made Easter Island, to refresh his crews; from thence proceeding to the Sandwich Islands, he surveyed the Island of Mowee, which Cook had discovered on his return in 1778, and sailing northward, made Mount St. Elias, on the American coast, in June, 1786. From this point Cook having commenced his examination of the coast to the north, La Perouse determined to proceed to the south. In latitude 58° 27′, he established an observatory at a harbour named by him Port des François, and which he proposed should form afterwards the depôt for a French fur trade on the coast; from thence sailing southward, he reached Monterey without having made any discoveries, though from the broken outline of the coast, he conjectured what English navigators subsequently proved, the existence of the extensive archipelago and the islands by which it is guarded for nearly ten degrees of latitude. La Perouse afterwards crossed the Pacific, and though he made no discoveries, made observations of much importance in fixing the true position of many points, especially of the Ladrone and Bashee islands, and on the coast of north-east Asia and Japan. He made the coast of Tartary in June, 1787, and found it uninhabited, though beautiful, and covered with luxuriant vegetation. Here he traced the coast northward, ascertained from the natives the insular character of Shagalien, and subsequently sailed between that island and Jesso, through the strait which bears his name. Having arrived at Kamschatka, he sent his journals and charts to France overland, and then exploring the ocean under the thirty-seventh parallel, dissipated many illusory discoveries of early Spanish navigators. At the Navigators' Islands, M. de Langle, his second in

command, was, with M. Lamanon, the naturalist, killed in an affray with the natives. This appears to have made him shy in opening communications with the natives of other islands. Arriving at Australia, he found the English commencing a settlement there, and sailing thence with the intention of examining the islands to the north, was never more heard of; and it was not till 1813, that Captain Robson, trading to the Feejee Islands for sandal-wood, having transferred some Europeans from them to Queen Charlotte's Island, Captain Dillon, who had been an officer on board his ship, going, in 1826, to visit them, obtained information of the relics of French manufacture on the Island Manicolo; and having communicated this to the Indian government, was sent to make further inquiries, and ascertained beyond doubt the loss of the ships of Perouse on that island.

In 1791, however, the French sent out Admiral d'Entrecasteaux to seek for La Perouse, who examined carefully the islands lying in the track Perouse had marked out for himself; he, however, passed Manicolo, which he named Isle de Recherche, without examination; and dying of sickness, as well as his second in command, and disease making great ravages among his crews, to sum up the misfortunes of his voyage, his vessels were seized as prizes at Java by the Dutch government. This voyage, however unsuccessful in its main object, was most advantageous to science. Sailing near the coasts, in hopes to discover traces of La Perouse, D'Entrecasteaux was enabled to examine them more minutely than former navigators, and to fix with great accuracy the position of the more important points. The collections also made by the naturalist of the expedition, added much to the scientific knowledge of the day.

7 *The Fur Traders on the North-west coast of America: Meares and others.*—The incitements offered by the accounts of the sailors of Cook's expedition, induced English merchants, in the East as well as at home, to turn their attention to the fur trade, and almost simultaneously, in the year 1786, expeditions were despatched from London, Bombay, Calcutta, and Malacca; and the year previous, Captain Hanna had been sent on the same errand from Canton.

In London a company was formed, called the King George's Sound Company, the year after the publication of the account of Cook's voyage, and two ships were despatched under Captains Portlock and Dixon, who had both been under Cook's command; from Bombay, Captains Lawrie and Guise; and from Bengal, Captain Meares, whose consort under Captain Tipping, sailed from Malacca to meet him. Meares wintered on the coast in 1786. Portlock and Dixon spent the same period at the Sandwich Islands; while Captain Tipping and his crew were lost, probably after reaching the coast. Captains Lawrie and Guise were on the coast at the same time as La Perouse, and no doubt, from the nature of their occupations, obtained a more intimate knowledge of it than he had done. It is, however, difficult, if not impossible, to allocate with exactness their respective discoveries. Portlock certainly examined many of the inlets to the north. Dixon sailed round and named Queen Charlotte's Island, or Islands, for it is still uncertain whether it be one or more. While of two more vessels, commanded by Captains Colnett and Duncan, the latter examined and named the archipelago called Princess Royal Islands, and observed an inlet under parallel 48° 30′, which he called after De Fuca. In 1788, Meares again visited the coast, built a tender to his vessel at Nootka, and proceeded southward to examine the Strait of De Fuca, in which he sailed, he says, near thirty leagues. Captain Douglas, in the tender, threaded the channels which divide the archipelago from the main from north to south. In the same year a vessel from Boston, under Captain Grey, arrived on the coast, and having received from Meares an account of the Strait of De Fuca, entered it, and on his return published an exaggerated account of its magnitude and extent.

The trade thus opened by the English had attracted the attention of the Americans, and even the Austrian East India Company sent, in 1787, a vessel under Captain Barclay, an Englishman; and in 1789, when a Spanish expedition arrived at Nootka, one English, two American, and one Portuguese vessels were at anchor in that harbour.

The Spaniards, who had intermitted their efforts at discovery since 1779, when an impotent attempt was made under Don Ignacio Arteaga to obtain a knowledge of the coast, had, in 1788, despatched Don Esteban José Martinez to the north, who found the Russians establishing settlements there, and moving rapidly southward. The report which he brought back, that they proposed to occupy Nootka, determined the Viceroy of Mexico to anticipate them. It is evident, from the subsequent conduct of the commander, that the rights of the English were those only which he esteemed likely to interfere with those of Spain, the Russians not having yet sent any expedition so far south, and indeed having no claim to any portion of the country south of the discoveries of Behring; but the claims which the English might base on the discoveries of Drake and Cook, and the opening of the fur trade consequent on the voyage of the latter, might prove serious; and the English company already alluded to, having purchased from the East India Company their real or supposed right of traffic on the coast, had sent vessels, not only to carry on the fur trade, but to establish a settlement at Nootka. The Spaniards, therefore, directed their hostility against the English alone, seized not only the English vessel lying in the harbour, but having allowed another to enter the harbour without notice, took possession of her also. This vessel was commanded by Captain Colnett, who had been selected to establish an English settlement there, ready for the reception of colonists, who were to arrive the year after. The Spaniards now established themselves at, and fortified Nootka; but Great Britain fitted out an armament immediately, and the Spaniards agreed to a formal surrender of Nootka. To receive this surrender, Captain Vancouver, who had been on the coast with Cook, and proved himself a most worthy disciple of that great navigator, was sent out in command of two vessels, not only for this purpose, but to extend and complete the discoveries of Cook, and ascertain accurately the existence or non-existence of any strait connecting the Pacific and the North Sea discovered by Hearne; and for this purpose, to examine every inlet of the coast which might promise such a result, from latitude 30° to 60°, especially that said to have been entered by the Washington, between parallels 48 and 49, and to correspond with the Strait of Juan de Fuca.

8 *Survey of the North-west coast of America: Vancouver.*—Vancouver, with Lieutenant Broughton for his second in command, sailed in 1791, and on his voyage out surveyed the south coast of Australia through nearly six degrees of longitude, and subsequently — having completed the survey of Dusky Bay, New Zealand, which Cook had not been able to finish—discovered the rocky and dangerous islands which he named the Swans, and a large island, which he called Oparo, one of the dangerous archipelago to the east of New Zealand; and arriving at Otaheite, he found his consort under Broughton, who had added another island to our geographical catalogues, which he named after his vessel, the Chatham. From thence he sailed to the Sandwich Islands, and having surveyed them, reached the coast of America the 18th of April, 1792; and the next day found he was in latitude 40° N. From thence he sailed northward, the wind enabling him to keep close to the coast. When off the mouth of the Columbia, the line of breakers stretching across the entrance, as well as the long-extended low land to the south, led him to think it not worth while to lose the favourable breeze he had by its exploration, and passing it, he, on the 29th, fell in with a vessel which proved to be the *Columbia*, commanded by the same Captain Gray who, in the *Washington*, had previously entered the Strait of De Fuca. He corrected the report which had been current in Europe of his discovery, limiting it to fifty miles within the strait; but his account that the natives reported it to extend to the northward, gave it its due importance in the mind of Vancouver, who accordingly proceeded to explore it, which he did, with all

its various indentations, with such minute accuracy, that the recent surveys of Captain Wilkes have added nothing of importance to our knowledge of it.

Vancouver named his discoveries after the officers of his own ships, and thus the names of Broughton, Puget, Whidbey, &c., have been handed down to posterity. In the strait separating the island in which Nootka Sound is situated from the main, he met two small Spanish vessels engaged in the survey of its coasts, and his own attention having been more particularly confined to the main by his instructions, he contented himself with the charts which they gave him, and, at their request, the united name Vancouver and Quadra was given to the island. To the inlet he gave the name Gulf of Georgia, and having sailed through the narrow strait which separates the northern extremity of the island from the main, continued a minute and painful examination of the coast to the northward, until August 17th, when, falling in with the *Venus*, of Bengal, he received from her commander an account of the arrival of a storeship, and of the murder of her commander and some of the crew at Woahoo, as well as of the wish of the Spanish commandant, Senor Quadra, to complete the transaction with the execution of which he was charged, he determined to return at once to Nootka; but being unable to agree on the terms of the surrender, and having despatched a messenger to England, he sailed southward to prosecute his inquiries; in the course of which, Broughton entered and surveyed the river Columbia, of the existence of which Gray had given information as having its outlet in the bay which Vancouver had noticed in the spring, but which river Gray had not entered, though he gave a rough sketch of the bay into which it falls. Broughton ascended the river more than 100 miles to the head of the tide-water, and named the point where his examination ended after his commander, as the Hudson's Bay Company did the fort subsequently erected by them, and now standing on that spot. Returning, he found the *Jenny*, of Bristol, detained by stress of weather, within the bay at the mouth of the river. The slow progress of the discovery of this river—the suggestion of Heceta in 1775; its confirmation by Meares in 1788; the conclusion of Vancouver, at first sight, as to the danger of entering it, in 1792; the entrance of the bay at its mouth, by Gray, the following year; and its subsequent survey by Broughton—is to be attributed to the dangerous line of breakers which cross its entrance, and leave but a very narrow channel for shipping. The number of vessels engaged, and the forwardness of the English and Americans, in the fur trade at this time, is particularly worthy of notice.

Vancouver spent the winter of 1793 at the Sandwich Islands; in the summer of that year, completed a close examination of the numerous channels which separate the islands from the main, on the north-west coast of the American continent, and the canals which stretch so deep into the land, as far as Cape Decision, in latitude 57°, when he again returned to the Sandwich Islands, and wintering there, received the cession of Owhyhee to the king of Great Britain. In the spring he was again on the American coast, and commencing his survey to the north, ascertained that Cook's River was only an inlet; and having completed the task imposed on him, he left the coast in August, and arrived in the Thames in October, after a laborious occupation during four years, in which he only lost two men, having surveyed minutely 9000 miles of coast. He, however, contracted in his labours the seeds of the disease from which he died four years after. To him we are indebted for ascertaining that no access is to be obtained from the Pacific to the North Sea, except by Behring's Strait, and he is to be esteemed the father of those laborious investigators whose surveys have, since his time, made the discoveries of the older navigators available, and who, though the results of their labours are less startling and romantic, are not less useful or worthy of record. This voyage had another important result, for Broughton, returning on a political errand, increased our knowledge of the islands and sea of Japan.

9 *Russian Voyages in the North Pacific: Krusenstern.*—The surveys of Broughton confirm and extend those of La Perouse. They differ, however,

in one important particular, the latter making Saghalien an island, while the former represents it as joined to the continent by a narrow neck of land. This difference appears to have been decided in favour of La Perouse by Captain, afterwards Admiral Krusenstern, famous in nautical history, not only as the first Russian who circumnavigated the globe, but as the accurate chronicler of the progress of discovery in the Pacific.

Broughton examined the west side, and reached latitude 52° in the Gulf of Aniwa, or channel of Tartary. Krusenstern sailed up the east coast, and doubled the northern Cape, but, baffled by the strength of the current from the river Amour, failed in his attempt to proceed southwards.

The voyage of Krusenstern, though useful to science, was totally unsuccessful in its primary intention, which was to secure to Russia a trade with Japan, an opening for which appeared to have been made by Russian agents from Tartary, who had kept up a friendly intercourse with the Japanese from 1780 until Krusenstern arrived there in 1804. In 1811, the Russian court sent Captain Golownin to complete the surveys of preceding navigators; but he was taken prisoner by the Japanese, and it was reserved for Captains Maxwell and Lyon, in command of H.M. ships *Alceste* and *Lyra*, after conveying the embassy of Lord Amherst to China—the former surveying the Gulf of Lea Tong, and the latter that of Pechele. The survey of the Yellow Sea, which was then completed, resulted in the discovery of the numerous islands to the west of the peninsula of Corea, and the consequent restoration of the coast to its proper position on the charts, from which it had been removed nearly 150 miles, probably from these islands being mistaken for it. To these important additions to geographical knowledge, these officers added that of the islands of Loo Choo. Notwithstanding the previous expeditions of Lutké, Hall, and Sarytscheff, much is wanting to complete our knowledge of these seas. This, no doubt, the expedition from the United States, now about to sail for Japan, will fully supply.

CHAPTER IV.

§ 1. Arctic discovery resumed: Sir J. Barrow.—2. The North-West coast: Mackenzie and Kotzebue.—3. Ross and Parry.—4. Buchan and Franklin.—5. Parry and Lidden.—6. Franklin's first journey.—7. Franklin's second journey.—8. United efforts: Parry, Franklin, Beechey.—9. Discovery to the North: Scoresby and Parry.—10. The Magnetic Pole: Sir J. C. Ross.—11. Discovery on the coast: Back, Dease, and Simpson.

ARCTIC *Discovery resumed: Sir J. Barrow.*—It has already been shown how discovery on the north-west coast of America was connected, especially in the case of Cook and Vancouver, with that on the east, and the object of both, the North-West passage from Europe. It remains to be seen how both were at last united. Although it has been the honour of our own day to demonstrate the barren fact that such a passage exists, how little worth the lives and treasure wasted upon it, is yet, perhaps, reserved for us to know.

2 *The North-West Coast: Mackenzie and Kotzebue.*—To the knowledge of the north-west coast of America, obtained by Cook, Vancouver, and their contemporaries, Alexander Mackenzie, by his two most enterprising and successful journeys over land, had made the important addition, that, between the mouth of the river which bears his name, in longitude 135° 37′ W., and latitude 68° 49′ N., and Bentinck's Arms, in about longitude 128° W., latitude 52° N., into which the Salmon river, also named after him, flows, the coast is continuous. Kotzebue, a navigator sent from Russia by private enterprise, son of a German writer of some note, had, moreover, in 1815, discovered a

secure harbour at the extreme north-west of Behring's Strait, thus offering facility for further exploration in that quarter. Before this, however, Sir John Barrow, the late secretary to the Admiralty, and chronologist of former Polar voyages, had been strenuously urging the revival of discovery to the North, and two expeditions were accordingly resolved on, the one to Davis Strait, the other direct to the North Pole.

3 *Ross and Parry.*—For the former, the *Isabella* and *Alexander* were equipped, and placed under the command of Captain John Ross and Lieutenant Edward Parry. They sailed from the Thames in April, 1818, and in June were fast to the ice off Waygat's Island. Of this voyage, perhaps, the less said the better; its results, uncertain at best, having, with one exception, been superseded by discoveries immediately subsequent; and this, which involves the integrity of Baffin's Bay, has just been resolved, and Captain Inglefield has assured us, that the land which Captain Ross saw at the head of Sir Thomas Smith's Sound, is as imaginary as that which precluded his further passage up Sir James Lancaster's Sound. It may be safely asserted, that the return of this expedition, thus unsuccessful, was not a greater disappointment to the country than to the other officers and the crews.

4 *Buchan and Franklin.*—The other expedition was not much more fortunate. The *Dorothea* and *Trent* were commissioned by Captain Buchan and Lieutenant Franklin. They also sailed in 1818, and arriving at the north-east point of Spitzbergen, from thence, proceeding northward, reached latitude 80° 34′, and being stopped by the ice, followed the edge of the bank towards the coast of Greenland; but in a storm which overtook them, the vessels were so damaged, that it was determined by Captain Buchan to forego the search, and return home—a disappointment to Franklin scarcely less than that which Parry was at the same time experiencing. It is remarkable that these officers, since the heroes of Arctic discovery, should have been seconds in command in those two most ill-managed expeditions. They were, however, soon to be rightly distinguished. The hasty decisions of Ross were too glaringly in error to be believed, and a new expedition was planned to place the truth beyond doubt.

5 *Parry and Liddon.*—The *Hecla* and the *Griper* sailed, for this purpose, in 1819, and fell in with the ice on the 18th June in Davis Strait. Parry, now a captain, commanded, and had for his second, Lieutenant Matthew Liddon. Having reached latitude 73°, by main strength and labour they worked the vessels to the entrance of Lancaster Sound, which they reached on the 31st July. Here the magic of true enterprise soon transformed land into water, a range of mountains into an open bay. Having reached latitude 71° 53′, longitude 90°, their further progress was arrested by the ice; but a broad inlet was discovered to the south, which Parry named Prince Regent's Inlet: the most distant point seen he named Cape Kater, and a harbour on the eastern shore, Port Bowen. Fortune favouring the bold, propitious showers opened a passage for the expedition, and a broad channel—that up which Franklin is now being sought—was discovered to the north, and named after the Master of the Ordnance, Wellington. Proceeding still to the west, up the strait which he had at first opened, though not discovered, it being a continuation of Lancaster Sound, and which he had named after Sir John Barrow, he reached the meridian of 110° west from Greenwich, and thus obtained for his crews the parliamentary grant of 5000*l.* Parry had now passed and named Cornwallis, Griffith, Bathurst, and Byam Martin's Islands, and reached Melville Island; here, however, his further progress was effectually stopped by a firm barrier of ice, and on the 5th of September he dropped anchor for the first time since leaving England, having, in one season, placed himself in the first rank of Arctic discoverers. On the 26th, the vessels were hauled through a canal cut in the ice into Winter Harbour, where they remained blocked up till the following August. In the spring, Parry made a journey to the west coast of the island; and when released from their long confinement, the same barrier to further progress still remaining, after sighting

a land to the south, which he named after Sir J. Banks, it was, on consultation, determined to return home. Of this voyage it is enough to say, that it is the limit even of our present knowledge to the west; and that so well did Parry combine with the skill and courage of the British seamen the care of the philanthropist, that, like those of Cook and Vancouver, his crews returned in as robust health as they set out.

6 *Franklin's First Journey.*—The longitude reached by Parry in this voyage was about that of the discovery of the Arctic Sea made by Hearne at the mouth of the Coppermine River. The probability of his reaching this point had not been overlooked by the Admiralty; and as although the actual trending of the coast was unknown from Icy Cape to Mackenzie River, and from thence to the Coppermine, its continuity was placed beyond doubt by Cook and Vancouver and Mackenzie. The most important portion, therefore, of the north coast of America to be examined was that to the east of Coppermine River, and an expedition was determined on to proceed down that river, and from thence towards the east, in the hope of meeting Parry in that direction, or at any rate ascertaining the line of coast. The command of this was conferred on Lieutenant Franklin, whose courage and constancy had often been tried in the arduous duties of his profession, and who, when second in command to Captain Buchan, had given sufficient evidence of his possession of the ardour so necessary to compensate the many difficulties and sufferings inseparable from Arctic research, and the readiness of perception, coolness, and self-confidence, without which it would be impossible to supply the defects in equipment which, in those days, want of experience made inevitable. He sailed from England in May, 1819, arrived at York Factory, the depôt of the Hudson's Bay Company, on the east coast of America, in August, and reached Fort Chipewyan, on the Lake of the Hills, in March the following year. His companions deserve mention for various reasons: Richardson and Back, as subsequently well known in the annals of Arctic research; poor Hood, for his sad and untimely end; and Hepburn, the model of a British seaman, for his faithfulness, courage, and constancy.

During the summer of 1820, they only succeeded in reaching 550 miles to the north of Fort Chipewyan, where, building a hut, which they named Fort Enterprise, they determined to winter. From this point Back returned to Fort Chipewyan for supplies. In June, 1821, the ice was sufficiently broken in Coppermine River to allow the expedition to proceed, and on the 18th of July it reached the Arctic Sea. In two frail birch canoes, twenty persons proceeded on their voyage of discovery towards the east, with a very insufficient supply of provisions, and consequently were only able to reach a point, therefore named Turnagain, being the eastern extremity of an extensive gulf, named by Franklin, Coronation Gulf, distant six and a half degrees eastward from the mouth of the Coppermine. Obliged to return, a new route was selected, by a river falling into the gulf, which was named after Mr. Hood; and the unexpected impediments here met with, both from the nature of the country and the character of their Indian guides, made the journey back to Fort Chipewyan one of the most disastrous on record. This it is not our province to describe; it may be sufficient to say that Franklin and his companions, with the exception of the murdered Hood, were reserved for further labours and sufferings in the same cause, and reached England in safety.

7 *Parry's Second Voyage.*—The success of Parry in dispelling one illusion induced the government, immediately on his return, to commission the *Fury* and *Hecla* for further research in the Arctic regions under his command. The object of the expedition was to ascertain any connexion which might exist between the southern waters discovered by him and the Sir Thomas Rowe's Welcome of old North-west Fox. With Lieutenant Lyon as his second in command, Parry left England in May, 1821, and after much difficulty reached Southampton Island in August. As his primary object was to reach the Repulse Bay of Middleton, Parry determined to attempt doing so by Frozen Strait, which, if its existence might be depended upon, offered a direct route.

This determination was the means of dispelling another doubt which had been a serious obstruction to Arctic discovery for nearly a century. By this channel the expedition safely reached Repulse Bay, which being clear of ice, the continuity of its shores was established, and Parry proceeded on his voyage of discovery to the north; but, detained for a long time by the rapid currents running in the narrow channels between the numerous islands on this coast, he could proceed no further than a deep inlet, which he named Lyon's Inlet, and where he determined to winter. Directed and incited by a sketch map made by an Esquimaux woman named Iligliuk, whose name should not be omitted in a geographical work, in July Parry proceeded to the north, and shortly after arrived at the mouth of what by a land-journey he discovered to be a strait open to the westward, and which he named after his vessels, *Fury* and *Hecla*. Precluded from passing through, he was soon compelled to go again into winter quarters, but not before the northern shore of the strait had been reached by Lieutenant Reid and Mr. Bushnan in latitude 70° north. In the spring, however willing to resume his researches, prudence compelled Parry to return home, where he arrived safely in October, 1823.

In this voyage Parry not only named islands, bays, and headlands, as usual, after his own officers, but adopted the unusual yet most proper course of retaining native names, among which his winter quarters at Igloolik will long be remembered.

8 *United Efforts.*—The double success of Parry and the partial knowledge of the coast obtained by Franklin, now decided the government to make at the same time as many distinct efforts as there were uncertainties to be cleared up and obstacles to further progress to be removed. The *Hecla* and *Fury* were again commissioned under Parry and Lieutenant Hoppner, and this expedition was directed to Prince Regent's Inlet. Franklin, Back, and Richardson, with whom was now associated Mr. Kendall, in the place of the lost Hood, were to proceed over land to Mackenzie River, to separate at its mouth, and thence trace the coast eastward and westward; the one to meet Captain Lyon, who was, if possible, to reach Point Turnagain by the shores of Melville Island; the other to meet Captain Beechy, who was to enter the Arctic Ocean by Behring's Strait. Parry sailed in 1824, and the first season only succeeded in reaching Port Bowen; during the winter, land-journeys were made with considerable success; Lieutenant Ross saw open water to the north, and Lieutenant Sherer nearly reached Fury and Hecla Strait, to the South. These are worthy of notice as the commencement of a system by the adoption of which so much has since been achieved in Arctic discovery. In the spring, Parry attempted his passage to the south by the western shores of the inlet; but the loss of the *Fury* compelled him to return home before he had gone as far south as he had done in his first voyage.

The season appears to have been a very bad one for research on the eastern coasts, for Captain Lyon was not more successful. He had sailed in June, 1825, and reached the Welcome in August; here he encountered such heavy weather as to lead him to anticipate the necessity of abandoning his vessel, but nevertheless he succeeded in reaching Wager Inlet early in September; but losing his anchors in another violent gale, he was compelled to return home, having effected nothing in furtherance of the object of his expedition. Captain Beechy also sailed, in the *Blossom*, the same year, for Behring's Straits, where a rendezvous had been appointed with Franklin in Kotzebue's Sound, which, true to his appointment, Beechey reached on the 25th of July the following year. From hence he proceeded north; but falling in with the ice in latitude 71°, and his instructions and equipment alike forbidding his entry of the dangers of Arctic navigation, he had no alternative but to return to Kotzebue Sound. The *Blossom* barge, however, under the command of the master, Mr. Elson, succeeded in reaching a point seventy miles further east than the vessel had attained to; and so well had all the arrangements been concerted and carried out, that he was at that time within 160 miles of Franklin's party proceeding westward. This point was named after Sir John

Barrow, whose scientific knowledge had originated, and whose ardent temperament had stimulated, so many expeditions; and none could be more fitly named after him than this, as it is the most northern point of the western coast of North America, and from whence it trends rapidly to the south, towards Behring's Strait. The *Blossom* returned the following year to Kotzebue Sound, after spending the winter in the Pacific; but finding no traces of Franklin, returned home, where arriving in October, 1828, Captain Beechey found that he and his companions had arrived safely the year before.

Franklin and his party started in July, 1825, and by way of New York reached the Mackenzie River, and finally Great Bear Lake, where Back being left to prepare winter quarters, Richardson surveyed the eastern side of the lake, while Franklin proceeded to examine the mouth of the Mackenzie, from whence returning in September, he found comfortable winter quarters provided, which were named Fort Franklin. In the following June the two expeditions departed together, and reaching the mouth of the Mackenzie in July, separated on their different voyages, that under Franklin leaving Point Separation first. He succeeded in tracing the coast for 374 miles, as far as longitude 148° 52′ about one-half the distance proposed, his progress having been impeded by ice and other obstacles. Richardson was more fortunate, fulfilling the intention of the expedition, tracing the coast for above 900 miles, and discovering to the north a coast, to which was given the name Wollaston Land, and of which above 100 miles were seen. Thus successful, Richardson returned by Coppermine River, and reached the Fort on the 1st September, where he was joined by Franklin on the 21st. The shores of the Arctic Ocean had thus been satisfactorily determined from Behring's Strait to Point Turnagain, through above 50° of longitude.

In these voyages Franklin discovered the Peel River, an affluent of the Mackenzie; two large rivers flowing into the Arctic Ocean, which he named after Clarence and Canning; and the point which he reached he named Return Reef. Richardson, crossing Liverpool Bay, discovered Cape Bathurst in latitude 70° 30′, crossed Franklin Bay to Cape Parry on the east, and gave the names of his boats, the *Dolphin* and the *Union*, to the strait between Wollaston land and the main.

9 *Discovery to the North: Scoresby and Parry.*—In the mean time circumstances had increased our knowledge of the sea between Greenland and Spitzbergen. Arctic researches in our own day, as in more remote times, were not to be confined to officers of the royal navy. Commerce, as it had caused those of the merchant service to take the initiative, so now it incited them to continued exertions; and among Arctic voyagers and discoverers, the name of Scoresby occupies a distinguished place. Brought up to the whale fishery, he had, in 1806, reached 81° 30′ north, in a vessel under his father's command; and in 1822, when himself in command, he made the coast of Greenland in 74° 6′. As already noticed, steering southwards he discovered a large opening under latitude 70′, but the duty of following the fishery led him from the land which, after being so many years shut up in ice, he had rediscovered. The experience of Captain Scoresby has been always at the service of subsequent Arctic voyagers, although he himself has changed the rough jacket of the sailor for the gown of the minister of religion. Captain Clavering and Colonel Sabine were employed the following year to make scientific observations in Spitzbergen, and having completed them, crossed over to Greenland, the coast of which they traced as high as latitude 76°. These voyages had, no doubt, much influence on Parry's attempt to reach the Pole in that direction, and it received the sanction of Scoresby. He sailed in April, 1827, in the *Hecla*, to attempt to extend discoveries northward, across the ice, in boat sledges. Laborious travelling during one month, usually not making more progress than a few miles in a day, only brought them to latitude 82° 40′; and the ice drifting to the southward under the influence of a northerly wind, it was found necessary to abandon the undertaking.

10 *The North Pole: Sir J. Ross.*—Government now suspended its efforts

towards northern and north-western discovery; it was not, however, entirely discontinued. His own hasty conclusion, and Parry's success, had subjected Sir J. Ross to some deserved, and to much undeserved censure. Private friendship enabled him to redeem his character at an expense of 17,000*l.*—a munificent act of generosity on the part of Mr. Booth, a due estimation of which was subsequently shown by the country in his being raised to a baronetcy. With this assistance to his own funds, Sir J. Ross commissioned a small vessel, fitted as a steamer, and named the *Victory*, and sailed from the Thames in May, 1829. He reached Fury Beach on the 13th of August, and sailing southward, commenced his discoveries at Cape Garry, and following the land reached the 70th parallel; but his further progress was stopped by a solid barrier of ice. Here he went into winter quarters, and following information obtained from the Esquimaux, his nephew, Captain J. C. Ross, traced the land both on the northern and southern shores of a broad strait, separated only by a narrow isthmus from the lower part of Regent's Inlet, and communicating with the open sea to the west, reaching the 99th meridian west longitude, or within 220 miles of the Point Turnagain of Franklin. To the land thus discovered the apparently punning name of Boothia Felix was given. Commander Ross bestowed his own name on the strait he discovered; and during the summer, before the *Victory* could be got out of her winter quarters, that active officer further signalized himself by the examination of fifty more miles of coast to the northward, and the discovery of a magnetic pole. Subsequently obliged to abandon the *Victory*, the small party under Sir J. Ross's command, almost exhausted, contrived to reach Fury Beach, after suffering the rigours of another Arctic winter. A vain attempt was made to escape towards the north, and the endurance of another winter followed. But the next year, in July, 1833, the ice, which had before blocked up Regent's Inlet, Barrow's Sound, and Lancaster Sound, and precluded all passage, had all but disappeared, and they were enabled to reach Navy Board Inlet in their boats. Here they were picked up by the *Isabella* whaler, the vessel which Sir J. Ross had formerly commanded, and arrived safely in England in October. The additions made in this expedition to geographical and meteorological knowledge were gratefully rewarded by the legislature.

11 *Discovery on the Coast: Back, Dease, and Simpson.*—The fate of Sir J. Ross and his party, while it remained uncertain, excited much anxiety at home. Stimulated by the leaders of the scientific societies in London, another expedition was decided on, and Back volunteering, was accepted as its leader. The companion of Franklin was the most fit man, without doubt, that could be selected for an expedition overland; and the Hudson's Bay Company having taken an active interest in, and contributed largely to the funds raised for it, the difficulties presented were much lessened. Captain Back, taking with him Mr. Richard King, as surgeon and naturalist, left England in February, 1833. His instructions were to proceed by New York and Montreal, and by the ordinary route of the fur traders to the Great Slave Lake, from which, or in the vicinity of which, it was believed a river took its rise, and, flowing to the north-east, would be found navigable to the Arctic Sea. Here, building two boats, he was to embark and endeavour to reach Cape Garry. It was presumed that two summers might be occupied in this, and that much knowledge of the coast might be obtained, as well as some knowledge of, if not communication with Ross; but the return of that officer enabled the government to send a despatch after Back, and thus direct him to devote all his energies to what would otherwise have been but a secondary object—viz., geographical discovery.

On reaching Slave Lake, after some difficulties, resulting from ignorance of the country, Back at length found the river to which he had been directed, the Great Fish River, since called by his name; and having made some explorations of the country, he returned to winter quarters at Slave Lake. Here he received the dispatch informing him of the safe arrival of Ross in England.

and with his mind thus relieved, he started in June, and in the end of July reached the sea, in latitude 67° 11′, longitude 94° 30′, after a tortuous course of 530 miles, having passed eighty-three rapids and many large lakes; a barrier of drift ice barred his further progress by sea; swamps and marshes on every side precluded any advance by land, and Back was obliged reluctantly to return. On reaching winter quarters, leaving Mr. King to bring up the expedition, he started express for England, where he arrived in September. In 1836, Back again braved the hardships of the Arctic regions. Under the auspices of the Royal Geographical Society, he sailed in the *Terror*, with the intention of reaching Repulse Bay, and thence making journeys over land to the west; but being caught by the ice off Cape Comfort, in September, he was held prisoner until the 10th of July following, when, with much difficulty, he succeeded in reaching England.

The same year was, however, marked with signal success on the coast, Messrs. Dease and Simpson having traced its windings from the westernmost point of Franklin to that reached by the boats of the *Blossom;* and the following year descending a river which flows from Bear Lake into the Coppermine, and which was named after Mr. Dease, they reached the shores of Coronation Gulf. By dint of incessant labour, being compelled to abandon the boats, Mr. Simpson traced 120 miles of coast, and the corresponding shores of Victoria Land to the north; but returning the following summer, and favoured by open water, on the 16th of August reached the point to which Back had attained five years before, having traced the whole line of coast between the Coppermine and Great Fish Rivers, and by the discovery of a strait, named after Mr. Simpson, ascertained the separation of Boothia Felix from the mainland towards the west. Incited by this great success, they pressed on, but were unable to get beyond longitude 92° west; on their return they surveyed more closely the shores of Victoria Land, and had the satisfaction of feeling that they had not only made the longest boat voyage then on record in Arctic regions, but of important additions to geographical knowledge. Mr. Simpson did not live long enough to reap the due reward of his labours, which were signalized by the promotion of his uncle, the governor of Hudson's Bay, to a baronetcy.

CHAPTER V.

§ 1. Discoveries in the South Sea.—2. Colonization: Port Jackson.—3. Van Dieman's Land: Bass and Flinders.—4. Traders and missionaries.—5. The Antarctic lands: Weddell and Biscoe.—6. The surveyors: Beechey, Belcher, and Fitzroy.—7. Recent labours in the Arctic seas: Franklin and his followers.

DISCOVERIES in the South Sea.—The voyages of Cook had not only opened the trade of the North-West to Europeans, but had incited them to traffic in the Southern and Central Pacific. This traffic had chances other than those of mere commercial profit to induce sailors to engage in it. The climate and productions of the country, the superiority so readily conceded by the people to Europeans, gave facilities for a luxurious life but too tempting to be refused by those whose previous existence had, in all probability, been one of long-continued hardship. This it was which seduced the crew of the *Bounty*, in 1788, to set their captain adrift in an open boat—in which he made the voyage from the Friendly Isles to Torres Strait successfully—as well as to the colonization of Pitcairn's Island; and in the many voyages which shortly after took place, the islands of the Pacific became the homes of runaway seamen, by the children of whom many are now in all probabilty governed. It is not a little worthy of remark, that the descendants of English sailors now inhabiting Pitcairn's Island, are among the most highly developed of the human race, no less physically than morally. Captain Bligh had been sent in the *Bounty* to procure a stock of bread-fruit trees, for plantation in the West India Islands. To fulfil this purpose he made a second voyage in 1792; in this no addition was made to geographical knowledge, nor indeed in any of the voyages subsequent to Cook, beyond the enlarging and correcting our ideas respecting the different groups of islands in the Pacific. Captains Marshall and Gilbert had indeed named two archipelagos after their ships, the *Scarborough* and *Charlotte*, as had Lieutenant Ball in the *Supply*. Don Alessandro Malaspina had, in 1793, surveyed the coasts of Mexico. The Pelew Islands had become better known, and were opened to commerce by the wreck of the *Antelope*, in 1783; and Captains Billinghausen and Sarytscheff, in the service of Russia, had made explorations among the archipelagos of the North Pacific. But the work of the discoverer was now to give place to the labours of the surveyor. In the meantime, however, that which was to confirm to Europeans the sovereignty of the Pacific had commenced—the work of Colonization had begun. The vessels of Captains Marshall and Gilbert were engaged in this service when they crossed the Pacific.

2 *Colonization: Port Jackson.*—The conquerors of the New World had, as an act of charity to the inhabitants, introduced negro slaves into it, unwitting the fearful consequences which must of necessity follow such a violation of the laws of God. The first settlers in Australia, with equally good intentions, and probably with as little anticipation of the consequences, in the formation of a penal settlement at Port Jackson, near Botany Bay, laid the foundation of that system of transportation which has been the bane of that country. Equally obnoxious in principle, the consequences of those acts are, however, very different; for the convict becoming free, may rise in the scale of humanity; the slave remaining so for ever, must degenerate. In the first case, the evil may be eradicated by time; in the last, time only confirms and increases it. It was in 1788 that Governor Philip sailed from England for this purpose; and the results have been too important, politically and socially, to be disregarded.

3 *Van Diemen's Land: Bass and Flinders.*—Colonies are proverbially the theatres of daring exploits, and this forms no exception to the rule. In 1795-6, Messrs. Bass and Flinders, of the royal navy, who had gone out with Governor Hunter, surveyed a long line of coast, in a boat only eight feet long; and in 1797, the former, now provided with a whale boat, discovered the strait which separates Van Diemen's Land from Australia, and dissipated the illusion which had been perpetuated by the misplaced confidence of Cook in his colleague's accuracy. This voyage of 600 miles, in an open boat, was followed by one in which, with Mr. Flinders, Bass circumnavigated Van Diemen's Land. Subsequently, in 1801, Mr. Flinders was employed in the *Investigator* to continue his researches on the coasts of Australia. His surveys were directed, first to the south, and afterwards to the north-west. On his outward voyage, he filled up the omissions of D'Entrecasteaux to the west; and on the south coast, in latitude 35° 40′, longitude 138° 58′, encountered the expedition of Captain Baudin, which had been sent from France on a similar errand to his own. The following year he explored the Gulf of Carpentaria and Torres Strait; and his vessel proving unfit for further service, he was proceeding to England to obtain another, when he suffered shipwreck on the barrier reefs off the eastern coast, till then unknown; and being afterwards detained at the Mauritius as a prisoner of war, his career of discovery was stopped; but its success, under more than ordinary difficulties, and with means wholly inadequate, stands out in striking contrast to the meagre results paraded with such care by the French, who, under Baudin, fully equipped, did little but give French names to places already discovered by the English; and their ludicrous alarm at finding themselves benighted on shore, shows how unworthy they were to be the followers of those who, not in the Pacific only, but in the north, had done honour to the name and service of France.

4 *Traders and Missionaries.*—The trade in sandal-wood, and the whale

fishery, as well as the supply of the wants created among the inhabitants by the visits of more civilized races, had, not long after the voyages of Cook and Vancouver, filled the Pacific with European vessels. The crews of these, not being confined within the strict limits of duty by national authority, not only introduced diseases before unknown, but frequently aided and incited the inhabitants in their wars with each other; retaliation as often followed, and thus, while the knowledge of the Pacific and its islands was daily increasing, its inhabitants were daily diminishing in numbers; and the antagonism thus generated might have been fatal to the remnant, had not Christianity followed in the traces of commerce. Both from England and America, missionaries were sent to the South Sea. The docility of the inhabitants of Otaheite singled them out, in 1799, for the scene of the earliest efforts; it was not, however, till 1817 that their success was confirmed, by the adoption of the King Pomare into the Christian Church. In 1820, missionaries arrived in the Sandwich Islands from the United States, and by 1827 they had obtained paramount authority there. While even in New Zealand, where the fiercer passions of the natives might have been supposed likely to retard their conversion, a mission, established in 1814, though for a time its efforts were frustrated, at length prevailed. The colonization of the islands followed, and now a Bishop of New Zealand prosecutes his missionary labours among the neighbouring islands. Thus the three principal stations in the Pacific have been brought under the influence of European teachers. Of these, however, New Zealand only has been preserved to England, the Sandwich Islands being now to all intents and purposes a portion, though not yet integral, of the United States, and the Society Islands a dependency of France. The fisheries and trade of the Pacific, originally opened by the enterprise and skill of Englishmen, are now fast passing into the hands of their trans-atlantic descendants.

5 *The Antarctic Lands: Weddell and Biscoe.*—The results of the voyages of Cook and others for the discovery of the Terra Australis have been already mentioned. These were followed up by the discovery of the South Shetland Islands by Captain W. Smith in 1819; and a further survey was made, under the direction of the admiral commanding in the Pacific, the following year. Captain Weddell fell in with the South Orkneys in 1823. In 1829, Captain Foster, in H. M. ship *Chanticleer*, made land to the south of South Shetland, of considerable extent, and mountainous; and in 1832, Captain Biscoe discovered a continuous coast of considerable extent beyond the 67th parallel of south latitude. Captain Clark, of the United States, also discovered land under the 66th parallel. These discoveries, however, have only served to verify the opinion of Cook, that there was much land about the South Pole, but too far to the south to be of any importance, except for the seal and whale fishery.

In 1839, two vessels despatched by Messrs. Enderby, of London, whose names deserve to be placed beside those of Digges, Wolstenholme, Roe, or Booth, under Captains Balleny and Freeman, discovered the islands named after the former, and subsequently continuous land named after the vessel of the latter, *Sabrina*. In 1840, Dumont d'Urville also discovered land, which he named after his wife, Terre Adélie. In 1839, the American expedition under Mr. Wilkes, also confidently reported land to the west of that discovered by d'Urville; but in the following year, 1841, this portion of the globe was freely traversed by Sir J. C. Ross, with the *Erebus* and *Terror*.

6 *The Surveyors: Beechey, Belcher, and Fitzroy.*—General knowledge, to be available for practical purposes, must be made particular; the marine surveyor must, therefore, follow close on the track of the discoverer. The early navigators, who were cosmographers in the largest sense of the word, were succeeded by those who were unable to reach, in a second voyage, the lands discovered in the first. In the South Seas accurate observations began again with Dampier. As Cook may be said to have been thus the last of the race of discoverers, Vancouver may be called the first of the surveyors. They

had worthy successors, some of whom have been already named; and as their discoveries in the Pacific were carried on in connexion with efforts after a North-West passage, so in later years and in our own time it has been likewise. The voyage in the *Blossom* has been already noticed. In addition to what Captain Beechey effected to the north, we are indebted to him for the examination and survey of the Low Archipelago, the Bay of San Francisco in California, the Loo Choo and Bonin Islands.

The voyages of the French in the Pacific were, however, unconnected with any other object than discovery and survey in it. To that of M. Freycinet, in 1819, we owe our knowledge of the Ladrone and Samoan group, and still larger results followed the two under the command of M. Dumont d'Urville—the first in 1826, in the *Astrolabe*, in which he examined the islands from New Caledonia to New Guinea, and subsequently the Caroline Islands, and the second, ten years later, in the same vessel, having now the *Zelée* for her consort, in which he visited the archipelagos of the Central Pacific. Both added much not only to our knowledge of these places, but their inhabitants, besides what was obtained in the South Shetland group, and in the Antarctic regions.

The encouragement of the whale fishery led Admiral de Petit Thouars to the Pacific the same year; and in the collection of information on this subject he visited various parts of that ocean, and had opportunities for careful scientific observation. The results were satisfactory; among others may be mentioned a chart of the Marquesas Islands. While at Honolulu in the Sandwich Islands, De Thouars met Captain Belcher in the *Blossom*. Captain Beechey had left England in 1835 in that vessel, accompanied by Lieutenant Kellett in the *Starling*, to fix such positions on the north-west coast of America as were in dispute between Cook and Vancouver; but invaliding at Valparaiso, Captain Belcher took the command at Panama. In this expedition a portion of the coasts of Mexico and California was surveyed, and the islands of Revilla Gigedo, and subsequently the principal archipelagos of the Central Pacific, *en route* to China. Previous to this, however, in 1825, Commanders King and Stokes, the latter of whom was, on his death, succeeded by Captain Fitzroy, had been sent to the south. The result of this voyage was the survey of the Atlantic coast of South America, from the La Plata to the Strait of Magelhaen. In 1831, Captain Fitzroy again commissioned his old ship, the *Beagle*, completed the survey of Terra del Fuego and the coasts of Chili and Peru northwards to Guayaquil, as well as the Galapagos Islands, and, for the first time, carried a chain of meridional distances round the globe.

Within the interval already alluded to, Van Siebold visited Japan, and has given to the world the results of his observations and experience.

The same cause which led De Thouars to the Pacific, induced the United States to send an expedition there. This, after much delay, was effected in 1838, under the command of Lieutenant Wilkes. It was at first directed to the west coast of America, which was examined from south to north as far as the Strait of Juan de Fuca, but with small results beyond confirming the accuracy of Vancouver, Beechey, and Belcher. The most important results of this expedition were, however, the survey of the Hawaian and Feejee groups, as well as examination of the Samoan and the Union groups. In the Phœnix group, doubtful islands were surveyed, and their existence established. Ellice's group and the Kingsmill or Gilbert's Archipelago, were delineated, and an examination made of Marshall's Archipelago. Of the Antarctic cruise made by this expedition, little must be said, as its supposed results were, as has been seen, negatived by Sir J. C. Ross in his voyage with Captain Crozier, in the *Erebus* and *Terror*, in 1841-2, in which he not only discovered but explored Victoria Land. Those voyages are, moreover, within the recollection of all, and therefore require general reference only.

7 *Recent Labours in the Arctic Seas: Franklin and his Followers.*—It has

been noted that the only geographical problem of importance remaining to be solved by the maritime discoverer was the existence of a North-west passage from the Atlantic to the Pacific. This had indeed been almost effected by the labours of Sir J. C. Ross, of Dease and Simpson, following up and completing those of Franklin and Richardson; but their discoveries, as well as those of Parry, had made known the existence of extensive lands to the north of the continent of America, the character of which had not yet been fully ascertained. To have accomplished so much and failed in the completion of the work, would have been unworthy of the men themselves; still more so of the country to which they belonged. Further discovery was, therefore, immediately contemplated; and in this once more Sir J. Barrow took the lead, and his plans, as approved by Franklin, Parry, Ross, and Sabine, were adopted by the government. The *Erebus* and *Terror* were again put in commission under the command of Sir J. Franklin and Captain Crozier, who had shown his fitness for the service when with Sir J. C. Ross in the Antarctic Ocean. These vessels were fitted with auxiliary screw propellers of power sufficient to move them, though slowly, in calms or adverse winds; and it was only under such circumstances that their use was contemplated; they were, moreover, supplied with all the sanatory and scientific *materiel* that the advanced experience of the age could suggest; and from the character of the officers and men it was fondly hoped that they would not fail to open the route by Lancaster Sound and Barrow's Strait, to the Pacific, either direct to the west of Melville Island or to the north by Wellington Channel. The distance to be achieved was only about 900 miles, and to the westward the sea was supposed to be open. On July 25th, 1845, the expedition was seen in latitude 74·48 in Baffin's Bay, waiting the opening of the ice towards Lancaster Sound; at that time, the crews were in high health and spirits, and sanguine of achieving the object of their voyage, having plentiful stores and provisions, fuel and other necessaries, for three years, besides five bullocks. Time, however, passed away, and no further tidings of the adventurers were received. In 1846, Dr. Rae, in the service of the Hudson's Bay Company, left Fort Churchill, and proceeded to Repulse Bay, from whence, taking advantage of a chain of lakes, he transferred his boats to the western side of Melville Peninsula. Here he found a large expanse of water, the shores of which he succeeded in tracing during that and the following summer—on the west, to the Lord Mayor's Bay of Sir J. Ross, and on the east, to within a very short distance of the Fury and Hecla Strait of Parry: to this he gave the name of Committee Bay; it is beyond doubt the Attoolee of the intelligent Iligliuk. From the Esquimaux with whom he communicated, he could obtain no information respecting Franklin. Public anxiety for the fate of that great man and his companions now demanded the immediate despatch of searching expeditions. The success of the combined researches of 1825, and the subsequent years, justified the adoption of the same plan, and accordingly Capt. Moore, in the *Plover*, was ordered to Behring's Strait; Sir John Richardson and Dr. Rae were despatched over land to the Mackenzie; and two vessels, the *Enterprise* and the *Investigator*, were fitted out under the command of Sir J. C. Ross and Capt. Bird, to proceed direct to Lancaster Sound. A reward of £20,000 was offered by government to any who should render efficient assistance to Sir J. Franklin, and to this Lady Franklin, out of her private resources, added £3000 more. In the year 1848, Captain Kellett, in the *Herald*, was despatched to the assistance of the *Plover*, and the *North Star* was sent, under the command of Mr. Saunders, with supplies for the missing expedition, and instructions to Sir J. C. Ross to keep his ships together and examine Wellington Channel if an opportunity was afforded, and afterwards, if possible, the *North Star* was to examine the sounds hitherto not penetrated at the head of Baffin's Bay.

The *Plover*, a dull sailer, having wintered at Noovel in Kamschatka, was overtaken by the *Herald* in Kotzebue Sound, where they were joined by Mr. Shedden in his yacht, the *Nancy Dawson;* and, having in vain endeavoured to penetrate beyond 72½° N. latitude, the *Plover* was left to winter in Kotzebue Sound, while the *Herald* and *Nancy Dawson* returned to Mazatlan, where Mr. Shedden died, overcome by the fatigues and anxieties of the voyage; but Commander Pullen, having been sent forward with boats, effected the passage from Wainwright's Inlet to the Mackenzie, and the following summer traced the coast eastward to Cape Bathurst. So that, notwithstanding Dr. Rae had failed in his attempt to make the traverse of Wollaston Land, it could be confidently stated that the expedition of Franklin had not reached the American coast between Behring's Strait and the longitude of Melville Island; and although these expeditions returned without tidings of the missing voyagers, Captain Kellett enriched geography with the discovery of an extensive land, having a bold coast 1400 feet above the sea, in latitude 71° 20′ N., longitude 170° 30′ W.

The expedition of Sir J. C. Ross also returned without success, having been beset with ice and carried bodily out of Lancaster Sound into Baffin's Bay, until abreast of Pond's Bay. Yet he had traced the coast of North Somerset in winter journeys on foot, and observed that only a very narrow isthmus separated Prince Regent's Inlet from the western sea at Creswell and Brentford Bays, through the latter of which indeed Captain Kennedy afterwards found a passage in the summer of 1851, and thus proved that Sir J. Franklin had not been detained on any of the coasts or islands in that direction, but rather must have pushed on beyond Melville Island, to the north or west. Further efforts were therefore to be made, and the highly organized researches of 1850 will be long remembered in the annals of geographical discovery. The *Enterprise* and the *Investigator* were again commissioned and despatched to Behring's Strait under the command of Captains Collinson and M'Clure; two large vessels, re-named the *Resolute* and *Assistance*, with two screw tenders, the *Pioneer* and *Intrepid*, were fitted out to renew the search in Barrow's Strait, under the command of Captains Austin and Ommanney, and Lieutenants Osborn and Cator; while two others, one a ship re-named after Lady Franklin, the other a brig, named the *Sophia*, were placed under the command of Capt. Penny, an old and experienced whaler; and while Sir J. Ross, aided by private subscriptions, backed by £500 from the Hudson's Bay Company, was enabled to take the command of a schooner named the *Felix*, after Sir Felix Booth, and a small tender, the *Mary*, of twelve tons burden, Dr. Rae was also ordered to organize expeditions to the west of the Mackenzie, and to conduct one himself in the direction of Cape Walker; and lastly, a citizen of the United States, Mr. Grinell, of New York, rivalling in generosity Sir Felix Booth, prepared two vessels, the *Advance* and the *Rescue*, for the same service, which he placed under the command of Lieutenant De Haven, of the United States navy, who had been with Captain Wilkes in his exploring expedition to the Pacific; finally, Lady Franklin herself fitted out the *Prince Albert* ketch, of eighty-nine tons, under the command of Captain Forsyth. Thus eleven vessels, well manned and equipped, met together to prosecute the search for Franklin in the summer of 1850. Captain Austin's instructions were to reach Melville Island and search the shores of Wellington Channel and the coast about Cape Walker. Captain Penny was to penetrate through Jones's Sound, if possible, or if not, into Wellington Channel. Sir John Ross, acting of course on his own discretion, proposed the examination of Melville Island and Banks's Land; while the *Prince Albert's* course was to be directed to Prince Regent's Inlet and the adjacent coasts. De Haven's researches were especially directed to Wellington Channel. All were cautioned against remaining out the second winter, as all were provided with ample means to make expeditions by land during the first. To give detailed accounts of the operations of these various expeditions, would far exceed the limits of necessity assigned to this subject. It must therefore be sufficient to state the general results.

Of the vessels despatched to Behring's Strait, the *Investigator* alone succeeded in her attempt to get to the eastward. Captain M'Clure proposed endeavouring to reach Banks's Land by way of Cape Bathurst, and was fully prepared to remain in the Arctic regions until 1854. The *Plover*, under Commander Moore, was stationed as a store-ship at Port Clarence, in Behring's Strait; and from thence Captain Collinson, in the *Enterprise*, sailed to make a second attempt to penetrate the north-east, in July, 1851. The *Herald* returned home in the autumn of 1850.

The numerous and well-appointed vessels forming the expeditions to Barrow's Strait sailed under one serious disadvantage—separate commanders and divided responsibility; and to this may justly be attributed, if not the practical want of success, at least the unpleasant reflections and recriminations which resulted from it. On arriving at the scene of their labours, Captains Austin and Ommanney divided their squadron, with the intention of examining respectively the southern and northern shores of Lancaster Sound. The latter, during his search, found traces of the missing expedition of Franklin at Cape Riley; and when subsequently rejoined by the former, failing in the endeavour to penetrate to the westward, the expedition went into winter quarters at Griffith Island.

Captain Penny, finding it impossible to enter Jones's Sound, proceeded towards Wellington Channel, and on Beechey Island discovered the winter quarters of Franklin in 1845-6. Believing Sir John to have gone to the north, he would have pursued his search in that direction, but was prevented by the ice, as he was also in his subsequent effort to penetrate to the westward; and accordingly he went into winter quarters also, in Assistance Bay, at the mouth of Wellington Channel, to the eastward of the spot selected by Captain Austin, where he was joined by Sir John Ross; who, on being released from the ice in the following August, returned home. To Sir John Ross's belief in the report of the Esquimaux interpreter, that Franklin's vessels and crews had been destroyed at Wolstenholme Sound, is to be attributed some loss of time on the one hand, and on the other the subsequent expedition of Captain Inglefield. The only geographical result of his expedition was an exploration of part of Cornwallis Land by Commander Phillips.

The American expedition under De Haven, unable to penetrate into Wellington Channel, attempted to proceed westward; but failing, as others had done, in that, determined to return home for the winter, but being caught in the pack ice, was drifted with it through Lancaster Sound and Baffin's Bay, until June in the following year, when he returned to the north-west; but, unable to get beyond Melville Bay, he again steered homeward, where he arrived safely in September. The return of the *Prince Albert*, unsuccessful in the attempt to penetrate Regent's Inlet, the same year, brought the exciting news of the discovery of Franklin's winter quarters, and the absence of all traces of the expedition in other directions. Lady Franklin, therefore, sent back that vessel, now under the command of Captain Kennedy, of the Hudson's Bay Company, who carried with him Sir John's old and faithful companion, Hepburn. In the interim, Captain Pullen, who had been dispatched by way of the Mackenzie, to achieve, if possible, the passage from thence to Banks's Land, returned, as Rae had done, without success.

The spring of 1851 will ever be memorable in the history of Arctic discovery, for the number and success of the expeditions made in sledges, and the extent of surface travelled over. From Captain Austin's squadron no less than fourteen sledges were despatched, with above 100 officers and men. The zeal and constancy with which these were conducted may be estimated by recording the labours of Lieutenant M'Clintock, who travelled in eighty days a distance in direct line from the ships, of 350 miles, reaching the western shores of Melville Island. By these various parties the coast to the north, south, and west of Lancaster Sound was carefully examined; and though little was added to the geographical knowledge obtained from the first expedition of Parry, yet it was satisfactorily ascertained that Franklin could not have passed westward in that direction. Captain Austin therefore, when released from the ice, left Lancaster Sound with the intention of examining Jones's Sound, but, being prevented by the ice, returned home. Captain Penny's sledge expeditions were directed towards the north: here he was stopped by open water, but the jealousies consequent on divided authority prevented the examination of this important channel, up which there could be little doubt that Franklin had proceeded; and Captain Penny also returned home. In these journeys Captain Austin's parties traversed 3914 miles, and Captain Penny's 2220, which, with 150 by Sir J. Ross's crew, make a total of 6284.

During the same spring Dr. Rae had left Great Bear Lake, and from thence with sledges reached the mouth of Coppermine River, and, crossing over the ice to Wollaston Land, surveyed the coast between 110° and 117° 17′ of longitude, thus concluding the most extensive series of sledge explorations ever carried out in any country in one season. The following year he traced the south and east coasts of Victoria Land, from the longitude of Cape Alexander to latitude 70° 14′, a voyage interesting no less from its extent than from the conclusion which naturally follows from Dr. Rae's observations—viz., that a channel exists separating Wollaston and Victoria Lands from those to the north and east, named Banks and Prince of Wales' Lands; which, when combined with the discovery of the channel already referred to by Captain Kennedy, places it beyond doubt that a vast mass of land, intersected by numerous channels, lies between Baffin's Bay and the open water to the north-east of the Mackenzie River; in which discovery must ever be difficult and dangerous, as well as unproductive of useful results, except to science.

In 1851-2, Captain Kennedy did not get farther than Batty Bay, and making excursions to the south, in January discovered, at Brentford Bay, a channel dividing North Somerset from Boothia Felix, which he named after Lieut. Bellot of the French Navy, a volunteer with his expedition; and having examined the shores to the west and north, as far as Ommanney Bay, sailed for Beechey Island, where he communicated with Sir F. Belcher's squadron, and returned home. This expedition, despatched from England in April, 1851, was formed of the four vessels already well known in the service, the *Assistance, Resolute, Pioneer*, and *Intrepid*, with the addition of the *North Star* as a store-ship. It reached Beechey Island in August, and leaving the *North Star* there as a depôt, divided; Sir E. Belcher, with the *Assistance* and *Pioneer*, proceeding in open water up Wellington Channel, while the other vessels under the command of Captain Kellett, sailed for Melville Island, to communicate, if possible, with Captains Collinson and M'Clure. Thus much, which is all we know respecting them, we obtain from the accounts brought home by Captains Kennedy and Inglefield, the latter of whom was sent in a small screw steamer, the *Isabella*, to examine the northern and western shores of Baffin's Bay. At Wolstenholme Sound his careful examinations satisfactorily proved the falsehood of the Esquimaux's statement of the destruction of Franklin's vessels and crews by that people; and to the north his discoveries have placed beyond doubt that Whale Sound and Sir Thomas Smith's Sound are channels leading into some larger expanse of water, probably a polar basin, which may communicate with the Atlantic to the east, and with Wellington Channel and Behring's Strait to the west. It is to be noted, also, that Captain Inglefield reached the highest northern latitude ever attained on the American coast—viz., 78° 36′ and, had he been in a condition to have wintered, might have gone much further.

Of the ultimate result of these expeditions conjecture only can be offered, excepting that there appears no reason to doubt that communication will be established between Captains Kellett and Collinson and M'Clure, across Melville Island, since its western shores were reached by Parry's and Austin's expeditions, and we know of nothing to prevent access to it from Behring's Strait. To the north, however, all is uncertain, though the rise of temperature and presence of animal life lead to the conclusion that open water, by which alone they could be occasioned, must exist in that direction; and that therefore egress from it will be found in other directions, as access to it has been from Wellington Channel. But, in reviewing the whole course of maritime discovery, as we cannot but be struck with its gradual progression, adapted precisely to the wants of the human race in the different periods of its political and social development, we are necessarily drawn to the conclusion that there is no portion of the world without its proper and particular use, and that even the frozen regions of the north will eventually be found to have not only important physical relations to the rest of the world, as the researches of science prove, but that they have yet to perform an important part of the economy of human life; and that therefore the life and treasure which have been expended on their discovery will not have been altogether wasted.

Having thus taken a very brief and rapid survey of the progress of maritime discovery, we are better prepared to contemplate the surface of the earth in its horizontal contour, and its apparent divisions of land and water. It is for others to record, with the minuteness they deserve, the labours and sufferings, the heroism whether of ardour or endurance, which have been necessary to the attainment of the results which geography claims as her own: such details belong to History and Morals. It may, however, be well to indicate where most easily those details can be supplied without the expense of time and labour which original researches require. Mr. Cooley's *History of Maritime and Inland Discovery* is in itself a most complete index to, if it be not a perfect epitome of the subject, containing all that is most worthy of note or most interesting in the more voluminous compilations of Hakluyt, Purchase, Churchill, Harris, Prevost, &c., and is particularly valuable with reference to Africa and the East. Barrow's account of Voyages in the South Sea, with those of Hawkesworth, lead up to Cook and Vancouver, and the later discoveries in that ocean are carefully epitomized in *Findlay's Directory to the Pacific.*

A most admirable sketch of Portuguese and Spanish discovery in Western Africa and Central America is to be found in a recent valuable addition to the history of the sixteenth century, entitled *The Conquerors of the New World and their Bondsmen;* a very useful outline of Arctic discovery has been compiled by Mr. J. J. Shillinglaw; and the original chronological list of Locke, with all its conciseness, as it has been the basis on which most subsequent compilers have established their labours, is still most useful.

The history of inland discovery being of course confined to the countries of which it treats, is naturally local in its character, and is therefore reserved until each portion of the world comes separately under our notice.

DESCRIPTIVE GEOGRAPHY.

PART THE SECOND.

CHAPTER I.

INTRODUCTION.—1. Of distribution.—2. Of proportion.—3. Of position.—4. Of contrast in vertical contour.—5. Effect of vertical contour on climate.—6. General laws of reliefs.—7. Results of comparison.—8. Of geological contrast.—9. Of contrast in climate.—10. In productions.—11. In man.—12. General conclusions.

IN describing the surface of the Earth, the first consideration that presents itself is its division into land and water; and before proceeding to more detailed inquiries, three things must be understood in relation to this—viz., distribution, proportion, and position.

1 *Of Distribution.*—The unequal distribution of land and water has been already noticed (*Physical Geography*, p. 216). It may be further considered hemispherically or in zones. The former is perhaps that which most readily presents itself in consequence of there being two great masses of land, apparently divided from each other by vast expanses of water; and if, as will be seen by the tables which follow, the area of the land may be estimated in comparison with that of the water as 1 to $2\frac{1}{2}$, the same proportion will be found between the western and eastern continents, and very nearly between the Atlantic and Pacific Oceans. In dividing the globe hemispherically from north to south, we see a preponderance of land in one hemisphere, and of water in the other. In the Old World the breadth of the mass of land averages 160°, and in the New less than 80°: while the centre of both is cut by the opposite meridians of 80° from Greenwich. Again if the hemispheres be separated by the Equator the same result will follow, but in two ways, for not only will the distribution be found unequal as before—the mass of land in the eastern continent predominating to a great extent—but the northern will contain more than the southern. In the southern, however, although the area of water far exceeds that of land, yet the proportion of land is more equal. Lastly, if we place Great Britain in the centre of one hemisphere, we shall find it contains nearly all the land in the world, while its antipodes are in the centre of a corresponding mass of water. (See *Physical Geography*, p. 149.) This unequal but so far regular distribution of the great masses of land and water will be found to have had an important effect on the history of the human race, especially in its commercial relations.

The latter mode of considering this distribution is not less important; for while by the former we perceive causes which have contributed to place the great masses of the human race in close proximity, this has given to the localities in which they are found, the climate, and consequently the productions, of the Earth most suited to the development of the mental and physical capacities of man.

In pursuing this inquiry, Malte Brun arrived at the following estimate of the distribution of land and water in zones:

Northern Hemisphere.		Southern Hemisphere.	
Icy zone . . .	0·400	Icy zone . . .	0·000
Temperate . .	·559	Temperate . .	·075
Torrid. . . .	·297	Torrid. . . .	·312
Average .	·419		·129

In this calculation it will be observed that the land about the Antarctic Pole is not estimated; but even if it should ultimately prove considerable, as the recent discoveries in the Arctic zone lead to the conclusion that there is much more land there than was formerly believed, the proportion may be esteemed sufficiently correct, and does not much exceed that already found to exist between the oceanic and continental masses. Estimated in English miles, the contents of the zones have been thus calculated:

	Northern Hemisphere.		Southern Hemisphere.
Arctic . .	3,252,589	...	—
Temperate	28,531,631	...	3.828.036
Torrid . .	11,628,440	...	12,215,735
Average	14,470,887		8,021,885

Of which calculation it may be remarked, that it shows very strongly the predominance of land in the northern hemisphere; for while in it the land in the torrid zone is about equal to that in the southern, and in both cases above the average, in the temperate the land is double the average, and more than double that in the torrid zone, of the southern hemisphere, which is nearly four times that in the temperate.

From this consideration, it will be apparent that the northern temperate zone, as the centre of the life and energy of the human race, will always be the centre of political and commercial influence as it has hitherto been, and that Great Britain being the centre, or as it might be termed the clasp of that zone, has a position in this respect equal, if not superior, to any other in the world. The extreme linear extension north and south of both continents placing her within 80° of one half of each continent, while the whole of North and Central America, South America on the west coast to Lima, and on the east to the southern confines of Brazil, the whole of Africa, and the entire mass of Asia, part of Cochin China, and the Malay peninsula alone excepted, being above the horizon, are within 5400 miles direct distance. And that this advantage of position is singular may easily be seen; for if, after placing London in the zenith, the globe be turned westward, Southern, Central, and great part of North America immediately disappear below the horizon, and their place is occupied by water; while, if it be turned eastward, and America be brought uppermost, the greater part of Africa and the whole of Southern Asia with its islands disappear in like manner; and not only does Great Britain thus occupy the centre of the habitable world, but commands the ocean routes round both continents, as will be seen in considering the linear extension of the shores of the ocean; as well as a direct route across the Arctic Ocean to Behring's Strait, which may possibly at no very distant date be found practicable; while in addition to her proximity to the outstretched points of the shores of the Atlantic, and the overland route to the East, which the continent of Europe offers her, she no less commands those across the isthmuses of Suez and Panama. This important position will, however, be fully considered when treating of our own country more particularly, but it should never be lost sight of by the British geographer.

The distribution of the masses of land and water also confers on the countries antipodal to Great Britain, a position of considerable importance as the natural centre of trade of the Great Southern Ocean, and as commanding the communications round Cape Horn and the Cape of Good Hope—the passages between the extremities of the lands; for, from the south of New Zealand, the Auckland, Macquarrie's, and Balleny's Islands, approach Victoria Land;* while from Cape Horn, the South Shetland Islands, and Graham's Land, appear extensions of the mass of the Antarctic land, leaving, in either case, but comparatively narrow passages between them; while to the north the islands of the Pacific lie grouped in their numerous archipelagos; and to the east Australia extends her vast surface, to the western and northern portion of which, these considerations seem to give a greater importance than they have hitherto received.

It may also be noticed, that while Behring's Strait, and the seas between Iceland and Europe and America respectively, lie between 60° and 70° N. lat., the passages above referred to between the southern extremities of the continental masses and the Antarctic land are in about the same relative latitude; and further, that while the greater mass of land is found to the E.N.E. and S. of Great Britain, the greater mass of water is found in a corresponding position with respect to its antipodes; in other words, they are opposed to each other on the surface of the globe, in character as well as position.

2 *Of Proportion.*—The proportion of land and water has been thus estimated. (See chapters IV. and V. *Physical Geography.*)

Superficial Area of Land.			
Eastern Continent . . .	33,000,000		
Australia and Islands . .	4,000,000		
Western Continent . .	14,500,000		
		Total Land	51,500,000
Superficial Area of Water.			
Pacific Ocean	90,000,000		
Indian ,, ...	23,000,000		
Atlantic ,, ...	30,000,000		
Arctic ,, ...	3,000,000		
Antarctic ,, ...	2,000,000		
		Total Water	148,000,000
			199,500,000

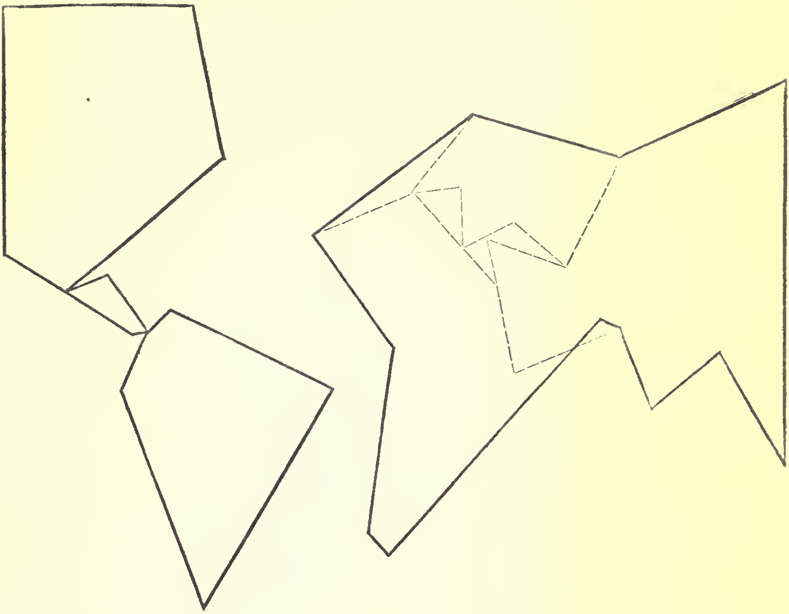
Or more generally.

Land . . .	52,000,000
Water . . .	145,000,000
	197,000,000

The following normal figures constructed as proposed in the *Theory of Description*, p. 419, will convey to the eye a just idea of the relative propor-

* As an illustration of this, it may be noted that a direct line drawn from the Land's End to Canterbury in New Zealand passes round Cape Horn in the usual track of vessels, and as New Zealand is only about 400 miles beyond our Antipodes, this is within that distance the shortest line that can be drawn on the globe between those points, and certainly the shortest route that can be taken.

tion of the two great masses of land, and facilitate the application of the accompanying tables:



In these figures, the natural divisions of both continents are apparent: the eastern into Europe, Asia, and Africa, as shown by the dotted lines; the western into Northern, Central, and Southern America. The small size of Central America, and its relative position, make it desirable, in general calculation, to include it in the northern division.

These figures have been constructed by inspection and measurement on an 18-inch globe, to enable all students the more readily to test their accuracy, and teachers to explain their construction and application. For more minute calculation, by mathematical process, a table of the position of the points from which the lines, including the figures, are drawn, is subjoined. For the length of their sides see Appendix B.

Positive position of Places at angles of normal figures.

Eastern Continent:—

Lewis (Western Isles Butt)	58·31	N. Lat.	6·14	W. Long.
Gulph of Kara (S. point by estimation)	67·30	,,	67·30	E. Long.
Cape Navarin	62·16	,,	178·56	,,
Singapore	1·17	,,	103·50	,,
Calcutta	22·33	,,	88·19	,,
Cape Comorin	8·5	,,	77·30	,,
Cape Monze	24·51	,,	66·37	,,
Cape Babelmandeb	12·41	,,	43·27	,,
Dardanelles (castle of Asia)	40· 9	,,	26·24	,,
Cape Apcheran	40·12	,,	50·20	,,
Gibraltar	36· 7	,,	5·21	W. Long.
Nice	43·42	,,	7·17	E. Long.
Cerigo	36· 7	,,	22·59	,,
Odessa	46·28	,,	30·44	,,

Guadel	N. Lat.	E. Long.
Cape Ras el Had	22·23 „	59·55 „
Cape Agullas	34·59 S. Lat.	20· „
Cape of Good Hope	33·36 „	18·28 „
Fernando Po	3·48 N. Lat.	8·43 „
Cape Verde	14·43 „	17·34 W. Long.
Western Continent:—		
Cape Romanzov	61·49 „	166·18 „
North-East Point of Greenland	75·50 „	19·20 „
Cape Race	46·40 „	53·7 „
Tehuantepec (S. Fr. de)	16·11 „	94·44 „
Cape St. Lucas	22·52 „	109·53 „
Cape Catoche	21·36 „	87·6 „
P. Caribana (Gulf of Darien)	8·38 „	76·55 „
Cape Mala	7·25 „	80·2 „
Point Gallinas	12·25 „	77·44 „
Cape St. Roque	5·28 S. Lat.	35·16 „
Cape Horn	55·59 „	67·16 „
Cape Blanco	4·17 „	81·16 „

In calculating the comparative extent of the continental masses, the following will also be useful:

North Cape, Norway	71·11 N. Lat.	25·40 E. Long.
Cape Roca (Lisbon)	38·46 „	9·30 W. Long.
Cape Severo	78·25 „	108· E. Long.
South-East Point of Corea	35·15 „	129·42 „
Cape Bon	37·4 „	11·3 „
Cape Guardafui	11·50 „	51·16 „
Cape Disappointment	46·16 „	124·5 „
Coro, New Grenada	11·24 „	69·46 „
Chicareni Point, G. of Conchagua	13·17 „	87·44 „

Superficial Area.—All calculations of superficial area must be esteemed approximations. The following tables will show that, even among British geographers, considerable differences are found in their estimates. They are selected from five of the most popular, and are in English miles of 69½ to a degree at the Equator.

Comparative Tables of estimated Area.

	Highest.	Lowest.	Mean.
Europe	3,900,000	2,635,700	3,732,540
Asia	17,500,000	15,526,300	16,683,260
Africa	12,000,000	8,902,000	11,048,000
America, North	8,500,710	7,400,000	7,666,900
America, South	6,500,000	6,147,450	6,355,813
	48,400,710	40,621,450	45,486,513
*Eastern Continent	33,000,000	33,000,000	33,000,000
Western ditto	14,000,000	12,892,600	13,630,866
	47,000,000	45,892,600	46,630,866
Area, Land	60,000,000	39,956,600	50,318,866
Area, Water	150,000,000	108,200,930	134,566,976
Total Area	210,000,000	148,187,500	184,895,833

* Three writers out of the five omit this calculation.

Typographical errors may probably account for the differences found in the calculations of any one writer, for instance in the area of Asia given in Black's edition of Malte Brun, 1832, as 154,000,000, which is evidently a misprint of an additional cipher: but when, in Europe, the smallest of the areas calculated, a difference is found of one-third of the highest, and half of the lowest estimate, it is evident that the bases of the calculations must be so different as to make an average estimate of little value for general purposes; therefore the estimate already given (*Physical Geography*, c. iv.) may be assumed sufficiently accurate.

For the purposes of comparison, however, more particular calculations are required; and as, when made in English miles, the difficulty of reduction is often a source of confusion, those of Guyot are adopted, being made in geographical miles of sixty to a degree at the equator; and having been used by him in his lecture on Physical Geography for that purpose, the results will be more easily estimated. It will be seen that they are considerably below those given in the former part of this work.

	Superficial Area.	Coast Line.	Proportion.
Europe	2,688,000	17,200	156
Asia	14,128,000	30,800	459
Africa	8,720,000	14,000	623
North America	5,472,000	24,000	228
South America	5,136,000	13,600	376
Australia	2,208,000	7,600	290
Total	38,352,000	107,200	2132
Average	6,392,000	17,866	338*

From this it will be seen that the disproportion of the area to the coast line is more considerable in Europe than in any other division of the globe, and that the sequence is as follows: Europe, North America, South America, Africa, Asia, or, with the exception of South America, in inverse proportion to their size. The islands, however, which cover the eastern coast of Asia, give an additional value to her in this relation, and with the irregularity of the southern and eastern coast, and her inland seas, compensate for the otherwise enormous extent of her area, which is nearly equal to the united areas of Europe, Africa, and one division of America.

A comparison of the linear extension of the coast line of the continental

---

* According to the estimate already given, the above table would stand thus:

	Superficial area.	Coast line.	Proportion.
Europe	3,550,000	17,250	205
Asia	14,150,000	28,500	496
Africa	10,550,000	13,000	811
North America	6,700,000	22,250	302
South America	5,800,000	12,035	481
Total	40,750,000	94,035	2295
Average	8,150,000	18,807	457

Mr. Peterman's calculation is as follows:

Europe	3,900,000	17,000	229
Asia	17,500,000	35,000	500
Africa	11,870,000	16,000	741
North America / South America	14,000,000	3200	437
Total	47,270,000	100,000	1907
Average	11,317,500	20,000	381

masses, with the sums of the sides of the normal figures containing them, will further illustrate this subject.

	Normal figure.		Coast line.		Decimal proportion.
Europe	8,220	—	17,200	—	2·092
Asia	17,280	—	30,800	—	1·724
Africa	13,500	—	14,000	—	1·037
North America	11,340	—	24,000	—	2·116
South America	10,170	—	13,600	—	1·337
Total	60,510	—	99,600	—	8·307
Average	12,102	—	19,920	—	1·661

From the above it appears that North America and Europe differ in their coast line most from their normal figures. It should, however, be noted, that the greatest irregularities of the former are in the frozen north, while those of the latter are to the south. Asia approaches very nearly to the mean proportion. Australia would present about the same proportion as South America, but for the purpose of comparison it certainly cannot with justice be separated from the adjacent islands if it may from the continent of Asia.

3 *Of Position.*—The positive position of the extreme angles of the continental masses may be ascertained from the preceding table. More generally it may be stated, that the eastern continent extends between the meridian of 15° W. and 185° E. long., and between the parallels of 75° N. and 35° S. lat.; while the western extends from 30° to 160° W., and from 70° N. to 55° S.; the greatest extension of the one being from N. to S., and of the other from E. to W., or more properly from N.E. to S.W. The relative position of the continental masses makes them almost continuous; for while to the north of the Atlantic, from the shores of Iceland, the distance is only 200 miles from Greenland and 700 from Norway; to the north of the Pacific, at Behring's Strait, the shores approach within thirty-six miles of each other, and the continuity of the vertical contour of the land is marked by the shallowness of the adjacent seas. In this direction also the line of the principal mountain chains, of volcanic action, and consequently of the axes of elevation and depression, will be found continuous throughout the globe.

The calculations already given, have shown that as the Atlantic is to the western, so is the Pacific to the eastern continent. The distance of the points on the coast may be estimated as under:

Table of Distances between the shores of Europe, Africa, and America, and between America and Asia.

	G. M.
Blasquet Island (Ireland) to Cape Spear, Newfoundland	1,631
Cape St. Roque to Cape Palmas	1,759
Cape of Good Hope to Cape Horn	3,591
Cape Agullas to Tasman Head, Van Diemen's Land	5,289
Tasman Head to Cape Horn	4,777
San Francisco, California, to Chusan	5,360
N.E. Cape, Asia, to east part of Melville Island	1,546

It has been well observed that what the Mediterranean was to the ancients, and the traders of the middle ages, the Atlantic is to us. Indeed, the present facility of communication between the shores of the latter is far greater than in earlier times it was between those of the former. This has, it is true, been effected by the power of steam, for whereas not so very many years since there was no certainty of communication between England and even France or Ireland, now there is regular fortnightly communication across the Atlantic. The facilities for this, which its long and comparatively narrow channels and deep indentations present, form, as has been shown, important elements in the estimation of the comparative position of the continental masses.

The main channel of that ocean connects the Arctic Ocean in a direct line with the Pacific by the Caribbean Sea, and the southern shores of North America and Europe with the Indian and Pacific Oceans by the Cape of Good Hope and Cape Horn; the former in a direct line from the head of Baffin's Bay, the latter in as direct a course from the shores of Norway; while the wide expanses and deep inlets of Baffin's Bay, Hudson's Bay, and the Gulf of Mexico, on the one hand, and the Mediterranean, Black and Baltic Seas, on the other, offer an extent of coast for commercial intercourse not elsewhere to be found on the surface of the earth.

While the shores of the Atlantic have this deeply indented character, those of the Pacific afford facilities of a different description from the islands with which they are lined in the north, and from the innumerable groups of islands which supply the place of a coast line to the south. Like those of the Atlantic, the shores of the North Pacific lie nearly in a straight line, and consequently the communication afforded by them is as direct as possible.

In considering this subject, it is desirable that a globe should be used rather than a map, neither the ordinary hemispherical, nor the cylindrical projection of Mercator, giving the true impression to the eye. This, indeed, no map can do, though the stereographic projections in ordinary use with respect to the land, might very properly be applied for this purpose to the water;* and the use of the artificial globe cannot therefore be too strongly recommended. Much confusion has, since the time of the early cosmographers, been the result of the constant use of maps rather than globes, and it will take long to remove the erroneous impressions thus formed.

A table of distances, taken between well known points, which will be found in Appendix B, will illustrate the importance of the above considerations, and especially confirm what has been said respecting the use of the globe in acquiring a knowledge of geography; they are taken from a route map of the world, published by Mr. E. Stanford, of Charing Cross, on which the actual routes are laid down, and make the direct line apparent; while the indirectness of the apparent course is most clearly seen. This also appears on the relief map of the world in the atlas attached to this work.

The angularity of the channels of the Atlantic, and the linear extension of the shores of both oceans, direct attention, in the next place, to the comparative vertical conformation of the continental masses from which they result.

4 *Of Contrast in Vertical Contour.*—In contemplating the two great Continents in this relation, we observe—

1st. That the line of greatest elevation accords with the watersheds of the basins of the Pacific and Indian Oceans; and

2nd. That in consequence of this, the highest elevations in the globe are most distant from each other; while the greater expanses of the lower lands are brought into more immediate communication by the channel of the Atlantic.

From the first, it might be expected that the terminations of the Continents to the south would be promontorial, as Lord Bacon remarked; and of considerable elevation, as Foster noticed. This would also make the existence of islands beyond them more probable than that of a large southern continent. And the same careful observer notices this also. He, as the companion of Cook, had been an ocular witness of the fact, and of the absence of that Terra Australis, the extent of which Dalrymple had so pertinaciously maintained. (See 'Maritime Discovery,' page 176.) The knowledge that volcanoes of considerable elevation have been found in the Antarctic regions, suggests the probability that evidence of the continuity of the vertical contour will hereafter be discovered in that direction.

---

* A stereographic chart of the North Pacific, constructed for this purpose, was exhibited at the meeting of the British Association at Hull, September, 1853.

It has been further remarked by the same writer, that these facts may be taken as evidences of the violent action of water on the continental masses from the south; and perceiving the deep indentations which present themselves on the western shores of South America, Africa, and Australia, he gave that cataclysm also a westerly origin. This hypothesis favours another, namely, the submersion of a large mass of land towards the south, that Australia and the Islands of the West Pacific are the remains of a submerged continent. Depression and elevation are, as has been shown (*Physical Geography,* chapters 4 and 7), common; so much so, that they may possibly be found to be the constant conditions of the surface of the globe. But these elevations and depressions are, for the most part, gradual. Forster's hypothesis is dependent on the suddenness as well as the greatness of the rush of waters. Modern science, and especially the researches of M. Elie de Beaumont, lead to the conclusion, that the forms of the continental masses are due to elevation and depression only; the connexion between the geological epochs and periods of elevation, is a subject foreign to the present purpose; but the rectangular direction of the axes of elevation, as shown by him, confirms the importance of, while it fully accounts for, the linear extension of the coast lines. It has already been noted (*Physical Geography,* c. 7), that the linear extension of volcanic action coincides with that of the greatest elevation, as well as with the areas of greatest known elevation and depression; and this is further illustrated by the list of volcanoes given at p. 271, *Physical Geography.* Moreover, as hitherto the greatest depths discovered in the ocean have been considerably south of the Equator, the slope of the basins of the ocean in that direction may be conjectured, as well as the tabular nature of the bottom of the North Pacific, of which the islands of that ocean may be considered the buttresses and supporters. On this subject, however, our information is lamentably deficient. It will be treated of as fully as may be, in the chapters to be devoted to the Oceans and their Islands. The system of M. Elie de Beaumont, which he has fully developed with respect to Europe, will be further considered in reference to the orography of that continent. (*Systèmes de Montagnes,* par M. E. de Beaumont. 3 vols. Paris.)

The analogies suggested by Forster have been expanded and enlarged by Pallas, Humboldt, Steffens, Ritter, and subsequently by Guyot (*Earth and Man,* English Edition. Lond. Chap. ii.). Besides the principal promontorial extensions towards the south, others scarcely less marked are observable, as India, the Corea, Kamschatka, Greece, Italy, Scandinavia, in the Eastern Continent; and California, Florida, Nova Scotia, in the Western; to which may be added, from their position, of such islands as Great Britain, Newfoundland, Greenland, Madagascar, the Japanese Islands; and those on the North Western coast of America, all. of course, indicating elevation.

A further analogy has been observed in the threefold grouping of the continental masses, of which the best example is afforded by the western. Steffens further remarked, that the connexion of the more southern portion in both cases was by a narrow isthmus; and carried the analogy so far as to discover that both had deep indentations, containing archipelagos opposed to the other, with a peninsular extension on the other side; as on the East, the Mediterranean, with its islands, and Arabia; and on the West, the Gulf of Mexico, the West Indies, and California; but in such relation the Eastern might not improperly be considered a double continent—Australia balancing Africa, and the islands and seas of the Indian Archipelago those of our Mediterranean basin. Cochin China, and Arabia, would thus correspond with Central America, and the peninsula of India be the caudal appendage common to both. But Steffens considers Australia, and its adjacent islands, as a third triple group. These analogies, however, have been by many thought exaggerated; those more general ones, which have been already adopted and extended from Ritter, are certainly more valuable.

To these may be added the contrasts presented by the two great masses into which the land on the surface of the globe is divided.

The contrast in linear extension has been already referred to, and an important consequence follows this arrangement—viz. that while the great mass of land in the eastern continent lies within the same climatic zones, the western, from its greater proportionate length, and its linear extension from north to south, traverses nearly all. Further, the eastern division presents all its parts in more immediate connexion, and is therefore more 'eminently continental' than the western, which, from its comparative narrowness, may be esteemed oceanic. The eastern continent, moreover, has its own characteristic vertical contour, presenting mountains extending into table lands and plateaux; while the western, offering only mountains and plains, characterized by the simplicity of its forms of relief, is more easily comprehended and described; and as in position it is oceanic, so its waters occupy a much larger portion of its surface.

5 *Effect on Climates.*—The contrasts in Orography and Hydrology naturally include those of climate and production, the details of all which will be found under the head Physical Geography. But the importance of elevation in this respect may be estimated by the consideration that 350 feet of elevation equal one degree of thermometrical depression, or about one degree of latitude, while a few thousand feet reach the base of the eternal snows, which are the winding-sheet of animated nature on the tops of the mountains. This will be apparent from the subjoined table, which has been so frequently copied from Humboldt, of the estimated level of the line of perpetual snow on different mountain ranges in different latitudes, and on their different slopes.

TABLE OF ELEVATION OF SNOW LINE.

Northern Hemisphere.

Places.	Lat.	Elevation.
Norwegian Coast	71·15 N.	2,400
Inner Norway	70·15 ,,	3,500
Ditto	67·30 ,,	4,200
Iceland	65·00 ,,	3,100
Inner Norway	62·00 ,,	5,100
Siberia	60·55 ,,	4,500
North Wales	59·40 ,,	4,800
Kamschatka	56·40 ,,	5,200
Ounalashka	53·44 ,,	3,500
Altai	51· ,,	7,000
Alps	46· ,,	8,800
Caucasus Elbrouz	43·21 ,,	11,100
——— Karleck	— ,,	10,600
Pyrenees	43· ,,	9,000
Rocky Mountains	43·3 ,,	12,500
Ararat	39·42 ,,	14,200
Asia Minor (Mount Argæus)	38·33 ,,	10,700
Bolor	37·30 ,,	17,000
Sicily (Etna)	37·30 ,,	9,500
Spain (S. N. of Granada)	37·10 ,,	11,200
Hindoo Koosh	34·30 ,,	13,000
Himalaya (N. side)	31· ,,	16,600
Himalaya (S. side)	— ,,	13,000
Mexico	19·15 ,,	14,800
Abyssinia	13·10 ,,	14,100
South America (S. N. de Merida)	8·5 ,,	15,000
South America (Tolima)	4·46 ,,	15,300
South America (Purace)	2·18 ,,	15,400

Places.	Lat.		Elevation.
Equator.			
Quito	0·0	,,	15,800
Southern Hemisphere.			
Andes of Quito	1·30	S.	15,800
Bolivian Andes (E.)	18·	,,	15,900
Bolivian Andes (W.)	—	,,	18,500
Chili Penquenes	33·	,,	14,700
Chili (Andes of coast)	44·	,,	6,000
Strait of Magellan	54·	,,	3,700

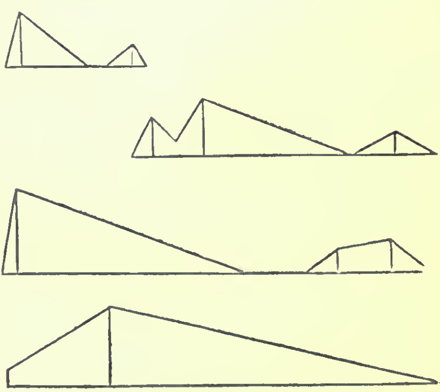
It thus becomes apparent, that while the snow line falls generally from the equator to the poles, it rises on the sides of the greatest general elevation, the greater mass of land generating or retaining the greater quantity of heat. This is true in all cases, but most remarkably so in Asia, where the influence of its great central masses elevates the snow line on the north 3600 feet above its level to the south.

6 *General Laws of Reliefs.*—This illustrates what Humboldt calls the effect of elevation, and shows the necessity of considering and comparing the forms of the different continents in their vertical contour or relief. This will be found treated generally in the fourth chapter of the part of the work devoted to Physical Geography. It may be sufficient here to subjoin, in a tabular form, Humboldt's estimate of the effect of elevation preparatory to a comparison of reliefs. This may be considered in two respects of equal importance.

1. Elevation in mass of lowlands, plains, table lands, and plateaux.
2. Linear extension of mountains and ranges of hills.

And in following out these it will appear—

1. That all the continental masses rise gradually from the sea to some line of greatest elevation in the interior.
2. That this line is placed out of the centre at unequal distances from the limits of horizontal contour.
3. That the height of elevation in mass will correspond with that of linear elevation ; and that—
4. The greater number of subsidiary lines of elevation will be found on the side of the greatest extension.



The importance of this in systematizing geographical description has been already shown in treating of the theory of description.—(p. 423.)

The extreme line of elevation, or, as we have termed it, primary watershed of a continent, is therefore the apex of the triangle formed with the base of its section above the sea level, i.e., the normal figure of its relief in a certain direction. The following examples and tables will illustrate the importance of the consideration of the continental masses in these relations, which is more fully shown in the orographic map of the atlas attached to this work.

Table of Length of Slopes and Culminating Points of Continental Masses. Reduced from Guyot.

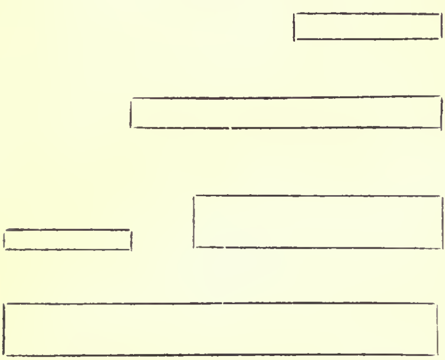
	Length of Slopes.		Culmination.
Asia, from Frozen Ocean to Ganges	N. 2600	S. 400	... 28,178
America, S., from River Maranon to Pacific .	E. 1850	W. 70	... 21,400
America, N., from Washington to St. Francisco	E. 1600	W. 800	... 14,000
Europe, from Baltic to Lombardy	N. 450	S. 100	... 12,800
Average . . .	1615	342	19,094

Table of Length of Slopes and Culminating Points, to agree with Diagrams in reverse order.

Asia, from Frozen Ocean to mouth of River Kistna	N. 2520	S. 840	... 20,000
America, S., from River Maranon to Pacific .	E. 1740	W. 120	... 21.400
America, N., from Nova Scotia to Pacific . .	E. 2040	W. 450	... 15.000
Europe, from Arctic Ocean to Gulf of Genoa .	N. 960	S. 120	... 15,700
Average . . .	1815	382	18,025

Table of Proportion of Elevation to Base.

	Extent.	Elevation.	Proportion.
Asia	3360	... 20,000	... 5·952
South America .	1860	... 21,400	... 10·967
North America .	2490	... 15,000	... 6·024
Europe	1080	... 15,700	... 14·444
Average .	2197	... 18,025	... 9·346



The above tables are calculated on opposite principles, the one taking the mean and the other the central extension of the continental masses at right angles to the principal elevation, South America. being in both cases the same, though in that estimate more appropriate to the second. In South America, also in both cases, the line chosen passes through the culminating point, as it does also in that of Europe.

7 *Results of Comparison.*—The general results are, nevertheless, sufficiently apparent when compared with the diagrams and tables of effect produced by elevation, showing very plainly the more simple forms of South America, the superficial extension of Asia, and the irregular and highly developed forms of North America and Europe.

Comparative Table of Effect to Proportion of Elevation to Base.

	Effect.	Proportion.
Asia	1151	... 5·952
South America	1132	... 10·967
North America	748	... 6·024
Europe	671	... 14·444
Average	925	9·346

Table of Proportion of Elevation to Effect.

Asia	1151	20,000	17·202
South America .	1132	21,400	18·904
North America .	748	15,000	20·053
Europe . . .	671	15,700	24·483
Average	925	18,025	20·160

Assuming then one thousand miles of extension to 9000 feet of elevation as a rough average on the continental masses, it will be seen that while North America and Asia are about in the same proportion below and above the average, Europe is considerably below, affording another and very marked example of the variety of her configuration.

In Asia, then, we find the highest mountains, the most extended and elevated table lands;

In South America, the most extended plains and greatest elevation in proportion to the shortest slope, and the greatest contrast between tho opposite slopes;

In North America are intermediate configurations, the East approximating to Europe, the centre to South America, and the North and West to Asia; while in Europe we find the greatest variety and the greatest elevation in proportion to extension.

The continuation of these reliefs into the oceans cannot, under our present imperfect knowledge, be attempted; nevertheless, it may be noticed that the comparison just instituted bears out the remark already made (p. 209), that the deepest water will probably be found in the Southern Ocean, while the Arctic and North Atlantic will be found comparatively shallow, and the bottom of the North Pacific bear the same relation to the volcanic chains of East Asia and North-west America, that the table lands of central Asia do to the Himalaya. The following general table of proportions arranged from the preceding will complete the apparatus for forming a sufficiently accurate contrast.

	Long and Short Slopes.	Extent of Elevation.	Effect of Elevation.
1. Asia	3,000	5,952	17·202
2. South America	14,500	10,967	18·904
3. North America	4,533	6,024	20·053
4. Europe . . .	8,000	14,444	24·483
Average	4,751	8,200	20·160

This affords the following sequences:

1.3.4.2 1.3.2.4 1.2.3.4

showing that while the proportion of effect to linear elevation is in regular order, as stated above, according to the third rule which has been deduced by Guyot, the others are not constant, and do not appear to follow any general law.

It may be well therefore to follow out the comparison in another way—viz., by considering the general character of the surfaces of the continental masses.

It has been already noticed that the character of North America is intermediate. The northern portion of that continent has a very similar character to that of Northern Asia; thus to the north of the 32nd parallel in the one, and of the 42nd in the other, we have the largest extent of lakes and water surface throughout the earth; in both cases this is connected with a long and very gentle slope, as well as with the greater extension in breadth; both present their shore to the Arctic basin, and in this direction the present greatest axis of upheaval in both continents would appear to be situated. This would suggest a contrast of the land surfaces of our globe as they surround that basin, and show the relative value of North and South hemispherical comparison, or, even more, of that by land and water hemispheres. To the south, in both cases, we have a great river with a vast delta flowing in its middle course through wide extended plains; on the one hand, the Ganges; on the other, the Mississippi; while the Euphrates and Tigris, with the saline districts about their head waters, and the extremes of aridity and fertility which they present, bear strong analogy to the Columbia and the rivers which fall into the bay of San Francisco. On the east of America we have a district not dissimilar, though in some respects inferior to that of the west of Europe, while the eastern coast and islands of the Old World bear no small resemblance to the West Indies and Central America. Africa and South America stand alone, and in striking contrast. Australia and New Zealand have intimate relations with both, and with respect to them, the intermediate character that North America bears to the other continental masses.

8 *Of Geological Contrast.*—The same may be said of the formation of the superficial crust of the earth—i.e., the geology of these districts, and especially in relation to the position of the more useful minerals and metals. Thus we find the larger deposits of coal in Central and Western Europe, and in the central and eastern portions of North America; here, also, we find abundance of iron and copper. These productions, the necessary materials for manufacturing industry, thus abound where life will be always most abundant, while the greater masses of the precious metals, as they are called, gold and silver, are located nearer the equator.

This arrangement, which generally obtains, is not, however, probably so remarkable as the immediate propinquity of these masses to the natural lines of communication either on the coast, as in Australia and California; near great lakes and rivers, as in North America; in an insular position, as in Great Britain, or in proximity to the more general facilities for transport afforded by the varied configuration of Europe; and if this subject be considered in reference to the most important present use of coal, now the most precious of all minerals, it will be seen that the localities in which it is found are such as would be most desirable to facilitate the rapid intercourse which modern social and commercial requirements necessitate, being placed not only in those routes into which commerce is now being carried, but in larger quantities, where manufacturing interests, and the consequent accumulation of inhabitants and constant traffic, are now or hereafter to be found.

In this connexion we observe,—1st, that the coal fields of North America, the largest at present known, are placed in the centre, and at the eastern extremity of her natural lines of communication; and this is, perhaps, the most striking example that can be adduced. By the Mississippi and its affluents, access is obtained to nearly one-third of the entire surface of that portion of the New World; by the river Saint Lawrence and its great lakes, to one-third more; these are connected directly to the east and west, with the corresponding sea-boards, and most immediately with each other, and the Arctic Ocean. Thus the valleys of these rivers, and the adjacent country, are the most desirable localities for coal: and here, and on both sea-boards, that mineral occurs in abundance, the largest deposit being near the centre, or rather the convergence of these lines, and in close proximity to its other mineral wealth, and even the northern coast presenting it in abundance, as well as other minerals; and thus affording proof that hereafter it is to be brought into commercial relation with the other portions of the world. What is true of North America, is also true, though not to the same extent, on account of its more simple form, of South America, and more especially of Europe, and other portions of the world's surface. Our own country, Belgium, France, Germany, and Italy, afford illustrations of this; as do the peninsula of India, Southern and Western Australia.

2nd. That what is true particularly, is true also generally, as has been observed, the longer routes of commerce being, it might be said, indicated by these localities. Thus in connecting Europe and America, we have coal at both ends of the route, and it occurs near the extremities of the two continents. The long voyage from the Cape of Good Hope to Australia is broken by Kerguelen's Island, where coal is deposited. In Australia it abounds, and is found in New Zealand. India possesses abundance for manufacture, as well as internal and external communication. The route from the Cape of Good Hope, or from Australia to China, is supplied by a deposit in Borneo, and probably by others in the neighbourhood. China and Japan have both plenty, while the route from North West America to China has not only coal at both extremities, on the West as already mentioned, and on the East in Vancouver's Island and other parts of British America, but along the whole route which follows the direction of the coast line. South America has also coal to facilitate communication between the Atlantic and Pacific by the Isthmus of Panama, as well as across and around that ocean; and even the inland seas, as the Mediterranean, Hudson's and Baffin's Bay, the Gulf of Saint Lawrence, and the Gulf of Mexico, are not without it.

Nor are the overland routes, not directly connected with river valleys, or passing from one to another, less fully supplied. The line from England to the Black Sea, through Germany and Russia, has abundance. Extend the same line to India, and it does not fail. Pass from the great lakes of Canada to the coast of the Pacific, and you find it half way, on the Saskatchewan. And although of these localities we know less than of those already referred to, yet we know enough to predicate, without hesitation, that it will be found wherever it is most wanted, for the general good of mankind, the spread of civilization and commerce, the bringing men more into communication with each other, the consequent extension of knowledge, and, by consequence, of the Christian religion, and of love and charity between the families of mankind; so that we may now adopt more fully than has ever yet been done, the words of the Psalmist—'O Lord, how manifold are Thy works! in wisdom hast Thou made them all: the earth is full of Thy riches!'

9 *Of Contrast in Climate.*—The consideration of the extent and elevation of the continental masses leads naturally to those of climate and productions. With respect to these, it has been already observed, that the greater surface of the land lying within the temperate zone, possessing a climate and consequently productions most suited to the residence of man upon it, is the more historically and practically valuable portion of it, and must so continue.

In regard to climate, however, important results follow directly from the vertical contour of the continental masses, especially with regard to the presence or want of moisture (see meteorological map of the world in atlas attached to this work): this will depend on two causes—the direction of the currents of air near the surface of the earth, and proximity to the ocean; the former must be in a great measure influenced by the relief of the continents, especially by the mountains and valleys, and upon the results of both the presence of animal and vegetable life, and their character, must very much depend.

The currents of air are generated by difference of temperature, and will be found generally taking the direction of the linear elevations of the continental masses, with the exception of the trade winds, which are indeed only winds acting without any disturbing influences arising from vertical configuration, as may be seen by their cessation on approach to continents, or even islands, as in the Pacific, where they are replaced by monsoons directly they reach the insular portion of its surface.

This is observable, on the coast line, in the North Atlantic, where north-east and south-west winds predominate; in the South Atlantic, where the reverse may in general terms be asserted; in the North Pacific, where they are for the most part directed by the trending of the coast, as they are also in the Indian Ocean. It will follow that, wherever opportunity for precipitation is found in the conformation of the coast district, there will be an abundance of moisture; wherever a river, or lacustrine basin, or deep indentation of the coast line offers facility for it, that moisture will be carried far inland. Thus Europe, although not possessed of great river basins, from the configuration of her coasts, is abundantly supplied. America, for the opposite reason, has no lack; but in either case, the table lands of Spain and Mexico, diverting the currents of air towards other localities, are, in proportion to their relative extent and elevation, deficient in this important element of natural production. The vast lateral extent of Northern Africa and Central Asia, separated on all sides from the sea by mountain ranges, includes the most arid districts in the world. The plateaux of Asia, Persia, Arabia, and Thibet, not only present the same obstacles as those of Europe and America, but lie within that limit. Central Australia and Southern Africa labour under both disabilities, not only presenting the obstructive barriers of mountain ridges on the coast to the action of water-bearing currents of air, but by their wide expanse having their larger surfaces removed from the sea. The same may be said in a less degree of the southern portions of South America. They are, therefore, partially, the great generators of the currents of air, as being the localities of the greatest heat and least moisture. These, the great air-pumps of the earth, as producing the rarefaction and vacuity on which the motion of the atmosphere depends, maintain by their constant action its healthy condition; and, although least fitted for his residence, themselves are most important in making other places fit for the residence of man.

In the immediate locality, and in the direction of the elevations radiating from or parallel to those districts, are found those also of greatest precipitation. These are within the deepest indentations of the coast line and the most insular portions of the surface of the ocean; India and its islands, Western Africa, the West Indies, British America, east and west, and Western Europe. Of these, the three former and most important are in close proximity to the most important mountains in the world, the Himalayas, the Andes, and the Plateaux of Mexico; and though we know but too little of the mountain system of Africa, we know enough to predict with certainty, that its greatest elevation must not be far from its western coast, a little to the north of the equator, as the primary water-shed of its most important river, and consequently close to the district of the greatest precipitation which is found in that latitude, on the shore of the Indian Ocean.

But what is true of the coast line, is no less true of the interior. In this respect, the contrast of the two great continents is very marked; for while in North America a slight elevation of about 1800 feet offers no impediment to the passage of the currents of air, and thus affords not only moisture, but extremes of heat and cold to the interior of that continent; while in the northern part of South America, the connexion which exists between the Orinoco and Maranon, proves a corresponding slightness of distinction between their main basins; in Europe and in Asia, with the exception of the broad waters of the Ganges and Indus, and the Rhine and Danube, the rivers are separated by important elevations, and the passage of currents of air impeded; the climate of those countries is therefore more variable, if not less extreme. The vast expanse of both continents towards the north is, of course, exposed to the full influence of water-bearing winds; but the influence of the frozen zone interposes to vary and modify its effects.

And in this relation the currents of the ocean, and even its tides, are not to be omitted, for though with respect to the former we have not data sufficient to form just conclusions as to the influence of the vertical contour beneath the surface in their formation, we do see most plainly the influence of vertical contour above the surface. Thus the main currents (see meteorological map) flow round the great projections of the continental masses, and receive their direction from the linear configuration of the coast lines: thus the shores of Western and Northern Europe feel the influence of the warm current of the gulf stream, and South America of the cold current from the Antarctic seas (see Part I., p. 235 *et seq.*), and similarly the great tidal wave modified by the larger projections of the Continent, and retarded in its progress by the windings and indentations of the coast lines, not only receives its direction from them, but is regulated as to its velocity, so that it reaches districts within nearly the same limits of positive position at very different times; in one case may be so diffused as to be scarcely perceptible, as in the Pacific, in another be accumulated into a bore, as in the narrow channels of the coasts of the Atlantic and Indian Ocean, in the British Channel, the Bay of Fundy, and the mouth of the Hooghly river, where advancing in solid mass with fearful rapidity, it has rather the appearance of an inundation caused by some convulsion of nature.

The distribution of heat and cold is similarly modified by vertical contour, by means of which we get the eternal snows of the Pole, and an Arctic flora beneath the vertical rays of a tropical sun (see p. 210).

10 *In Productions.*—From what has been said, another contrast becomes apparent between the eastern and the western continents similar to that already noticed, and, indeed, dependent on it. The table lands of the Old World wanting moisture can never present the same vegetable productions in the same proportion as the well-watered plains of the New; these, therefore, present incitements to the residence of man upon them which the former never can; and here we see the fecundity of nature in vegetable life to an extent unparalleled elsewhere. To this reference has already been made in the portion of this work on *Physical Geography;* but it may be further remarked, that the similarities already observed may be carried out thus far, the vegetable productions of North East America assimilating with those of North West Europe, the West Indies, and Central America, with India and its islands, &c., the distinctive features of the vegetation of the Old and New World being of course maintained.

The distribution of animal and vegetable life from this cause, also affords interesting contrasts, not only in the general way already alluded to, but more particularly. If, for instance, the limits of the cultivation of grain be considered, they will be found confined by the great mountain ranges, and following their linear extension. River and lacustrine basins, and indentations of the coast line also afford their distinct localities for varieties of Fauna and Flora, not unfrequently confining them within their limits. In islands, of course, this is even more observable; while the great mountain chains form all but impassable barriers against the transmission of either, except by the instrumentality of man; but these things need not be enlarged upon, as they have been already treated of at length, in the chapter on *Physical Geography* appropriated to them.

11 *In Man.*—Finally, as already noticed in the chapter on the *Theory of Description* (p. 423), the vertical contour of the earth's surface has mainly determined the paths of man's migrations, and fixed the limits of the habitations of the human race; and it has been shown how preparations have been made for his more extended dispersion, and at the same time more intimate communication by the distribution of minerals and metals. In the chapters devoted to that consideration, it will hereafter be seen how atmospheric and aqueous action, the winds and currents of the ocean, contribute to this great end. Here it will be only necessary to remark, that the table lands of the Old World afforded the easiest means of locomotion to man in his infancy; while the Mediterranean basin, embosomed between the three divisions of the Old World, presents the natural cradle of more extended commerce and navigation; that the valleys of the Nile and Danube afford access respectively into the interior of the continents, but with very different results; for though in both cases they are cut off from immediate communication with the great central basin, yet to the one there is opened a varied field for the development of the human mind in its social relations, which has subsequently extended the influence of the countries to which it tends, Germany, France, and England, over the whole world; on the other, the vast but comparatively increased expanse of Africa presented little to further such development, and offered

no extensive connexion to its inhabitants, who are therefore at present the least advanced of those of any of the continental masses. Further, the range of the Himalayas, confining for the most part the nomad races of the vast steppes of Asia to the north of its linear extension, and its spurs to the east separating China from communication with the south, has given the northern and eastern portions of Europe and Asia into their hands; and thus three great and well defined varieties of the human race have resulted, the main areas of which are indicated in the small ethnographical map (in Plate v. of the Atlas), which shows at a glance the influence of vertical contour on distribution, and, in conjunction with what has already been said, gives sufficient reasons why the least extended and numerically smallest of the three should be historically the most important, and that also which, by its influence upon the others, is doubtless hereafter to effect an amalgamation which shall raise them to its standard, and, at last, possibly, absorb the more distinctive varieties, whether of physical conformation, habit, or language.

12 *General Conclusions.*—In concluding this introductory chapter, it may be again noticed that all these similarities and contrasts depend, first, on the vertical contour of the land, and secondly, on position; that the mass of Asia presenting vast mountain chains, buttressed by massive table lands extending into immense plains, watered by rivers second only to those of the New World, presents a type of all other portions of the continental masses; that America, in its more simple configuration, with its two great features of mountains and rivers, is most intelligible; while Europe and part of North America, to which no doubt hereafter must be added North East Asia, are the portions of the world's surface most worthy of study, and which will best repay for their detailed consideration; they are moreover those which are affecting the world most at the present time; they are those where our own race is working out its gigantic destiny; to them therefore particular attention will be directed. Asia historically the first, and as,—if not because it is,—the type of all the others, should come first in the series. The Mediterranean basin, and consequently Africa and Europe, next in order; thus combining the whole eastern world, after which the contemplation of the western will be easy.

The general connexion of the whole will be completed by the consideration of the two great divisions of the ocean and the islands they contain, as well Australia, New Zealand, and the Eastern Islands, appertaining to Asia, and the West Indies, and others belonging to America; and also the more oceanic and distant islands, which, however subaqueously connected with the continental masses, and forming links between them, are too distant from their shores to be considered in more particular description as appertaining to them. But as historically our knowledge of the Atlantic preceded that of America, and as that ocean is the link between the two continents, its consideration may more properly assume that place in the series.

CHAPTER II.

OF ASIA.

1. Historical sources of our knowledge of the interior.—2. More recent information.—3. Of the boundaries and limits.—4. Of the coast line.—5. Of the watersheds.—6. Of orographical classification.—7. Classification of rivers.—8. Of geological formation.

HISTORICAL Sources of our Knowledge of the Interior.—To the information obtained by European travellers in the middle ages, by Carpini, De Rubruquis, Pegoletti, the Poli, and others, respecting the interior of Asia, but little was added for about two centuries. The course of traffic having been transferred from the land to the sea, and passed from the hands of the Genoese and Venetians into those of the Portuguese, the Dutch, the French, and subsequently the English.

The mission of Chancellor to Moscow had, however, made known the importance of the inland commerce which Russia, even at that time, enjoyed with the interior of Asia, and, in 1558, Anthony Jenkinson, a merchant of importance engaged in the Russian trade, was despatched on a journey for the purpose of opening the interior of Asia to English commercial enterprise, which though unsuccessful, so far as its primary object was concerned, added much to the knowledge then extant of the countries through which he passed.

His voyage and journey extended down the Volga to the Caspian sea, and from the port of Mangerslave, at its South Eastern angle, through the land of the Turkman, along the course of the Oxus to the city of Bokhara.

Here he found a great change since the palmy days of Tatar rule, for although it was still the centre of the internal commerce of Asia, that having been interrupted, especially from the east, by war, its importance had diminished accordingly. Jenkinson returned to Moscow convinced that it offered no inducement to English merchants.

His observations, however, fixed with greater accuracy the position of many important places, and reduced the boundary of the Caspian sea to something nearer its present proportions.

The stimulus given to English commerce in the chivalric period of the reign of Elizabeth induced the merchants of London to endeavour to extend the Levant trade, which they were then beginning to take out of the hands of the Venetians. For this purpose, Messrs. Fitch and Newbury proceeded overland to India, by way of Aleppo and Bagdad to Ormuz and Goa, but the appearance of Sir Francis Drake in the Indian seas had created a not unnatural panic among the other Europeans there, and the travellers were thrown into prison at Goa, and prevented extending their journey to China. The success of Drake and his followers led to the adoption of the sea route to India, and its maintenance until the recent re-opening of the so-called overland route by way of Egypt; to the formation of the East India Company; and the sending Hawkins as ambassador to the Great Mogul in 1607.

During this interval, however, Russia was extending her knowledge of the interior. About the period of Jenkinson's mission Anika Strogonoff established a lucrative fur trade with Siberia, and, obtaining grants of land there from the Czar, founded several colonies. Russian troops also made incursions as far as the river Oby, and Ivan Basilievitz extended his empire to the shores of the Caspian. The Cossacks inhabiting those districts plundered the caravans; troops were sent for their protection, and at length Yermac Trinovief, a Cossack chief, driven by the Russians from his own country, attacked the Tatars, defeated Kutchum Khan, and subjugated the country about the river Irtish; finding, however, his situation precarious, he invited the protection of Russia; the Czar sent troops to his assistance, but these were surprised and cut to pieces, and Yermac perished in his flight; but soon after more Russian troops were sent into the country, the fortresses of Tobolsk, Sungur, and Tara were founded, the authority of the Czar finally established in Siberia, and the frontiers of his empire extended with great rapidity to the Eastern Ocean and the confines of China; indeed, to its farther extension that empire alone opposed any serious obstacle.

In 1639, the Russians became acquainted with the great river Amur; in 1643, Wasilei Pojarkof followed the course of that river to the sea, and proceeding northward along the coast returned to Yakutsk, a town recently built on the river Lena, from whence he had set out by a different route. This led to an attempt on the part of the Russians to subjugate the Tatar tribes inhabiting the banks of that river, and brought them into collision with the Chinese. The immense distance of the seat of war from Moscow, and the difficulty of sending men and supplies so far through so difficult a country, gave the advantage to the Chinese, and brought about a treaty by which the country about the river Amur, and the navigation of that river, was ceded to them. Under Peter the Great a Russian factory was established at Pekin, and privileges of trade given to the Russians, but these latter were forfeited, their people expelled on account of their bad conduct, and the trade subsequently confined to a caravan every three years, but permission was accorded for the establishment of a Greek church, and the residence of scholars at Pekin. This arrangement, made by Count Ragusinski in 1728, has continued until now.

As the Amur had given a means of transport to the Russians as far as the North Pacific, so the other great rivers of Northern Asia afforded means of traversing its interior and arriving at different parts of its coasts, from whence subsequent expeditions, as already noticed, continued to extend geographical knowledge. Their first establishment on the Lena was formed in the year 1636; in 1644, Michael Staduchin built a fort on the Kolyma, and in 1650, after the discovery of the mouth of the Anadir by Deshniew, having discovered that river to be the same as the Pogitska of which he had heard, proceeded overland to it from the Kolyma; here he found Deshniew, and together they established a lucrative trade in sea-horse ivory.

In 1696, the Cossacks penetrated into Kamschatka, and in the following year Wolodimer Atlassow commenced the conquest of that peninsula, and finally, it having been found impossible by the Russians to circumnavigate the great promontory of Tshutskoi Noss, but it having been crossed by Staduchin, who reported its inhabitants as dangerous from their ferocity, in 1701, an expedition was organized for their subjugation. The contest lasted ten years, and since then they have enjoyed semi-independence; recent expeditions to Behring's Strait have added to the knowledge of the coast of that country obtained by Cook and his followers. It was not only towards the East that Russia had extended her discoveries or the limits of her territories; Jenkinson had been followed, in his exploration of the Caspian, by Christopher Borrough in 1580; in 1633, Oelschlœger, or Olearius, a professor of Leipsig, examined and ascertained the position of several points on the western and southern shores of that sea, when accompanying an embassy from the Duke of Holstein to the Schah of Persia, and Peter the Great employed Dutchmen, under Charles Van Verden, to make a chart of that sea, which was afterwards submitted to the French geographer, Delisle. Further information was obtained by Jonas Hanway, in 1745, from an expedition despatched by English merchants to open the trade of India from Astrackan, and subsequently the expedition of Gmelin and Hablitzl fixed its limits with some precision; it was, however, reserved for our own times, and the recent expedition sent by the Russian government, to complete our knowledge of that sea, and to present an accurate chart of its shores.

Some knowledge of the countries to the east of the Caspian was also obtained in the reign of Peter the Great, who despatched Alexander Beschewitz, a captain of his guard, with a small army, to take possession of the countries about the river Oxus, gold having been reported to be found there in large quantities. Beschewitz was, however, defeated and killed by the Tatars. Russia has never ceased to extend her knowledge of the interior, but until the present century the labours of other Europeans were, for the most part, confined to the districts near the coasts.

Since the year 1836, regular accounts of the progress of geographical knowledge have been published by the Royal Geographical Society, in its journal annually, and from these the obligation which we owe in this particular to different travellers may be seen. It will be sufficient, therefore, in this place, to notice them by name, as the information obtained from them will be embodied in the description of the countries through which they travelled. These may be, for convenience, arranged under the following geographical classifications:—

1. The great northern plain of Siberia and Central Asia. 2. China. 3. The Eastern Islands and Peninsula. 4. The Peninsula of India and the Valleys of the Ganges and Indus. 5. Kashmere, Khurdisthan and the countries on the slopes of the Himalayah mountains. 6. Persia and Armenia. 7. Arabia Palestine, and Syria. 8. Asia Minor.

In the first division we find the names of Ermann, Fuss and Wrangel, as affording information of the countries on the lower course of the great northern Asiatic rivers, Kamschatka, Lake Baikal, and the connexion between Asia and America respectively; Klaproth in Central Asia; Leochine, Basiner, and Atkinson, in the Steppes of the Khirghis; of Federow, Karilin and Middendorf in Siberia; Beghalowski and Zehman in Alpine Tartary; Shrenk and Tchikatchef in the Altai, and Sayanes; Murchison, de Verneuil, and Helmersen, in the Ural; de Moulhereux, in the Caucasus; Abich in the country between the Black and Caspian Seas: Hommaire de Hell, on the coasts of the Caspian; Basiner, Abbot, and Shakespear, in Khiva; and Silverhjelm on the frontiers of China.

In the second, Davis, Bruguiere, Vignault, Huc and Gabet in Chinese Tartary; the embassies of Macartney and Amherst in China; Bethune, Colchester, Caltinson, and others on the great rivers, and their connexion by canals, and. more generally, Gützlaff and Fortune. In Japan, Van Siebold and Doefl'.

In the third, Newbold in Malacca; Reinwarte, Raffles, and Junghuhn in Java; Oliver in Molucca and Celebes; Horsburgh, Rienzi, Earl, Crawfurd, Low, Brook, Keppel, Mundy, Belcher, Gordon, Stanley, &c., in the Archipelago generally.

In the fourth, between Persia and the Valley of the Indus, Stirling, Burnes, Massom, Edwards. In Scinde, and on the Indus, Burnes, Carless, and Outram; Du Vernet in the Punjaub; on the eastern frontier, Pemberton, Richardson, and M'Leod; Hetfer in Tenasserim, and Hannay on the Irrawady; Grandjean in Siam, besides those engaged in the general government surveys, conducted by Lambton, Everest, and Waugh.

In the fifth, Moorcroft, Hoffmeister, Hügel in Cashmere; still farther north and to Lè, the capital of Ladack, Cunningham, Strachey, Thomson, Des Granges, de Koros: in the Himalayah, Colebrook, Madden, Hooker, Forbes Royle, Johnston, Lloyd, Herbert, Guthrie, Trebeck, Young, Agnew, and the Gerards; on the north-west frontier Kandahar and Kurdistan, Conolly, Burnes, Wolf, De Bode, Shiel, Ainsworth, Lynch, Vigne, Jackson and Irwin, Grant and Chamcour, Vivien de St. Martin, and Badger; Wood, at the source of the Oxus; Rose and Monteith on the Caspian, all united to Persia by the labours of Rawlinson, Layard, and their fellows; and Johnston at the source of the Jumna.

In the sixth, Rich, Morier, Lynch, Ross, Ponjoulat, Campbell, Selby, Rassam, and, above all, Chesney, Layard, and Rawlinson, &c., &c., in Mesopotamia and on the rivers; as also Brent, Hamilton, Grant, Glascott, Southgate, Letellier and Chopin; Forbes, in the Sinjar and Seistan, and Kempthorne, on the eastern shores of the Persian Gulf.

In the seventh, of De Laborde, Wellsted, Bird, Cruttenden, D'Abaddie, Botta, Koller, De Wrede, Carter, Amand, and Brockman, Wallin and Lepsius; in that Peninsula and Palestine, Lindsay, Berton, Robinson, Smith, Napier, Beke, Symonds, Wilson; Moore and Molyneux on the Dead Sea; in Syria, Chesney; Barker on the Orontes; Parrot at Ararat; Pollington in Syria and Asia Minor; Engelhart on the shores of the Black Sea.

In the eighth, Callier and Texier, Raoul Rochette, Hamilton, Fellows, Cohen, Ainsworth, Rassam and Russell, Davidov, Forbes and Hoskyn in Lycia; Bone about the sources of the northern rivers, Kiepert and his companions; Branfort on the northern coast; and all summed up, combined, and enlarged in the careful and elaborate survey of Tchichatcheff, one part of which has recently issued from the Paris press.

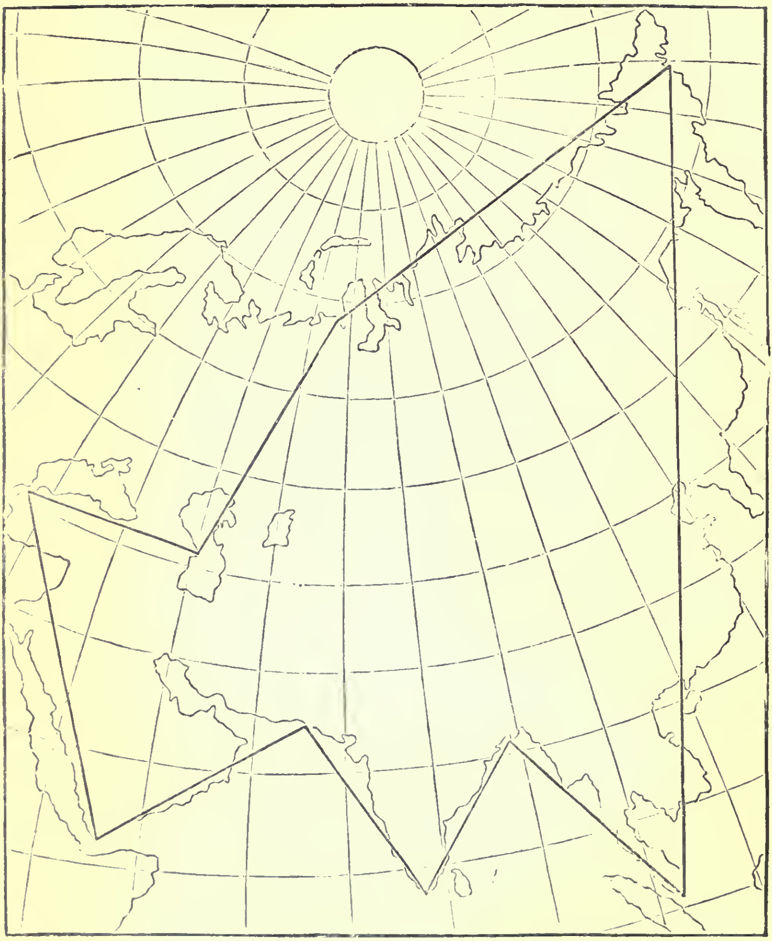
This long list, incomplete as it no doubt is in many respects, will show what has been done of late years to increase our knowledge of the vast continent which historically is the cradle of the human race of civilization, literature, and science. It will be apparent from their well-known names, that by far the great majority of these travellers, those to the north and east of course excepted, have been engaged in a military or political capacity on the frontiers of the dominions of Great Britain in Asia, and under the authority of the East India Company, and especially in originating and carrying into effect means of overland transport between Europe and Hindostan.

It would be obviously impossible within the limits of the present work to do more than give the names of those to whom we owe our knowledge of the particulars of the geography of the interior of Asia. The mention of their names alone appears of little practical utility, unless it be taken as an index of the amount of labour from which our knowledge is derived, and the opportunities afforded in their works to individuals to make themselves more intimately acquainted with it. It must be remembered, also, that Asia, on account of the size and variety of configuration for which it is distinguished among the continental masses, demands more extensive labour for the elucidation of its geography than the others; and, indeed, as will appear in its description, much more remains to be done.

Having thus given indications of the sources from whence our knowledge of the interior of Asia is derived, its boundaries and limits must be next detailed.

3 *Of the Boundaries and Limits of Asia.*—Asia is bounded physically by the Arctic Ocean on the north; by Behring's Straits and the Pacific on the east; by the Straits of Malacca and Indian Ocean on the south; and by the Red Sea, the Mediterranean, the Sea of Marmora, and the Straits of the Dardanelles and Bosphorus, and the Caspian Sea on the west. The exact boundary on the land cannot perhaps be defined at either extremity; but at the Isthmus of Suez it is usually given as from Suez to El Arish, while the Oural Mountains are taken as the boundary on the north, from the Sea of Kara, and from their southern declivity, the river of the same name may perhaps be best assumed; the natural division between the Black Sea and Caspian will be the watershed of the Caucasus. Formerly the Don was considered the natural boundary: subsequently, as European knowledge extended westward, arbitrary lines from the mouth of the Don to that of the Dwina, and even the Obi. Pallas proposed a division purely political; Malte Brun, the course of the rivers Manich and Kouma, from the Sea of Azov to the north of the Caspian. The Russian geographers, however, whose interest in the subject, and more recent and exact knowledge, give them the best title to decide the question, have fixed on that taken above. The boundary given in the Straits of Malacca may be, as has already been suggested, physically incorrect, but it is recommended by convenience and sanctioned by custom.

The positive position of the limits of Asia, as connected with the normal figure, will be found in the table at pages 204-5. It may, however, be well to contrast them with the extreme points which project beyond those selected for that purpose.



Angles of Normal Figure.	N. L.	W. L.	Extreme Point.	N. L.	W. L.
Gulf of Kara .	67° 30′...	67° 30′	Cape Yalmale (?)	72° 40′...	70°
Cape Navarin .	62° 16′...	178° 56′	East Cape (?)	66°	...179° 50′
Singapore . . .	1° 17′...	103° 50′			
Cape Babelmandel	12° 41′...	43° 27′			
Dardanelles . .	40° 9′...	26° 24′			

As the other points coincide, this comparison will show how little the normal figure differs from the true development in its extreme limits. There is, however, a considerable difference between the extreme limits in latitude, as is apparent by the diagram, for to the north the mainland of Asia reaches 77° 20′. The main area of Asia has been already given (*see* table, page 205) as 16.683.260, or one-third of all the land on the surface of the globe.

4 *Of the Coast Line.*—The trending of the eastern coast is nearly north-east and south-west. On the coast of the southern peninsulas this is slightly

varied—in Arabia the direction being more easterly; but the coast of the Red Sea and Malabar have nearly an equal trending to the north-west. The coast of the Caspian has rather more northing, and the Oural Mountains run nearly north and south. This shows the gradual change in the direction of the slopes, losing their westerly tendency as they become more northerly in position, as is well shown on the coast of Asia Minor, which at its south-western extremity projects a full degree beyond the line of the normal figure drawn from the Straits of Babelmandel to the Dardanelles. It will be seen hereafter that the axis of the central watershed of the continent rises gradually to the north-west, as is especially observable in the chain of the Caucasus. It has been shown that the coast line of Asia is less indented than that of either Europe or North America. The most marked features in its outline are afforded by its vast promontorial or peninsular masses—Kamschatka, the Malay peninsula, Hindostan, Arabia, Asia Minor, to which may be added the extension of its secondary chains in the Islands of Japan, the Eastern Archipelago, and beyond them, of Australia and New Zealand.

According to the calculations given in the portion of this work devoted to physical geography, the proportion between the area and coast line would be 205. The former being estimated at 14,150,000 square miles—the latter at 28,500 linear miles.

The principal variations from the normal figure will be found as under:—

Projections.		Indentations.	
Country of Tchutski on East	6°	Sea of Ockhotsk . . .	$5\frac{1}{2}$°
Kamschatka	5°	Leatong Gulf	7°
The Korea	3°	Gulf of Tonquin . . .	7°
South of Arabia . . .	$2\frac{1}{2}$°	Gulf of Siam	$8\frac{1}{2}$°
Siberia	$3\frac{1}{2}$°	Gulf of Martaban . . .	$2\frac{1}{2}$°
		Gulf of Perna	$11\frac{1}{2}$°
		Levant	$4\frac{1}{2}$°
		Caspian	5°
		Gulf of Obi	4°
		Borghai Bay	4°

These are in a linear extension of 97° from N.E. to S.W., and of $72\frac{1}{2}$° from N.W. to S.E., or 5820 and 4350 miles, of sixty to a degree, at the Equator respectively. It will be seen that the greater irregularities are on the eastern coast, which is also covered by the islands before named. They are all, of course, consequent on the extension of the mountain ranges and depressions between them.

It may be noted, that the extreme length from east to west—*i. e.*, from the Dardanelles to the south point of the Corea, is 75°, or 4560 miles; and from north to south, from Cape Severo, the north point of Siberia, to Singapore, 77° 8′, or 4628 miles of 60 to a degree at the Equator, or 5212 and 5360 English miles respectively.

5 *Of the Watersheds of Asia.*—On the examination of an orographic map of Asia, it must be apparent that its mountain systems cannot be separated from those of Europe and Africa, but that these latter are dependant on the former; nevertheless, as those of Arabia, Palestine and Asia Minor with the Caucasus are, as it were, the intermediate links which unite the two smaller with the larger division of the Eastern Continent, the great mass of its mountain system may be well considered distinctly and apart from them.

The country lying to the north of the sources of the Indus and Ganges, which presents to the eye on every side the greatest mass of mountains in the world, is a fit centre from whence the massive radii which form the skeleton of the vast continent, extend on every side to the sea. These, however carefully laid down on orographic maps, can only be considered as suggestive sketches. The knowledge of the truth has yet to be arrived at, and probably will be found far vaster and more important than is even now supposed. This mass, extending over above 30° of longitude and 10° of latitude, is generally represented as consisting of distinct chains, having their common origination in the knot between the Hindoo Koosh, and Himalaya, to the north-west of the Valley of Cashmere. The recent information afforded by Captain Strachey, and others, respecting this region, has, however, confirmed what some geographers, reasoning from analogy, had suspected—viz., that these distinct chains exist only on the map, and that the confused mass of towering rocks and glaciers has yet to assume in our minds regular form.

Thus far, however, has been made apparent, that the centre and most compact portion of it, situated in the locality already indicated, is not that in which the highest peaks are to be found; for although presenting many above 25,000 feet in height, none have yet been seen rivalling in elevation Kinchinjinga, Dhwalagiri, or Cumulari. Still, in this part the greater mass is to be found, and here must elevation also produce its greatest effect, the most elevated peaks being situated some distance to the eastward. Nor is this a singular instance. In Europe, Mont Blanc is situated some distance to the south and west of the central mass of the Alps, which must be sought around the summit of Mount Gothard. In North America, Mounts Brown and Hooker are esteemed the most elevated points near the centre, and they lie far to the north of the Sierra Nevada and mountains about the southern pass, where the centre of the mass is usually placed; while Mount St. Elias, of still greater elevation, lies near 10° further north. In South America, also, the same is true: for the Andes of Bolivia, or those of Quito, particularly the former, must certainly be esteemed the central masses of the system, while the highest summit, Aeocangua, lies 15° to the south; and in Africa, if the newly discovered mountains, Kilimanjaro and Kenia, be the highest, then the central mass must be sought to the north, where the summits do not rise nearly to the same altitude; and no doubt this will be found under the parallel of 10° north latitude, forming the watershed of the eastern head waters of the Nile, as those more elevated peaks will be found to be the watersheds of the more eastern or White Nile; making good the account of the father of descriptive geography, the venerable Ptolemy; and indeed this rule is found in juxtaposition with another, for as the highest peaks are not in immediate proximity to the central mass of the system to which they belong, so they are in the proximity of some of the principal sources of the greater rivers. This is less apparently true in South America than in the other divisions of the continents; still sufficient evidence may be adduced, if necessary, to show that this is an exception to a general rule.

Assuming, then, the mountains to the north of the Valley of Cashmere to be the point of intersection of the principal axes of elevation of the eastern continent, we find diverging from thence four, sufficiently well defined, at nearly right angles to each other; or if the expression be preferred, two intersecting each other—viz., the great mass of the Himalaya on the east, the Hindoo Koosh to the west, the Bolor to the north, and the Suleemanie to the south, separating India—*i. e.*, the Valleys of the Indus and Ganges from Mongolia on the east, and Iran from Turan on the west.

Speaking generally, these districts accord with great physical divisions of this continent. We have the plateaux of the Mongul, the valleys of Hindostan, the table lands of Persia, Arabia, and Asia Minor, and the steppes of the Caspian, the Oural and Siberia, lying beyond the secondary chains which buttress up on the north side the great plateau of Tarim, the Gobi or Shamo, the desert lying between them and the Himalayas; while both the primary and secondary seem to lose their distinctness and individuality in the irregular mountain districts of Mantchouria and China.

If from this general survey we proceed to more detailed and systematic description, we find a great central axis or primary watershed extending the entire length of the Old World, from west to east, varying in latitude from 35° to 45° north, having its most southern extension near its greatest mass, and its most northern at either extremity. If, however, the entire length of this watershed be considered, the primary mountains of Europe and Africa must be esteemed as extensions from the main and principal axis on the west, as those of North West China and the Indian Archipelago must be also to the east.

The central mass from which all the mountain chains of Asia originate is, as has been stated, not only the highest, but the most extensive range of mountains known. Its recent surveyors speak of it, without hesitation, as extending from the plains of Hindostan to the desert of Gobi. "Neither the Koenlun nor the Himalaya, as marked on our maps, have any definite special existence as mountain chains, apart from the general elevated mass of Thibet. That rugged country, then, seems to form the summit of a great protuberance above the general level of the earth's surface, of which these two chains form the north and south faces." * The plains on the south have not an elevation of more than 1200 feet, nor those to the north probably of more than 3000, above the level of the sea; thus illustrating most remarkably the opinion of Humboldt, that the bases of mountains have less extent than is usually supposed.

6. *Of Orographical Classification.*—In classifying, therefore, the orography of Asia, this must form the primary watershed, and the order will stand thus:—

Primary Watersheds.	*Secondary Watersheds.*	*Tertiary Watersheds.*
Himalaya.	The Vindyha and Aravalli and Western Ghauts.	The Eastern Ghauts.
Kuenlun, and its extensions to the N.W.	Cochin China, Fokein, and Assam hills.	The Mts. of Borneal.
Hindoo Koosh.	Yun ling and Peling.	Malacca.
Taurus.	Sih-hih-tih.	Hadramaut and Hejaz.
	Sulieman.	Libanus.
	Zagros.	Ural.
	Tianshan.	Mts. of N.E. Siberia.
	Altai.	
	Anti Taurus.	

Of the mountains of China we know little. Probably the tertiary range appears in the Philippine Islands, as the termination of the secondary does in Formosa, Japan, and Kamschatka.

The most marked features of the orography of Asia is its linear extension, specially in rectangular forms; nevertheless, the Oural chain cannot be looked on as an extension of the Bolor, as it is by some geographers.

7. *Classification of Rivers.*—Of the primary rivers there are—

Ganges and Brahmaputra, with the Irrawady, of the valley of which the Bay of Bengal forms the extension.

Indus and Euphrates, having their extension in the Persian Gulf and Indo-Persian Sea.

Kisilermac, extending into the basin of the Black Sea; besides the smaller streams on the southern slope; the

Aras and Kour, extending into the Caspian Sea, from the west, or the Kiziiouzan, from the south.

Amoo, or Oxus, forming the upper S.E. portion of the valley of Aral.

The river of Yarkhand, which, under various names, falls from the E. face of the Bolor, and is low in the lakes of the central plateaux of Asia.

Ynesie, having its sources in Lake Baikal, which again is fed by the Selenga, possibly by the Sena.

Amur, the extension of which is into the Sea of Okhotsk.

Hoangho and the Yangtsekiang, the valleys of which are prolonged into the Yellow Sea.

---

* See Mr. Strachey's paper in 21st vol. *Royal Geographical Society's Journal.*

Mekiang, or Cambodia, extending into the gulf of the same name, and probably the Martaban.

Of primary rivers Asia has therefore more than all the rest of the world together; but inasmuch as the secondary chains to the south approach closely to the sea, the extension of these rivers is not so great—excepting in the cases of the Chinese and northern rivers—as is due either to the mass or elevation from which they derive their waters. The gulfs and seas surrounding the continent are to the E. and S.; the extension of its primary valleys generally to the W. and N.W.; they are represented by the basins of the Black Sea, the Caspian, and Lake Aral, as well as the great central area, whose rivers and lakes have yet to be distinctly traced, and which wants so little depression to open its communication with the secondary valleys to the north. In Persia, also, the stream of the Helmund, primary as to its source, is lost in Lake Zurrah, the ancient Seistan, and does not reach the sea.

Of the secondary rivers, there are, the Nerbudda, the Godavery, the Kishna, and the Coleroon, in the Peninsula of India. In Persia and Arabia their place is supplied by torrents. The Jordan, and Alhazzi or Adonis, in Syria; the Sir Daria, the Obi, the Olensk, the Kolymas, the Anadir, in the north; the Le Ho, Pe Ko, Hong Kiang, and Tonquin river, in China; the Menam, in Siam.

Of tertiary rivers, Asia can be said to possess but few, and those unimportant; they must be looked for principally on its northern slope.

5. *Of Geological Formation.*—If, after a general review of the orography of Asia, the constituents of the surface be inquired after, assuming the general accuracy of De Boué's results, we find the primary schistose formations corresponding to the masses of the principal watersheds, and extending through Asia Minor, Armenia, Persia, Northern India, and passing from Thibet into China, Mantchouria, and along the coast of Kamschatka to Behring's Strait, forming also an immense mass in the centre of the continent, in the region of the Altai, and the extensions of Arabia, the peninsula of India, the Malay peninsula, and the Corea. To the south of the line of principal extension, the change is extremely rapid, the metamorphic and transition rocks appearing overlaid at once by tertiary deposits. These occupy a large portion of Persia and Armenia, of Syria and Arabia, and are found in China and Mantchouria. To the south of the Ganges, however, the secondary stratified formations appear clear and well defined, and on the summit of the Himalaya chain the stratified rocks appear plainly to the eye. Following the crystalline schists, Mr. Strachey says the Silurian beds rise to a height of 20,000 feet, and the palæozoic strata extend to about 3000 feet in thickness; farther north the oolitic beds rise to the same altitude, and give direction to the streams which flow from their watershed.

All the valleys are filled with tertiary deposits, the gradual elevation which has at length formed the rivers Indus and Ganges having placed some of them, as in the plain of Thibet, 15,000 feet above the sea, and in them are found fossil remains identical with those at the southern foot of the Himalayas, in the Siwalik range. Vast tertiary deposits are also found in the great central desert, the valley of the Obi, and surrounding the Caspian and Lake Aral, while they form the surface of the larger portion of Arabia and Persia. It may be remarked generally that the forms assumed by the mountains of Asia belong to those of stratified rocks, and this is especially the case to the south of the primary watershed, in Persia and the Ghauts. The rapid declivity of the Himalayas to the south is equalled only by that of the Andes. Tables of the extent of basins and other particulars relating to the principal rivers of Asia will be found in chap. v. *Physical Geography*, and in describing the water basins of Asia in order, such further particulars as are most essential, and within the limits of this work, will be inserted.

The most remarked depression in the eastern continent is that which forms the basin of the Mediterranean: this, however, must be connected with the Caspian and Lake Aral as well as the Black Sea, perhaps the Red Sea; in any case as connecting Asia with Europe and Africa. This would be the most important and natural point at which to commence description if the whole eastern continent were to be considered at once. As, however, its divisions must, according to custom, be taken separately, this will more properly form the bond of union between them. It is better therefore to commence with the watersheds of the basins opening to the south and east of these, and as in most immediate proximity to the great central mass, those of the Indus and Ganges most naturally present themselves.

CHAPTER III.

OF THE INDUS AND GANGES.

1. The primary Watershed and Valley of Thibet.—2. The Sutlej and its affluents.—3. The Indus and its affluents.—4. The countries watered by it.—5. The river Loony and district of Cutch.—6. The sources of the Ganges and primary affluents.—7. The lower water-parting and secondary affluents.—8. The great plain of Hindostan.—9. The Brahmaputra and San Po.—10. The Delta of the Ganges.

Of the primary Watershed and Valley of Thibet.—The southern slope of the primary watershed falls rapidly from the line of its greatest elevation, but the two great rivers, the Indus and the Ganges, which flow from it, have their principal sources in valleys parallel to that line, and are found in the closest connexion, and interlacing as it were with each other between the meridian of 77° and 82° east longitude, lake Tso Mapham, or Manasarowar, the confluence of the highest sources of the Jumna, being in longitude 81° 30; and the elevated valley through which that river runs extending from west to east to the north of the principal sources of the Ganges; and, in like manmer, the sources of the Indus and its tributary the Sutlej overlap each other, having their rise in close proximity to those of the Ganges and Jumnah, and flowing through valleys of similar character from east to west. This at first singular characteristic will be found to obtain in most if not all primary rivers.

The mountains to the north and south of these valleys differ more in their culminations than in the general development of their masses. Mr. Strachey gives the height of Tisekailas to the north of Lake Manasarowar as 22,000 feet, and another immediately to the west as 20,500; of Gurla immediately to the south, 25,200. Of others to the north, however, we know but little; to the south we have several accurate measurements. The same authority gives the following, on the 80th meridian N.L.:—Nandadivi, one peak, 25,700, the other 24,400; about 79° 30′—Kamil, 25,000; about 78° 45′—Porgyul, 22,700. The elevation of passes which communicate between the sources of the Sutlej and affluents of the Ganges is respectively, on the south, with the Khali, Lankpya, 18,000, Metadhura, 17,800; with the sources of the Alakananda, Lakhur, 18,400; Balch, 17,700; Holi, 15,000; Manna, 18,760. The elevation of the Nilary Pass communicating with the Bhagirathi is not given. The name Thibet is commonly applied to the entire length of the mountain region, from the sources of the Indus to those of the Menam. This country is too little known for any general geographical description to be attempted. Such local particulars as are available will be given in their respective places: it may, however, be fairly questioned whether the name Thibet can be properly applied to so large a territory, for since it must consist of a vast number of irregular and almost isolated mountain valleys, it seems scarcely probable that the same name was originally extended to them all, but rather that Europeans, in their ignorance of its geography, applied that name to the whole country to the frontiers of China, under the supposition that it was a continuous, though perhaps irregular, plain, and that there were no mountains of any importance to the north. The general character of its valleys may perhaps be obtained from considering that of the Sutlej.

2 *The Sutlej and its Affluents.*—The two rivers which united form the main stream of the Indus have both their rise in the same mountain chain, below their junction it has no affluents; it is, therefore, one of the few primary rivers which receive no accession from a secondary watershed. The dividing watershed between the sources of the Sutlej, and as may be concluded those of the Brahmaputra, is in about east longitude 82°, and must be of extreme elevation, as Lake Manasarowar is stated by Mr. Strachey to be 15,200 feet above the sea level. He speaks with rapture of the magnificent scenery of this lake, which must, however, be considerably diminished in comparison with many others by the want of vegetation; it is of circular shape, with rocky coasts, and may be about fifteen miles in diameter; a stream flows from it into the neighbouring Lake, Tso Lanak, or Rakas Tal, about five miles distant. This is of more irregular form, extending in greatest length from north to south, showing several islands in its southern extremity, where it spreads considerably to the east and west; it may be in its greatest length twenty miles, and in its greatest breadth at the south thirteen. From this lake flows the main stream of the Sutlej, taking a direction to the northward of west through one of the Thibetian valleys, where that characteristic commences, which is continued throughout the whole course of this river and the Indus into which it flows, viz. that while the banks are fertile the country at no great distance is arid and barren for want of water. The bottom of the valley, covered with alluvial soil to the depth of nearly 3000 feet, is cut into deep channels by the affluents of the river, which accumulates them in a tremendous ravine, the sides of which 'straight and almost as even as a railway cutting,' rise apparently like the sides of mountains, through which it rushes with the rapidity of a torrent. This valley is described as of about 120 miles in length by 60 in breadth, and with but little irregularity of surface. The elevation of the sources of the streams which fall into Lake Manasarowar cannot be less than 16,000 feet. After passing through the gorge which separates this valley from the southern slope of the mountain, its height to the north of Dabling is given as 8300; nearly half the fall of the entire course of the river is therefore obtained in this valley, and in a direct line of not more than 200 miles. The eastern portion of this valley, as it is the more elevated, so it is the more rugged and mountainous; from under the alluvial deposit the tertiary beds appear rising at the Rioti Pass to a height of 17,000 feet, beyond which the deposit extends. It is, therefore, clear that the whole of this valley at one time formed a great lake, or before it was elevated a portion of the sea.

It has been already remarked that the snow limit on these mountains rises higher to the south than the north; on that side, few of the mountain peaks, though rising to an elevation above 20,000 feet, are covered with perpetual snow, and this no doubt is to be accounted for by the want of aerial moisture, the clouds passing from the south being intercepted by the peaks on the spurs extending southward; but little snow therefore falls on the plain, and it can lie there but a short time, as not only sheep and goats, but the larger yak are fed without provision being laid up for them during the winter. At Lé, the capital of Ladak, it seldom exceeds an inch in depth; vegetation is, nevertheless, extremely scanty, and no doubt checked and stunted by the violence of the winds, which, in the afternoon, are a cause of dread and danger to the traveller; the nights, on the contrary, are still and calm.

To the north of the Sutlej, which is the most eastern branch of the Indus, the main source of that river has its rise under the name Singe Tsiu. The eastern fountains of this branch are found under the 81st meridian, and within a few miles of those of the Sutlej; passing far to the north and west, it encircles the other principal sources—viz., the Jelum, the Chenab, and the Rhavee, from which the country about the middle course of the river obtains the name Punjaub, or five rivers.

The Sutlej issues from its upper valley by a depression of not more than 8500 feet in elevation; here it receives a considerable affluent, the Spiti, but the passes on either side connecting its waters with those of the neighbouring rivers rise to a much greater elevation, as the Keobrang, of 18,300 feet. The name of this river, derived from the word Sutoodra, hundred channelled, gives an accurate idea of the country through which its upper waters flow, in the narrow channels cut by them at the bottom of deep ravines. Below the range of the Himalayas, it receives the Beas, its principal affluent, also from the north, but before leaving the hills it is above 100 yards across, and above the junction of the Beas 700, and navigable for small vessels. The Sutlej may be said to receive the accession of the waters of the inferior sources of the Indus, before joining the main stream, which it does 28° 55′ N.L., and 70° 28′ E.L., 470 miles from the sea, after a course of about 1000 miles. The Sutlej is the Hesudrus of antiquity; the Beas, the Hyphasis. This river has its source in the Ritanka Pass, 13,200 feet above the sea; it has a course of above 200 miles, a breadth of above 700 yards, but is shallow, and generally fordable in summer. The Chenab, the ancient Acesines, is usually said to receive the waters of the Jhelum and Ravee, the Hydaspes and Hydraotes of the Greeks, before its union with the Sutlej, 29° 21′ N.L., 71° 6′ E.L.; its course is about 700 miles; it is only navigable for rafts. The Jhelum, or Jailen, is, on the contrary, navigable nearly to the pass through which it emerges from the mountains, and for 70 miles in Cashmere, the valley of which it drains; its estimated course is 350 miles; it has a considerable affluent, the Kishengunga.

3 *The Indus and its Affluents.*—The Indus, or Sindhu—*i.e.*, the Sea*—has within the mountains a course of 120 miles; it has three affluents to the north, of which the Gartope is the principal, and one, the Cabool, immediately to the south of the mountains. This river rises at an elevation of 8400 feet above the sea, about 34° 21′ N.L. and 68° 20′ E.L.; it has a course of 320 miles, and is navigable for vessels of forty tons and upwards for 50 miles; it has several affluents, and the passes at its head-waters form the natural line of communication between the upper valley of the Indus and Persia. As stated above, the river of the Punjaub, the Punjnud, joins the Indus 470 miles from its mouth; below this it has no affluent, but frequently anastomoses. The Delta commences in 25° 9′ N.L. 68° 21′ E.L. It enters the sea by five mouths; the tidal movement is perceptible in its waters 75 miles from the sea; the river is navigable to the junction of the Cabool, at which point, 940 miles from the sea, it is 1000 feet above the ocean, 800 feet in breadth, 60 in depth, and a current of six miles an hour in rapidity; in the level country below, its course is from two to three, and it then becomes encumbered with sandbanks and alluvial deposits, which render its navigation difficult, if not dangerous. The land in its immediate vicinity, and especially its Delta, is of the highest fertility, but fertility at any distance is the result of irrigation. This river was the limit of the actual knowledge of the ancient Greeks.

4 *The Countries watered by the Indus.*—Of the countries drained by the Indus and its affluents, the Valley of Cashmere claims the first notice. It lies between the Punjaub on the south and Thibet on the north, and within 33° 15′ and 34° 30′ N.L., and 73° 40′ and 75° 30′ E.L.; its area is estimated at 4500 square miles. It is surrounded on all sides by mountains, and is approached by passes, some of which are at all times practicable. This valley is noted for its beauty and fertility; it is well watered, and has three lakes connected with the river Jailem; the largest of these, Lake Oolar, or Wuller, may be about fifteen miles in length, and is surrounded by forests. Lake Dal, which has become proverbial for its beauty, is about six miles long. Its climate

* This is the commonly received etymology, but there is another which connects it with the mythology of the Hindoos in the worship of the moon goddess, and is consequently a link between them, the Ionians, Assyrians, and Egyptians; it seems, therefore, the more important and more likely to be perpetuated.

is temperate, and rain falls plentifully in the early part of the year; it is subject to earthquakes. It produces the fruits and flowers, the rose especially unrivalled, both of tropical and temperate climates; rice is the principal product, with the water nut, which is raised for food in immense quantities; wheat, melons, tobacco, and cotton grow luxuriantly, and vegetables are cultivated in gardens floating on the surface of the lakes. Basalt is found in its mountains; marble and limestone are common, but there are few minerals or metals.

To the west of Cashmere the Valley of the Indus is inclosed by mountains of primitive rocks, while to the south are secondary stratifications, abounding in fossil remains. The valleys of the affluents of the Indus, which together are known by the name of Ladak, extend over an area which has been roughly estimated at 30,000 square miles. They are narrow and precipitous, and, consequently, sterile. The climate is severe, but the industry of the inhabitants secures sufficient produce for their sustenance. This country is the centre of the manufacture of the shawls known as Cashmere. Minerals are abundant, especially iron and copper; it extends to that of Bulti or Bultisthan, the character of which is very similar; and the area of which may be estimated at 12,000 square miles. Here the Upper Indus passes through the Valley of Iskardoh, which is little more than a gorge, nineteen miles long, by six or seven wide, but commands the passage to the lower country. The Kohisthan, or mountain-land of the Affghans, forming the valley of the River Cabool, is of similar character, as is all the country above the plain to the south and east of the junction of the Cabool and Indus. This plain is buttressed up by the Jangheer or Salt range, which rises abruptly from the plain to above 2000 feet, and may have an average elevation of 800 feet above the sea. The hills consist principally of sandstone, and have an average breadth of about five miles. This portion of the Salt range extends from the mountains of Affganisthan to the Jhelum, and forms the natural limit of the Doabs or arid plains below. Both the upper and the lower are, however, included in the district of the Punjaub. The upper is extremely fertile, and cultivated to the base of the mountains, and in many parts covered with thick jungle. The lower, where irrigation is possible, is also abundantly fertile, but only a very small portion of its surface has been made accessible to water.

The plain of the Punjaub is divided into five doabs by the rivers which intersect it; and extending from the Sulieman Mountains to the Sutlej and Punjaub, forms a triangle, which may be estimated at about 350 miles from east to west, and 400 miles from north to south, in extreme length and breadth. By some, however, it is made to include Ladak, and its length therefore estimated at 600 miles. Its northern limit is more usually placed at the junction of the Cabool and Indus; and with that limit this district would, on a rough estimate, contain above 75,000 square miles. The soil is generally sandy, yet all kinds of fruits and grains are cultivated; the sugar-cane flourishes, as do opium, indigo, and tobacco. The extensive pasture grounds support large herds of buffaloes, horses, and camels. From the hills are procured gypsum and rock-salt in immense quantities, alum, sulphur, nitre; and they contain abundant supplies of coal. In summer the climate is excessively hot and dry; but the winter is cold, and often frosty. Hence the inhabitants and animal and vegetable productions are vigorous. As on the east the Punjaub communicates with the Valley of the Ganges, so on the west it commands the passes into Persia and Affghanistan. It is, therefore, in many respects, the most important portion of Asia south of the Himalayas, not only in its political, but in its commercial relations.

Below the Punjaub, is the territory of Scinde, which has been compared, and not inaptly, to the lower valley of the Nile, bounded by mountains on one side and a desert on the other. It requires only the industry of man to render it by irrigation of extreme fertility; but like the Euphrates, which it more nearly resembles in its character, it has not the fertilizing periodical inundations, which give such importance to the river of Egypt. Its greatest length is nearly 400 miles, and its greatest breadth about 300: it may contain 60,000 square miles of surface. The upper part is the more fertile, approximating in character to the neighbouring district of the Punjaub, and affording the same products. Much of the country has, however, become unproductive, having been converted into hunting grounds by its late masters the Ameers. Wool is an important product, and a staple of manufacture. Wild animals abound, especially tigers, hyenas, wolves, and alligators. Climate excessively hot and dry. The Delta is covered with jungle and tall grass, and the deposit of the inundation is saline; yet the land in the immediate vicinity of the river is of high fertility. The Delta communicates directly with the Runn of Cutch. A portion of the waters of the river are anastomosing, and find their way through a lake formed by an earthquake in 1819; this during the inundation forms part of the Runn, which is an extensive salt marsh, formed at the same period, extending over an area of 7400 square miles.

5 *The District of Cutch and the River Loony.*—The district of Cutch, nearly an island, lies between the Runn and the Gulf of Cutch, which separates it from Gujerat. A chain of volcanic hills, called Lunkni Jubberl, stretches across it; and parallel to it, on the north, another, with a narrow valley between them; this, with the plain extending about twenty-five miles from the hills to the sea, affords the only cultivatable land in the district. Its soil is for the most part sterile; the products are principally dates, cotton, iron ore, and horses, a tract of land called the Bunnee, extending for forty miles along the shore of the Runn, and about seven miles wide, producing most luxuriant pasture. Its inhabitants, as might be expected from its position, are for the most part sailors. Cutch Gundava is a district of Beloochistan, lying between Lower Scinde and Affganisthan, not dissimilar in character from that of the Valley of the Indus generally; it is bounded on the north by the Gindaree Mountains; its area is estimated at 10,000 square miles.

The southern coast is formed by a high bank of sand, which extends from the Indus to the Gulf, and rises considerably above the level of the land behind it. At the eastern extremity of Cutch is the large island of Sauntulpoor, occupying nearly the entire entrance to the Runn, and leaving access to it by two narrow channels. There are two islands in the Runn, named Puchum and Kureer.

Cutch consists generally of secondary formations, sandstones, &c., interspersed with beds of iron and coal; basalt prevails in the volcanic range. The earthquake above alluded to raised a great embankment across the eastern branch of the Indus, now known as the Ullal bund, or God's dam. Though the vegetation of Cutch is scanty, animal life is abundant. The wild ass is peculiar to the Runn; pea fowl are numerous; insects are so numerous during the monsoon as to be a plague to the inhabitants. The climate is during the greater part of the year equal and temperate, but in midsummer it is excessively hot, and in midwinter ice is not uncommon; but little rain falls during the year.

The Gulf of Cutch receives the waters of the river Loony, and this river may very possibly at one time have been a secondary affluent of the Indus; but in this valley, as in that of the Euphrates, great changes have resulted from recent volcanic action. This is the only river which derives its waters from the western slope of the Aravalli hills, which separate the valley of the Indus from that of the Ganges; its sources are in the sacred lakes of Poolkur and Ajmeer, at the northern extremity of the Aravalli, and flows for 300 miles through Marwar; it has one affluent, the Jahu, which rises near Purbutsur, at the southern extremity of the same range. The Gulf of Cutch will, with other inlets of the sea, be described in the portion of this work devoted to Marine Hydrography.

6 *The Sources of the Ganges and Primary Affluents.*—The Ganges, the most important river of this portion of the Eastern Continent, as draining a

larger and more fertile country than any other, is usually said to rise from two principal sources, Bhagirath and Alakananda, in lat. 31° N., long. 79° E. The former, at Gangoutri, from beneath a snow-covered glacier, 13,000 feet above the level of the sea; the latter at Badrinath, about twenty miles to the west. Captain Strachey's map, however, shows the Jahnani to be the primary source; this, extending to the north, round Gangoutri, rises near Kedarnath, in immediate proximity to one source of the Alakananda. The Jahnavi receives a tributary stream from the southern face of the Nilang pass, about ten miles below the village of Gangoutri. The Bhagirathi flows in a southerly direction to Deopraga, where, joining the Alakananda, it forms the main stream of the Ganges. It receives a small tributary, the Bilangna, which has also its source near Kedarnath, at Tirhi; and as its primary source may be estimated at 15,000 feet in elevation, Tirhi as only 2300, and Deopraga as 1500, it must have a fall of 14,000 feet in about 150 miles; to describe the ravines through which its torrents rush is therefore unnecessary.

The principal sources of the Alakananda are in the southern faces of the Mana, Niti, and Balch passes; and as these are all about 17,000 feet high, they cannot have much less elevation than the sources of the Bhagirathi. One smaller tributary has its source near Nanda Achri, on the western face of a pass which opens to the valley of the river Kali; while, from the southern slope of that mountain another and more important tributary, the Pindar, has its rise at Rudarpujag. The Mandakni, having its source at Kedarnath, joins it from the east, and here the elevation is about the same as at Tirhi. Below the junction of its two principal streams, the Ganges receives two smaller tributaries, the Nagar and the Dun, which rise in proximity to the sources of the Ramganga and Jumna respectively; from thence the river flows with a southerly course to Hurdwar, and then, bending to the east and south, continues that direction to the Bay of Bengal. Its course is above 1500 miles; below Hurdwar it is from 1 to $1\frac{1}{4}$ mile in width; below Allahabad, often 3; at 500 miles from the sea it is 30 feet deep. It enters the sea by several mouths, which form the islands known as the Sunderbunds; at the eastern mouth the Brahmaputra unites with it, and its western, the Hooghly, is the entrance for sea-going vessels. The navigation is uninterrupted to the foot of the mountains.

The most important of the primary affluents of the Ganges is the Jumna, or Yamna—the Josnanes of Pliny. The main sources of this river are the Supin and Rupin, the former rising between thoso of the Bhagirathi and a tributary of the Sutlej. They are joined by the Pabar, which has its rise in the south slopes of the Barenda pass; their united waters form the Tons river, which unites with the Jumna at Kalsi, only 1700 feet above the level of the sea. This has its rise on the southern slopes of Jumnotri, which, like Gangoutri, is one of the loftiest peaks of this portion of the Himalaya range, having an elevation of 25,500 feet. At Raighat, about 10 miles in direct line from their junction, another tributary unites with their waters, which has its sources in the mountains to the N.E. of Simla. A larger and more important affluent, the Hindan, has its rise in the lower range of the Himalaya, and, with a course nearly parallel, unites with it below Delhi.

The Jumna, receiving tho first secondary affluent from the south, the Chumla may not improperly be considered the main stream of the river, although it receives, when united, the name Ganges. Its entire course is estimated at above 700 miles: it is shallow, and its navigation difficult; its breadth varies with the season, from 300 to 3000 feet. The Jumna joins the Ganges at Allahabad, and the district between the rivers is called, from its position, the Doab, as is usual to districts so situated, but the term is given to this without addition, *par excellence*, others, as in the Punjaub, having distinctive names given them.

The Ramganga, the next important primary affluent of the Ganges, rises in the lower range of the Himalaya, to the south of the main stream of the Alakananda and its affluent, the Nayar; it has a course of about 250 miles;

it receives from its left bank the waters of the Kosilla, or Kosi, the Khylas, or Bhurgoo, and the Gurra, the latter not far from where it joins the Ganges at Canouge. Higher up, however, the Ramganga bifurcates and joins the Ganges near the mouths of two smaller affluents having their rise below the hills; the Ganges receives no other primary affluent till it joins the Jumna at Allahabad; below this the Goomtee, which draws its waters from the plain between the Ganges and its affluent the Sariou, adds its tribute to the main stream; it has also a considerable affluent from the right, the Sei. The next, and one of the most important primary affluents, is the Goggra, or Garghara; it is also called the Sariou, and is properly the Sareghu of Indian mythology. Its principal sources are in the Kali and Kalipare, or Dewa, the former having its rise from three principal heads—to the east, the Gori, on the south slope of the Untadfura pass, in close proximity to those of the Dhauli and Piudar; the centre, also called the Dhauli, on the southern slopes of the Nyne and Kach, passes, from the north slopes of which flow the affluents of the Sutlej; and that to the east, the Kali having two heads, one at the Lankpya pass, opposed to one principal source of the Sutlej, and the other from the Lipu pass, from the other slope of which flows one tributary of the Karnali, when their sources unite about 25 miles from the Lankpya pass the river has an elevation of above 13,000 feet; while at the junction of the Gori, 40 miles in direct line to the W., it is only 2000 feet above the sea, showing a fall of above 11,000 feet in about 65 miles. The sources of the Karnali overlap those of the Kali, rising a little to the east of the Lankpya pass, and in the mountains forming the southern portion of the basin of Lakes Rakastal and Manasarowa; this is evidently one of the principal sources of the main stream of the Ganges. Thirty-five miles in direct line from its most easterly source, the elevation given by Captain Strachey is 14,500 feet; it is probable, therefore, that its elevation at that source is not less than that of Lake Manasarowa, or above 15,000 feet. Five other affluents, the Charka, on the right, and the Rapty; and two smaller on the left, drawing their waters from the plain, join the Goggra before its junction with the main stream. The Raptu is an important river, having its sources in the hills to the south of Nepaul; its course is estimated at above 270 miles. Almost all these rivers bifurcate and connect their waters: the Goggra thus connects itself with the Ganges by the Sarjoo, and that again is connected with the upper waters of the Goggra by the Tonse; the little Gunduck also, the lower affluent of the Goggra, on the left, is in like manner connected with the Gunduck, which again is connected by bifurcations both with the lower course of the Goggra and with the Ganges. The Goggra has a course of above 500 miles.

The next important primary affluent of the Ganges is the Gunduck, which rises from two principal sources in the Valley of Nepaul, from the southern slope of the watershed of the Sanpo; that to the west, the Gunduck, or Salagra, are about lat. 33° 30′, and that to the east, the Bori Gunduck, or Trisul Gunga, in about 35° 50′. This latter also receives two important affluents from the north, the Naling and the Marachangdi. The importance of this river will be seen in the extent of country which it drains; its course is estimated at above 360 miles: it joins the main stream opposite Patnah.

The Coosy has also its principal source in Nepaul, the San Coosy rising from the opposite slope of the watershed of the Bori Gunduck, on which stands Katmandu, the capital of the district, and the Aruin, far to the north, from the southern slope of the mountains which form the Valley of the Sanpo. This river has one important affluent on the right, the Cumlah, whose numerous tributaries drain the lower range of the Nepaulese hills, as the Bogmuttee does the district intermediate between the Gunduck and the Coosy.

The remaining portion of the country between the Coosy and Brahmaputra is intersected by a network of canals and rivers which renders description impossible, and can only be made intelligible by a map. The Mahanudda and the Teesta are the two most marked channels, the former having its sources in the lower range of hills, the latter in the valleys formed by the spurs of the highest mountain peaks in the world, Kunchinginja and Cumulari in the district of Sikkim; the principal bifurcation connecting them is the Parnabubah, and the lower course of the Teesta is called the Attri, the Carattyal, and Issamuttee form channels connecting these waters with the lower course of the Ganges and the Labnee, a bifurcation of the Brahmaputra. To the south of the Mahanudda and Teesta, the Ganges forms the bifurcations Sooty, Jellinghy, and Mattabunga, which uniting above the town of that name, form its eastern mouth, the Hooghly; this receives from the west several tributaries, the principal of which are the Dummoodal, Dalkissor, and Cossa; bifurcations of the Mattabunga form the Issamot mouth, and others, the Cobbaduck, while others again, stretching further northward, form what is called the Ballisore river, which debouches on the Horingottah; this is again fed from the main stream of the Ganges.

The mountain region in which the primary affluents of the Ganges have their origin, are not dissimilar from those about the sources of the Indus; here are, however, the loftiest peaks of the Himalayas, the culminating points of the vertical contour of the earth's surface; many of these are above 20,000 feet high, six above 24,000 have been measured, and more than one exceed 28,000: they are generally met with about 80 or 90 miles from the southern axis of the main chain, and are grouped together in masses, from the sides of which radiate the gigantic ravines through which the sources of the great river of the south find their way to the plain. In tracing these ravines, approach may be made within ten miles of the snowy peaks without having reached a greater elevation than 4000 or 5000 feet; the more northerly of these sources are found about 25 miles to the north of these peaks, and probably, therefore, the mean elevation is there much greater. The valleys to the north are entirely barren, the moisture being intercepted by the mountain summits, while those to the south are clothed with magnificent forests. The main valleys open principally to the south; the lateral valleys have distinctive characters and vegetation on their opposite sides, owing to the different proportions of heat and moisture by which they are affected, the northern being fertile, the southern comparatively sterile.*

At the foot of the mountains is a line of hills known as the Siwalik range, and between them a series of valleys called Duns; further to the east, in Nepaul, they are termed Mari; these are about 2000 feet and upwards above the level of the sea. Below the Siwalik range a belt of forest extends, being in breadth about ten miles, and below this again, a belt of marsh land, covered with a thick growth of reeds; this is not the result of any depression of the surface, but most probably of the filtration of the surface drainage of the upper country through the sandy soil in which the minor streams flowing from the lower hills are absorbed, and which is covered by the forest above noticed. This swamp is, however, confined to the country to the east of the Ganges, where the level is generally lower than to the west; it is called the Tarai.

The transition from the Siwalik hills, or sub-Himalayan range, to the plain is very rapid; rising abruptly from it to an elevation varying from 3000 to 4000 feet, they are well defined along the whole line of the mountains.

The Siwalik hills are of tertiary formation; to the north of them is found a belt of sandstone, possibly secondary; to the north of the Duns, argillaceous schists, grits, and limestones; but, like the sandstones, apparently devoid of fossils. The intermediate valleys, or Duns, are covered with deposits of boulder and gravel. Fossiliferous rocks do not appear until the highest peaks are passed, and the whole area between them and the line of sandstone is filled with metamorphic rocks. Two lines of granite traverse this portion of the mountains coincident with the highest peaks, generally found in veins, the peaks themselves being most apparently of stratified rock; the other, to the south, is of a different mineral character, and appears to exercise no marked influence on the contour; eruptive greenstones are also found. The crystalline schists which accompany the northern line of granite are followed by slaty

* See Appendix C.

beds, both argillaceous and calcareous, on which rest strata of the silurian period; indications of Devonian and carboniferous strata have also been found, and beyond these, muschelkalk and oolite, which form the northern watershed. The palæozoic strata appear to be about 9000 feet in thickness, and, with the oolitic, rise to a height of 20,000 feet: they support, as already noticed, the tertiary deposits of the great valley of Thibet, which appear identical with those of the Siwalik range.* Irruptive rocks occur in the vicinity of the lakes, and greenstone forms the summit at the pass of Balch, at an elevation of 17,600 feet.

In all parts of the mountains, covered with perpetual snow, glaciers abound, some of great magnitude.† The elevation of their extremities is from 11,500 to 12,000 feet. To the north, where the elevation of the snow line is the greatest, that of the extremities of the glaciers rises to 16,000 feet. The average motion of the glaciers may be about ten inches in twenty-four hours; and their ancient extension must have been very great beyond their present limits. To the south of the highest peaks, the limit of the snow line is 15,500, while to the north it rises to 19,000 or even 20,000; and, as already noticed, but small quantity of snow lies on the level of the Valley of Thibet, and none ever in summer.

Below 16,000 feet elevation tropical vegetation prevails to the height of 4000 feet on the face of these mountains; but the pinus longifolia often usurps the whole surface from 3000 to 6000 feet. From 4000 to 6000 feet, oaks and rhododendrons are numerous; and, from 6000 to 8000 feet, those trees, with andromeda, constitute the great mass of the forest. Above are found the deciduous trees of the temperate zone, mixed with pines, which prevail in the upper regions of forest, from 8000 to 11,000 feet. 'The arborescent grass (arundinaria) is, however, a marked and beautiful feature of the forest region to its extreme upper limit;' and the camærops palm is found at an elevation of 8000 feet, and growing to the height of 50 feet in places in winter covered with snow. The conditions required for this are heat and moisture, and these being abundant in the deep valleys of the rivers, tropical vegetation is carried in them into the centre of the mountains; and 'the traveller's eye rests on palms and acacias, intermingled with pines; on oaks and maples covered with epiphytal orchideæ; while pothos and clematis, bamboos and ivy, fill up the strangely-contrasted picture.'

The line of forest terminates suddenly at an elevation of about 11,500 feet. Above are found the mountain ash, rose, lilac, willow, juniper, &c., interspersed with a few scrubby and stunted trees. The pinus deodar seems confined to the western half of the Himalaya chain. The last tree met with is usually a birch, from the bark of which paper is made. The oak, horse-chesnut, walnut, elm, yew, and several maples are found in the forest belt; and below, within the belt of evergreens, the cypress, ash, birch, elm, holly, hornbeam and alder, with the laurel, all attain considerable size. The Alpine region above the forest is clothed with most luxuriant herbaceous vegetation; but the Thibetian valley is almost entirely divested of it. The limit of vegetable life varies from 17,000 to 19,000 feet. Wheat and barley are cultivated within the valleys at an elevation of 11,500 feet; but on the outer slope of the hills, this cultivation is seldom carried above 5000 feet, never above 8000 feet. A species of wild ass is found in Thibet. The Yak, the domestic animal of that country, is also found wild in secluded portions of the mountains. Two sorts of wild sheep are found, one of which appears identical with the Rocky Mountain sheep of North America. The hare, marmot, and mouse are not uncommon at elevations from 14,000 to 16,000 feet. The ounce, lynx, wolf, and fox are also met with in those regions. The raven, chough, hoopoo, bustard, goose, with ducks and teal in abundance, were found by Captain Strachey at elevations above 15,000 feet; vultures, eagles, and hawks, with herons, gulls, and tern about the lakes; the pigeon, dove, lark, wagtail, and other small birds, as well as the partridge.

---

* See Captain Strachey's paper, vol. xxi., *Royal Geographical Society's Journal.*

† Dr. Hooker describes a wall of ice 4000 feet in perpendicular height.

The lakes and all, even the smaller, streams abound in fish.

7 *The Lower Waterparting and Secondary Affluents.*—The watershed between the Jumna and the Sutlej, immediately below the line of hills, is of scarcely perceptible elevation, the extreme height above the level of the sea not being more, probably, than 1200 feet. To the south, however, the limits of the respective valleys of the Loony and Chumbul are clearly defined by the range of the Aravalli Hills, at the western base of which extends the great desert, with its fringe of forest, which stretches from Ferozepoor to the Runn, a distance of about 450 English miles; its breadth varying from 50 to 100 miles. It lies on a basis of sandstone. The Aravalli range extends S.W. and N.E. for about 300 miles, rising abruptly from the desert toward the west, but descending more gradually to the east, throwing out spurs and table-lands for sixty miles from its main axis, and reaching towards Delhi and the banks of the Jumna. Indeed, the entire country between the Aravalli and the Vindhya range is known as the table-land of Malwa. The Aravalli rise to a mean height of 3500 feet, and are of primitive formation. Their summits consist of large masses of quartzose rock, and hard red sandstone is found at their western base. To the south they bend eastward round the sources of the small rivers Suburnulty and Mhye, and join the Vindhya range, which, stretching away to the eastward, forms the entire southern watershed of the secondary affluents of the Ganges. These mountains rise abruptly from the valley of the Nerbuddah on the south to an elevation of about 2500 feet, and form the southern buttresses of the table-land of Malwa, which may have an extreme elevation of 2000 feet, and slopes gradually to the north and east into the Valley of the Chumbul, which, with a N.E. course of about 500 miles, falls into the Jumna, eighty-five miles below Agra. Its affluents are the Sind and Nemij, which unite before reaching the main stream and the Parbuttee, both on the right bank. Below the Chumbul the Kohary, Bettwah, Sind, and Dessam are affluents of the Jumna. The Cane, with its three sources, the Sonar, Beernic, the Tonsa and its affluent the Boaker, which have their rise in the northern slope of the hills which form the Valley of the Sone, a more important affluent of the Jumna. This river, rising near the sources of the Nerbudda and Mahanuddy, receives several important affluents from the south, the Nurar, Kunker, and Coyle; although flowing through a hilly country, they are not of much use for purposes of commerce. The Sone, after a N.E. course of about 450 miles, flows into the Ganges, twenty-five miles west of Patnah. Near its mouth the Sone anastomoses; and the smaller affluents from the south, the Pangoon, Fulgo, and Dunnean bifurcate, and the country assumes a similar character to that on the opposite bank of the main stream.

8 *The Great Plain of Hindosthan.*—The great plain through which the Ganges and its tributaries flow extends from the debouche of the Indus to that of the Brahmaputra, prolonged to the south, on the one hand, to the Bay of Bengal, and on the other to the Arabian Sea—i.e., from the mouth of the Ganges to those of the Indus. Its area has been estimated at 500,000 square miles; but of this about 150,000 are occupied by the great desert already alluded to. The Valley of the Ganges and its tributaries is extremely fertile, and varies but little in its character or productions. The course of the main streams, the Jumna and Ganges, before their junction, being through the district of Delhi, naturally sultry and dry, but fertilized by canals constructed by the Mahomedans after their conquest. To the south, Gualior is of similar character, but intersected by mountain ranges, and the district of Malwah derives its name from its mountains, which are continued on the southern bank until the junction of the Sone. This district, a large portion of which consists of secondary sandstones overlaid with argillaceous limestones, is rich in precious stones, and contains the diamond mines of Punah. Here are also the Salt Lakes, Samber, which is twenty miles long, by one and a-half broad, the Deedwannah, and Sir; and the river Sursootee is lost in the sand, under which it is believed by the Hindoos to find its way to Allahabad. On the north, the district of Oude forms a fertile plain, yielding the richest produce

of grain, both wheat and rice, sugar, indigo, opium, &c., and this character is maintained through the districts of Allahabad and Bahar. The climate is more temperate, and, consequently, more healthy than that of Bengal, through which the lower course of the river is continued to the sea. The upper portion of the delta forms the district of Jessore, which is low, hot, and very fertile. Though much of its surface is still covered with jungle, it produces abundant crops of rice, sugar, hemp, mustard, indigo, tobacco, and turmeric. The lower portion of the delta is known as the Sunderbunds, a densely wooded tract, extending 170 miles along the coast of the Bay of Bengal. Here the annual deposit of mud is estimated at 6,000,000,000 cubic feet. In the dry season the main rate of the current is less than three miles, and in the rainy season not more than seven or eight; and, consequently, the principal mouths of the river are rendered inaccessible to large vessels by bars of sand and mud.

9 *The Sanpo and Brahmaputra.*—The Brahmaputra brings to the sea a far larger volume of water than the Ganges; for sixty miles above its confluence with that river, it has a regular width of from four to five miles; the estuary into which their united waters flow has a breadth of twenty miles; in lat. 27° 45′ N. and long. 95° 25′ E., it receives the waters of the Dihong from the west, or rather the main stream comes from that direction and receives its tributary waters from the north and east, the Dihong having three times as large a volume of water as the Brahmaputra. Where this can be derived from, unless it be from the Sanpo of Thibet, it would be impossible to say, and in the absence of actual surveys it may be assumed as certainly the continuation of that river. Of the Sanpo little is known, but that it rises in immediate proximity to the main sources of the Sutlej and Ganges, and flows through an elevated valley similar to that of the former river, but in all probability of far greater extent and fertility. One of the sources of the Sanpo is in Lake Paltce, remarkable for its circular form and for containing a large island, which occupies the greater part of its area; the lake is forty miles in diameter. Breaking through the mountain barrier, from whence its upward course is unknown, it flows through Assam, receiving several important affluents, and here it anastomoses, and encloses several large islands, two of which are seventy-five and fifty miles in length respectively; in Assam it is said to receive more than sixty affluents, principally from the left; on the right, the Bonap flows from the slopes of the mountains through the district of Bohtan, as does the Gadala, which joins the main stream after it issues into the plain of Bengal; here it is 1200 yards wide and very rapid, from hence to the sea its course is 400 miles in length; as already noticed, a large bifurcation, the Jena, unites it with the Ganges. The entire course cannot be less than 1500 miles; it flows through jungle and marsh lands, is very inaccessible, and the rapidity of the current renders its navigation impracticable. It is more than probable that in its upper course it receives important affluents from the western slope of the watershed of the Chinese rivers; below Assam it bends round the hill district of the Garrows, and below receives the united waters of the Soormal and Barak, the principal rivers of further India. The latter has a course of above 300 miles, but very tortuous, is frequently 200 yards across, and has during the rains a depth of 30 to 40 feet; the former may extend above 200 miles. The further portion of this district, Cashar, is mountainous and well-wooded, abounds in limestone; the greater part remains still uncultivated; the plains are fertile and produce rice, cotton, and sugar. The district of Assam is also very fertile and well-wooded; the tea-plant grows wild here, and coal and iron abound; gold-dust, amber, and petroleum, are also found.

The district of Bohtan differs from the other sub-Himalayan regions in having its lower elevations but scantily covered with vegetation; it is rich in metals, especially iron and copper; it produces abundant supplies of timber and esculent vegetables, but of grain, insufficient for its inhabitants, who import from Bengal.

CHAPTER IV.

THE SECONDARY WATERSHEDS AND RIVERS OF SOUTH-EAST ASIA.

1. The Gulf of Cambay and Gujerat.—2. The Ghauts and the Deccan.—3. The Secondary Watershed of the Brahmaputra and Yang-tse Kiang.

THERE is more connexion between the secondary watersheds of India than is at first sight apparent. Of those to the east of the Brahmaputra we, indeed, know little, but of those to the west and south of the Ganges, a careful examination of a map will show that, however they may, for the convenience of arrangement or of division of the country, be separated, they in reality all diverge from the table-land of Malwah between the head waters of the Sone and the Chumbul, as from a centre, and that the Vindhya chain and the Western Ghauts are, together with the Aravalli chain, but one system, forming the secondary watershed of the great plain of Hindosthan, and by their extension to the south with the subordinate or tertiary system of the Eastern Ghauts forming the peninsula of India.

From the Rhamghur hills, which form the watershed of the Dumoody, an affluent of the Hooghly, to the Gulf of Cambay, the Vindhya chain is continuous to the south and west; it appears to throw out spurs, which form the valleys of the Mhye, Nerbudda, and Tapty, and then passing directly south becomes, to the north of Goa, the limit of the coast line. To the south below Seringapatam, the Neilgherry hills form the point of junction between the secondary and tertiary chains, which latter passing to the north-east, forms in the Eastern Ghauts the coast of Coromandel. The valleys which in their extension form the Gulf of Cambay, and naturally, therefore, appertain to the Valley of the Indus, claim our attention first.

1 *The Gulf of Cambay and Gujerat.*—The watershed of the three small rivers, the Bunnass, Surraswattee, and Sundramuttee, which fall into the north-east part of the Gulf of Cutch, is extended into the Peninsula of Gujerat, or, as it is also termed, of Kattiwar, which forms the western limit of the Gulf of Cambay, and divides it from the Gulf of Cutch. This district is about 150 miles in diameter, its surface diversified and watered with many streams, of which the principal are the Matchoo, falling into the neck of the Gulf of Cutch; the Bhandur, falling into the sea on the south-western coast; and the Setroonjee, which adds the tribute of its waters to the Gulf of Cambay.

The name Gujerat is not confined to the peninsula; in a political sense, it is now more properly applied to the coast of the gulf, and especially the embouchures of the rivers Nerbudda, Tapty, Mhye, and Sabermutty. The peninsula is separated from the main land on the east by extensive low marshy lands, which are continued round the coast. The Sabermutty river flows into the head of the gulf; it rises from two sources, the one near the head waters of the Burnass, the other near those of the Mhye; it has a course of about 150 miles in length, but is nearly dry during the hot season. The northern sources of the Mhye are found in close proximity to the western sources of the Chumbul, while its southern approximate as closely to the southern sources of the same river, having their rise in the northern slope of the watershed of the Nerbuddah; thus, while the two principal sources of the Mhye flow south-east and north-west, its main stream, after their junction, takes a south-west direction. The Anass, its principal tributary, flows from the same watershed and parallel to its southern waters; this is the next important river of Gujerat to the Nerbuddah; it has a course of above 300 miles, and the inlet of the gulf into which it falls is above five miles in width; from the irregular course of the river, the varied character of the country which it drains may at once be concluded.

The Nerbuddah, or Narmada, Narmadus of the ancients, is next to the Indus the principal river of India, flowing into the Arabian Sea; its head-waters are found in immediate proximity to those of the Sone, Mahanuddy, and Godavery, and it extends for 620 miles, or about two-thirds of the distance across the entire peninsula; rushing with rapid torrent through a narrow valley, it receives no affluent of importance; it is 600 yards across at about 100 miles from its source, nearly double that width before it passes the line of the sources of the Mhye, and in parts three miles wide near its mouth; its navigation is impeded by cataracts, rocks, shoals, and islands. The north-west limit of its valley is formed by the precipitous escarpment of the Vindhya range; its southern by the more gradual northern slope of the Sautpoorah, which separates it from the valley of the Tapty, and must be considered an elongated spur of the Vindhya chain.

The Tapty rises in the centre of the peninsula near the head waters of the Godavery, from many sources, which combine to form two principal streams—the Tapty and Poorna, these unite about 150 miles in direct line from the main source, and continue their course to the sea under the former name for about 250 more. The valley of this river is more extensive in proportion to its length than that of the Nerbudda; and its affluents larger and more numerous. Several of these, of which the Boary is the principal, fall from the inner flank of a spur of the Ghauts which approaches the main stream about 100 miles from its mouth, and forms the amphitheatre in which their waters are collected. Their sources are found in close connexion with the extreme western source of the Godavery.

Below this river the Gunga and Gooria drain the coast district, which narrows gradually, and still lower the sea forms a deep inlet round the islands of Salsette and Bombay, and others of less note. The former is in length eighteen and in breadth thirteen miles; the latter eight by three; it is formed of two ranges of greenstone connected by sandstone strata; the sea is kept out of the valley between by an embankment. To the south of Bombay the sandy district of the Concan stretches in long narrow line at the foot of the Ghauts, for the most part covered with cocoa palms. The hills produce teak in abundance; cardamoms and pepper are cultivated for export, and sheep are fed for wool. Still further south, where the Ghauts approach more closely to the sea, the torrents Caidynuddy, Gungawally, and Sheravutty almost claim the rank of rivers; the former, also called the Carawotty, near Goa, is noted for the magnificent fall with which it descends from the hill.

The districts of Cochin and Travancore to the south are mountainous, fertile, and well watered; some of the small rivers have considerable inlets at their mouths, one at Cochin extends for fifty miles, and receives the waters of several rivers.

2 *The Ghauts and the Deccan.*—The Godavery and the Kishna drain the table-land of the Deccan, and their waters fall into the Bay of Bengal at little more than 100 miles distance from each other, while their extreme sources are 700 miles apart from north to south, and above 600 west from the coast of Coromandel. From this it will appear that what is usually termed the table-land of the Deccan is a congeries of valleys converging from north by west to south, and having their outlets by the channels of those rivers in a south-east direction, into the Bay of Bengal, the table-land being formed on the slope of the mountains extending round their head waters, and as far as the sources of the Mahanuddy.

These are the Vindhya range and its spurs, already described, to the north, and on the south the double chain of the Ghauts and the Neilgherry hills, by which they are united. The Western Ghauts, a word meaning a mountain pass, and therefore incorrectly applied to these mountains, rise abruptly from the sea to the west at an average distance of thirty miles, as already noticed, but descending by terraces to the east form the valleys of the rivers flowing into the Bay of Bengal, and enclosing the greater part of the peninsula. The northern portion of this chain is less elevated than the southern, not exceeding for the most part 3000 feet in elevation. About the north-west sources of the Kistnah it assumes an average height of about 4500 feet, and about the south-west sources of the same river granite rocks rise 6000 feet in elevation; further south the lowest summits reach 5000 feet, and the Neilgherrys approach 9000.

The Eastern Ghauts join the Neilgherrys on the south, and the Ramghur hills on the north. Their highest part is near Madras, reaching an elevation of 3000 feet. Beyond the valley of the southern affluents of the Cavery a mountainous coast stretches for 200 miles to Cape Comorin, covered with luxuriant forest vegetation, and terminating in a granite bluff 2000 feet high, from which a low ledge of rocks extends into the sea. This country is intersected by numerous lovely and fertile valleys.

Between the Western Ghauts and the sea there is but a narrow slip of land, and the abrupt sides of the mountains are covered with vast forests of the finest teak, and dense jungles of rattan and bamboo. The slope of the Eastern Ghauts to the sea has a different character; their summits are for the most part bare; their line is not continuous, and the land along the coast is low and of considerable breadth, forming alluvial plains of great fertility, along the shore of which the deposits from the rivers form a gradually shelving bank of upwards of 100 miles in breadth.

The Godavery, the more northern of these rivers, has, as already noticed, its sources in connexion with those of the Sone, the Tapty, and the Nerbudda, by which it is overlapped, to the north; on the west its tributaries rise near the sources of the Mahanuddy. Its principal affluent on the north is the Wyne Gunga, which receives from the west the united waters of the Whurdah and Pain Gunga. The larger number of the affluents of the main stream are from the north-west, but before its junction with the Wyne Gunga it receives the waters of the Manjera from the south, the tortuous channel of which is but little separated from the north-west affluents of the Kishna. The course of this river is estimated as above 800 miles; its breadth in the rainy season is frequently one and a half miles, but in the Eastern Ghauts at the pass of Papkoonda it is contracted to a quarter of a mile. It reaches the sea by two principal mouths, enclosing a delta of fifty miles in extent both on its base and from its apex; these are navigable for ships of large burden.

The Kistna or Krishna rises in the Western Ghauts, within thirty miles of the sea, at an elevation of 4500 feet; it has a course of about 600 miles through a mountainous region, and receives several large affluents. The principal of these are the Toombuddery or Toongabuddra from the south, and the Beema from the north. One of the smaller affluents in the upper course of this river, before the junction of the Beema, is the Dhou, the waters of which are salt. The northern head waters of this river are within forty miles of the sea coast, near Bombay, and the southern about fifty miles from Goa. It enters the sea by several mouths, anastomosing both to the right and left, but its delta is not as extensive as that of the Godavery, being not more than twenty miles from the apex, and extending about thirty along the coast, unless indeed it be considered to reach to Massulipatam, where some of its waters find their way to the sea by a narrow channel. The space intermediate between the Godavery and Kishnah is occupied by Lake Colair, and the anastomosing branches of the two rivers connecting with it. This lake is about forty-five miles long, and twelve broad, but this space is only covered with water for the three months of the rainy season, during which time the higher portions of ground form many small islands; during the rest of the year much of the soil, which is very fertile, is cultivated.

The Mahanuddy (the great river) though not so large as its name implies, is still of considerable importance, since it is navigable 300 miles from its mouth, rising, as already noticed, in immediate proximity to the head water of the Sone, Nerbudda, and Godavery; it enters the Bay of Bengal by numerous mouths after a course of 500 miles; beyond it the Eastern Ghauts lose their identity, and are connected with the Rhamghur hills. It is during the dry season fordable at Cuttack seventy miles in direct line from its mouth; yet there it is during the rains two miles wide, and one mile, above 200 miles from the sea, where its course bends at right angles from south to east. The mouths of the Mahanuddy extend along the coast for above 100 miles, from the Bargoby river, near Juggernatha, to the northern mouth, which joins the sea in false bay; below Buddee, its stream anastomoses frequently, and its delta is apparently much larger in proportion to the size of the river than that of the Godavery or Kistnah. Its anastomosing branches to the north join with those of the Brammy, or Mypurra, and that river again with those of the Byturny Domrah, or Cayle, both of which rivers fall into the sea to the north of Cape Palmyras. To the north of these the Subunrecka, or Golden line, falls from the north-east slope of the Rhamgur hills to the sea, with a course of 250 miles, of which it is navigable for twenty; it has a great fall in its upper course.

Between the Mahanuddy and the Godavery the Polair, Cicacole and other smaller streams fall from the slope of the Ghauts into the Bay of Bengal, and form the tertiary waters of the peninsula; with these must be classed the Vellore to the south. In the same district is the Chilka Lake, properly to be classed among lagoons, being separated from the sea only by a narrow belt of sand; it is about thirty miles long, and more than ten broad. It was estimated to cover an area of near 800 square miles, but it is gradually decreasing in size; it has numerous inhabited islands, and great quantities of salt are produced from it.

The Pennar river drains the country, encircled by the Kistnah and the Cavery. It has a course of nearly 300 miles; it has numerous affluents on both banks, one of which, the last from the south, spreads into an extensive lake. Two smaller rivers to the south, the Polar and Punnair, may possibly be classed in the tertiary system. Pulicat Lake, an inlet of the sea rather than a lake, or even a lagoon, is about forty miles south of the mouth of the Pennar. It is in length about forty and in breadth about ten miles, and separated from the sea by a long narrow island.

The Cavery or Cauvery and its branches drain the southern and eastern slopes of the Neilgherry hills, and the Pennar and Urgel and its southern affluents occupy the valley between them and the hills which terminate the peninsula at Cape Comorin. The district which it drains, buttressed up by the Neilgherry hills, has an average elevation of 3000 feet above the sea, and its main sources have an additional elevation of 1000. Its principal affluents are the Henavutty, Shimsona, and Arkavutty from the north, rising in close proximity to the southern sources of the Kistnah, and the Cabanny, Paniang and Urgel from the south. In its upper course above the island of Sivanasamudra it forms two cataracts of 460 and 350 feet in height respectively; in its lower course, near Trichinopoly, it divides and forms the island of Serinham, and after a course of near 500 miles it falls into the sea through many mouths, forming a most extensive delta, which may be roughly estimated at seventy miles from apex to base, and near 100 in extension along the sea shore. Its northern mouth, the Coleroon, flows through higher land than the rest of the delta, and is supported by a massy dam. It is probable that this has resulted from the gradual deposit of the waters of the river, assisted by the labour of man, which has been bestowed on it in preference to the other mouths, the most southern of which join the sea to the west of Cape Calimere. This river, though not navigable for large vessels through a great part of its course, is more useful in irrigation than many apparently more important.

The rivers of Tinevelly to the south are small and comparatively unimportant. The surface of the country is diversified with small streams and lakes; to the north it is fertile, but to the south sandy and covered partially with palms; rice and cotton are produced in the valleys, grain on the hills. The climate is equable, but rain falls in both monsoons, in consequence of its position between the Bay of Bengal and the ocean.

The island of Ceylon, which geographically must be considered a continuation of the peninsula, will be described, as well as the coasts and their inlets, together with the Indian Ocean.

The Deccan, so called from 'Dacchina," i. e., the south, offers three distinct characteristics, that of the higher table lands about the sources of the rivers, producing grain of all sorts, with tobacco, limestone, marble, iron, and copper; in the district below, rice and cotton. To the south, in Mysore, which is more elevated than to the north, a great portion of the surface is pasture land, and European grain, drugs, and spices are raised. The coast district, which is the hottest in India, produces principally rice; to the north, however, in the Circars, there is much pasturage.

3 *The secondary watershed of the Brahmaputra and Yangtse Kiang.*—Of this we know less than of most other portions of the earth's surface. It appears, however, distinctly traceable in an easterly direction by the sources of the rivers from Assam to the north of the parallel of 25° N. lat. until it bends northward round the lower southern affluents of the great river of China, and approaches the sea in about latitude 29° N. Should the Latchou prove, as some suppose, a source of the Mykiang, and not, like the Petchou, of the Chinese river, this continuity would be broken, and it may be assumed as more probable, if not as certain, that the rivers of Burmah and Siam are secondary rivers, falling from its southern face. What little we know of this hill country to the west shows it to be rich in minerals and metals as well as precious stones, in timber and the vegetable products, but the narrow course of its streams, and the small number of affluents which they receive, show also very plainly that the greater part of its surface must be mountainous, rocky, and barren.

The most extensive valley to the south is that of the Irrawaddy, which flows through Burmah, on either side of which long narrow spurs stretch from the principal range to the sea. The coast district to the west of Burmah is low, hot, and very moist, its soil very fertile, and much covered with forests; its products spices, sugar, cotton, tobacco, betel, and indigo: the hills afford iron and other metals. Its rivers are the Chittagong and Nauf, the former being a mile wide, and navigable at its mouth. Lower down, in Arracan, the coast is swampy, much indented, and covered with islands. Its rivers, the Arracan, Urgas, Aeng, and Sandoway, are all partly navigable; the former, also called the Kirlandyne, has a course of 200 miles, and vessels of 250 tons enter its mouth. In addition to the products of the more northern, the portion of the coast is rich in timber and cattle, iron, coal, and naphtha. The island of Cheduba has an area of 300 square miles, and has similar products to the coast, as has also the island Ramree, which is fifty miles long by fifteen broad.

The river Irrawaddy rises from several sources in the southern slope fo the secondary watershed of the Brahmaputra to the east of Assam; these form two principal branches, which unite more than 350 miles from its mouth; above this point the country soon becomes mountainous, and of the rivers which drain it little is known; for 800 miles the river is navigable during the rainy season, and may always be ascended as high as Ava by vessels of 200 tons. The course of this river is generally south, but about fifty miles north in direct line from the junction of its two principal streams, it bends at right angles to the east, and again to the south; at the eastern extremity of this portion of the river it receives a large affluent from the east, the Mogoning or Mynnganny, which is the limit of navigation for sea-going vessels. It is navigable for canoes upwards of 200 miles further north. The main stream varies from one to four miles in breadth. The Delta commences about 120 miles from the sea, and its numerous mouths and anastomosing branches cover an area of about 10,000 square miles, and occupy the whole coast from Cape Negrais to the mouth of the Thalaian, i. e., the whole northern shore of the Gulf of Martaban. The lower part of the course of this river is covered with teak, forest aud jungle; further north the country becomes more open: rice is at present the principal serial product, but maize and wheat grow well, and all the productions common to India might be forced here. The forests furnish valuable woods aud gums. Palms, the sugar cane, tobacco, cotton, and indigo, are indigenous.

The mountain region produces turpentine, limestone, and marble, precious stones, especially sapphires and rubies. Gold, silver, iron, copper, tin, lead, antimony, amber, petroleum, natron, nitre, salt, and coal. The petroleum wells on the banks of the Irrawaddy occupy an area of sixteen miles square. Among the quadrupeds common to this country are the tiger, leopard, elephant, rhinoceros, hog, deer, ox, buffalo, bear, otter. The upper portions of Burmah are said to be of primary formation, the secondary series occupies the district lying between 18° and 22° N. lat., below which the surface is alluvial. The climate varies with the soil and elevation, and in all respects this country may be considered a type of the districts south of the Himalayas and east of the Indus.

The Saluen Thawneng, or Thaliain, is also a noble river, navigable to a considerable distance from the sea, and flowing through a country similar to the valley of the Irrawaddy, but of it little is known. It is, probably, connected with that river by anastomosing branches and canals in the delta; it falls into the east angle of the Gulf of Martaban, so named from a town situated at its mouth. The Meinam is larger, and falling into the Gulf of Siam, has a well-defined watershed between it and the Saluen, which prolonged to the south and east forms the peninsula of Malacca. The name implies mother of waters, and the three principal mouths of this river admit large vessels, but of its upper course little is known, nor can more be said of the great river of Anam or Cambodia, the Menam Kong, which is, however, supposed to have a course of above 1300 miles through highly fertile country, rich in minerals and metals, and the delta of which extends above 150 miles, stretching into the sea above fifty miles beyond its present principal mouths. Cochin China, which lies on the outer slope of the east watershed of the Menam, is about 600 miles long, but does not exceed 150 in width; it consists of numerous transverse valleys, opening to the east, formed by spurs projecting from the main range of mountains; these are lofty, and approach the coast, which is consequently deeply indented. This country is to be noted for the beauty of its scenery, the salubrity of its climate, and the richness of its vegetable productions; it adds tea to the other products common to the mountainous districts already described.

To the north is the fertile alluvial plain of Tonquin, watered by the river of the same name, which has two principal sources, the Sang-Kai and Lisien-Kiang; other smaller rivers flow into the Gulf of Tonquin to the north and south; in this district rice is abundantly productive in the low lands, the products of the mountains being similar to those of the rest of the peninsula.

The mountain ranges dividing these rivers are estimated, probably on insufficient data, as from 3000 to 5000 feet in height; that which passes through the length of the Malay peninsula is there more elevated, rising to 6000, and although depressed to the south, Mount Ophir, a detached peak, is estimated at 5700 feet elevation. This peninsula extends through 13° of latitude, and varies in breadth from 60 to 170 miles. It is fertile, and its products similar to the other mountainous district already noticed; it abounds specially in spices, caoutchouc, resins, coffee, and sago. Gold and tin are its principal metals, and produced in considerable quantities. The eastern coast is thickly covered with islands; off its southern extremity is the great island of Sumatra, from the north-west point of which a range of volcanic islands is continued to the coast of Arracan, enclosing a portion of the Indian sea of the length of the peninsula, and about 350 miles wide, which communicates with the China sea by the Strait of Malacca.

CHAPTER V.

THE WATERSHEDS AND RIVERS OF EASTERN ASIA.

1. The primary watershed of Eastern Asia.—2. The great river of China.—3. The secondary watersheds.—4. Kwan Tung and Fokein.—5. Chang Tung, the Corea and countries bordering the Yellow Sea.—6. The river Amour and Mantchouria.

TO the north of the valley of the San-po the primary watershed of Asia appears to assume the character of a vast knot, surrounding a plateau from whence the ranges which form the limits of the valley of China diverge to the east, while the main range is continued along the edge of the Great Desert, until it joins the secondary range, which forms the northern limit of the Shamo, and passing round the sea of Okhotsk issues in the peninsula of Kamtschatka and towards Behring's Straits. Of this, in truth, very little is certainly known, and its general character may be, perhaps, best considered from the Chinese description of the district of Koh-ko-nor.

So far as an intelligible account can be given, it would appear that from the great mass of mountains to the north and west of the sources of the San-po, the great knot of Padisha, the main line continues to the north-east until it sends out spurs of considerable elevation between the sources of the Yangtse-Kiang and the Yellow river enclosing the district of Koh-ko-nor; the principal of these, under the name of Suieh-ling or snowy mountains, unites with the Yung-ling or cloudy mountains, which projecting south below the 30th parallel of latitude, gives that direction to the main sources of the Yangtse-Kiang, which bends round their southern extremity, and then following the impulse of the secondary chain takes a north-east direction to the sea, the intermediate mountains receiving various names of local significance.

To the south, four smaller ridges diverge from the same centre and run parallel, and within 100 miles of surface to the frontiers of Burmah. Another range passes away due east, forming the watershed between the Hoang-ho and Yangtse-Kiang, which is again nearly met by other ranges from the north-east, thus separating the upper, by well defined limits, from the middle and lower course of the rivers of China. Koh-ko-nor, the northern extremity of this central knot, is rough and most irregular in its character, mountain peaks rising from it far above the limit of eternal snow, a desolate region glistering with quartz crystals, and reflecting back the rays of the sun from its dazzling rocks and sand covered valleys. Its terrific character peoples it, in the imagination of the Chinese, "with Gorgons, Phantoms, and Chimæras dire." The eastern slope of these mountains is studded with lakes, the Koh-ko-nor, which gives its name to the district, is seventy miles long and forty broad; it is also called the Tsing-hai or Azure Sea, and was formerly considered the source of the Yangtse-Kiang.

2 *The Great River of China.*—The Yangtse-Kiang, Yangtzkiang, son of the ocean, or simply Kiang or Ta Kiang, the great river, used commonly to be called the Kiang Ku, i.e., the mouth of the river. The primary sources are probably about the 89th meridian east longitude, near the Tengkirinor in Thibet. From thence these streams unite to form the Murussu or Muhlusu, which is soon after joined by three other streams, the more northern of which have their sources in immediate proximity to the southern sources of the Hoang-ho; by some, the main streams before their union are called Ya-lung-Kiang and the Kucha-Kiang, but here both names and positions are uncertain; from the junction of the Ya-lung-Kiang, which is an important afflnent, flowing for 600 miles from the north, its course is better known, but this is not improbably 1500 miles from its main sources. It bursts from the mountains in latitude 26°, and then turns to the

northward. Until its junction with the Ya-lung the main stream is called Kinsha-Kiang, gold sand river, afterwards the Ta Kiang; by the Chinese the Ya-lung is esteemed the more important. From its junction with the Yuen-Kiang it takes the name by which it is more generally known. It has several other large and important affluents, the names of which are differently represented; of these the Siang and Yuen fall into the Tunting Lake on the south, and thus unite with the main stream. This lake may be estimated at seventy miles in length by thirty in breadth, and 220 in circumference, many smaller lakes connect with this, covering an area of 200 miles long by eighty broad. The Kang-Kiang, also from the south, in the lower course of the river, flows through the Payang Lake, and continues the connexion of the provinces from north to south, effected between the great rivers by the Grand Canal. The Payang Lake is about 90 miles long by twenty broad, it is studded with beautiful islands, and from its trade and fisheries more important than Tunting Lake. Several other large lakes add their waters to the main stream, among which the Tai-hou or Great Lake on the south, and the Toan-hu on the north, are most worthy of notice: both these are connected with the river by navigable streams, and the former with the ocean by more than one channel. The Ha-Kiang and Kia-lin are the principal affluents on the north below the Ya-lung. These drain the country from the Peh-ling, the southern watershed of the Hoang-ho. The course of this river is variously estimated from 2500 to 3500 miles; the influence of the tide is felt to the junction of the waters of the Payang Lake, 450 miles from the ocean, beyond which it is navigable for 250 more, and ships of the largest class can ascend its waters 200 miles. Although the Yangtse-Kiang and the Hoang-ho are esteemed two distinct rivers, they are in reality as closely connected as the Ganges and Brahmaputra, to which indeed they have additional resemblance in the opposition of their character. The same delta is common to both as well as to the smaller stream of the Tsien-Tang-Kiang which flows into it from the south.

The Hoang or Hwang-ho, or Yellow River, rising in the Koh-ko-nor district, has one of its main sources in the Singsuh-hai, or sea of constellations, a marshy plain, on which a number of small lakes unite their waters in two larger ones, called Ala Nor. These are also named the Olin or Orin, and Dyaring or Tcharin, and lie about 150 miles to the south-west of the Koh-ko-nor, close to the sources of the Yangtse-Kiang as already noticed, in about 35° 40′ north latitude, and 96° east longitude. This river has a very circuitous course, its direction is first south for thirty miles, then east for 160, then bending to the west through mountain gorges for 120, it takes a north-east direction for about 400 more, from whence its course is north for 430, when it is bent to the east for about 230, and finally to the south for 500 miles; and during 1130 miles of its course receives scarcely one stream of any considerable dimension. Here, in about 34° 30′ north latitude and 110° 30′ east longitude, it receives its most considerable affluent the Wei from the west, and here also its waters become tinged with the clay from the colour of which it derives its name. This river has a course of 400 miles, and is more navigable than the main stream.

From the junction of the Wei the course of the Yellow River is east and south for 650 miles to the sea, and at the head of its estuary the waters of Lake Hungtsih-hu unite with it; this lake receives the waters of the Hwai River. The Yellow River has fewer affluents than any large river, the Nile probably not excepted; two others, the Loo and the Fau, are alone worth naming. The Hwai drains the whole of the valley between the lower courses of the two great rivers, and may be considered one of the secondary rivers of this part of Asia. No two rivers can present more opposite characteristics than the two great rivers of China. The Yellow River is described as 'a mighty, impracticable, turbid, and furious stream;' the Yangtse-Kiang, in its lower course, uniform, deep, and steady, and navigable for boats for more than 1700 miles from its mouth, and the largest ships lie in ten fathom water, close to the rushes at Nanking. When near the ocean they approach within ninety miles of each other, but their united delta extends along the coast nearly 250 miles; beyond, at the mouths of the estuaries, are several islands, of which Tchou-chan or Chusan and Tsang-min are large and important. The former is one of a group lying off the estuary of the Tsien-tang, is of irregular shape, mountainous, but fertile, and having rice swamps at the base of the hills; its circumference is estimated at fifty miles, Tsang-min is rather larger.

Of the country drained by these rivers in their upper courses little is known, our knowledge of China scarcely extending beyond the limit of the great plain, and for that we are for the most part indebted to Chinese accounts. This plain extends 700 miles from the great wall north of Peking to the confluence of the Han with the Yangtse-Kiang, from whence to the sea its southern boundary passes east nearly on parallel of 30½° N. lat. Its western limit is the eastern watershed of the Yellow River and sources of the Han, in about 12½° E. long.; its breadth varies, but north of latitude 35° an average of 200 miles may be fairly taken, and its area estimated as 70,000 square miles. In the line of the Yangtse-Kiang, however, it extends inland 400 miles, to the limit of the tidal water, and along the Yellow River about 300, and here its area cannot be less than 140,000 square miles, giving a total of above 200,000, or about the same area as the plain of Bengal.

The northern portion of the plain is dry and sandy, destitute of trees, but producing grain and vegetables in abundance. That lying near the coast is low and swampy, covered with lakes and intersected with watercourses; to the west it is varied by the contour of the watersheds. The climate of the different divisions of what is therefore, perhaps erroneously, called the great plain, varies extremely, the eastern portion being 'a marsh half drained,' and during summer excessively hot, is very prejudicial to the health of man, though favourable to the increase of vegetable productions. To the north, about Pekin, the reverse is the case—dry and arid in summer, and suffering from severe frosts in winter; the average extreme temperature ranges from 10° to 100°, and the rivers are frozen from December to March. The hill country presents every possible variety of climate and temperature. Extending, as it does, through 20 degrees of latitude, with very mountainous surface, the average temperature of the whole of China is probably lower than that of any country situated between the same latitudes. At Canton, almost the southern limit, the thermometer ranges from 29° to 94°. Snow has been seen, and ice occasionally forms in shallow vessels.

3 *The Secondary Watersheds.*—Of the secondary watersheds of Eastern Asia very little is known. To the south, the Nan-ling mountains extend, under some fifty local names, from the Snowy Mountains, on the east, to the Chinese sea. The southern spur of this range, which passes round the north and east of the Gulf of Tonquin, and into the Island of Hainan, has in the latter some peaks approaching the snow line, and from this it may be concluded that its eastern and northern portions reach a very considerable elevation. The eastern extremity, the only part well known to Europeans, does not at the Mei-ling, or plum ridge, exceed 2000 feet, and the pass by which it is crossed has only 1000 feet elevation. It is formed of limestone overlying granite; on the main chain the peaks are limestone; but on the coast and in the islands igneous rocks predominate. Lead, iron, and coal, are abundant; its vegetable products are similar to those of the other mountain regions of this part of Asia. Of the northern secondary chains our only knowledge is obtained from Chinese maps and comparatively distant observations.

It has already been noticed that the primary mountain range of Eastern Asia extends round the Valley of the Amur, until it approaches the sea; here it is known as the Yablonoi Khrebet, and from it an important spur extends east between the head waters of the Amur and the great northern bend of the Hoang-ho. This is called the inner Hingan or Sialkoi range. Its northern extremities separate the Amur from its affluent the Songari. Of its height, climate, and productions, nothing certain is known, but that it is covered for the most part with forests. The northern and western watersheds of the valleys of Mantchuria being thus formed, the eastern or secondary watershed follows nearly a direct line from the boundary of the Corea, in lat. 40° to the mouth of the Amur, in 52°; and here it is only separated from the spurs of the more northern by the comparatively narrow valley at the mouth of that river. This chain, called the Sih-hih-tih, passes close to the sea, with an average elevation of about 4500 feet, having but a narrow slip of cultivatable land. The connecting link between this secondary and the primary range is formed in the Chang-peh-shan, or Long White Mountains, which pass through Leotung to the north of Pekin, in about lat. 43°. One of its peaks, called Pecha, is estimated at 15,000 feet in height.

4 *Of Koang-tung and Fokien.*—The Chu Kiang, or Pearl River, which flows past Canton, unites in its estuary three rivers, respectively named from the direction of their sources, the West, North, and East Rivers. Of these the first two unite west of Canton, while the East river joins their waters at Whampoa. Of these the Pe Kiang and Se Kiang constitute more properly one river. The Pe Kiang, or North River, has a course of 200 miles, and may be considered an affluent of the Se Kiang, which has in its main stream a course of above 500 miles, and receives important affluents from the north and south. It is said to be navigable for above 200 miles. Most of the larger affluents are navigable for boats, and thus water communication is attained between all parts of the district. The delta of these rivers forms a triangle, which may be roughly estimated as 100 miles each way. The islands formed by the many mouths of the river are numerous and large. Among them is that of Whampoa, at the mouth of the East River, or Tang Kiang. This is about the same size as the Pe Kiang. Fifty miles below Canton and thirty below Whampoa, is the Bogue or Bocca Tigris, in Chinese Fu Mun, where the estuary unites with the inlet of the sea, at the mouth of which is situated the island of Hong Kong. The Hang Kiang is a small river to the east of the Canton River, with an important harbour at its mouth, on which is situate the city Chian Chau Fou. Among the more important products of the districts drained by these rivers are gold, silver, quicksilver, cassia and cabinet woods.

To the north, in the district of Fokein, Min Kiang, or the river Min, is likewise formed by the junction of three streams, two of which, from the north and south respectively, join the main stream at the foot of the mountain. The course of this river is, however, only known to Europeans for about seventy-five miles from its mouth, to which point it is navigable for large vessels, although its course is obstructed by rocks and shoals. The mountains approach very closely to the mouth of this river, and the whole surface of the country through which it flows is diversified with ranges of hills, yet the upper course is for the most part regular, and affords access by its waters to most parts of its valley. A large portion of the country is rocky and barren—much of the upper parts of the hills covered with pine trees; but it is, nevertheless, the principal tea district of China. The Sung Kiang, a river with a course of 200 miles to the south of the Min Kiang, flows into the Gulf of Amoy.

The irregular spurs of the secondary chain as they approach the sea form the valleys of small rivers and streams, which widen into gulfs and bays, and, in their extension, cover the coast with innumerable islands. The principal valley formed by the secondary rivers of the north-east is that of the Pei-ho, or White River. Of this little more is known than that it passes Peking, and receives several affluents. Its mouth is the northern terminus of the Grand Canal, which unites all the waters of the east coast of China. A bar at its mouth renders it inaccessible to large vessels. Its banks are flat and sterile; and in some parts of its lower course it is higher than the adjacent country. It drains the district of Chili, commonly called Pechili, in which are several lakes; the largest of which receives the waters of the Ha-to from the south, and is connected with the Pei-ho.

Granite and marble are abundant in this district; from which it may be assumed that its hills are of the same character as the secondary ranges to the south. Precious stones are also found; nitre and China clay are abundant. The eastern extension of the secondary chains which form the north watershed of the main stream of the Hoang-ho, and from the reverse slope of which the waters of the Pei-ho are collected, presents some of the highest mountains in China, from the southern limit of the Gulf of Chili, or Pechili, and contracts the Yellow Sea to one half its width which it has to the south. The secondary watersheds already descried to the north of the district form the northern limit of the Gulf of Liatong, and extend into the Corea. The former is a sterile and inhospitable region; the latter nearly surrounded by sea, more fertile and genial. It produces grain, tobacco, cotton, rice, fruits, timber, cattle, furs, gold, iron, rock-salt, and coal. It extends through ten degrees of latitude.

The Lia-ho, or Sira Muren, which drains the district of Liatong, and falls into the gulf of the same name, is a secondary river of considerable size, but, with the country through which it flows, unknown to Europeans. Its course has been estimated at 500 miles; its largest affluent is the Hoang-ho, which joins it from the north-west; between it and the Pei-ho, a small river, the Chantan, remarkable for the high temperature of its waters, flows into the gulf of Chili. The Yahung Kiang, a river with a course of 300 miles, falls into the Yellow Sea at its northern extremity.

6 *The River Amur and Mantchouria.*—To the north of the Long White Mountains lies the valley of the great southern affluent of the river Amur, the Songari, while the principal sources of that river are found far to the west of the Hingan, or Sialkoi range. Its irregular course is naturally divisible into four distinct portions,—the upper valley of its principal sources, its middle course and the valleys of its northern affluents, its lower course after the junction of the Songari and the valley of that river.

The Amur, Sagalien, Koangtung, or Hehlungtang—for it is known by all these names—has its principal source in about lat. 50° N., long. 110° E.; its embouchure is in lat. 53°, and long. 143° E.; its course is estimated at 2200 miles.

The names Sagalien-ula and Hehlung Kiang mean Black Dragon River, in Mantchu and Chinese respectively. Koantung is the name given to its estuary; after it enters Mantchuria, its upper course being in Russian territory, it is called Amur, or Great River, by the people of that country. The spurs of the Hingan separate the two branches.

The principal source of this river, called the Onon, rises in a spur of the primary range called Kenteh, and after a course of about 500 miles, is joined by the Ingoda, a stream of about the same magnitude, rising in the east slope of the mountains which form the watershed of the tributaries of Lake Baikal, which uniting are known by the Russian name Chilka, or Shilka, and flowing 260 miles in a north-east direction, it receives the waters of the Argun from the south. The Chilka is considered the main stream, but the Argun is fully as large; it rises in the southern slope of the Kenteh, and after a short southern course, bends and flows for 430 miles, under the name Kerlow, to the north-east, receiving few tributaries till it reaches Lake Hurun, or Kulan, which also receives the waters of a large stream called the Kalka, which gives its name to the country, derives its waters from a lake of the same name in the Sealkai mountains, and flows through Lake Puyur, Buyour, or Pir. The united waters of these streams, leaving Lake Hurun under the name Argun, have a northerly course of near 400 miles to their junction with the Chilka. Lake Hurun is about 200 miles in circumference; of the others nothing but the names are known. Below the junction of its two principal head waters, the river now called the Amur flows round the Sialkoi mountains and their north spurs, in an east and south-east direction, its course broken by rapids, through a narrow valley, as far south as lat. 47½°, when it is joined by its principal affluent, the Songari. In this course it has received one considerable affluent from the north, and several smaller from the north, south, and west, of which nothing is known.

The Songari river is formed from two principal sources; that on the south rises in the Long White Mountains, in about 42° north lat., and flows northward as far as lat. 45°, when it is joined by the Monni, a stream far more considerable in size and length. This has its rise in the north-east bend of the Sialkoi Mountain; and its western sources approach close to those of the Kalka and other eastern affluents of the Argun; it drains the elevated plateau to Tcitrihar; and its course cannot be less than 400 miles in direct length. Lower down its course the Amur receives another considerable affluent from *the south*, the Ussiri, which flows from Lake Hinkai, or Kinka. This lake is about forty miles long, and not more than seventy distant from the Sea. In its lower course, just before its junction with the sea, the Amur receives a considerable affluent from the north-west, which drains the east portion of the country lying in the great bend of the river; its course from the junction of the Songari being north-east: this is named the Kenkon, possibly the same as the Hourda; but of all these rivers our information is very uncertain.

CHAPTER VI.

THE WATERSHEDS AND RIVERS OF THE NORTH.

1. The northern slope of the primary watershed.—2. The eastern basin of inland waters—the great desert Gobi, or Shamo.—3. The secondary watersheds and mountains of Mongolia.—4. The rivers of North-east Asia, and the peninsula of Kamstchatka.—5. Lake Baikal and the Yuesei.—6. The river Obi.

THE *Northern Slope of the Primary Watershed.*—From what has been already said any detailed description of the northern slope of the primary watershed of Asia will not be expected. It would appear to consist of several narrow valleys, of which that containing the waters of Lake Tenkiri is the largest, and sloping down to the great desert of Gobi, or Shamo, which has also a north-east slope from its western extremity, the Plateau of Tarim. As the position of the headwaters of the rivers is only known to a vague approximation, the exact limits or direction of the watershed cannot be stated. In all probability it commences its north-east trending from about the 90th meridian east long., forming the western watershed of the district of Koh-ko-nor, as already stated. No doubt, a large proportion of the mountain peaks included in it rise far above the level of perpetual snow, but we have as yet no means of ascertaining these elevations unless it might be by deduction from the computed elevation of the sources of the rivers, estimated from the rapidity of their currents—not, indeed, a very satisfactory method if minute accuracy was intended, but fully sufficient to satisfy any one, that as the watershed of the Brahmaputra, the Yantse-Kiang, and the Ho-ang-ho, they cannot be of very much less elevation than their neighbours to the south and west.

The Tengkiri-nor is situated in the midst of stupendous mountains, and receives the small river Tarku from the west: it has no outlet for its waters. To the north-east, between it and the Koh-ko-nor, there are several valleys, each containing similar lakes, varying in size, the majority of which are saline. Of this district little can be said, but that it is excessively dry, cold in winter, and hot in summer; its productions similar to those of the upper valleys of the Indus. The winter long—ice frequent in May; but corn grows during the short summer.

2 *Of the Eastern Basin of Inland Waters—the great Desert Gobi, or Shamo.*—Three distinct basins of inland waters, all, however, in close proximity to each other at the central mass of the primary watershed, are to be distinguished in Asia. The great area of depression of the Caspian and Lake Aral on the north-west, that of Lake Helmund on the south-west, and that of the

Great Desert on the north and east. There are other smaller undrained areas, as of Lake Van, and those on the west of China, already alluded to; but these are of marked importance. The eastern basin stretches through about 45° of longitude from the watershed between the rivers Sir Daria and Tarim, to that of the southern headwaters of the Amur. The general slope seems to be east and north, but its surface is probably divisible into several distinct valleys. Of these the principal is that of Lake Lob, which receives the waters of the river of Yarkand and Kashgar, the Tarim. The various streams which unite to form this river in its short course have their rise in, perhaps, the most elevated portion of the earth's surface. Their watersheds are the reverse slopes of those of the Sutlej, Amoo, and Sir Daria. The great Bolor chain is the limit to the west; the mountains forming the northern boundary; the valley of Thibet, already described from Captain Strachey's account, is its limit to the south; and on the north, a lofty range, little known, but at its western extremity, forming a mass, called Bogdo-ula, from which rise some of the highest peaks in Central Asia, and which is covered with glaciers. On the east this declines towards the general level, and here the volcanic peaks. Pe-shan Ho-tchou, and Solfat Urumtsi show that the influence, so powerful to the south and east of the continent, is not altogether wanting towards the centre.

The river Tarim, formed by the united streams of the Khoten, Kashgar, Yarkand, and Alisu or Aksu, after a course of about 1500 miles, falls into the Lob-nor or Lok-nor, commonly known as Lake Lob. A considerable affluent, the Kaidu, joins the Tarim, about eighty miles from its mouth. This has a course of about 200 miles, through a valley nearly parallel to the main stream. It flows through Lake Bostang, nearly as large as Lake Lob, which is estimated at about fifty miles long. The valley of this river is about 900 miles long, by 200 broad. It is represented by the Chinese, especially in the southern part, as producing, as do other parts of this country, grain and fruit, rice, tobacco, and cotton; horses, camels, the yak, and other horned cattle, are numerous; the lakes abound with game and fish; gold, copper, iron, saltpetre, sulphur, and asbestos, too, are found in the mountains. Jackals, tigers, bears, wolves, lynxes, and deer abound, as do birds of prey of the larger kinds. The climate is pleasant, and remarkable for its dryness, rain or snow seldom falling, the moisture of the clouds being intercepted by the lofty mountains which surround it. The jealousy of its governors, the Chinese, renders it inaccessible to foreigners, and it is little known. As the sources of the Amoo or Oxus are above 15,000 feet above the level of the sea, it may be assumed that those of the Tarim are not of less elevation; but as the latter river flows through a fertile valley, its fall cannot be so rapid; moreover, as Lake Baikal is nearly 1800 feet above the level of the sea, and as the eastern portion of the Gobi is estimated at 4000 feet and upwards in elevation, in the absence of accurate measurement it cannot be far wrong to give Lake Lob, an elevation of about 5000 feet. The region about Lake Lob is inhospitable, situated on the edge of the desert. It is surrounded by extensive swamps, which extend to the Kaidu, and probably to Lake Bostang. A considerable portion of the country, imperfectly drained by its southern affluents, is also marshy. This district is called by the Chinese Thian-shan-nan-lou, and that immediately to the north Thian-shan-pe-lou. This latter is more rugged and mountainous, divided into separate valleys by spurs from the main chain, the general direction of which is east and north. In these valleys are Lakes Toti and Balkash, and under the meridian, 95° east, a considerable depression occurs, in which Lake Dzaizang collects the headwaters of the river Irtish, one of the principal feeders of the Obi. Around Lake Balkash the mountains rise above 10,000 feet; those separate it from the valley of Lake Toti, as do a similar range of less elevation from some smaller lakes to the south. If the elevation of Lake Dzaizang be estimated as equal to that of Lake Baikal, Lake Balkash may probably have a somewhat greater, and Lake Toti about the same elevation as

Lake Lob. The former, also, called Lake Tenghiz, is about 150 miles in length, and 75 miles in breadth. Of Lake Toti little is known. It is placed between long. 77° and 81° east, and lat. 44° and 47° north. An extensive marsh occupies the surface of the country immediately to the north. This lake receives the waters of the river Ili; but like Lake Lob, and so many others in the centre of Asia, has no outlet. This river is of the same name as the district through which it flows, which extends east into the Gobi; its course is about 300 miles. The area of its basin, and that of Lake Balkash, has been stated as 40,000 square miles. In this country coal is found.

The country to the north, known to the Chinese as Kob-do, is also little known, but seems to approximate most nearly to that of the Upper Irtish, which immediately joins it. It has many small lakes, but these are, for the most part, of fresh water; and it appears to be more generally fertile than the neighbouring districts to the south. It is also probably warmer, as the slope from the Gobi to the Russian territories is known to be.

The great desert, called by the natives Gobi, or Shamo, occupies an area of 1000 miles in length, by 500 in breadth. It appears to be a continuation of the slope of the table-lands from north-east and south-west, having its own gradual declension to the north; its principal outlets by Lakes Dzaizang and Baikal; and its elevation from 2500 to 4000 feet. It differs little from the steppes of north-west Asia—consists of a barren, treeless, arid waste of shifting sands, which give an undulating contour to its surface.

3 *Of the Secondary Mountains of Mongolia.*—From the volcanic range of the Bodkka or Bogdo Ula, already noticed, the secondary mountains of Central Asia pass in irregular and broken lines to the north-west of the great desert round the sources of the Obi, Yenesei, and Lena, when they again join the primary chains to the north of Mantchouria, enclosing the basin of inland waters above described, which may be said to take a semi-lunar shape, having its diameter from north-east to south-west. Among the variety of names Russian, Mongol, and Chinese, given to these ranges, it is difficult to make selections, nor indeed would mere names be of any use; generally the whole have been denominated the Altai; to the north-east the Ala-shan and In-shan divide the desert from the Koh-ko-nor and basin of the Saghalien; others are termed Tangun Khangai and Kenteh; these form the junction with the main chain to the north, and extend south and west to long. 90°; beyond these the Saratau reaches the main depressions near Lake Dzaizang, and is continued on the other side to the south-west on the Alatau and the other chains which connect with the primary watershed to the west. These latter rise with an elevation of from 7500 to above 10,000 feet in height, in the centre peaks rise above 11,000 feet, and to the north-east at Chikonda, at one source of the Amur, an elevation of above 8000 feet is given; a general average elevation of 10,000 might, therefore, be fairly assumed. The pass between the head waters of the rivers Saghalien and Tola, which flows into Lake Baikal, may have an elevation of from 4500 to 5000 feet, and immediately to the north-east of this is the mountain knot of Kenteh, from which the spurs in this district appear to diverge. As in the south on the primary chain, so here to the north in the secondary, the main sources of the rivers flow through lateral valleys, among which the spurs stretch, having a general elevation of from 3500 to 4500 feet. These mountains do not for the most part rise in peaks, but present level plains of considerable extent at the top, with valleys through which the rivers flow, fertile and fit for agricultural purposes. The terraces on the sides of the mountains afford pasturage for cattle. They are rich in metals and minerals, gold, silver, lead, onyx, topaz, amethyst, and other precious stones. Sandstones, conglomerates, and chalk, rest on the granites which crop out at the summits. The sands of this range are auriferous.

4 *The Rivers of North-East Asia and the Peninsula of Kamtschatka.*—The river Lena may in respect of its eastern sources be considered a primary river: it has, however, its main source in the secondary chains to the west of

Lake Baikal. Its anomalous character in this respect accords with that of the mountains, since about its eastern headwaters the secondary chains unite with the primary, and form one, which passing round the sources of the Indigirka and Kolyma, throws out spurs to the north and south, enclosing their valleys, and forming the peninsula of Kamtschatka, and is continued to the north-east extremity of the great continent, re-appearing again in the primary mountains of America, on the other side of Behring's Strait. Of this chain we may be said to know nothing but its general direction, yet as the mountains of Kamtschatka are estimated at an average elevation of 2000 feet, it may probably have a general elevation of from 3000 to 5000. It will be noticed hereafter how the volcanic range of the peninsula is continued to the east through the Aleutian Islands, and to the south through Japan, and it may be therefore considered as the connecting link of the secondary and tertiary mountains of the east of Asia.

Kamtschatka forms the north-east limit of the Gulf of Okhotsk, as the island of Saghalien at the mouth of the Amur or Saghalien is the south-west; its length is about 400 and its breadth 170 miles; at its southern extremity detached volcanic mountains, some of which rise above 11,000 feet, are scattered; as they are along its deeply indented eastern coast. The longer slope of the watershed is towards the east, and from it a river of the same name as the peninsula, having its principal affluent, the Yelowka, from the north, flows with a course of 250 miles; near its southern point is a lake, the Kurile, twenty miles long by twelve broad.

The climate of this peninsula is severe, the winter lasting nine months, and frosts being common in summer; consequently even in the sheltered valley of the Kamtschatka river only the hardier sorts of grain will grow, and of trees the larch; but the hills are rich in fur-producing animals, and probably in minerals and metals. Not dissimilar but more sterile is the country about the Anadyr river, which flows into the gulf of the same name, after a course of about 450 miles; but of the country it drains little is known, still less of the Tchaoun, which falls from the north slope of the same watershed into the Arctic Ocean.

Even on the Kolyma vegetation is confined to grasses and stunted willows. In the valley of the Indigirka the cold is even more severe and the country more sterile, while on the Lena the district of lowest temperature is found. The Kolyma has several sources, a course of about 700 miles, and an estuary of considerable breadth.

The principal source of the Lena is to the west of Lake Baikal; it flows first north-east, and then bending to the north receives its principal affluent, the Aldan; from the north-west slope of the primary watershed it flows into the Arctic Ocean through numerous mouths, after a course estimated at about 2500 miles, 800 miles from the ocean; it is from five to six miles in width, near the intersection of the 120th meridian, east long., and 60th parallel of north lat.; the elevation of Olekmintsk is given as 400 feet, and lower down, at Yakutsk, long. 129° 44′, lat. 62°, only 288, which cannot be less than 700 miles in direct line from the ocean, giving a fall to the country through which it flows of only five inches per mile in its lower course; and while that through which its middle course flows cannot have more than eight, assuming 2400 miles as its length, and 2000 feet as the elevation of its main source to the west of Lake Baikal, the Lena throughout its entire course would have an average fall of ten inches only to a mile: but it must be remembered that this estimate relates to its lower sources; of those in the primary chain of the Yablonoi Krebet, or of the Vitima to the north-east of Lake Baikal, we know nothing but that they must be considerably higher. The Vitima is the name usually given to its main source; and two large affluents, the Talbatchin and Olekmah, join it below Olekminstk.

To the west of the Lena several small rivers flow into the sea from the north slope of the watersheds of the lower affluents of that river and the Yuesei. Of these as of some of the affluents of the larger rivers scarcely the names are ascertained with any certainty; from east to west they have been thus given, in the Olenek or Olensk, Olem, Anabara, Khatanga, and Piastla, or Piasina.

5 *Lake Baikal and the Ynesei.*—The river Ynesei has already been said to have its main source in Lake Baikal, which receives the waters of the Selinga, a river which has several sources in the valleys formed by the spurs to the east, north, and west of the mountain knot of Kentch, its south-west source, the Tola, being in close proximity to that ot the north stream of the Saghalien or Amur. The Ynesei in this respect, therefore, may lay some claim to be considered a primary river, but as all its other sources have distinct relation to the secondary watersheds, exception can scarcely be taken to its classification among secondary rivers on this account.

The Selinga has a tortuous course of 700 miles, and besides that river Lake Baikal receives the waters of the Upper Angara at its north-east extremity, and the Bargusin from the east. These rivers are said to have respectively courses of 450 and 300 miles.

Lake Baikal has been described as an extension of the basin of the Upper Angara; for this there appears little reason except that its length is from north-east to south-west; the general fall of the country, and of the course ot the main streams is, however, from south and east to west and north, and the Lower Anagara, by which its surplus waters are carried into the Ynesei, being near its south-west extremity, its irregular crescent-shaped basin may be more properly considered as the result of the prolongation and union of the valleys of the three rivers which supply its waters.

This lake is held in respectful admiration both by the Russians and natives. Its name, properly Bayakal, means, in the Yakutsk language—the rich water. Its length is estimated at nearly 400 miles; its breadth from 25 to 50; its circumference about 1200, and its area 15,000 square miles; its height above the sea from 1419 to 1793 feet; the depth of its waters varies from 20 to 200 fathoms, and in the centre is not known; it contains many islands; these are like its shores rocky and precipitous; the largest, named Olkon, is stated to be thirty-two miles long and ten broad. In the waters of Lake Baikal bituminous matter is found; seals and herrings are caught there, though they are not known to ascend the Ynesei; the sturgeon fishery is important, as is that of a fish called by the Russians Golcomanka or Soliamanka. This lake freezes in November, and thaws in May; its surface is subject to violent agitation, and as in the case of other remote and comparatively unknown waters rendered sacred by the solitude and sublimity of their position, fabulous causes are said to produce these effects: as, however, the surface of the ground to the north-west of the lake from the Altai to the junction of the two principal sources of the Lena, across those of the Ynesei, is in process of elevation, it is not improbable that the subterraneous action which is producing that effect may have occasionally caused perturbations in the waters of the lake.

The Lower Angara flows from Lake Baikal through a narrow and precipitous valley. The district of Udinsk, which it drains, has a surface composed alternately ot sand and rock, producing nothing but moss and small plants besides the stunted forest which covers its north-west portion. The fall of the country here must be considerable; the main source of the Selinga cannot be less than 5000 feet in elevation; the pass by which its waters descend from the mountain is above 4000; the point at which the several sources of that river unite may be estimated at above 2000, and of Irkutsk, thirty miles to the north of the effluence of the Lower Angara, the estimated elevation is 1330 feet, which agrees better with the lower than the higher estimate of the elevation of the surface of the lake itself. The fall of the Selinga may, therefore, be roughly stated as six feet in a mile. The length of the Ynesei is probably underrated; assuming, however, 2800 for its extreme course, or about 2200 from Lake Baikal to the sea, the fall through that distance would not differ greatly from the estimate made for the secondary affluents of the river Lena, or eight inches to a mile. After leaving the lake the

Angara soon changes its name to that of Tunguska; it receives two affluents of the same name, distinguished as the Lower and the Podkamenaia Tongouska, or Tunguska beyond the rocks; these rise from the west slope of the watershed of the Lena, and join the other principal source, which flows from the valleys of the Altai to the west of Lake Baikal; at Yneseisk, in lat. 58°, the river is 3600 feet wide, its stream deep and rapid; its estuary is thirty miles in breadth, and contains many islands. The district about the secondary sources of this river is extremely rich, producing heavy crops of grain for several successive years, as does also the country about those of the Lena; the sand of the mountains is rich in auriferous deposit, but the lower course of the river is through a level country; in summer a waste of marsh and lakes, in winter a frozen desert. The valleys of the Altai and of the knot of Kentch confined between walls ot rock, offer extraordinary varieties of climate; that at the foot of the mountain is milder than might be expected, but at Irkutsk too cold for the cultivation of fruits; a large portion of that district is covered with forests.

6 *The River Obi.*—This, like the two other great rivers of North Asia, is formed by the junction of two principal streams. Of these the Obi, or eastern, has several sources on the Altai mountains, one of which flows through Lake Teletskoi or Altun-nor, after receiving the Tom and Choulin, its principal affluents from the right, it flows in a north and west course till its junction with the Irtshi, a stream by some estimated as the larger and more important of the two, and which has its main sources in the waters which fall into Lake Dzaizang. This lake, which is eighty miles long and twenty broad, is, as already noticed, situated to the north of a spur of the Tianshan mountains, which rise from 7000 to 10,000 feet above the sea. The elevation of its surface might, therefore, possibly be assumed as greater than that of Lake Baikal; but at about 150 miles in a direct line from its north shores the elevation is only stated as 844 feet, and 100 miles lower 755, so that it is improbable that the elevation of the surface of Lake Dzaizang should be greater than the lower estimate for that of Lake Baikal, or about 1400 feet. Yet if 1700 be the correct elevation of the surface of Lake Altun, that of Lake Dzaizang must be considerably greater, for at about seventy miles from that lake the elevation given is only 703 feet, while the sources of the Tom are given as 990; these apparent discrepancies cannot be reconciled without more numerous and accurate observations. The Irtish receives two principal affluents from the left, the Ischim, which has its sources in the hills to the north of Lake Aral, and the Tobol, which rises from several streams on the east slope of the Oural mountains, and from a chain of lakes between its main stream and the Ischim. The sources of the Tobol are not less probably than 3500 feet in elevation, but at Tobolsk, where it joins the Irtish, the elevation is only 115 feet; its direct course is 600 miles, and the general slope of its watershed about six feet in a mile. The entire length of the Obi is estimated at 2000 miles, less, probably, than the truth; the size of its affluents, however, makes the area it drains greater than that of the Ynesei.

Between the Obi and the Ischim, in the district of Baraba, are numerous lakes, among the more important of which are Lake Tshamy, eighty miles long by fifty broad, and Lake Yamish, which though only about seven miles in circumference is famous as producing salt of extreme whiteness, crystallizing in cakes. Lake Eilshi, or Bielshi, also produces abundance of salt.

The entire country drained by these rivers, from Behring's Strait to the Ural mountains, is known as Siberia, Sibiri or Asiatic Russia; the area may be roughly estimated as containing five millions and a half square miles of surface. A very large proportion of this has the subsoil constantly frozen; to the north of Irkutsk the soil always remains frozen to the depth of twelve or fifteen feet, at Yakutsk to twenty-seven, at Bogoslovsk, lat. 59° 44′, near the Urals to six.* The warmest part of Siberia is the upper course of the Ynesei, in the valley to the west of Lake Baikal, and at Irkutsk "the country" is said

* *Physical Geography*, p. 213.

to be "agreeable, the soil fertile, and agriculture flourishing." At Tobolsk there is no ground ice, but the line of its limit reaches further southward, as it is extended towards the east; 70° below zero have been experienced on the Lena; in the summer the temperature rises the same number of degrees above; but even when the stunted vegetation shows signs of life beneath the warmth of summer, a northern blast will cover it with a thin coating of ice, destroy the blossom and blight the leaf. At Okhotsk no ice is found, and the shores of the Pacific, protected by mountains to the north, are considerably warmer. In summer, in the regions of ground ice, the soil is thawed to a depth varying from one to three feet.

The vegetable life of Siberia is, however, not so scanty as these facts would suggest. The lime tree and ash cease, indeed, at the Irtish, and the pine does not reach a higher latitude there than 60°, 10° lower than in Europe; the gooseberry, which grows in Greenland, only reaches 66° on the Ynesei; at 60°, potatoes do not grow larger than pease; yet the banks of the rivers in their middle and upper courses are skirted by dense forests of alder, willow, elm, maple, poplar, aspen, with numerous species of pine, of which the Siberian cedar, as far as the Ynesei, often reaches 120 feet in height, the balsam poplar perfumes the air, and the crab, cherry, and several fruit bearing under-shrubs, supply acid juices grateful in summer. The similarity of this district to that of Northern America will be hereafter noticed; 60° in the west and 55° in the east, appear to be the average northern limit of the growth of grain on the Obi, but under the 112th meridian it reaches three or four degrees further, flax 66°, hemp 55°. On the plains rein-deer, elk, wild dog, fur producing animals, and water-fowl, are indigenous; of the former and latter there is abundance, and Siberia is next to North America the most productive hunting ground for the fur trader in quantity, the best in respect of quality. In the mountain districts the animals of the south and north meet and intermingle. The tiger has been seen on the northern shores of Lake Baikal, the camel accompanies the caravans of the south, the horse has been naturalised in the south and west by the Tatars; bears, both white and brown, the lynx and glutton, are common. Besides gold, the mountains are rich in iron and copper, the former often found in large masses of what is termed native iron, the latter as malachite.

Signs of the elevation of the surface are common in Siberia, especially to the north-west of Lake Baikal, and on the coast as far as Behring's Strait. This coast is covered with islands, separated by a narrow strait from the main land. Kotelnoi is one of the largest of these, and, 140 miles off the coast of new Siberia, another group has been explored; these are rich in fossils and animal remains, which have formed a profitable export, indeed the whole lower courses of the rivers abound in such remains; here those of the mammoth were first found, and off that coast, as in the Liakov islands, entire animals have been found, with the flesh in good preservation; the connexion of these remains with the fossil deposits of the Siwalik hills is as yet an unsolved problem.

CHAPTER VII.

THE CASPIAN AND LAKE ARAL

1. The north-western slopes of the primary watershed.—2. The Amoo and Sir Daria.—3. The basin of Lake Aral and the steppes of the Kirghis.—4. The basin of the Caspian and boundary of Europe.—5. The south-western watersheds of the Caspian.

THE Western Slopes of the Primary Watershed.—The Bolor Tagh at its junction with the Hindoo Koosh forms an angle in which the waters of the Amoo, or Oxus, are collected, and from which they fall into Lake Aral, in like manner from the knot formed by the junction of this chain with the Tian Shan, those of the Sir Daria have their rise and fall into the same lake. These mountains, of which very little is known, have their culmination probably above 20,000 feet in elevation, and must, if the results of Captain Strachey's observations are adopted, be considered as forming not the least important part of the primary watershed of Asia. They may be described, so far as the slight knowledge we possess justifies description, as of most rugged and irregular form, passing round the head waters of the rivers already mentioned on the west, and those of the Tarim on the east. Two principal passes are named as connecting Yarkand and Kashgar with the valleys of the Aral, and one from thence into that of the Jhelum. The Hindoo Koosh or Koh, which separates the valley of the Aral from Affghansthan, is also called the Indian Caucasus; its summits rise above 20,000 feet, one in lat. 35° 40′ N., long. 68° 50′ E., eighty miles north of Cabool, is of much more considerable elevation, though its exact height is not known. This portion of the primary range differs little from that more to the east, save that it is more barren and destitute of the forests which are so remarkable a feature of the Himalaya. The sources of the Amoo fall from the passes which connect its valley with those of the Cabool and the Helmund. The Oonna Pass to the north-west of Cabool, indeed, connects all these valleys, and gives great importance to that city; it is estimated as above 10,000 feet above the level of the sea; further to the west, the Kaloo pass rises above 12,000 feet; the Karakootul, above 9000; but the Sikkim pass, at the head waters of the river of Balk, probably once a source of the Amoo, has only an elevation of about 8000 feet: from this, if from nothing else, the greater elevation of the mountains to the north and east might be predicated.

2 *The Amoo and Sir Daria.*—The Amoo, or Oxus, also called the Jiboon, has one of its principal sources in Lake Sirikol, at an elevation of 15,600 feet above the level of the sea, in lat. 37° 27′ N., and long. 73° 40′ E. The course of this river is estimated at 1300 miles, and it falls into Lake Aral by numerous mouths. Of the affluents of this river and their sources scarcely anything is known, but they must have undergone considerable change, since the course of this river formerly was not into Lake Aral but into the Caspian. Its present channel is straight; its lower course might be navigable for 600 miles, the great fall of its upper course averaging about fifteen feet to one mile, gives it great rapidity; its waters are deep and turbid, yet in the upper course it is frozen every year; it has a delta of considerable extent but marshy, and the channels through it are obstructed by sand-banks; its principal affluents are the Soonkul or Karategin, the Kohsah or Badakshan, the Kateruchan or Hissar, the Tupulak or Zirhal, on the right; and the Sirkab or Goree, the Kholoom, and Ardishar or Dehar, on the left. Possibly its southern source, the Sirkab, may have the greatest elevation.

The Sir Daria or Sihoun rises from two principal sources in the Tian Shan mountains, the Sir Daria and Narym; it has several considerable affluents; it is smaller than the Amoo, but, it is said, more rapid, probably in reference to its lower course; it has an anastomosing branch about 250 miles from the Lake Aral, which appears to have, or have had, several reconnecting branches in the delta. In its middle course it is 250 yards wide, in its lower it narrows, but widens again; its anastomosing branch, the Kouran, forms a chain of lakes, and subdivides into several branches. In summer, the Sir Daria is fordable; in winter, like the Amoo, it is frozen; both rivers are subject to floods, at the melting of the snows, which continue for a long time. The course of this river is estimated at 900 miles, and from the rapidity of its current, and analogy with those of the Tarim, its sources must be very elevated, though possibly not so much so as those of the Amoo; it is the Jaxartes of the ancients. To the north are two considerable rivers, the Tchoni and Yar Yatchi, the waters of which are now lost in Lakes Telekou and Kalab Koulah, which at one time might possibly have added their tribute to the main stream; the course of the former is estimated at 700 miles; in like manner, the Zohik or Sirafshan falls into Lake Karakoul, called also Denghis—*i. e.*, the sea—which is about twenty-five miles long; its waters are salt. The river Kurshee has a course parallel to the Zohik; its waters are lost in the sand; both, probably, were at one time affluents of the Amoo, as was the river Balkh, the lower course of which, divided into numerous channels, now disperses its waters in the desert, and there are in this district others of similar character.

The country which forms the valleys of these rivers is for the most part a sandy, treeless waste, but on the banks of the rivers, and where irrigation can be effected, the soil is fertile,—in some parts, as in Bokhara, extremely so. The mountain valleys on the east and south are narrow and precipitous; a great plain extends below them, having an elevation of about 2000 feet; this slopes gradually north to the Lake Aral and the Caspian, until it reaches the sea level. The fertile parts of the country are famous for rice, grain, and especially for fruits; horses and cattle abound, but timber is very scarce.

3 *The Basin of Lake Aral and Steppes of the Kirghis.*—This basin extends from the valleys of the Amoo and Sir Daria 270 miles northward to the Monghojar hills; this northern portion of the country is a salt desert, covered with small lakes but without rivers or fresh water; to the north of the Sir is the desert of Karakom, or the Black Waste, in some parts 175 miles in extent, covered with movable sand-hills, some rising fifty feet; to the south, between the lower courses of the Sir and Amoo, is the Red Waste, the surface of which is red sand thinly spread over argillaceous rock. It should be noted that in these deserts water is frequently found a few feet below the surface.

The Monghojar hills have been considered as among the southern extension of the Ural chain; these seem to the west to form the watersheds of the Tobol, Oural, and Irghiz, of no great elevation, indeed, but sufficiently well defined to be recognised. They re-appear again to the east of the Kirghiz Steppe in the Tchingis, which form the watersheds of the Yar Yatchi, Tchoni, and the streams falling into Lake Balkash, and are continued to the Altai; the east part of these hills contains abundance of copper, and its geological character sustains its identity with both the Oural and Altai ranges, the same red sandstone being found in them. Towards the south and east, where the hills lose their distinctness, the surface is composed of clay, marl, and calcareous tufa covered with sand, but the rising grounds present localities where agricultural industry would be rewarded, and large districts producing abundant pasture; while still further north, in the line of the watershed of the rivers flowing into the Arctic Ocean, forests of fine timber and fertile plains are found, abundantly watered by lakes and streams. The southern and eastern portion of the valley of the Aral and its tributaries is therefore the most arid and desert. In the ranges of hills which traverse its northern part, and which reach the north-east extremity of the lake, abundance of marine remains are found, and at forty miles distant from its present shore evidences of the former presence of the waters of the lake are abundant. These hills, known as the Great and Little Bourzouk, prolong the northern watersheds between Lake Aral and the Caspian into a table-land, called the Ust Urt, extending to the south for about 400 miles, from lat. 41 to 44, rising abruptly from the Lake and Caspian to the N.N.W., to about 640 feet; in some places it reaches a height of above 700;* a chain of calcareous hills found at its base is near the shores of the lake. This tract resembles the steppes in everything but its elevation, which, exposing it to the whole force of the wind, renders it unfit for habitation and dangerous to pass over.

The Lake, or, as it is more commonly called, Sea of Aral, is known to the Southern Asiatics by the name Kharasm, by the Russians as Cinæ, or Blue Lake; the inhabitants of the country, however, call it Aral Denghiz, or the Sea of Islands. Situated between 43½ and 47 parallels of north latitude, and 58 and 61 meridian of east longitude, it has been estimated at 370 miles in length, and 124 in breadth; its form approaches that of a parallelogram with the S.W. angle cut off and extended to the south, in the long, narrow, winding lake or marsh called Aybughir or Landan; its surface is 117 feet above the Caspian, from which it is distant about 200 miles; its area is above 20,000 square miles; it is shallow, and has no outlet; its waters are slightly saline; it is said to be occasionally frozen all over in winter. The eastern and southern shores are low and marshy, and in this part of the lake are numerous islands, some of which are inhabited; to the north and in the centre there are large islands covered with wood. Similar fabulous marvels are related of this as of Lake Baikal. Sturgeon abound in its waters, which, however, are said to be rapidly diminishing, and are so shallow and encumbered with sandbanks that flat-bottomed boats are used, but a depth of 37 fathoms has been found near the north-west coast.

4 *The Caspian and Boundary of Europe.*—The Caspian Sea, or more properly Lake, generally known now as, simply, the Caspian, is the largest lake in the world, being 700 miles in extreme length, and 420 in breadth, being about the same size as the Black Sea. Its coast line is irregular; it may naturally be divided into three parts: that on the north having the mouths of the Volga and Oural: on the east the bays Merkroi and Manghishlak; while its west limit is the peninsula forming the bay of Arashan to the south of the river Terek; from thence to Cape Apsheran, about 300 miles, the lines of the coasts are nearly parallel, but the eastern is deeply indented by the Kouli, Deria, and Balkan bays; the southern extremity has a rectangular form. The shores of this lake are for the most part low, its waters shallow, often not exceeding 12 feet at several miles from its northern shores; in the centre, to the north, it varies from 100 to 300 feet, and soundings have been attempted where no bottom has been found with 480 fathoms of line. The waters of the Caspian are, like those of the Aral, decreasing, and are probably 300 feet lower than they were in early periods of history; they are now 83 feet below the level of the Black Sea; it has no tides, and in winter the north part is frozen; seals, sturgeon, and salmon abound in its waters.

This lake receives from the north and east the waters of the Volga, Kouma, and Terek, which, as rivers of Europe, must be reserved for description with that division of the Eastern Continent. At Cape Apsheran the mountain chain of Caucasus extends itself into the lake; this must be considered a spur of the primary chain which, forming the southern boundary of the lake, extends into Asia Minor to the west, and joins the Hindoo-koh on the east. The spurs which, extending from the main chain on the south, separate the Black Sea from the Caspian, and from the watershed of the river Kour, are those which also form the boundary between Europe and Asia; they enclose the valleys of Georgia, which are drained by that river and its affluents. These expand into a very fertile plain, 75 miles in width, abounding in corn,

* Butakoff gives its average elevation as between 200 and 300 feet. Vide *Journal of the Royal Geographical Society*, 1853.

hemp, flax, cotton; the fruits, especially pomegranates, are very fine, the grapes capable of producing the best wine, though that of the country is ill prepared: numerous horses, cattle, and sheep, of the finest kind, are reared; the hills are covered with extensive forests, composed of the trees common in Europe, and contain vast stores of minerals, especially of coal and iron.

The area of these valleys is estimated at about 20,000 square miles, its length 240, and breadth 120. The Koor, Kur, or Cyrus, has a course of about 500 miles; its chief affluents are the Aras, Alayan, and Yara. The Aras has a larger stream than the Kur; it rises in the mountains to the south of Erzeroum. The lower part of the united streams of these rivers communicates with a chain of small lakes and swamps. A large portion of the upper part of this valley is volcanic, especially where the Traporanic falls into the Kur; here layers of lava, from 20 to 100 feet in thickness, rest on volcanic rocks, and beyond, a circular valley, from three to four miles wide, contains a lake from which volcanic débris are continually ejected; this lake is about 500 feet in length, and situated 50 feet above the river.

The peninsula of Apsheran is not of great elevation—not, indeed, exceeding 1000 feet; it is rocky, barren, and on the surface destitute of water. Some fruits and grain are cultivated on the higher grounds, but from the soil naphtha exudes wherever an opening is made; of this spirit there are two kinds, black and white, the former is used for coating the outer surface of roofs and buildings, as well as for burning; from the latter the inhabitants obtain light and fire for domestic uses. Near Baku is a hollow, the surface of which consists of sand, ashes, and sulphur, from the clefts in which naphtha is constantly rising. A lake in the vicinity also emits flame without heat. The south portion of this district is formed into volcanic amphitheatres by the crowding together of the spurs from the main chain of mountains; and this character is continued to the west round the sources of the Aras, where Lake Sivan occupies one of the largest of these valleys; it is 5300 feet above the level of the sea, above forty miles in its greatest length, and from six to twenty in breadth; it has at its north-west extremity an island of the same name; its depth must be very considerable, a 400 fathom line failing to reach the bottom within a very short distance of the shore; it is called from the colour of its waters Gokcheh-derga, or the blue lake, more commonly Gukcha or Kukcha. The surplus water of this lake supplies the Zengue river, which flows into the Aras from the north; it is surrounded by extinct volcanoes and projecting rocks of trap and porphyry. The valley of Somkhiti in the neighbourhood is of similar character though it has no lake, but contains immense deposits of lava and obsidian.

5 *The South-Western Watershed of the Caspian.*—The sources of the Aras approach those of the Euphrates; here Mount Ararat rises above 18,000 feet, but to the north the mountains are not so elevated, few, if any, exceeding 10,000 feet in height, and at the sources of the Kur the depressions of the chain is very perceptible. To the north, however, the elevation increases; the summits are covered with perpetual snow, and rise at Mount Elbruz to near 18,000 feet, and in Mount Karbek to above 15,000. The term Elbruz should be applied to the whole range, implying snow-capped. The Circassian name of the peak, which is usually called Elbruz, is Orha Makna, mountain of happiness. It is also called Oneif Gubb,—heavenly mountain; and by the Tatars Ildistaghtar—mountain of stars. The passes from the north into Georgia are difficult; the principal, the Dariel, passing to the east of Mount Karbek in long. 345, is about 8000 feet above the sea level; those between the sources of the Kour and Aras and the rivers falling into the Black Sea are lower and more available for transit. On this side the chain of the Caucasus trends north-west round the Black Sea at about thirty miles from its shore, decreasing gradually till it passes the fortieth meridian, where, at Gagra, the limestone, which forms its summit at an elevation of near 800 feet, approaches close to the sea, leaving only a narrow pass; to the east, granite and porphyry prevail and are flanked by masses of black schist; beyond Gagra to the west the chalk formation supervenes, and the

mountainous character of the east coast is changed to low, rounded, and wooded hills, with white and grey shelving rocks forming the sea shore.

The valley of the Rioni river, the ancient Phasis, which flows from the west slope of Mount Elbruz, differs considerably from that of the Kur; it is covered with extensive forests; has a humid climate; the lower part is a marshy level; and its mouth is only thirty-four miles from that of the river Tchoruk. The valley of this river is extremely fertile; coal is found here in abundance, of excellent quality.

The Tchoruk rises to the south-west of Trebizond, and flows through a valley separated from the sea-coast by a range of hills; it has also a northern branch, which is separated by their mutual watershed from the valley of the Phasis; it has a course of 170 miles; its banks are steep, and its current rapid; its extreme width scarcely exceeds 200 yards; the greater part of the country through which it flows is well wooded, some portions very fertile, but all mountainous. The north coast beyond the Phasis is also well wooded and fertile, but consists of little available land save the narrow valleys of the mountain stream, and at the edge of the Black Sea; but that great basin being rather European than Asiatic in its relations, will be considered together with the Mediterranean, of which indeed it forms the north-west part.

CHAPTER VIII.

THE WATERSHEDS AND RIVERS OF THE WEST.

1. The primary watershed of West Asia, and its inland waters.—2. The Euphrates and Tigris.—3. The secondary watersheds of the south and coast district.—4. The basin of the Helmund and its west watershed.—5. The table-land of Syria and Arabia.—6. The watersheds of the western coast and basin of the Jordan.—7. The peninsula of Sinai, and isthmus of Suez.

The Primary Watershed of West Asia.—It has been already noticed that the primary watershed of Asia has its western extension from the south of the Caspian round the headwaters of the Euphrates, and thence in a south-westerly direction, forming the limit of the Mediterranean by its southern escarpment; and in its northern slope the table-land of Asia Minor, buttressed up by the secondary range of Anti-Taurus until its outlet in the valley of the Kizil-ermak. The centre from which the mountain ranges of West Asia diverge must therefore be sought between the headwaters of the Euphrates on the south, the Karas on the east, the Kour on the north, the Joruk and the Kizil-ermak on the west.

This district, situated in the north-west of Armenia, presents similar characteristics to the other central masses of the mountain ranges of the eastern continent; for while here the greatest effect is undoubtedly to be found, the highest peaks are removed to some distance: Mount Ararat or Aghri-dagh—is, indeed, at its eastern extremity, and has an elevation of 17,210 feet above the sea; but Mount Elbruz, in the north-west Caucasus, and Aghri-dagh, in Asia Minor, are remote from it, and may be considered the points of junction of the secondary with the primary systems, on the north, indeed ill defined, but very clear and definite to the west. This district has, like that to the north, and those about the central table-land of the continent, its lacustrine basins, having no outlet to the sea: all these, indeed, surround that of the central table-land, which is of the same character; and with them those of the Caspian and Sea of Aral are generally ranked; but as those about the mountains have considerable elevation, while the basin of the Caspian is depressed even below the level of the sea, they cannot so well be classified together. Without them, however, the basins of inland waters of Asia extend from the Salt Lakes on the north, to those near the headwaters of the Songary on the east; and from the mountain district to the south of the Helmund, as far north as Lake Balkash—i.e., from 30° to 125° east long., and from 17° to 47° north lat., or through 95° of length and 30° of breadth, and may be roughly estimated as containing more than one-fourth of the entire surface of the Asiatic division of the eastern continent.

The irregularity of the surface of this mountain district renders its description difficult, notwithstanding it has been frequently traversed, as the roads connecting the valley of the Euphrates, the Caspian, and Persia with the Black Sea and Asia Minor pass by it; although lower in elevation it is not dissimilar in character from the other central masses of Asia, and may be said to consist of a series of valleys, having for the most part a north-east and south-west direction, with lateral valleys formed by the spurs projecting from the main ranges; of these three are distinctly traceable between Armenia and the Black Sea, separating the waters of the Kizil-ermack from those of the Joruk. The mountains belong to the secondary range of Anti-Taurus, which stretches to the westward, while to the south-west Taurus extends its volcanic craters, confining the valley of the Euphrates, and giving it a south and east direction in its middle course. To the east and south from the neighbourhood of Ararat the spurs from the main chain diverge, surround Lakes Van and Urimeyah, and separate their basin from the valley of the Aras on the north, the Euphrates on the west, the Tigris on the south, and the Kizil-ouzan on the east.

Lake Van, situated between 38° and 39° north latitude, and 42° and 44° east longitude, is about 80 miles in length from north-east to south-west, and has three distinct and deep indentations to the north-east and west respectively, the two latter forming the base of a triangle nearly equilateral, which would enclose its waters: it may have in the centre a breadth of about 37 miles; in the west 15 or 16, in the east 9 or 10, and in its northern basin still less. The surface is estimated as above 4500 feet in elevation; the waters are saline, and also contain carbonate of soda, which, in conjunction with sea salt (chloride of sodium), is found floating in masses. The lake occupies the bottom of a volcanic amphitheatre; it contains two large islands, one is named Aktamar, a name extended to the lake by the Arminians; a small herring abounds in its waters.

Of similar character, but larger, is Lake Urimeyah, or Shahee, which, though not politically, is geographically in the same district; it is 85 miles in extreme length from north to south, and 25 in breadth, contracted towards the centre by promontories extending into it from the north-west and south-east; it forms two basins, into the southern of which issue the waters of the river Tabriz; its waters are extremely salt, and may have an elevation of 1000 feet less than those of Lake Van; it receives the waters of several streams.

The mountains which separate these lakes are often covered with snow in the month of June, and in their southern valleys the head waters of the Zab are collected. Round Lake Urimeyah is an extensive and fertile plain. The beauty of Lake Van and the country surrounding it is often celebrated by eastern poets.

2 *The Euphrates and Tigris.*—The river Euphrates rises from two main sources in the mountain valleys of Armenia, the Murad on the south-east, and the Phrat or Kara-su on the north and west. This latter gives its name to the united streams, though the Murad is the principal source; but, as usual, the secondary source, falling from the lower depression, has been known from an earlier period as offering the most accessible pass across the mountains.

The Murad rises on the south-west slope of the mountains of Ararat, the two peaks of which, Allah-dagh and Aghri-dah, rise above the limit of perpetual snow; its extreme elevation to the north-west is estimated at 17,210 feet above the sea; its lower at 14,320; the depression between forming the connexion between the valleys of the Kour and the Murad; and the sides sloping gradually until their outlines are lost to the west and east in the mountains which surround the headwaters of the Euphrates, and separate the Araxes from Lake Urimeyah. The mountain peaks to the north-west must be of nearly equal elevation to the summit of Ararat, as they are covered with perpetual snow, the limit of which may be assumed as 14,000 feet. It may be remarked of this mountain, that, like all others covered with perpetual snow, it assumes at its apex a conical shape, but it has, also, a ridge-like extension towards its lower summit, which, when occasionally uncovered, rises in irregular and lofty peaks. Here are plentiful evidences of volcanic action, and iron and rock-salt are found in abundance.

The course of the Murad is first to the north-west and then to the south-west; but before it joins the Phrat it resumes the former direction. Its length is estimated at 300 miles; it receives the waters of numerous streams from the mountains on either side. The Phrat has its principal sources in the mountains, about 150 miles to the east of those of the Murad, and flows through a narrow valley in nearly a direct south-east course till it joins the Phrat, in lat. 39° east, long. 39° north; and their united waters continue in the same direction for about fifty miles in direct line, where, bending suddenly to the south-east, they receive the waters of the Tokmehi from the north-west; continuing this course in direct line about sixty miles, they burst through the secondary ranges, which here, in close proximity to the primary, extend from the south of Lake Van to the shore of the Mediterranean, forming an amphitheatre through which the affluents of the Phrat descend from the north and east, and after a circuitous course, in direct distance rather more than 100 miles, assume a final south-east course, which is continued to the Gulf of Persia, near Bir, or Birijik, where they issue from the hills: the elevation of the plain is only 630 feet above the sea: at Tamosat, about fifty miles to the north-east of Bir, the rivers form a double cataract, below which point it is more or less navigable to the sea; at Bir it is only about 100 miles in direct line from the Gulf of Iskanderoon, the north-east angle of the Mediterranean; at Balis, about seventy miles to the south, it is only 120 miles from the Bay of Seleucia; this is nearly the direct caravan route from Antioch, by Aleppo, to the Valley of the Phrat; from Bir the river still flows in a confined and narrow bed; and though from this point Colonel Chesney descended the river in iron steam-boats constructed on purpose, yet it cannot be considered as navigable for commercial purposes until within a short distance of Hit; between that place and Anah there is a ford having only four feet water in the dry season.

In the latitude of Baghdad the Phrat approaches within forty miles of the Tigris, and here the two streams are connected by several canals or branches, nature and art having both probably assisted in their construction; about fifty miles below Hillah, the ancient Babylon, situated in latitude 32° 28′ N. longitude, 44° 28′ east, the river passes through a marshy district extending about twenty-five miles, through which its numerous branches anastomose, and here the main stream is in some places not more than thirty-five feet broad; 1100 miles below Bir, at its confluence with the Tigris, the river has assumed a north-west direction, and between those points its average inclination is six and a quarter inches to a mile, its current from two to four miles an hour. From the confluence of the rivers the united stream is called Shat-al-Arab; its length to the sea is about 130 miles; and the entire length of the Euphrates, from the source of the Murad to the sea, although it has been variously estimated at from 1500 to 1800 miles, cannot be less than the latter. In its middle course the Euphrates receives two affluents from the left, the Bilikh and Khabour, the latter the more important, giving nearly an insular character to the country between Mossul, on the Tigris, and the ford above mentioned on the Euphrates, below which the Khabour forms the main stream, and its conflux with the Tigris. At Hillah the Euphrates is only 140 yards in width, but it flows at the rate of about seven miles an hour; in its lower course it is from 200 to 800 yards in width, and flows through a very fertile level. The effect of the tidal wave is experienced on the Euphrates as high as Arja, under the 31st parallel of north latitude; on the Tigris further north, but not nearly so distant from its mouth; the distance on the one being sixty and on the other thirty-five miles.

The Khabour rises in the limestone range which forms the south boundary of the valley of the Tigris, and extends from that of the Murad on the north-west to the Sinjar hills, near Mossul. This river has two principal sources, the Khabour to the west, and the Ras-al-Houali, or Nar-al-Sinjar to the east; both run parallel in a south-east course, until they come into a line with Mossul, where the east branch, bending to the south-west, the river continues that direction until its junction with the Euphrates; before the junction of the two branches the Khabour receives the waters of Lake Katonieh, or Kutaniyeh, which contains an island, and may be about fifteen miles in length by five in breadth.

The middle course of the Euphrates is through a country desert, without irrigation, but capable of being made extremely fertile: near Annah, to the north of the 34th parallel, chalk is found. The river is bordered with tamarisk, and embraces many islands, none of which are inhabited. In the marshes of Lemloun, below Hillah, the bank is covered with a thick jungle of canes; this is at present only a fit habitation for the buffalo and wild Arab. On the west bank, although now it receives no affluents from the right, there are the remains of former water-courses, that would indicate not only that the river has changed its course, but that it formerly received tributary streams from that direction.

The country about the upper course of the Khabour is fertile and romantic in its appearance, in some parts well wooded, and the plains covered during the spring with most luxuriant pasture, and this is the general character of the upper country in the valley of both the Euphrates and Tigris.

The Tigris has its main sources in the district west of Lake Van, its most western is in the east slope of the mountains which form the valley of the Murad, and is about 5000 feet above the level of the sea; its eastern, the Buhtan, rises near Lake Van, at, probably, a greater elevation, and these unite about seventy miles to the south-east of the lake, before which, however, many other streams have added the tribute of their waters. The upper course of this river is extremely rapid, but at Mosul it flows scarcely three miles an hour; here it is 100 yards across, but between the point where it approaches nearest to the Euphrates and its confluence with that river it averages 2000, and here it has received the waters of its affluent, the Diala or Dijaleh, and between that point and Mossul it receives the greater and lesser Zab, and above Mossul the Kirnib or Khabour; this is scarcely more than a mountain torrent, but the lower affluents are important streams. The middle course of the river is interrupted by both natural and artificial dykes, and at Hamrun the hills contract its channel to 150 yards; it is navigable to fifty miles above Bagdad for boats and vessels of light draught; during the floods in spring its waters rise twenty feet at Mossul, while those of the Euphrates do not rise more than twelve; not unfrequently at that period the lower course of the rivers become united in one immense expanse of water, extending far beyond their banks, and great quantities of mud and detritus in suspension are brought down from the hill country; its course is estimated at above 1000 miles. The greater Zab rises in the mountains of Khurdisthan to the west and south of Lake Urimeyah from several sources, the eastern of which pass to the north of the head-waters of the lesser Zab and Diala; its course is tortuous, and probably exceeds 200 miles in length; it receives the waters of the Rowandiz and Khazir rivers, and its upper course is through precipitous valleys and ravines; it is rapid, but when it reaches the plain deeper than the Tigris, and nearly as broad. The lesser Zab rises in the south-east watersheds of the greater Zab, and flows through an undulating country to the river stream, which they join respectively twenty-five and seventy-eight miles below Mossul; below this the Toak and Adorneh are affluents from the left, and the Diala adds its tribute to the waters a little below Bagdad, near Koural; it also receives a considerable affluent from the north-east, the Mendeli, but of the course and the courses of the rivers and country through which they flow little is known.

From the confluence of the river to the sea one principal channel conveys other waters to the sea; this receives a single affluent from the left, the Kerhka, Kurah, or Karasu, the ancient Choaspes, which rises from several sources in the Kurdish mountains to the south of Lake Urimeyah, from whence the waters of greater Zab and Kizilouzan flow to the west and east, and which form the southern watershed of the valley of the lake; it has several considerable affluents, but the country through which it flows is little known; its course has a general southerly direction, and may be estimated as above 350 miles in length.

The principal mouth of the river, the Kohre-el-Busral, has a bar with only three fathom water in it at low tide, but a channel extends to the east, and surrounds a delta of islands, divided by seven channels, this is called the Hafar Canal, and at its eastern extremity receives the waters of the Karoon, Karun or Kurum, river, which rises from two principal sources, the one to the north near those of the Koural, in about 34° north latitude, the other to the east, from the slope of the table-land of Persia, in the Koh-i-zerd, about the intersection of the 32nd parallel north latitude and 51st meridian east longitude; their united waters are navigable to the east for boats to within six miles of Shuster, under the 32nd parallel; its course is estimated at 250 miles. At the south-eastern extremity of the delta of these rivers, the Jirahi, a small river, falls into the sea. The four eastern mouths of the delta are not important, the fifth, the Kohre Omegal, though seldom used, is navigable for vessels drawing ten feet water; the seventh, the Kohre Abdallah, is by some supposed to have had direct communication with the stream of the Euphrates above Kornah, as well as the ancient channels of that river to the west of its present course; it is broader and deeper than the Shat-al-Arab. The delta of these rivers has increased with great rapidity during the historical period, and now extends about fifty miles from the Hafar Channel to the sea, and 120 along the coast.

Until recently little was known of the countries watered by these rivers; the ancient civilization of which they were the theatre led to the conclusion that a large proportion of the surface must be extremely fertile; the accounts of the ancient geographers and historians were sufficiently detailed to satisfy every one that their surface must be as varied as the character of the inhabitants, that much was always, as it is now, the natural habitation of a nomad race, that extreme fertility was confined to the immediate neighbourhood of the rivers and lakes, and that much of the mountain region was wild and rugged, but that its valleys were not the less luxuriant in their vegetable life than the hills in the timber with which their sides are covered; nor has our more recently acquired knowledge done more than confirm this; by making us accurately acquainted with a few particular localities, we are able to form a judgment of the whole, but this judgment does not alter that of antiquity. The hill region is especially one of fruits and flowers; the vine, fig, and olive grow with peculiar richness and vigour; its present products are chiefly rice, cotton, and tobacco, with herds and flocks of horses, sheep, and goats; the striking features of the low country are the absence of trees, the short duration of vegetation, and the abundance of aromatic plants; great variations of temperature take place, both on the plains and in the hill country, more, of course, in the latter; bituminous and saline lakes occur frequently in both. The mountains no doubt abound in minerals, of these lead and copper are worked in the upper valley of the Euphrates, and the latter at Arghana, to the north-west of Diarbekir. The mountains about the head waters of the rivers consist chiefly of igneous and volcanic rocks, granite, gneiss, schist, &c., with lateral formations of serpentines and outlying sandstones and limestones; the boundary of the plain of Diarbekir to the north-west is of indurated chalk, the plain itself has an average elevation of about 2500 feet above the sea. The mountains to the east are cretaceous, broken, and interrupted by volcanic rocks. The plains appear to be for the most part of sandstone, with ranges of limestone traversing them; lower down the rivers a country of dates, rice, and pasturage is succeeded by canes, rushes, and saline marshes. Antelopes and grouse abound in the plains, wild fowl and buffaloes in the marshes; fish are plentiful in all the fresh waters.

3 *The Secondary Watershed of the South and the Coast District.*—The great range called Zagros, which forms the eastern watershed of the affluents of the Tigris, and the southern of the Kizil-ouzan, must be considered a part of the main primary range of the eastern continent; its spurs in this direction differ in nothing from those to the north-west, unless they be more abundant in vegetation, rising in lofty peaks 14,000 feet, covered with forests of walnut, oak, cedar, fruit trees, vines, and roses, to a height of 6000 feet; and of pine trees still higher: to the south, however, well-defined secondary ranges, still known by the same name, form the eastern limit of the valley of the Tigris, and buttress up the great plains of Persia, in which limestone and sandstone predominate; the latter of very recent elevation, in some parts encroaches on the lower course of the Tigris and its affluents. These ranges are for the most part parallel, having a south-easterly direction, and form narrow valleys, enclosing the upper waters of the affluents of the Tigris and Kerah.

As already stated, of the western slope of this watershed, little is known; its eastern is the great plain of Persia, having an elevation of from 2000 to 3500 feet, and having no outlet to its waters from the south, these secondary ranges are extended at but a short distance from the coast, until they meet the lower spurs of the Suliemanie range, and thus complete the circuit of the country.

The coast district is still for the most part the sandy desert which Alexander found it. The eastern portion forms the district of Beloochisthan; its general elevation is very considerable; Kelat, in latitude 28° 52′ north, longitude 66° 33′ east, having an elevation of 6000 feet; the Bolan Pass to the east, nearly the same elevation, the peaks rise above 10,000 feet. The rivers are inconsiderable in volume of water; one, the Dirstel, though at the mouth only twenty yards wide and as many inches deep, is supposed to have a course of 1000 miles; it falls into the sea in about longitude $61\frac{1}{2}$° east.

Those mountains, where they have been examined, show the continuance of sand and limestone strata, as well as of recent volcanic action; iron, lead, copper, antimony, sulphur, &c. abound; on them comparatively few trees are found, and the products of the low lands are equally scanty; the date is found on the desert plains, and horses, camels, sheep, and goats find maintenance. This district extends 600 miles to the Gulf of Persia, and as many more along its eastern coast to the delta of the Euphrates and Tigris.

4 *The Basin of the Helmund and its Western Watershed.*—The river Helmund, the Etymander of the ancients, flows through a country not dissimilar in character to that which forms the valley of the Oxus, the difference between the northern and southern slope of these watersheds being taken into consideration; fertile only near the waters, it is more so than that of the Oxus, the winters being less severe, the difference in summer temperature not being so great. This river rises from the south slope of the Oona Pass, in close proximity to the head waters of the Cabool river, and flowing south and west, is lost in Lake Hamoon after a course of about 650 miles; it has one considerable affluent, the Urghundaub, which, flowing in a parallel course for about 230 miles, joins it eighty miles to the west of the town of Kandahar; before their confluence the Helmund is, in spring, 1000 yards across, and from ten to twelve feet deep, but is much reduced in the dry season. The principal source of this river is estimated at about 11,500 feet above the sea, and if its direct course be taken at 400 miles, may have a fall of about twenty-six feet in a mile.

The Ghomul, a considerable stream, rises from several heads to the north-west of the Urghundaub, of which it may possibly at one time have been an affluent, but is now lost in the salt lake at Istada. Lake Hamoon is also salt, and is about seventy miles in length, by from fifteen to twenty in breadth. It is of irregular shape, and said to be increasing in size; the eastern shore is marshy; it has an island, on which is Fort Rustum, or Koh-i-najeh; it is the Seistan of the ancients. Lake Zurrah, to the south, is now nearly dry.

Lake Hamoon receives, besides those of the Helmund, the waters of the Furrah-rood, which has a course of 200 miles, from the north, and other small rivers; it has no outlet for its waters. The Zorah, which has a course of the same length, rises to the south of the Doru, an affluent of the Helmund, from the north slope of the Bolan Pass, but loses itself in the sand.

The course of the Helmund shows the main slope of this district to be south and west; the greatest elevation of its watershed is to the north-east, where the mountains rise suddenly to an elevation of 20,000 feet and upwards; the passes connecting this district with that of Balk, at the sources of the Helmund and Cabool rivers, the Oona and Hajeeguk, are 11,000 and 12,400 feet in elevation, and that of Kaloo lying beyond, may be 13,500. The whole of this district to the north and east is veiy irregular, and interspersed with mountains, and hence is called Koh-is-than, or the hill country. The range named Suffeid Koh, or white hills, which separate it from the valley of the Indus, rises about 14,000 feet above the sea, and is prolonged to the south in an irregular mountain district, of which the peaks known as the Suliemanie range, form the projecting spurs; to the east, the Suffeid Koh alone retains its snows during the whole year.

The irregular valleys which slope down to the desert of Seistan are all fertile, the sides of the hills covered with forests of pine, oak, olive, and fruits of various kinds, in great luxuriance. Three ranges have been traced on these mountains, geologically, of which the third and lowest being sandstone, is barren, and the productions are similar to those of the hill countries to the east; the fruits are especially excellent; and minerals of all kinds, gold excepted, which, however, is not wanting, are abundant. The two principal passes connecting this district with the valley of the Indus, are the Khyber on the north and the Bolan on the south. The former connecting the upper valley of the Cabool river with the main valley of the Indus, more than 100 miles east of the city of Cabool, and 150 from the sources of the river, is sufficient evidence that the range, through which it extends for thirty miles, is to be considered secondary to that of the Hindoo Koh, being, in fact, a continuation of the salt range to the west. Hemmed in by precipices of slate rock 1000 feet high, it affords difficult and dangerous connexion between the lower and upper valleys, the latter connecting Kutch Gundava with the Pisheen district, which again is connected with Kandahar by the Kojuck Pass; the ravines, stretching above fifty miles north and west, having an extreme elevation of 5793 feet above the sea; here the Bholan river rises, which waters the district of Kutch, and were its waters not absorbed in irrigation, would form a considerable affluent of the Indus.

The desert lying to the west of Lake Hamoon, forms part of Iran, an appellation rather historical than geographical, and which has enlarged and contracted its limits according to the political circumstances of these countries—originally, perhaps, extending even to Syria, now, probably, limited to the narrow district between Lake Hamoon and the eastern watershed of the Tigris. The district known as the table-land of Iran, extends from the Koh-i-bundun, the western watershed of Lake Hamoon, to the Zagros mountains, the eastern watershed of the Tigris; and from the Elbruz mountains on the north, to those of the coast district already described, for about 500 miles in each direction. Though arid, and for the most part barren, it has fertile spots wherever water is found; these, though few and far between, are the resting-places of caravans, by which commercial intercourse is carried on between India and the east of Asia; our knowledge, therefore, of this country has but little increased in modern times. Its natural productions are salt, most minerals and metals; and horses, sheep, and camels constitute the wealth of its inhabitants; it belongs, physically, to the great belt of arid and unwatered land which stretches north-east and south-west from China to Africa, and then taking a more easterly course, is continued through that continent. The principal rivers of this district are the Bundemis, which, after a rapid course of about 150 miles, falls into Lake Bakhtegan; and the Zendarood, which, rising from the opposite slope of the same watershed to those of the Karun, loses its waters in the sands of the desert. Lake Bakhtegan is about sixty miles in length from west to east, with an average breadth of eight miles; its waters yield salt in large quantities. The elevation of the lower portion of this district may be 2000 feet above the sea.

5 *The Table-land of Syria and Arabia.*—The name Syria, like that of Iran, has varied much in the extent of its application. Originally the same with Assyria, by the appropriation of the latter to the eastern portion, the former has been limited to the western; yet we have no other name by which to designate the country which extends from the eastern slopes of Lebanon to the Euphrates on the east, and into Arabia on the south. The appellation, desert, is not justly given to this district, it being a continuation of that which, extending along the base of the lower ranges of the mountains of Assyria, Persia, and India, is capable of being made abundantly productive by cultivation, having a surface of fine mould, based principally on limestone; desert now, simply because deserted by industry, and given up by its barbarous governors to their still more barbarous subjects. Like the prairies of North America, it is the natural home of a nomad race, and probably will never be cultivated but under the influence of immigration; still the district of Haouran, on the west, is the granary of the country, and gives sufficient evidence of what it might be in better hands. There can be no doubt that in the early historic period it was thickly peopled, and studded with cities of importance (see pp. 143, 144). This is the natural country of the horse, as the deserts, more properly so-called, of Arabia and Persia are of the camel.

The peninsula of Arabia has two well-defined districts of opposite character—those of the coast, fertile, that of the interior, arid; this is the Nedjed of the Arabs, and may be again subdivided, being crossed by irregular ranges of hills stretching from the Gulf of Persia to the Red Sea. The principal of these, the Jeb-el-Shammar, rising about 1000 feet above the plain. To the north of these the desert country, called by the Arabs, Shamah, extends to beyond the thirtieth parallel, rising diagonally eastward to the Euphrates, and to the south reaching the mountains which form the shore of the peninsula in that direction. Of these portions the northern is better known, from the route for caravans from the valley of the Euphrates to Mecca lying through its plain; yet the knowledge of this is extremely limited: it has been recently traversed by Dr. Wallin; the eastern portion, according to his account, appears to have a surface of loose sand, while the western is rocky, and in some places by no means wanting in fertility. "Taken in the aggregate," he says, "Nejd presents an undulating and rocky surface, intersected on the west by offshoots of the hilly ranges which run out from the western chains, and in other places varied by the occurrence of broken groups and isolated hills and peaks, apparently unconnected with each other. The plains among these hills are of greater or less expanse, and consist sometimes of 'nufood,' soft or clean sand, producing a scanty desert vegetation, and sometimes of a hard and barren soil totally destitute of verdure and life;" in the western parts sandstone predominates, but crystalline limestone occasionally protrudes, as at Teima. This district, though thus generally barren, is not destitute of fertile valleys. Dr. Wallin estimates it as about 250 miles across.

Possibly the entire of Arabia may be found to consist of two irregular mountain valleys, sloping gradually to the Persian Gulf, surrounded and intersected, especially to the south and west, by spurs from the main chains; those continued from Lebanon to Sinai and Horeb, on the north, rise 7887 feet above the sea: the mountains of Arabia reach an elevation of above 6000 at the north-western angle, at Jeb-el-Tybut, to the east of the gulf of Akaba, at Jeb-el-Akdar, at the south-east near Muscat; and of above 5400 at Jeb Tudhli, on the southern coast, near the strait of Bab-el-Mandeb; the general fall of the country must, therefore, be east and west.

The coast districts of Arabia are very similar in character, on its three sides, separated as they are from the centre by mountain ranges of an average height of 5000 feet, composed of granite, flanked with limestone, and on the south by sandstone: coral rock abounds on the coast of the Red Sea, the steep cliffs of which are formed by that rock and sandstone. These mountains are intersected by fertile and well-watered valleys, have plentiful pasturage for large flocks of sheep, and formerly produced coffee in abundance; maize, wheat, barley, indigo, sugar, tamarinds, dates, and other fruits, are plentiful, as are valuable woods and gums.

The climate of the interior is excessively dry; of the hill country more moist, the coast of the Red Sea being healthier than that of the Gulf of Persia, which is hotter and moister.

6 *The Watershed of the West Coast and Valley of the Jordan.*—From the knot of mountains to the north-west of the sources of the Euphrates, the chain of Libanus, with its parallel range, Anti-Libanus, radiates to the south, as the Caucasus-Taurus, and Anti-Taurus do to the west. These two ranges must, therefore, be considered as the prolongation of the main chain of western Asia in that direction; the one apparently terminating in the peninsula of Sinai, but not to be disconnected from the eastern watershed of the Nile; the other extending into and round that of Arabia; and thus the Red Sea appears to be the continuation of the valley which they enclose.

To the north of these ranges the valley of the river El Aa'sy, the Orontes of the ancients, opens an easy route from the Mediterranean to the valley of the Euphrates, the mountain ranges being here depressed, and offering little impediment to the transit. This river has a course of 240 miles, and would, if cared for, be navigable for twenty miles from its mouth to Antioch; at Antioch its course changes from north to west, where it is 150 feet wide; its upper course is rapid, as its name, El Aa'sy, the Rebellious, implies; but its lower has a fall of not more than five and a half feet in a mile; it flows through Lake Homs, Ems, or Kadez, which is about thirteen miles long and two broad. The number of large cities and temples now in ruins, show the importance of this country in old times, an importance which the return of its natural trade with the East would quickly restore to it.

Libanus Lebanon, the White Mountain, so called from the white limestone of which it is principally composed, is separated from Anti-Libanus by the valley of Cœle-Syria, about ten miles in width. This country is deservedly celebrated for its beauty and fertility; the mountains producing valuable timber especially cedar, and fruits, and the valley all things necessary for the use of man; the date palm grows on these mountains at an elevation of nearly 2000 feet. The snows are permanent on Jeb-el-Makmel and Jeb-el-Sheik, as also on Jeb-el-Sannin, to the south of the former, which has an elevation of 9350 feet; the pass over Northern Lebanon to Zaleh may be nearly 5500, and that on the road from Beyrut to Damascus about 5000; the cedars may be about 6000. Jeb-el-Makmel, the culminating point of this range, is estimated as above 12,000 feet in elevation; and here the chain of Anti-Libanus diverges; from the north slope of the knot here formed, the Orontes flows, while the sources of the Litany, the ancient Leontes, rise in its southern slope. This river has a course of above 100 miles, throughout which it is for the most part a mountain torrent, unapproachable, and impassable; it is said that there are only seven places between the mountains and the sea at which its passage can be effected; nevertheless, in the valleys it is made subservient to the purposes of cultivation. To the south of this valley another knot, of which Hermon, or Jeb-el-Sheik, is the culminating point, rising to an elevation of 10,000 feet above the sea, separates it from the valley of Damascus, and of the Jordan, which having now no outlet for their waters, must be considered separately. The former might be designated as a fertile plain, if its extent and comparatively level surface were only considered; but the numerous streams which flow from the mountains which surround it, and give it its extreme fertility and verdure, uniting at the bottom of its basin, form the Bahr-el-Margi, or Lake of the Meadows, which shows its true character. This valley, from the abundance of its flowers and fruits and the salubrity of its climate, is one of the four paradises of Eastern poetry.

The valley of the Jordan presents one of the most remarkable features of the surface of the earth, on account of its great depression below the level of the sea. This depression has only been satisfactorily proved within the last few years by actual survey, although satisfactorily demonstrated by science before (*see Journal* R.G.S., vol. xviii.), the very gentle declivity of the valley from the north, and absence of an horizon by which to determine its level, having deceived the eye of the traveller; and even now it is difficult to realize, when on the spot, the truth, which has been nevertheless most satisfactorily ascertained.

The Jordan has a course of 120 miles, rising from two sources, and flowing through Lakes El Huleh, the Merom of the ancients, and Tabariyah Gennesareth, or Chinnerith; throughout the greater portion of its course the river is very rapid, and broken by cataracts, of which twenty-five have been enumerated. The principal source of the Jordan may be estimated as 2000, and Lake Merom 100 feet above the sea; Lake Tiberias is 755, and the Dead Sea 1312 below that level, which will show an average fall of the river of twenty-seven feet in a mile; its upper course would not have less than fifty-five, its lower ten, in direct linear extension, which, broken as it is by rapids and falls, must be interspersed with deep pools and still water in many places; this gives great beauty to the river, the banks of which are constantly covered with verdure, and is indeed the character of the river throughout its course; at Jacob's Bridge, to the north of Lake Kaleh, where it may be 100 feet broad, it has been compared to a continuous cataract, but a temporary level is obtained in that lake, or marsh (as it should more properly be called, being covered with aquatic plants), which is about four miles in extent either way, but increases considerably in the rainy season. The Jordan has two affluents, the Sheriat-al-Mandhur, and the Zurkah; the former collecting its tributary streams from the southern slope of the watershed of the valley of Damascus; the latter, with several similar small streams which fall into the Dead Sea, draining the western slope of the mountains of Abarim and Jebel-ez-Zubleh, which form the watershed between affluents of the Jordan and the Euphrates. Lake Tabariyah is in form oval, its shores in many parts precipitous, giving evidence of volcanic action, which has been continued until recently; it is in length fourteen, and in breadth eight miles. The Dead Sea or Lake Asphaltites, the Bahr-el-Lout or Sea of Lot of the Arabs, is in length about thirty-five, and in breadth twelve miles; as already stated, its surface is 1312 feet below the level of the Mediterranean; and as it has a depth of above 2000 feet, the entire depression from Jeb-el-Sheik possibly exceeds 13,500 feet, by far the most considerable depression *not connected with the ocean* known on the surface of the globe. This lake has an extreme depth of 1350 feet near the centre, and the contour line of 100 fathoms approaches its shores, but the bay to the south has not more than two fathoms water, and is in the dry season little better than a morass. The south-western shores of this lake are volcanic, and several extinct craters are perceptible; the south and south-east are low and marshy; the hills in this district present granite, gneiss, and dolomite: the waters are strongly impregnated with salt, and bitumen was found in considerable quantities after earthquakes which took place in the years 1834 and 1837; rock salt abounds in the vicinity, but the mountains are principally limestone. Of this, as of other similar lakes, wondrous stories have been current, and in this case they have received apparent confirmation from the miraculous transactions which have happened on its banks; of the localities connected with these, and even of the country, its productions, and climate, modern travellers give different accounts; it is of course in such a case very difficult to dispossess the mind of preconceived opinions, or to make the necessary allowance for religious prejudices and predilections. At Jerusalem the maximum range of the thermometer is from 45° to 80°; snow falls occasionally during the three first months of the year, and in September the corn is green, and oranges begin to ripen in January; the fruit ripens in the next month; the end of April and beginning of May is the time of harvest; but in the valley of the Jordan, by this time of the year, the heat is so extreme that everything is burnt up and withered ; July and August are the first months in which grapes and olives abound in great perfection ; maize and cotton are gathered in September ; October is the month of vintage ; November of rice harvest, and seed time for corn ; December the only winter month, in which the plains recover their verdure, and give food to the cattle. This country might well be naturally as it is spiritually, the joy of the whole earth ; and even now, in spite of the tyranny and extortion of its governors, the insubordination of the Arab Sheiks, the indolence and demoralization of the population, its natural wealth and beauty cannot be concealed.

The mountains of Moab to the south-east of the Dead Sea rise to an elevation of 3000 feet, and are continued, as already noticed, into Arabia. From the Dead Sea the valley is still continued southward, but gradually ascends for about seventy miles to El Sateh, a little to the north of the thirtieth parallel, which is the watershed of the country, at an elevation of about 500 feet ; from whence it again descends, and is continued into the Red Sea, through the Gulf of Akaba, the Sinus Elanites of the ancients.* This country, the Edom of Scripture, is the Arabia Petræa of Ptolemy, well deserving its name ; its principal city, Petra, has been hewn out of the rock ; the inaccessible character of the country has been the protection of its inhabitants from their more powerful neighbours ; its barrenness an incentive to a predatory life. The commerce of Palestine with the Red Sea, and consequently with Africa and India, must be dependent on its possession.

7 *The Peninsula of Sinai and Isthmus of Suez.*—This peninsula has already been indicated as resulting from the continuation of the mountains of the coast of Syria to the south. Physically, therefore, the whole coast district from Mount Carmel to the eastern mouth of the Nile must be included ; historically we know that it has been so : speaking of this district generally, it may be said that the mountains of Syria extending southward as the west limit of the valley of the Jordan or El Ghor, and the Wady-el-Araba, the continuation of that valley towards the Red Sea, take a semicircular sweep to the west, as far south as Jeb-el-Edjme, under the twenty-ninth parallel, corresponding in outline nearly with the shores of the Mediterranean, having a gradual slope towards that sea, but broken and divided by spurs from the main hills, which are more elevated, and massed to the east ; the plateaux immediately below the Jeb-el-Edjme may be 2000 feet above the sea, that mountain having an elevation of 4645, behind which, to the south the great mass of Mount Hor, with its buttresses, Serbal on the west, and Abu Muzrud on the east, rise respectively 8850, 6753, and 8700 feet above the sea, from which the highest peak is not more than thirty miles distant. The grand triangular knot is separated from El-Edjme by the plain of Hadarah, which rising in the centre, about 4000 feet above the sea, falls gradually towards the east and west. It is also divided from Arabia on the east, and Egypt on the west, by the Gulf of Akaba and the Gulf of Suez respectively, on the shores of which, at nearly a right angle, the lofty Tybut Issum, Moileh and Agrib, rise above 6000 feet in elevation.

The Jeb-el-Tyh, of which Jeb-el-Edjme is the centre, may be considered as a continuation of the mountains of Edom, from El Sateh, if El Sateh be the water parting between the Gulf of Akaba and the Dead Sea ; and also the watershed of those torrents, which at some former time united in one stream, fall into the sea at El Arish, the Rhinocorura of the ancients, the outlet of the valley between it and Sinai being, as already noticed, east and west. That a great change must have come over this country since Abraham led his flocks and herds through it, and all nations went down into Egypt to buy food, is apparent ; which, whether it has been consequent on a rise of the land on the shores of the Mediterranean, or a depression of the valley of the Jordan, or

* See, however, on this point, Journal Royal Geographical Society, vol. xxiii.

generally from the multiplied action of volcanic forces over a large surface in many years, has yet to be determined.

As Lebanon and the spurs projecting from it in the extension to the south terminate at the sea in bold headlands, the coast district is broken into small fertile valleys, more fertile to the north in the neighbourhood of the mountains, and becoming less so from want of water to the south, where the watershed is depressed. In this district the heat is considerable, tropical fruits flourish, and the sides of the hills afford plentiful pasturage for flocks and herds. The elevations to the west of the Jordan are of oolitic limestone and indurated chalk, full of caverns and fissures, resting on a basis of silurian rocks, which crop out in Lebanon. The limestone formation is continued through the Isthmus of Suez into Egypt; here it appears like steps through the shifting sand, and is interspersed with saline pools; but when the water of the Nile can be used for irrigation, the soil is found to be fertile. The Isthmus is seventy-two miles in width. The pools or lakes, above alluded to, are found principally on the south side, occupying the bottom of a valley about twelve miles wide, to the north of Suez, which is only divided from the sea by a narrow strip of land, and may have been, not improbably, once filled by the sea, as the lowest level of its waters is fifty feet below that of the surface of the Red Sea. To the north the surface of the country falls toward the Mediterranean, and the valley of Egypt. It was formerly thought that the level of the waters of both the sea and the river was lower than those of the Red Sea; the surveys of Mr. Stephenson, however, have shown that of the two seas to be the same, and leave little doubt that the valley of the Bitter Lake was once a portion of the latter. In the months from October to May the southerly monsoons heap up the waters in the gulf, so that their level is at that time higher than those of the Mediterranean.

There is a remarkable similarity and a remarkable diversity of character observable between the three great peninsular masses, Arabia, Asia Minor, and Iberia; their general character, shape, and position are similar, but their external relations and productions are strongly contrasted. Arabia, the most southern and largest, has the least elevation, by much the least in proportion to its extent, which is, with respect to the others, as seventeen to four, and three, hence it does not approach the line of perpetual congelation, and is deficient in moisture; it has, however, the advantage in local attachment both by sea and with the valley of the Euphrates, while the others are cut off from the continent by the mountains which form the basis of the systems.

CHAPTER IX.

OF ASIA MINOR.

§ 1. General description.—2. The watersheds.—3. The inland basins and lakes.—4. The rivers of the north.—5. The rivers of the west and south.

GENERAL Description.—Few portions of the earth's surface afford more interesting subjects for consideration than Asia Minor, either in their natural or historic relations; occupying an intermediate position between the great European and Asiatic basins, connected by its river basin with the interior of Asia, and by the proximity of its shores—as at the Hellespont and Bosphorus—as well as by the islands, with Europe, it has been the intermediate stage of civilization; it lies between 36° and 42° north latitude, and 26° 4′ and 37° 50′ east longitude; its area may be estimated at more than 200,000 square miles; it may extend 450 miles in length by 360 in extreme breadth, and its coast line may be three times the length of the normal figure which would bound it, being a parallelogram, having its longer sides from east to west; the greatest breadth is in the centre, on each side of which it decreases to 210 miles.

The mountain systems of Asia Minor, extremely irregular in their arrangement, may yet be grouped into two great masses: that on the east forming a vast triangle, covering the head waters of the Kizil Irmak, united to the mountains of Armenia on the east, and throwing out great spurs to the north and west, having Mount Argeus for its culminating point at the apex of the triangle; and that on the west formed by Ak Dagh, which, though of less elevation, projects its spurs, in broad and extended masses, in every direction, giving to the western coast a varied and deeply-indented outline. These divisions are united by the coast range of the south, an extension of Anti Taurus, which, culminating at Kara Dagh, only 75 miles from the coast, bends in a semicircular direction round the great central plain, which is the peculiar characteristic of Asia Minor, and may be 150 miles long by 100 broad. The great mountain masses are formed of igneous and volcanic rocks, with chalk and limestone superimposed, and, in the north, sandstone; they have, therefore, two characteristics, presenting themselves at their greater elevations, in rugged cliffs and peaks, and in their extensions, especially on the margin and within the limits of the great plains and river basins in rounded plateaux.

As the mountains cover the greater portion of the surface, and in their ramifications enclose considerable basins, the drainage into the sea is not in proportion to the extent of the area. The rivers are rapid and intermittent as to the quantity of their waters, the lower courses subject to inundations, the upper to drought.

2 *The Watersheds.*—It has already been noticed (p. 261) that the point of divergence of the mountain systems of Asia Minor must be looked for about the head waters of the Kizil Irmak, and here, near the intersection of the 37° meridian east, from Greenwich, with the 39° parallel of north latitude, the pass connecting the head waters of that river with those of the affluents of the Euphrates and the Seyhoon approaches 6000 feet in elevation. Irregular but lofty chains, (the ancient Taurus?) of which little is known, connect this point with the coast chains of Syria, these may culminate in Giaour Dagh, at above 11,000 feet; but the pass which connects the head waters of the Djeihoon with the Geksou affluent to the Euphrates does not much exceed 3200.

Two long parallel ranges, commonly known as Anti Taurus, extend to the south-west for nearly 100 miles, at about ten miles distance from each other: the eastern, comparatively unbroken, is sufficiently elevated to be covered with snow in summer; it culminates about the centre in Binboa Dagh, below which lies to the north-west a lower parallel range, covered with wood; the western, more broken, is known under several local names; it culminates about the centre in Katran Dagh, where the sources of the affluents of the Kizil Irmak closely approximate to the centre of the upper valley of the Seyhoon, on either side the pass of Sarris; the mean elevation of this chain may be 4000 feet, its culminating points probably exceed 7000. The greatest elevation in this district appears, however, in Kernes Dagh, a transverse chain at the south extremity of Anti Taurus, which rises above 11,000 feet.

The slope of the western chain to the valley of the Kizil Irmak in the north is first abrupt, and then descends in a succession of terraces, forming shallow parallel valleys; the north-eastern extremity extends, in a series of elevated plateaux, towards the mountains of Armenia. The principal watershed between the Kizil Irmak and Seyhoon is continued westward in the two spurs of Kale Dagh, and the southern of which forms the connecting link with Mount Argeus, and rises 6500 feet. Mount Argeus, Ardjis Dagh, the culminating point of the eastern systems of Asia Minor, stands, as usual, in advance of the main watershed, on a plateau of about 200 square miles in extent, of irregular shape, about forty miles from north to south, and as many from east to west, but having its greatest extension to the south, on which side the longer slope is covered with volcanic cones projecting from the basaltic rocks, which form the body of the mountain, a feature repeated on the north-west, but on a more irregular and broken surface, even beyond the basin of the silvery Salt Lake, the eastern limit of which is indented with numerous ravines, at an elevation of above 4000 feet on the north. The descent is precipitous to the valley of the Kara-sou, an affluent to the Kizil Irmak, while the eastern projections are marked by the isolated peak of Karmas Dagh, abounding in fossil remains.

From the upper plateau, Mount Argeus appears in two conical peaks, the eastern rounded in form, the western 'bristling with needles and furrowed with cavities,' and forming, on the north-east, an immense crater-like funnel, remarkable for its depth; the western peak is the most elevated, and reaches an altitude of about 14,500 feet. The highest point yet attained, the inclination of the side of the cone being 50°, has been about 11,500 feet, which may be considered the limit of the snow-line; glaciers descend into the valleys on all sides. This mountain is the centre of a triangle formed by the chains already mentioned with those of Hassan Dagh and Kodja Dagh to the west, seventy-five miles from north to south, on a base of 175 miles from east to west, the sides being above 100 miles in length, the apex at south in Ala Dagh, and the angles in Tonnous Dagh to the east, and Kary Oglan Dagh on the west, the valley of the Kizil Irmak forming the base to the north. Hassan Dagh, on the west, has an elevation of 9000 feet, and throws out considerable spurs; these rise 5000 feet to the north-west, spread into extensive plateaux, of about 4000 feet elevation. Yekil Dagh unites Hassan Dagh to the apex of the triangle by a steep wall of rocks, furrowed by gorges; and here is the principal pass of Misti, from the plateau of Mount Argeus to the central plateau of Asia Minor, at an elevation of 5000 feet; while another, somewhat lower, opens communication to the south and east with the valley of the Seyhoon. Hassan Dagh is formed of trachytic rock, and from it extends, to the west, the almost isolated mass of Karadja Dagh, covered with cones and craters, one of peculiar shape, rising from the centre of Salt Lake at the base; this is connected with the mountain ranges to the west by extensive plateaux, which form the limit of the upper basin of the central portion of Asia Minor, the tertiary plain to the north being separated from it by conical hills, like palisades; the general elevation being about 4000 feet.

The apex of the triangle already described, Ala Dagh, is separated from the range of Anti Taurus by the gorge of Farach, and, on the west, from Boulgar Dagh by the pass of Genzel Thoro, or Thoroglou, the Pilæ Ciliciæ of the ancients, where the harshest features of Alpine scenery are conspicuous; both opening to the upper valleys of the Seyhoon. This great mountain mass culminates about 13,750 feet above the sea; its north face is distinctly defined, and its western summits rise in picturesque peaks; on the north, ranges of chalk hills form parallel valleys; on the east, terraces, divided by pointed rocks, descend gradually, also forming parallel valleys, at an elevation exceeding 7500 feet.

Boulgar Dagh extends the range of Anti Taurus into ancient Cilicia, culminating more than 13,000 feet above the sea; the south and east faces are precipitous; the vine fails here, at an elevation of 6000 feet on the north side, but flourishes at that elevation on the east side; it stretches to the south-west in wide plateaux to the valley of Ermenek-sou, as well as to the north-west. The pass of Karaman, opening communication with the valleys of Cilicia, may have an elevation of above 7000 feet.

The coast chains of Andricus and Imbarus, to the south-west, present inaccessible precipices towards the sea; these surround the fertile and beautiful valleys of the Ermenek-sou, and join the deep gorges and rugged peaks which are formed by the north-western spurs from the great mass of Geuk and Tinas Dagh, which extends to the west fifty miles along the coast, and culminates 11,000 feet above the sea; these spurs extend to the isolated peak of Kara Dagh, which rises from the plain opposite to Karadga Dagh. From Tinas Dagh, rugged spurs extend southward to the sea, forming the valleys of the small rivers which flow into the Gulf of Adaliya, and culminating in Boz Bourun Dagh, opposite the centre of the gulf, about thirty miles from the shore, at about the same elevation. Kara Dagh is the point of junction to the west of the coast chains, and their irregularity and rugged character is seen in the pass from the valley of Lake Kestel, being nine miles long, at an elevation of 3500 feet. Kestel Dagh, extending to the south, joins Kizildga Dagh and Elmalu Dagh, having an elevation of nearly 12,000 feet; here the mountains are divided by narrow and deep gorges, forming funnels and craters; their peaks are lofty, reaching up to and beyond the snow-line. The unbroken semicircular mass of Baba Dagh presents an amphitheatre to the west, and its extension towards the north is formed by three chains—Lida, Grinium, and Latmus—which extend to the Gulf of Mendelia, and to the north spread out into the plateau of Beck Permak Dagh (round the base of which the Meander flows into the sea), surround Lake Akiz, and are reproduced in the islands of the Ægean; the southern spurs form the promontory between the Gulfs of Kos, Syme, and Makri, and appear again in the island of Rhodes.

The region of lakes to the north is encircled by a range of mountains, extending above 150 miles, from the spurs which unite them to Karadga Dagh and the mountains of the east, to the southern spurs of Ak Dagh on the west; on the east it is formed of two chains, parallel for near 100 miles, Sultan Dagh on the south, and Emir Dagh on the north; here isolated peaks attain considerable elevation, and from them broad masses spread to the south and west. The elevated platform between these ranges and Kestel Dagh to the south opens communications in all directions: those from east to west have an elevation exceeding 4000 feet over the southern spurs of Sultan Dagh; that to the north, through a deep ravine, does not exceed 3500 feet, which is about the elevation of the passes to the south leading to Kestel Gheul.

The northern watershed of the Meander is formed by ancient Missoguis, which extends to the coast near Gumuch Dagh, or Silver Mountains, and Samson Dagh, and is continued through the island of Samos from the eastern extremity, the ancient Tmolus diverges towards the north-west, and extends in irregular broken spurs along the Gulf of Smyrna, and to the island of Kios; its extension to the west approaches within three miles of the sea, is massy, and furrowed with deep gorges; the pass leading over Missoguis by Djuma Dagh has an elevation of 4500 feet; there does not appear to be any pass over Tmolus until towards the western extremity. To the south, Ak Dagh, which is the centre of the western system of Asia Minor, extends its massy spurs in every direction; these are more remarkable for their breadth and solidity than their elevation, Ak Dagh, rising only about 9000 feet above the sea; Emir Dagh and Sultan Dagh must be considered the extensions to the east; and on the west, Mouzluk Dagh stretches in solid mass for fifty miles, almost to the shore of the Propontis, throwing out three considerable spurs to the west and south, enclosing valleys, which, however, do not attain a greater elevation than 2500 feet, nor do the passes to the north-east and west of this chain rise above 1500 feet; that of the Ougundja Yaila, to the east, is estimated at rather more than 1000 feet, and here the country is broken into fertile valleys and verdant plateaux, where the grass in winter flourishes, and the waters are never more than slightly crusted with ice; to the south, however, Hassan Dagh terminates in the bold trachytic heights of Dumanlu Dagh, culminating 5000 feet above the sea. Madara Dagh, to the north, is a mass of syenite, but Oulevan Dagh, its southern extremity, slopes gently towards the Gulf of Mytilene, having a plain three miles wide at its base.

The syenite rocks of Oulevan are of most irregular and romantic aggregation; to the north they assume imposing forms, broken by rugged peaks and rocky defiles. The highest elevation of the pass across this chain approaches closely to 2000 feet; a race of Troglodytes inhabit it at an elevation of 1000 feet. Similar features are apparent in the mountains on the northern coast of the Gulf of Adremia, which attains an elevation of 6000 feet. Here is Kas Dagh, known as Mount Ida. To the west and north the mountain forms are more regular and gentle, being composed of rounded masses, for the most part covered with pines; but the rugged, black trachytic rocks appear again on the southern shore of the Propontis, in the isolated mass of Kapou Dagh, the ancient Cyzicus. Terraced hills and undulating wooded country characterizes the coast to the east of the Bosphorus. The western spurs of Ak Dagh are extended across the central plains of Asia Minor, in plateaux which connect them with the mountains to the north of the Great Salt Lake; the southern spurs of Ketchich Dagh, the Mysian Olympus, connect it with Ak Dagh and the extensive plateau of Mourad Dagh. This is one of the most important mountain ranges in Asia Minor, it culminates at above 7000 feet, and its snowy summits are seen from Constantinople, sixty miles distant; it slopes rapidly to the valley of Lake Apolonya on the west, and extends a considerable spur to the east into the main valley of the Sakaria, its southern extremity, Moualar Dagh, is crossed by a pass nearly 4000 feet above the sea, remarkable for the picturesque grouping of the rocks which form its gorge. The rugged trachytic mass, Karakaya Dagh, is opposed to Olympus on the east, and rises in gigantic precipices; from it continuous ranges extend for 100 miles to the shore of the Black Sea, and it is crossed by a transverse range about the centre, where the elevation may reach 7000 feet.

The limit of the great central basin on the east extends from Mount Argeus by Kodja Dagh and the basins of the Great Salt Lake, to Kartal and Kure Dagh, which are the connecting links between the southern and northern chains, of which latter Ala Dagh is the most important, extending for 150 miles, until it meets the western spurs of the Karakaya Dagh. Ala Dagh culminates about 7500 feet above the sea; its western extremity is an elevated plateau, a deep valley and torrent intervening; numerous streams flow from the flanks of this range, which, extending to the east in Ichik Dagh, is crossed by a transverse line of trachytic peaks; the sides of this chain are remarkable for the beautiful parallel valleys formed by five distinct ranges of heights. Ichik Dagh extends to the south in Hussein and Hassan Dagh; the latter had snow on its summits in June. To the south the granitic ranges extend along the eastern basin of the Great Salt Lake; these have a mean elevation of about 4500 feet, and are crossed by numerous defiles; here the triple rampart of Kodja Dagh is connected with Mount Argeus by the plateau of Chehr, having a deep valley to the east, through which is the pass to the southern central plateau and the valley of the Seyhoon, by the southern extremity of Hassan Dagh, uniting with that of Misti; the upper plateau may have an elevation of 6500 feet.

To the north of Ala Dagh, the parallel ranges of Dogdou and Ilkas Dagh extend for 100 miles, and beyond Alfar Dagh forms the coast line; these are crossed near the centre by a pass leading from the little river Daourikan, which at its summit in the northern chain attains an elevation of nearly 2000 feet, and over the central mass of above 7000 feet; the sources of the torrent Karadere being 6000 feet above the sea, and the lateral valleys 4750 feet. Ilkas Dagh was covered with snow on its superior summits in August, 1850.

Yuldouz Dagh, a spur from the loftier chain of Keuch Dagh on the east, which unites with the mountains of Armenia, spreads in broad terraces between the head waters of the Kizil and Yekil Irmak; the pass across the chain between the valleys of the two rivers by the Yuldouz, an affluent of the former on the right, is through a defile at an elevation of about 3750 feet. The plateaux of Yuldouz extend westward nearly 100 miles, and then bend northward round and between the affluents of the Yekil Irmak, presenting rounded surfaces not reaching 4000 feet in elevation. To the north-east, however, Kourt Belli Dagh and Kal Boyuz Dagh, the northern spurs of Keuch Dagh, between the eastern affluents of the same river, present lofty and rugged ramparts; to the south and west the greater elevations are continued in Ak Dagh, consisting of parallel ranges, presenting fertile valleys and verdant plateaux, and culminating at the north-east in Nalban Dagh, at nearly 8000 feet; here are silver mines at an elevation of 4750 feet. The slope of Ak Dagh is very gentle to the north-west; there are gorge-like valleys, from east to west these are traversed by passes from the south, the highest elevation of which is 4750 feet. On the west, opposite Ak Dagh, Tchitchek Dagh presents a plateau furrowed by valleys and crowned by granitic hills; the valleys between these mountains are of higher level than that of the Kizil Irmak, and the Pass of Yuzgat over the western extension of Yuldouz Dagh, has an elevation of 6500 feet; the gorge to the south being formed by precipitous rocks. To the south of Tchitchek range is the great plateau of Bozok, presenting a circular face, for near 100 miles, to the valley of the Kizil Irmak, round which that river bends to the north; the elevation may be about 5000 feet; it is separated from the valley to the south by granitic ranges with deep gorges, nevertheless, vegetation is here luxuriant.

The extensions of Yuldouz Dagh to the north present themselves on the coast in rounded forms not exceeding, at Bouchalan Dagh, 5000 feet in elevation, over which the summit of the pass from the coast to the central basin of the Yekil Irmak is about 4000 feet. To the east, however, the chains are more lofty and better developed, and beyond the vast marshy plain at the mouth of the Yekil Irmak approach the coast, which is famous for its beauty, yet inferior to that of Cilicia and the rest of the southern coast of Asia Minor.

The central basin of Asia Minor may be estimated at 6000 square miles in extent; the most level portion is the upper or more southern, the basin of the Great Salt Lake, undulated with isolated mountains forming the buttresses of plateaux rising from it. The upper basin of the Sakaria is also of very varied character. The tertiary plain of the upper basin of the Kizil Irmak may have an extent of 1000 square miles from the junction of its principal sources at the foot of Yuldouz Dagh. The great plain or Yaila of Ouzoun, about the head waters of the western affluents of the Euphrates, east of the pass of Ouzoun, extends 250 miles, at an altitude of 5500 feet.

3 *The Lakes and Inland Basins.*—From what has been already said, it is apparent that, by much the larger portion, the surface of Asia Minor is covered with mountains; and that these enclose, in many parts, basins which have no communication with the sea. As in Asia generally, so therefore in Asia Minor, an account of the lakes forms an important element in its description. They may be divided into four classes:

1. Lakes of fresh water not belonging to river basins.
2. Lakes of salt water deriving their saline properties from the geological formation of the basins.
3. Lakes of brackish water often showing former connexion with the sea.
4. Lakes forming part of the course of rivers.

To the first, commencing from the north-west, belong the Lake of Nicomedia, or Sabandja Gheul, its area is estimated at twenty square miles, its circumference thirty miles, and its elevation 375 feet above the sea. The position of the lake, in a depression between the Sea of Marmora and the lower course of the river Sarkaria, has suggested a connexion with the Black Sea. The shores are richly wooded and fertile. The Lake of Nicea or Isnik Gheul, is in area forty-five square miles, in circumference forty miles, and in elevation about 100 feet; three miles distant from the sea, it is separated from Lake Nicomedia by Borondjoum Dagh, and by the range of Olympus from Lake Apolonya; it probably has connexion with the Gulf of Ismid.

To the south of Kemir Dagh and Kestel Dagh, there are several small lakes of this class, varying in area from three to six miles, at considerable elevations above the sea, receiving small mountain streams, but having no outlets; the largest of them is Kestel Gheul, which is intermittent, but has an area of twelve square miles, at an elevation of 3250 feet above the sea. This lake receives the considerable stream Istamak Tchai from the south.

Lake Eguerdir, lying among the south-western spurs of Sultan Dagh, bounded by lofty rocks interspersed with the richest vegetation, and having many islands, is famed for its beauty; its area is about fifty square miles, its circumference may be seventy-five miles, it being prolonged in a narrow gulf to the north-east, and its elevation about 3200 feet; it receives from the south the surplus waters of the small lake Geude, distant ten miles.

Lake Kereli, or Bey Chehr, lies between the south-eastern spurs of Sultan Dagh, and the rugged ranges of the coast; is in area 120 square miles, in circumference seventy-five miles, and in elevation above 4000 feet. Beautiful valleys open round this lake, crowned to the south with snowy peaks; its waters are said to be supplied from subterranean springs, and it may not be improbable that they are affected by the emission of gases from the rocks which form its basin; it is united with Lake Soghla, twenty-five miles distant to the south-east, by the small stream Bey Chehr; this, however, as well as the lake, was dried up when visited by Tchihatcheff. Several small fresh-water lakes, the dimensions of which vary with the season, lie in the valleys between Sultan Dagh and Emir Dagh.

Lake Eregli, or Bektik Gheul, situated on the southern edge of the great central basin, is surrounded by marshes, but may have a normal area of twelve square miles, at an elevation of 4125 feet.

In the second class we find two small lakes below the southern spurs of Sultan Dagh, Tchurouk-sou Gheul and Bouldour Gheul; the waters of the latter are strongly impregnated with sulphates of soda and magnesia, and chloride of sodium, like the German mineral waters at Seidlitz, &c.; the area of these lakes may be about twenty square miles, their elevation about 3000 feet.

The Great Salt Lake, *par excellence,* Touz Gheul, lies at the foot of Kodja Dagh, and the western spurs from the great knot of Mount Argeus. It has an area of 175 square miles, a circumference of seventy-five miles, and an elevation of 3550 feet. In the summer a mass of saline incrustations rests on the blue clay which forms the bed of the lake; in winter this is raised by the water of the several streams which flow in from all sides increased by the rain; the glistening whiteness of the salt contrasts singularly with the verdure of the surrounding hills. Many small salt lakes are found in the plains to the south and west; one of which, below Karadja Dagh, yields salt in equal abundance, as does Lake Develi Kara Hissar, or Givach Gheul, on the western side of Mount Argeus, at an elevation of 4600 feet; and Lake Pallas, a very small lake in the upper valley of the Kizil Irmak, and many others in the same valley, which is a region of saline deposits, stretching eastward beyond the thirty-seventh meridian east longitude, some of which are more than 5000 feet above the sea. In the great central plains to the east of Emir Dagh, there are also lakes belonging to this class, the waters of which are brackish and bitter, and are the harbourages of multitudes of wild fowl; and one to the north, in the valley of the Soaumer-sou, at an elevation of 5625 feet on the southern slope of Keredi Dagh. Mernierè Gheul, lying in a lateral valley among the lower spurs to the south of Ak Dagh, and close to the valley of the Caister, is also saline; its surface is scarcely above the sea level, it has an area of nine miles.

Of the third class, Lake Akiz Tchai is probably the remains of the Gulf of Latmus, it has an area of eighteen square miles, and its surface is about 100 feet above the level of the sea. Kendjez Liman, to the south of Boz Dagh, as its name (Liman Gulf) implies, was also probably once an inlet of the sea; its surface level is lower than that of Lake Akiz Tchai, its shores are marshy, and it receives several small streams. A large marshy tract, indicating similar changes, lies at the head of the Gulf of Adaliya, between the rivers Ak-sou and Kempru-sou.

The fourth class will be naturally included in the description of the rivers.

4 *The Rivers of the North.*—The longer slope of this country being to the north, the largest rivers of Asia Minor fall into the Black Sea; of these

the more important are the Yekil Irmak, the Kizil Irmak, and the Sakaria. The Yekil Irmak rises in the Kourt Belli Dagh and the northern slopes of Yuldouz Dagh, in close proximity to the northern sources of the Kizil Irmak; at the pass of Tokat it has an elevation of 1650 feet; the average fall may be five feet to a mile, and in its middle course it flows between precipitous rocks, it there holds carbonate of lime largely in solution; it is shallow, and generally fordable, its banks rocky to within twenty miles of its mouth. The principal affluent of the Yekil Irmak is the Tchekerek-sou, which rises to the south of the pass of Tokat, and encircling the plateau of Devedji Dagh, joins the main stream in its middle course; the upper extremity of its valley has an elevation of near 4000 feet; its length may be estimated at 100 miles; another affluent of the left is the Terchan-sou, which flows through the beautiful plain of Sulur Ovassi, and then receives the Sousandji, which has its rise in the little lake Ladik, 3250 feet above the sea, and encircles Boucharlan Dagh. The Tchoterlu is also an affluent of the left. The only affluent of the right is the Kouli Hissar, or Guermeli, which has its source in the mountains of Armenia, to the north and east of Geuk Dagh, and must have as great a length as the main stream.

The little river Termé, as its name seems to imply, flows through a valley noted for its hot springs, to the east of the Yekil Irmak.

The mouth of the Kizil Irmak is about forty miles from that of the Yekil Irmak, in direct distance across a deep bay, into which no streams flow worthy of notice. The main source of this river is in the Gueimbelli Dagh, at an elevation considerably exceeding 7500 feet; here a torrent, it is joined by other torrents from north and south, which, uniting, flow through a deep and rocky bed from east to west, below the northern spurs of Mount Argeus, where it receives the Kara-sou from the south; from hence it flows in a semicircular course to west and north, round the spurs at the base of the plateau of Bozok, where the fall is thirty feet to a mile, and continues its course to the north with great rapidity, through a narrow gorge of syenite rocks, from whence, flowing between lofty plateaux in a serpentine course, it issues on the fertile plains of Hadji Hamsa, and receives the Deverik-sou from the west. This may be considered the lower course of the river, which now assumes a north-westerly direction below the rugged sides of Ilkas Dagh; here it receives the Geuk Irmak from the west, about forty miles in direct distance from the sea; its length may be estimated nearly 700 miles; its width varies extremely, even at the mouth; its name, Kizil (Red), indicates the quantity of sediment brought down by it from the mountains. The affluents of this river, in its upper course, are unimportant; in its middle course it has only one from the right, the Delidgi Tchai, which has its rise in the western spurs of Ak Dagh, drains the great plateau between the Kizil Irmak and Yekil Irmak; it may have a course of 150 miles; but in summer much of its upper channel is dry, and many of its affluents are only winter torrents; its course is little known; about the centre it has an elevation of 3500 feet. In the lower course of this river, the affluents are on the left, these are the Deverik Tchai, which flows through the long, narrow valley to the north of Ala Dagh, and Ichik Dagh from west to east; its length may be seventy-five miles; its affluents are torrents from the northern face of Ichik Dagh, and much of its channel is dry in summer: the Geuk Irmak, which rises at an elevation of about 4000 feet, in the gorge between Dogdou and Ilkas Dagh, and flows with a rapid and deep stream through a narrow valley, hemmed in with mountains, where, at its junction with the main stream, it forms a highly picturesque defile; it has for affluents numerous torrents on the right: one, the Stavros Tchai, formed by the confluence of two streams, rising on the Taouchan Dagh, at an elevation of above 5000 feet.

Many small streams fall from the mountains into the sea, between the Kizil Irmak and Sakaria; two only appear to assume the character of rivers; of these the Boli-sou, known also as the Tilias Tchai, and by other names, receives for affluents many large mountain streams, among which the Soaumer-sou, from the right, is noticeable for size and beauty, and which has, in its upper course, an elevation of above 3500 feet; these drain the extensive valleys formed by the plateaux projecting to the north from Ala Dagh, while the main stream is shut in to the west by the north-eastern extension of Boli Dagh; of the country through which it flows, however, little is known. The Nulan-sou has its source in Boli Dagh, near the pass of that name; it receives many small affluents before reaching the plain of Dusdje; its course is slow, and waters muddy, though their volume, even in summer, is considerable.

The Sakaria rises from two principal sources, the eastern at an elevation of 3800 feet, in Mourad Dagh, and its eastern extension; these unite in an eastern course, 3350 feet above the sea, among the plateaux of the great central basin, and bending northward, and again westward, enter the mountain region between Bos Dagh and Karakaya Dagh, before which it receives its only affluent from the left, the Poursak, the ancient Thymbres, which, rising on the northern slopes of Mourad Dagh, has a tortuous course of seventy miles, and about its middle course has an elevation of 3500 feet; the stream is shallow, and its banks low; it has several small affluents from the left. In the upper course, however, the Sakaria has several affluents from the right; the Kutchuk Sakaria, rising in Bechir Dagh, at an elevation of more than 3500 feet, remarkable for its muddy bed, which renders it almost impassable; the Engunu-sou, rising in three sources, two from the south-western slopes of Ichik Dagh; from whence also the Kerimiz-sou, or Emir Tchai, rises, at an elevation approaching 4000 feet; and one smaller, called the Inje, or Tabak-sou, which flows through the little lakes Moan and Emir, at an elevation of about 4000 feet. These are all usually dry in summer, as are also the Ala Dagh and Enizy, which fall from the south-western spurs of Ala Dagh, from an elevation of about 4000 feet; the beds of these streams are covered with trachytic blocks, brought down from the mountains by the force of the torrent in the spring. Other small affluents fall from the mountains into the Sakaria, from the right bank in its upper course; in its lower course it has only one affluent of any importance, the Bedre Tchai, the ancient Gallus, a continuation of the Aine Gheul river, which flows through the small lakes of that name, as well as lake Yeniker, which, lying among the northern spurs of Mount Olympus, are noted for their beauty. The Sakaria, in its lower course, approaches within less than five miles of lake Nicomedia; but its bed has greater elevation.

The Moualitch has its principal source in the north-western valleys of Ak Dagh, and flows in the valley formed by the long-extended line of Kadga Dagh and Mouzlouk Dagh; it flows through the little lake Suriaou, at an elevation approaching 3000 feet; receives numerous small affluents, principally from the mountains on the right, in a westerly course of about fifty miles in direct distance, when it receives a small stream from the pass of Ouzoun Yaila, and turning to the north, waters the plain of Balikesri, about 2000 feet in elevation, beyond which it passes through the defile of Demir Kapoussi (the Iron Gate), to the north of which it opens on the plain of Moualitch, to the right and left of which are the lakes Apolonya and Maniyas. The waters of these lakes have connexion with the Moualitch or Susugurli-sou; but this is probably intermitting and dependent on the season.

Lake Apolonya, the ancient Apollonia, may have an area of thirty square miles, and circumference of about thirty-five; its elevation above the sea is about fifty feet; it has one principal and other smaller islands, and is traversed by the Adramas Tchai, or Rhyndacus, which, rising on the north-western slopes of Ak Dagh, near the sources of the Pursak, may have a course of 150 miles; it receives numerous small affluents from the valleys on the south of Olympus, and one more considerable from the left, the Bolal, or Guene, which opens communication with the upper valley of the Moualitch and the pass to the west of Ak Dagh, in its course of four miles between lake Apolonya and the Moualitch, it is called the Ouloubad. Maniyas Gheul has an area of fifty square miles, and circumference of fifty-five; it lies in a low, marshy plain, scarcely above the level of the sea, receives several small streams, and is traversed by the Karadere-sou, the river of the Black Valley, by which, in a course of fifteen miles, it is united to the Moualitch.

The Kaz Dagh or Alkayassi-sou, rising in the granitic range of that name, within ten miles of the Gulf of Adremid, flows, in a northerly course of fifty miles in direct distance, into the Gulf of Sighadjik, thus nearly separating the Troad from the rest of Asia Minor, it is rapid, and receives many small streams.

The Kadja, falling into the Sea of Marmora, and the Mendere into the Bosphorus just within its mouth, are the only other rivers of the north-west angle of Asia Minor, though numerous streams fall from every height. The first is formed by the junction of three streams, one of which is the Granicus of the ancients; the second rising in the northern semicircular slopes of Mount Ida, from four sources; in direct distance, its course westward is forty miles, and receiving numerous affluents, among which the Kirk Gheuz, or Forty Eyes, rises from numerous small, sparkling thermal springs. This river is the ancient Scamander, and flows through the plains of Troy in a network of streams, by which it is connected on the left with the Ægean Sea.

Near the southern angle of the Troad is the Touzla, or salt river.

5 *The Rivers of the West and South.*—Two considerable streams fall into the Gulf of Tchandarlyk: the Madara, flowing from the south-western spurs of Bouglouk Dagh, flanked by the granitic chain of the same name; and the Bakyr, which, rising in the slopes of Kadja Dagh and the Ouzoundja Yaila, opens communication with the Moualitch on the north, and the Gudjuk on the south —*i. e.*, between the Gulf of Smyrna and the Sea of Marmora. At the mouth of this river the shore is covered with salt lagunes.

The Guldis rises in Ak Dagh, near the source of the Adramas, at an elevation of about 5000 feet, about twenty miles below the pass of the same name; flows through a defile having an elevation of little more than 1500 feet, and receives several affluents, principally from the right, before entering the plains at Adala; at the confluence of the Demirdji its elevation is about 575 feet; its upper course is therefore extremely rapid and winding, through the region Catacacaumene, or burning land of Phrygia; in its middle course, it receives the Einegueni from the south, which, rising in the northern water-shed of the valley of the Bouyouk Mendere, or Meander, opens communication with the valley of that river in its middle course; the elevation of its source may be about 200 feet, and its course in direct distance forty miles. On the north, the Gudjuk, already mentioned, opens its valley to the lower course of the main stream; it may have a direct length of fifty miles, which, from its confluence, continues its westerly course for twenty miles, and then bending to the south for fifteen more, falls into the Gulf of Smyrna; its entire length probably exceeds 200 miles; the direct distance from its mouth to its source may be estimated at 150; this river, also called Sarabat, is the Hermus of the ancients; its delta forms extensive marshes, and may be ten miles in length by seven in breadth.

Numerous small streams fall into the gulf, which, bearing in suspension vast quantities of carbonate of lime, form incrustations on rocks and buildings in their passage.

The Tahtaly, a little stream, opens communication between the Gulfs of Smyrna and Scala Nuova, into which latter the Koutchouk Mendere, Little Meander, the ancient Cayster, flows through the narrow valley between Mounts Tmolus and Missoguis, from which, in its upper course, it receives many small streams; its middle course is slow but deep; near its mouth it stagnates among marshes; its direct length is about seventy-five miles.

The Bouyouk Mendere, or Great Meander, rises from two sources—one on the small lake Hoiran, in the plain of Dineir, at an elevation of above 3000 feet; the other, in the defile to the south-west of the spurs of Sultan Dagh; on the plain it is frequently lost in marshes, but on leaving it, the river enters a deep winding gorge, beyond which it flows through level sandy plains to the sea; it receives the Yendere-sou and Kara-sou, which drain the great amphitheatre of Boz Dagh from the left, and the Bana-sou, which, with its affluents, drains the valley of the southern spurs of Mourad Dagh from the right; in its lower course it also receives from the left the Tchinar Tchai, the sources of which are not more than ten miles from the Gulf of Kos. This river, in direct length, may be 150 miles; by its windings, more than 200.

The southern rivers in Asia Minor do not, in Lycia, much exceed 100 miles in length; their courses are extremely circuitous and rapid among the rugged spurs of the mountains. The Doloman Tchai rises in Masta Dagh, which attains an elevation of nearly 10,000 feet; its upper course is north and west, its lower south and east; it is in winter a deep and rapid torrent. The Ak Tchai, by some considered an affluent of the Kodja Tchai, the ancient Xanthus, and to which many other streams contribute their waters, rises in Kizildja Dagh, which is 10,750 feet above the sea; at the angle made by its southerly trending, in about its middle course, it has 1000 feet elevation. The Ak Dagh gathers its waters from numerous streams falling from the slopes of the southern watershed of the lake district, especially in passing Pamboukorassi, *i.e.*, the cotton plain; this is the ancient Cestrus, and was formerly navigable, as was also the Kempre-sou Eurymedon, which has its sources in Dispoiras Dagh, at an elevation of more than 4000 feet above the sea; its upper course is rapid, its lower through marshes, which occupy the site of the ancient lake Capria; the elevation of its principal source, in the Isbarta pass, may be 3250 feet, and it falls into the Gulf of Adaliya.

The Ermenek-sou drains the valleys of the north-western spurs of Ala Dagh; in its upper course its has an elevation of 2000 feet; but at the confluence of its principal source, not more than 150; from hence, in forty miles' direct distance to the sea, it flows through a narrow valley, shut in by precipitous rocks, with a very circuitous course; it has numerous affluents, but those from the right are alone important; it is the ancient Calycadmus. The Tarsus, ancient Cydnus, is to be noted for the Alpine wildness of the gorge through which it flows; its mouth is deep, though not broad. The lake of which Strabo speaks has disappeared.

The Seyhoon, as already noticed, rises from two principal sources, at an elevation of about 6000 feet, in the valley between, and in that to the west of, the chain of Anti Taurus; in its upper course of about 120 miles it is increased only by the waters of small streams; from the confluence of its two sources it follows an irregular winding course of about eighty miles in direct distance to the sea; it has only one important affluent, the Karabounar Tchai, from the mountain of the same name on the right.

The Djeihoon has, in its upper valleys, a very irregular course, winding among the spurs of the mountains, which link those of Armenia and Asia Minor to the coast range of Syria; the greatest elevation of its sources does not probably exceed 3000 feet; it is rapid, and has formed at its mouth, in the Gulf of Scanderoon, a considerable delta.

CHAPTER X.

OF EUROPE.

§ 1. Sources of our knowledge.—2. Extension of geographical knowledge.—3. More recent information.—4. The boundaries and limits.—5. The coast line.—6. The watersheds.—7. The orographical classification.—8. The classification of rivers.—9. Of the geological formation.

SOURCES *of our Knowledge.*—When, towards the end of the ninth century of the Christian era, our great Alfred translated the Geography of Orosius, little was known of the portion of the world which we call Europe beyond what had been ascertained by the Greeks and Romans. The latter knew little beyond the 'Agri decumates,' between the Rhine and Danube, the limits of which extended from Coblentz to Ratisbon, the north-west boundary of their empire; Dacia, shut in by the Carpathians, was its limit to the north-east. Though some general knowledge of the countries stretching from the Baltic to the Black Sea had been obtained by Ptolemy and his successors, and of the islands of the Atlantic belonging to Europe some ideas had been acquired, these were very general and indefinite. (See 'Ancient Geography,' chap. 8.)

The erratic propensities of the northern inhabitants of Europe had, however, in the time of that monarch, brought them into communication with the people of Western Europe, especially those of France and Britain: and from Other, a Norwegian nobleman who found refuge at his court, he obtained a knowledge of the limits of Norway to the north, of Lapland as far as the White Sea, and of the Baltic and its shores.

From the Travels of Wulfstan the Norman, Alfred also obtained a knowledge of Prussia, Poland, and Gotland, extending to the Gulf of Finland, and the interior of Russia.

In the seventh century the Northmen had extended their voyages to Ireland. In the ninth and tenth, Iceland, the Hebrides, and the Shetland and Feroe Isles were taken possession of by them; yet till the middle of the twelfth century the piratical habits of the northern nations, especially those inhabiting the shores of the Baltic, prevented the more civilized people of Europe from becoming better acquainted with them: but in the end of the twelfth and beginning of the thirteenth centuries, the Swedes, having embraced Christianity, turned their arms against their heathen neighbours, in order to impose on them their newly adopted faith, with the ardour natural to new converts; and at the same time the Germans raised a crusade, so to speak, against the Pagans residing in Prussia.

We owe therefore our first accurate knowledge of the north of Europe to the missionaries who preached in Sclavonia and the coasts of the Baltic. Of these, S. Boniface, Otho, Bishop of Bamberg, and Anscaire, are to be noted; the latter travelled through Sweden and Norway, and to his account subsequent writers were indebted for their knowledge of those countries.

The adventures of travellers and the wonders they have witnessed, have always been the most interesting materials for the writer and storyteller, and have not unfrequently been the basis of fiction; but they have also incited others to pursue the paths opened and discover new ones, and thus even exaggeration and falsehood have assisted in the discovery of truth.

The feudal system led to the survey and compilation of topographical accounts of those countries in which it was adopted. William the Conqueror in England in the twelfth; Waldimer of Denmark, in the thirteenth; and Charles the Fourth of Germany, in the fourteenth century, had their dominions carefully surveyed. Of the labours of those employed by the first, Domesday Book is a record, but these were for the purposes of government, and were topographical and statistical. Of the details much was known; of the general forms and limits of countries men were still ignorant, and maps were not unlike the accounts of travellers filled with matters selected either on account of their interest to the compiler, or as likely to excite the astonishment of the reader. Cities and monasteries, mythological stories and monsters, cover the surface, from which the natural features of the country are omitted. It remained for the astronomers and mathematicians of the sixteenth century to give their powerful aid to the geographer, and by establishing certain points with accuracy, enable him to deduce others from them with some approximation to truth.

2 *Extension of Geographical Knowledge.*—Science had enabled the Alexandrian philosophers to calculate latitude with some approach to accuracy, but longitude was beyond their reach. The difference between the calculations of Eratosthenes and Ptolemy in estimating the distance from Cape St. Vincent to Syracuse being 17,200 stadia (see 'The Mediterranean,' by Admiral Smyth, p. 4, sec. 1), and even from the fifteenth to the seventeenth century differences of longitude not less remarkable were common.

The Arabians led the way in the application of astronomy to geography; the Venetians and Genoese in accurate surveying and portraying on charts; but of their labours more will be said when speaking of the hydrography of the Mediterranean. It was not, however, till the time of Galileo that any great progress was made, and Louis XIV. witnessed the application of it in the curtailing the apparent limits of his kingdom by Picard and Delahire.

3 *More recent Information.*—From the time when science began to extend her dominion over the human mind, its administration, divided into departments, collected the results under their various heads, and like the Persian empire in olden time, its unity was violated. Science was no longer entire, and single inquiries were continued and extended in one branch almost irrespective of the others; and thus, although by division of labour much was effected, it remained for the Humboldts of our own time to unite it again, and bring something like order out of the collection of chaotic elements which had been made. Europe, our own historical ground, has therefore become known to us through the churchman and the warrior and the merchant, the mathematician, astronomer, botanist, geologist, &c., as well as the traveller. To recite names would however be a work of more labour than profit. Our knowledge of the geography of Europe, resulting from these labours, is now very extensive, not only in its general outline and topographical details, but in its meteorology and productions; it is, in short, that from which we are able to deduce laws applicable to the other portions of the world, and the result of correct averages; but it must not therefore be supposed that our knowledge, even of this our own portion of the globe, is complete. The surveys, however, made under the direction of the principal governments, as well as those undertaken for commercial purposes and international communication, are rapidly bringing it towards something like minute accuracy.

These surveys are no longer, like the Domesday and kindred works, confined to man and his occupations and productions, that they may be made subservient to the capacity of the ruler, but extended into every department of science, that physical nature may be made the handmaid of man, and contribute as much as possible to supply the wants of advancing civilization.

4 *The Boundaries and Limits.*—The western boundary of Asia having been given (p. 222), Europe may be considered as bounded on the east by Asia, the Black and Caspian Seas; on the west by the Atlantic Ocean, on the north by the Arctic Ocean, and on the south by the Mediterranean and Black Seas, and the line of the Caucasus mountains; or generally the north shore of Europe is the limit of the Arctic basin, the west of the Atlantic, and the south of the Mediterranean. Referring to the table (pp. 204-5), for the positive limits of Europe, the same comparisons between the normal figure and the extreme points may be instituted that have been already made with respect to Asia.

Lewis Western Isles	58·30 north latitude	6·14 west longitude
Gulf of Kara . . .	67·30 ,,	67·30 east longitude
Cape Apcheran . .	40·12 ,,	50·20 ,,
Odessa	46·28 ,,	30·44 ,,
Cerigo	36·9 ,,	22·59 ,,
Nice.	43·42 ,,	7·17 ,,
Gibraltar	36·7 ,,	5·21 west longitude

From this it will be seen how far in every direction the development of Europe extends beyond the normal figure. The mean area of Europe has already (p. 205) been given as 3,732,540 square miles.

5 *The Coast Line.*—The irregular trending of the coast of Europe is apparent from the above comparison. Yet it may be remarked that even in this irregularity system is observable, for while the great peninsulas to the south—Greece and Italy—have their principal extensions to the south-east, the islands Corsica and Sardinia have theirs to the south, and Spain to the south-west. So that they appear to point to one centre about the culmination of the Alps; while the outlying mountains to the north-west, whether of Scandinavia or of the British Islands, have the same linear extension as the north coast of the Spanish peninsula and the secondary chains of western Europe. The irregularities of the outline of Europe result rather from indentations than projections; its inland seas and gulfs being its most marked features, and conferring on it its maritime character; and in this consideration the mistake of separating it from Africa and Asia, and not therefore viewing the basin of the Mediterranean in its integrity, must be apparent. On the north the White Sea, on the west the German and Baltic Seas and Bay of Biscay, and on the south the Gulfs of Lyons and Genoa, the Adriatic, the Sea of the Archipelago, the Sea of Marmora and the Black Sea, with the Gulf of Odessa, and Sea of Azov, give a coast line of unprecedented length compared to the area it encloses.

According to the calculations in the portion of the work devoted to physical geography, the proportion between the area and coast line would be 205, the former being estimated at 3,550,000 square miles, and the latter at 17,250 linear miles. The principal projections and indentations may be estimated as follows:—

Indentations.		Projections.	
White Sea	5°		
German Sea . . .	7°	North Cape	3°
Baltic	10°	West of Ireland	1½°
Bay of Biscay . .	4°	Sicily	2½°
Gulf of Genoa . .	2°	At Constantinople . . .	1½°
Adriatic	7½°		
Gulf of Saloniski .	2°		
Sea of Azov . . .	2½°		
Caspian	4°		

These are in a linear extension of 61° 30′ east and west, on the 41° parallel north latitude, and 34° 15′ north and south, or 2700 and 2055 miles, of 60 to a degree, at the equator respectively; it may be noted also that these measures correspond with the extreme length and breadth of the Continent.

6 *The Watersheds.*—It has already been shown (p. 224) that the orography of Europe cannot in its general features be separated from that of Asia and Africa; yet in its more particular description it may well stand alone, not only because it forms a system complete in itself, though it be but part of a larger, but more especially because our knowledge of it is more minute and accurate than that of any portion of the world, insomuch as to leave little to be desired in this particular, and of this the orographical contour map of Europe, published by Mr. Johnston, of Edinburgh, affords ocular demonstration. Europe, like Asia, has orographically a centre to its system, but unlike Asia that centre has an outlet; and therefore Europe naturally divides itself by the valleys of its primitive rivers, and the classification of its mountains and rivers is easy; nevertheless, the lines of its watersheds are much more intricate than those of Asia, being, as they are, much more numerous in proportion to its area, and its surface therefore much more varied; a knowledge of this can only be obtained by first considering how its mountains may be classified.

7 *Of Orographical Classification.*—Mr. Johnston divides the mountains of Europe into six systems, the Hesperian, the Alpine, the Sardo-Corsican, the Sarmatian, the British, and the Scandinavian, including the whole of Europe from the Black Sea to the Atlantic in the second; the reason for this arrangement is not at first sight apparent, or why the Vistula should be the boundary of a system any more than the Danube, the Rhine, or the Rhone. M. Elie de Beaumont has divided the mountains of Europe, according to their geological construction or consequent probable period of elevation, into twelve principal, or twenty-two subsidiary, systems; but it must be obvious that such a classification, however valuable in its physical application, will scarcely answer the purposes of descriptive geography. The following extract from Mr. Johnston's recent edition of his 'Physical Atlas,' will show that the plan already adopted in this work is best adapted to the purpose in view, viz., the obtaining a comprehensive knowledge of the orography of the world.

'If an observer, placed on the summit of Mont Blanc, could so extend his vision as to embrace at one view the whole of Europe, he would find his position to be the culminating, and nearly the central, point of a long range of mountains, commencing at Cape St. Vincent on the west, and terminating at Cape Matapan on the east. He would perceive that several branches detached from the main chain traverse the Iberian peninsula, and that a formidable barrier rises between France and Spain. At the portion of the system nearest himself he would see it separating France from Italy; covering Switzerland and the Tyrol with its ramifications, and extending south-east into Albania, where it forms one of the shores of the Adriatic, the other side of which is enclosed by the remarkable chain of the Apennines. Beyond the Gulf of Genoa, and in the same direction, he would notice two great islands, formed by a chain of mountains extending due south, and cut into unequal portions by the sea. Farther east, he would remark in Sicily a continuation of the Italian chain crossing near Nicosia, and giving to the island a triangular form. On the southern frontier of Servia the chain bifurcates, one branch taking a southerly direction towards Greece, while the other bends east and south-east to the shores of the Black Sea. North of the latter branch he would distinguish a range of mountains, which first stretches in a direction perpendicular to the course of the Danube, and is cut off by that river near Orsova; it then curves, so as to embrace Transylvania; it then recurves, so as to envelop Transylvania, Hungary, Moravia, Bohemia. To the west of these, several small groups of hills are distributed over western Germany; but, beyond these slight elevations, he would perceive only vast undulating plains, extending to the shores of the Baltic and North Seas. Beyond these seas, in the west, he would descry the hills of Wales and Scotland, and in the north the mountains of Scandinavia—the latter blanched by perpetual snows, due less to elevation than their proximity to the pole. If the supposed view was enjoyed during the heat of summer, when the snow is melted on the lesser heights, the brilliancy of those on which it always rests would distinguish the most elevated summits.'

Without accepting this view, which Mr. Johnston adopts from the work of M. Bruquière, further than as an evidence that, geographically, all systematic arrangements should be made from the outward appearance or present condition of the surface, rather than from geological or other considerations, and noting, by the way, that such a view of the orography of the whole world has been attempted in the atlas attached to this work, the subdivisions of this arrangement may be stated :—

Systems.	Divisions.	Culmination.	
1. Hesperian	1. North chain, or Pyrenees	Pic Nethou	11,168
	2. Central, or Cantabrian	Sierra Gredos	10,552
	3. Southern, or Betican	Cerro de Mulhacen	11,663
		Mont Blanc	15,744
2. Alpine	1. Bernese Alps	Finster Aar Horn	14,026
	2. Vorarlberg	Hochspitze	10,330
	3. Carnic and Julian Alps	Mount Marmolata	9,802
	4. Jura	Le Molesson	6,584
	5. Gallo-Francian	Puy de Sancy	6,220
	6. Apennines	Mount Etna	10,874
	7. Sclavo-Hellenic	Mount Athos	9,628
	8. Hercinio-Carpathian	Mount Butschitje	9,258
3. Sardo-Corsican		Mount Olympus	9,749
4. Sarmatian		Valdai Hills	1,100
5. British		Ben Nevis	4,368
6. Scandinavian			8,500

The main mass of the primary watershed of Europe extends under the parallel 33° north latitude, from $7\frac{1}{2}$ to $14\frac{1}{2}$ east longitude, and from this all the mountains of Europe may be considered as originating. Here, in close proximity to each other, rise the primary sources of the Danube, the Rhine, the Rhone, and the Po; the secondary sources of which have their rise respectively in the German mountains and those of France, which form the watershed of the secondary rivers which flow through those countries; and in the Apennines, which, extending to the south-east, in the peninsula of Italy, form the watershed of its rivers. Beyond, to the east, the primary chain stretches to join the Caucasus, its southern spurs, developed in Greece and the islands, trending towards the western extension of the chains of Taurus in Asia Minor; to the west, those of Pigeum, if, with M. de Beaumont, we consider them to correspond to the Apennines, will be an extension of the secondary chains; but if, as seems more natural, they are considered as a continuation of the primary, then the extension of these must be estimated as from Gibraltar to Cape Matapan, in a semicircular arc, having a chord of 1400 miles, and a versed sine of 600 miles.

The secondary mountains of Germany will be found extended to the east, in those of Bohemia and Hungary, from which flow the secondary affluents of the Danube, while from their northern slope the important secondary rivers of Germany descend to the Baltic, their secondary streams falling from the mountains of the Nether Rhine and the Hartz, from the northern slope of which the tertiary rivers fall in the same direction. This watershed has its eastern extension in the plains of Pomerania, and to the west joins the Ardennes, which have their extension in the mountains of Brittany. To this system will also belong the British and Norwegian mountains, and possibly some of the mountains of the west coast of Spain.

The mountains of Europe may, therefore, be thus arranged:—

Primary Watersheds.	Secondary Watersheds.	Tertiary Watersheds.
The Alps	The Cevennes Vosges	The Nether Rhine and Hartz mountains
The mountains of Dalmatia	Jura and Schwartzwald	The mountains of Wales, Scotland, and Scandinavia and Brittany
The Balkans	Bohemian and Carpathian mountains	
Pindus	Sierra Monchique	
Pyrenees	Sierra Gerez	
Sierra Cuenca	The Apennines	
Sierra Nevada		

Of the primary watersheds, the Sierra Guadarama, the Sierra Morena, the Sierra d'Estrella, and mountains of the Asturias, may be considered spurs, as may the Erzgebirge, Thuringerwald, and Bohmerwald, of the secondary.

The hills of the coasts of England and France, of Germany, and the Valdai hills in Russia, cannot be considered as appertaining to any of these systems.

8 *Classification of Rivers* —Europe has been shown to have four primary rivers:—

The Danube, the basin of which extends into the Black Sea.
The Rhine, having the extension of its basin in the North Sea.
The Rhone, falling into the Gulf of Genoa.
The Po, the valley of which is extended in the Gulf of Venice.

None of these rivers have the remarkable double character which belongs to the Asiatic, although their deltas, especially that of the Po, are very considerable.

To the above it may be added that, if the Pyrenees are considered as primary mountains, all the rivers of Spain and Portugal must be classified accordingly—the Douro, Tagus, Guadiana, Guadalquiver, falling into the Atlantic Ocean; the Sigura, Jucar, Guadalaviar, the Ebro—the valleys of which extend into the Mediterranean—and possibly even the Minho.

The small rivers of Greece and Turkey must also be placed in this class. The Vardar, Struma, and Maritza; as well as the Kuban, which falls into the Sea of Azov; and the Tereck and Kuma, which fall into the Caspian.

The secondary basins to the south of Europe being in fact occupied by the Mediterranean, the primary rivers to the south are of course small in proportion.

The secondary rivers of Europe are the Seine, the Loire, and the Garonne, their valleys extending into the English Channel and Bay of Biscay.

The Elbe, extending into the North Sea; the Oder, the Vistula, into the Baltic; the Dniester into the Black Sea.

The tertiary rivers are the Adour, the Charrent, falling into the Bay of Biscay; the Meuse, the Scheldt, the Ems, the Weser, the Thames, Humber, and other rivers of the east coast of Great Britain, into the German Ocean; the Pregel, the Memel, the Vistula, the Duna, the Dahl, and other small rivers, falling into the Gulfs of Finland and Bothnia; the Stor, into the Skaggerack; the Severn, the Clyde, the Blackwater, the Barrow, and Liffey, falling into St. George's Channel; the Shannon into the Atlantic Ocean; the Bug, the Dnieper, the Don, which flow into the Baltic and Sea of Azov; the Volga and Ural, which extend into the Caspian. The characteristic feature of the hydrography of Europe is, therefore, the number and importance of its tertiary rivers, which would admit of further classification, should it prove desirable.

This characteristic corresponds to what might be expected from the comparison already instituted between the area, coast line, and normal figure of this division of the eastern continent; and shows how every portion of its surface is made available for the use of man, no less than that its great irregularity and diversity of surface make it most fit to develop all the qualities, mental or physical, which have been conferred upon him.

9 *Of Geological Formation.*—The irregularity of the surface of this division of the eastern continent indicates the variety of its geological development. On the north-east, the primary stratified rocks extend from the Oural mountains to the Arctic and White Seas, the Gulf of Finland and the Baltic, upon which the rocks of secondary formation occupy the larger portions of the basins of the Dwina and Volga; and upon these again tertiary formations extend from the steppes of the Caspian to the Baltic, and along the shores of the German Sea, the secondary strata reappearing on the slopes of the Caucasus and Carpathians, and extending through a considerable portion of Germany; they also reappear on the north shores of the Mediterranean, in Illyria, Italy, and Spain, and between them the earlier rocks have been thrust upwards, forming the watershed of the country. The primary strata also show themselves partially in north-west Germany, at the south-west angle of the Black Sea, on the north slope of the Pyrenees, at Cape Finisterre, and in Portugal more considerably; in Ireland, Wales, the north of England, and north-west of France; partially in Sweden and Norway, almost the whole surfaces of these countries, as well as of Lapland and Finland, consisting of unstratified rocks, which are extended to Nova Zembla and Spitzbergen, on the east shores of which the primary strata are again found. The unstratified rocks also prevail in the north of Scotland and Ireland, in the west of England, in the north-west and south-east of France, in the centre of Spain and Portugal, along the lines of the Alps, Balkan, and Bohemian mountains, and the south flank of the Carpathians. The tertiary system of the south and east of England is correspondent to that of the north and west of France.

Throughout the centre of Europe the volcanic rocks make their appearance occasionally, as they do in the west of Scotland and north of Ireland. Active volcanic operations are at present confined to the south coast, to Italy, Greece, and the Islands, but the remnants of extinct volcanic action and crateriform basins are of frequent occurrence. The most remarkable of the districts of ancient volcanic action is that of Auvergne, in France; of those not in the immediate proximity of recent volcanic action, but which have suffered from earthquakes, Lisbon, Constantinople, Hungary, and the lower valley of the Danube, Switzerland, especially Bâsle, the lower valley of the Rhone, Saxony, and the Rhine valley, and Auvergne. The north-west of France and England also appear to have had their full share in number if not in severity. A list of all the recorded earthquakes may be found in the 'Transactions of the British Association,' but it is probable that many of the earlier, chronicled only at one place, may have had considerable extension, as we find almost all the later to have had. There is probably no portion of this division of the world which is not subject to earthquakes.

The axis of elevation, as at present observable in the northern parts of Europe and Asia, is north-east and south-west.

CHAPTER XI.

THE PRIMARY WATERSHED AND THE RIVER DANUBE.

1. The primary watershed of Europe.—2. Its eastern extension.—3. The Danube and its primary affluents.—4. The secondary watershed of the north.—5. The secondary affluents.—6. The Sereth and Pruth.—7. The valleys of the Danube.

THE *Primary Watershed of Europe.*—Although Mount Blanc is the highest summit of the Alpine system, Mount St. Gothard must be considered its centre, and here therefore, as in the Himalayas, we find the most elevated peaks in advance of the main chain. The central Alps, extending from Mount Furca to Mount Cinnols are, indeed, the primary watershed of Europe; for from them rise the principal sources of the four great primary rivers of that division of the surface of the earth. This chain, extending for about fifty miles from east to west, rising like the curtain of a mighty fortress, is flanked by double bastions at either end; on the north-east the Noric Alps culminate in the Gross Glockner at 13,000 feet above the sea, and on the south-east the Rhætic Alps descend from the Ortler Spitz, which has an elevation of 12,852 feet, and Mount Adamello of 10,980, into the plains of Italy. Between these the sources of the Adige and the Drave are in close proximity, their main streams being parted by western spurs of the Dinaric Alps. On the west the more lofty peaks of the Bernese Alps culminate to the north in the Finstar aar Horn, having an elevation of 14,100; the Jungfrau and the Shreek Horn are respectively 13,718 and 13,386; while to the south and west, Mount Rosa and Mount Blanc attain the greatest elevations throughout the whole system; the former of 15,208 and the latter of 15,810 feet above the sea.

The sources of the Rhine, the Rhone, and the Po, fall from opposite slopes of the same passes on the west; as those of the Rhine and the Danube do from the passes on the east. The two ends of the chain of the central Alps have further similarity. On the east Mount Maloia, rising 11,483 feet above the sea from a rectangular base, having its greater length from east to west, is buttressed up by the Septimer on the north, the Bernina on the south, the Cinnols on the east, and Forcola di Mezzo on the west. The line of water-parting crosses the Septimer and Bernina, which rise respectively 9744 and 7969 feet; and, from the depression between, the waters of the Inn and the Maira fall, to join the main stream of the Danube and Po, through the transverse valleys of the Engadine and Brigaglia, separated by the gorge of the Bernina, rising 7672 feet above the sea. On the west likewise the Saint Gothard rises, its more massy form 10,595 feet from its base, which is also rectangular, and facing, like that of the Maloia, the cardinal points, but having its longer axis from north to south; its giant supporters are, to the north the peak of Gallenstock, to the south Mount Rovina, on the east Mount Nera, and on the west Mount Furca. This latter is the highest of the whole range, rising 14,037 feet above the sea, the others having their culmination respectively at 12,481, 9843, and 10,499 feet. The group of St. Bernard, like that of the Maloia, encloses two valleys, those of the Tessin and Reuss—the Levantine and the Valley of Urseren; while two others stretching east and west separate it from the Bernese and the Pennine Alps; the pass of the St. Gothard, connecting the valleys of the Tessin and the Reuss, has an elevation of 6808 feet.

The principal passes beside those already named are the Splugen, between the source of the Upper Rhine and that of the Ticino, having an elevation of 6814 feet; and the Bernardin, forming another line of connexion between the same valley, rising 6970 feet, which it connects with the Valteline and the Engadine.

The central Alps throw off to the north three great spurs; the Grisons, forming the watershed between the east sources of the Rhine and the Danube, and which, bending to the north-west round Lake Constance in the Vorarlberg, join the Schwartzberg, and form the water-parting between the Rhine and Danube; that which forms the mountain region about the lake district of Switzerland, and separates the head waters of the Rhine, of which Mount Dach is the most prominent feature; and the Krisfelt, which separates the Reuss from the Lower Rhine, the course of which it follows, bending north-east to Dodiberg, where, attaining an elevation of 11,765 feet, its numerous ramifications enclose the valleys of the tributaries of the Rhine.

Unlike the upper valleys of the Himalayas, those of the Alps are narrow, rugged, deep defiles, through which the torrents rush with fearful rapidity and hoarse roar: they may be compared to the lower valleys of the Asiatic mountains. The Engadine, the most extensive of all, is only one and a half mile in width, and 5753 feet above the sea. The lower level of perpetual snow is 8900 feet, but the glaciers descend as low as 3400; these are estimated as extending over a surface of 1500 square miles. In the range of the central Alps above 400 glaciers have been reckoned, varying from three to twenty-one miles in length, from one to two and a half in breadth, and from 100 to 1000 feet in thickness.

The valleys of the Alps are fertile, abounding in pasture; wheat is raised at an elevation of 3600 feet; the oak is found at 5400; pines, and other coniferæ at 6500; while the Alpine rose, and the saxifrage, blossom on the edge of the perpetual snows.

The central Alps are formed of primary rocks, principally granite and gneiss, flanked by limestone, sandstone, and slate. The southern slope to the valley of the Po is very precipitous, the angle of inclination to the north being much greater.

2 *The Eastern Extension of the Primary Watershed.*—The Alps of the south-east, like those of the south-west from St. Gothard, project from Mount Maloia in a circular arc of about 373 miles in extent, forming the basin of the Adriatic; these are the Carnic and Julian Alps. Of these, as well as the Noric Alps, the Dreyhernspitz is the central point, as Mount Gebatsch rising 12,366 feet, between the sources of the Inn and Adige rivers, forms the point of junction with the Rhætic Alps. This mountain has above 10,000 feet elevation, but the Gross Glockner, which projects from it to the east, and is the culminating point of the Noric Alps, rises to the height of 13,100.

Through the Rhætic Alps three passes connect the valley of the Inn with those of the Adda and Adige. The gorges of Rescha and Tchirf, having an elevation of 4659 and 6906 feet respectively, unite at Glurns on the Adige; these are extremely difficult and dangerous, but that of the Brenner, between the Inn and the Eisach, having an elevation of 4757 feet, is passable for carriages throughout the year.

To the north, spurs from the Dreyhernspitz, forming a confused mass of mountains, with narrow and precipitous valleys opening to the north and east, enclose the sources of the Inn and Salza, and separate those rivers; their summits exceed 11,000 feet in elevation. The Noric Alps in like manner separate the Salza and the Drave. These form a rugged and impassable barrier, covered with perpetual snow; and at Mount Eland, assuming a north-easterly direction, pass into the Styrian Alps, which culminating in the Eisenhut at an elevation of 7656 feet, throw out spurs to the north and east which reach the banks of the Danube, leaving scarce room enough for a road between; then turn, and bending in an arc of a circle round the Raab, again trend north and east between the waters of that river and the Balaton See, when it is known as the Bakonywald; and round its base the waters of the Danube change their course from east to south at a right angle, while another branch extending east round the Balaton See forms the north watershed of the Drave. The Styrian Alps are crossed by several roads, but have no passes, properly so called, the mountain mass being continuous. The Carnic Alps bend south and south-east to Mount Terglou, 9380 feet in height, but their culminating point is Mount Marmolata, which has an elevation of 11,509. A spur from these mountains separates the rivers Drave and Save. They are traversed by three principal passes, the gorges of Tolbad, Tarvis, and Bredil. The former unites the valleys of the Eysach and Drave, and the two latter those of the Tagliamento and Isonzo with that of the Villach, all leading direct from Italy to the middle valley of the Danube.

From Mount Terglou the Julian Alps take a south-east direction for 100 miles to Mount Kernicsa broken only by the pass of Adelsberg, which establishes a threefold communication between the river Isonzo and the Gulfs of Trieste and Quarnero with the valley of the Save. The Dinaric Alps continue the same line along the shores of the Adriatic, to which their descent is very precipitous, for 370 miles, to Mount Scardo or Scharratagh, having a mean height of about 5000 feet, but culminating in Mount Kom at 9000. Mount Scardo is estimated at 9843; Mount Dinara, 7458. This range is noted for a peculiarity, in which it assimilates to those further east, in that its spurs extending to the east, while they form the watersheds of the lower primary affluents of the Danube, also enclose plateaux or mountain valleys, some of which are twenty miles in extent, and which have no visible outlet for their waters. They form a rugged and difficult country, still but little known to the rest of the world. One solitary pass, to the east of Scardo, unites the valleys of the Morava and the Vandar, traversing the chain from north to south.

At Mount Scardo the Balkan chain commences, and extends to Cape Emineh on the Black Sea, a distance of nearly 400 miles from Despoto-dagh. The chain, Emineh-dagh, or Greater Balkan, trends east and north round the sources of the Maritza; and from thence it divides and sends out three spurs, one assuming a northern direction, terminates in Cape Kalakria; another having an easterly direction, and enclosing the valleys of Kamtchuk and Varna, extends to Cape Emineh; and the third, the Kutchuk Balkan, passing south-east to the north of Constantinople, forms the north-east boundary of the Bosphorus.

The Balkan throws out several considerable spurs to the north, the principal of which extends from the Egrisou-dagh (the Orbulu of the ancients) to the Danube, where it meets the opposing spurs of the Carpathians. This may be considered as a continuation of the transverse chain already noticed as forming the watershed of the Maritza, both having a common centre and a general north-west and south-east trending. A defile near the Egrisou-dagh unites the upper valley of the Isker and Morava; while that of the Soulu Derbend to the south unites the former with that of the Stromna; and immediately to the east another unites the latter valley with that of the Maritza. As the pass of Trajan's Gate, or Kapuli, opens a communication between the Maritza and the Isker, this point is therefore the key to all these valleys. Farther east, the pass of Kersânlisk unites the valleys of the Jentra and the Toondja, affluents of the Danube and the Maritza, not far from which that of Selimno, or Islamieh, affords access between the Toondja and the Kamtchuk. More easterly still the Borghaz connects the valleys of the Kamtchuk and Borghaz Bay; and lastly near the coast the Djezeh pass traversing, like that of Borghaz, the central range, opens a communication between Varna and Borghaz. As the northern spurs of the Balkans approach those of the Carpathians, so the Styrian Alps approach the Czerhatz mountains, and the Hansruck the Bohmerwald, thus dividing the course of the Danube into three principal basins, in addition to the plains and marshes about its lower course.

3. *The Danube and its Primary Affluents.*—It has been already noted that the secondary source of a river, or that rising in the depression which is usually formed between its primary and secondary watersheds, as affording the easiest passage into the opposite river valley, is the earliest and best known; and therefore gives its name to the united stream. In Europe, the Danube is a striking example of this, taking its name from the Donau, which rises on the slopes of the Schwartzwald, the connecting link between the

primary mountains of Switzerland and the secondary chains of Germany. Of the other sources of this river, those between the Donau and the Inn have their rise in the spurs from the primary mountains which form the water-shed of the Rhine on the one hand, and the Inn on the other. The Inn, therefore, as the first source of the Danube rising on the primary watershed, would be entitled to the honour of being considered the principal source of that river; but this is not its only claim, were it so the theory on which that claim is based would be vain. It has others which confirm it, viz., it has its source at an elevation of above 6000 feet, while the fountains of the Donau are only 2850 feet above the level of the sea; it brings down, after the junction of the Salza, a far greater body of water than the Danube, has much greater rapidity of current, and is at the confluence of the two streams 750 feet wide, while the Donau is only 492.

Assuming, then, the river Inn as the main source of the river whose united waters bear the name Danube, the description of the river must commence with it, leaving the other and more western to be described among the secondary affluents.

This river has its sources in the north face of Mount Maltia; the mountain streams which form them collecting in the Sils See, a small lake in the Engadine Valley, about four miles in length and one in breadth, and 5864 feet above the level of the sea. Flowing north-east through the Upper Engadine, it receives an affluent from the east, and issuing from the valley after a course of forty-five miles, it receives an affluent from the east slope of the Vorarlberg, and thence, trending, under the influence of the spurs of that range, which form the watershed of the Lech, it flows eastward, receiving accessions to its waters only from the mountain torrents which precipitate themselves from the Rhætian Alps. Here it again assumes a north-east direction, and becomes navigable, the valley still more open towards the east. Bending again to the north, it receives a considerable affluent, the Aiblinz, from the east, which has its sources in lakes among the mountains to the north of Mount Solstein. Here the country opens, and its surface is wooded, forming the forest of Hohenlinden, extending fifteen miles in length by four in breadth. On the right, the river is still closely confined by mountains, which form the basin of the Chien See, and the watershed of its affluent, the Alz, from the right, which is formed by the surplus waters of the Chien See, or lake, celebrated for its fish, in length twelve miles, and in breadth nine, and having an elevation of 1548 feet above the sea; it has three islands, and receives the waters of the Achen and Prien, the latter of which has its origin in one of the smaller lakes which are found in the district, and around the sources of the former the Salza trends to the east. Again turning east, the river changes its character, flows between low banks, and is studded with islands, which character it maintains for the rest of its course, till within ten miles of the junction of the Donau, when its channel is again narrowed between rocky banks, and, notwithstanding the volume of water it contains, is not 180 feet in breadth.

The Salza river is the most important affluent of the Inn, having its sources in the ravines of the north slope of the Dreyherrnspitz and Gross Glockner, and flowing through a valley of romantic beauty, has a course of [illegible] miles, of which the last [illegible] are navigable. [illegible] from the [illegible] the waters of the Saal, and [illegible] has a course of [illegible] [illegible] of the Saal [illegible] [illegible] is six miles [illegible] in so short a [illegible] that river receives [illegible] banks; at its [illegible] is only [illegible] feet above the level of the sea; and estimating the course of the Inn as 250 miles, its average fall would be twenty feet in a mile. From this point the Danube has a general easterly course, till it reaches the 19th meridian of west longditude, or, in a direct line, of nearly 250 miles, for the first hundred of which its valley is narrowed by the mountains, which approach it on either side; its affluents, during this portion of its course, are therefore inconsiderable. Of those on the right, the most important are the Traun and the Enns. The former has a course of 100 miles, and flows through the Traun, the Aller, and several other lakes; the Traun, or Gmunden Sea, is eight miles long and two broad, and 5470 feet above the sea; the latter has a course of 112 miles, and has two affluents, the Steyer and the Salza. The sources of the latter lie at the opposite point of the compass from the main sources of the Enns, at nearly 100 miles distant, their narrow valleys lying at the base of the long line of the Styrian Alps. The Steyer is famous for its iron mines; and the gorge through which it flows is as precipitous as that of the greater Salza, the affluent of the Inn. The Trassen and the Leitha are also small affluents of the right bank of the Danube; both descend from the slopes of the Weinerwald; the former rapid, shallow, and tortuous, is composed of five streams; the latter also meanders, but with a gentle current; it has a course of 150 miles.

Throughout this portion of its course, the Danube varies very much in character; below the confluence of the Inn it acquires a breadth of 2625 yards; at the north of the Krems only 656; below this point it divides into several channels, forming numerous islands, the greater volume of water flowing on the left bank. One island, 784 feet broad, separates branches 1575 and 1181 feet, respectively; while a third, 197 feet wide, surrounds an island 1969 feet in width. The island of Labau is about $3\frac{3}{4}$ miles long by $2\frac{1}{4}$ broad, high and well wooded, separated from the left bank by a channel averaging 400 feet in breadth, and here the river has an extreme breadth of four miles, but narrows immediately to two. Below this the river has several islands, and two anabranches; one on either side, forming the islands Gross and Kleine Shutt. The northern branch, called Neuhæsel, receives the waters of the Waag; the island it surrounds is fifty miles long by fifteen broad; the southern, the Weiselburg, receives the waters of the Leitha, which are thus united to the Raab; the island which it forms may be twenty-five miles long by five broad. This district is very subject to inundations, which frequently cover 1500 square miles of its surface; below, the river again contracts, and flows through a defile till it bends its course to the south.

The Raab flows from the east slopes of the Styrian Alps, having the Bakonywald for its east watershed, and has a course of 180 miles; thirty miles from its source it has an elevation of above 5000 feet The principal affluents, both of the left, are, in the upper course, which is rapid, the Labnitz; and in the lower, which is marshy, the Raabnitz, which however is rather confluent than affluent. Two extensive lakes lie in hollows to the right and left of the Raab. To the north-west, the Nieuseidler See, twenty-three miles long and seven broad; its waters are saline, and average ten feet in depth; the country to the west is high and well wooded, and from hence it receives the waters of the Vulka river; that to the east is low and marshy, and the surplus waters are carried by a canal to the Raabnitz. The Balaton See, to the south-east, has an area of 420 square miles, and extends from east to south-west forty-eight miles, having an average breadth of ten. The waters are saline, and supplied by upwards of thirty streams, the principal of which is the Szala. The depth does not exceed forty feet, and is in some parts very shallow; the banks are marshy, and the surplus waters are carried by canals to the Sio and Sarviz rivers, to the south. This lake is 918 feet above the sea.

The Sarviz is the only affluent of the right bank of the Danube during its south course, until it receives the waters of the Drave, when its course is again turned to the east by the Julian Alps, which direction it retains until, shortly before its junction with the Black Sea, it trends to the north, confined by the Balkan and its northern spurs.

The Drave is not only one of the largest, but, geographically, one of the most important affluents of the Danube: it has its principal source in the south slope of the Dreyhernspitz; and its upper valleys connect with those of the Inn, the Salza, and the Adige, thus opening paths to the Tyrol, Bavaria, and Italy. One principal source of this river is in the gorge of Tolbach, having an elevation of above 4000 feet; the other descends from the sides of the Dreyhernspitz, and flows with a rapid course for about sixty miles, in direct distance, when it receives the waters of the Moll, from the left; and about twenty-five lower down, those of the Gail, from the right, and between them the surplus waters of several lakes. The most important affluent is, however, the Muhr, from the left, which, rising in close proximity to the sources of the Salza and Enns, has a north-east course of about seventy-five miles, when it receives a small stream which flows from the north-west slope of the pass of the Semering, as the Leitha does from the north-east, the two valleys extending in the same direction nearly 100 miles; thence it flows to the south for forty-five more, and approaches within eight miles of the Drave, when, trending east, it has its course nearly parallel to that river, about fifty-five miles lower down; its entire course is estimated at 230 miles.

The course of the Drave may be estimated at about 400 miles, for three-fourths of which it is navigable; after the junction of the Muhr it flows through a level, marshy country, and receives no affluents of importance.

The Save has its rise near the pass of Tarvis, to the north of Mount Terglou, and the valleys of its head waters connect the interior with the coast of the Adriatic; its course is estimated at about 500 miles, and is navigable for vessels of above 100 tons to the influx of the Kulpa, a powerful affluent of the right bank; it also receives the waters of the Nuna, the Vurbas, the Bosna, and the Dwina, which drain the province of Bosnia. The Kulpa rises only twenty-nine miles north-east of Fimnel, and has a course of 120 miles; the Nuna and Vurbas have about the same length; the Bosna and Dwina about 180 miles; both have several affluents.

The only other river of importance on the right bank of the Danube, rising in the primary watershed, is the Morava, which is formed of two branches, flowing for about 130 miles, respectively, from the east and west: the latter receives the Ibar, an important affluent from the south, as well as several other streams: the former, which has also several feeders, has its main sources in the central pass of the Balkan, and opens to the grand defile of Trajan. After the junction of the two main branches, the Morava has a course of 115 miles before reaching the Danube; its basin is hilly, fertile, and well wooded.

The Danube, from the confluence of the Morava, has numerous affluents on the right; the more important are the Isker and Wid, the head waters of which are in immediate proximity to those of the Morava, Karasou, and Maritza, opening to the central passes of the Balkans; the Jantra, which flows from the slope of the Kezanlik pass; and the Jemurlu, the valley of which extends from Shumla to Silistria. The Isker has a course of about 150 miles; the Jantra of seventy-five.

4 *The Secondary Watersheds of the North.*—The western watershed of the Inn is formed by the mountains of the Vorarlberg, an extension of the Grisian Alps, as already noticed. From Mount Selvretta, the central knot of this district, these spurs diverge, one forming the watershed of the Inn, to the east, and the affluents of the Dwina, to the west; this was known by the name Alps of Algar; another, separating the Lanquart from the Ill, both sources of the Rhine; a third, which stretching north, forms the boundary between the main basins of the Rhine and the Danube. To the south, the valleys of the Inn and Upper Rhine are connected by two very difficult passes, those of Mount Julier, 8133, and Mount Albula, 7713 feet above the sea: the pass of Seira Plana also, 9710 feet in elevation, passes over the western spur, and unites the upper valleys of the Rhine.

The mountains of the Vorarlberg form a broad mass, ranging from 7870 to 9843 feet in elevation; and throwing off, right and left, considerable spurs between the head waters of the Rhine and Danube. The principal pass by which it is crossed is the Col d'Adelsberg, on the summit of Mount Arlberg, which rises 9200 feet in elevation. This pass connects the valleys of the Ill and the Inn, and debouches on the latter at Landeck, where the river, pressed upon by the spurs of the Arlberg, assumes an easterly direction.

From the north extremity of the Vorarlberg, the Alps of Constance enclose the Baden See, and extend to the Schwartzwald; this can hardly be considered an Alpine region; it is rather an elevated and rugged district, formed by hills varying from 3280 to 3937 feet in elevation, the summits of which are plateaux; they are crossed by several defiles, the principal of which are from the extremities of the lake. The Schwartzwald, or Black Forest, is more rugged, and rises in many places above 3500 feet; its culminating point is Feldberg, which attains 4765 feet in elevation. The mountains project from the principal line of elevation between the sources of the Rhine to the south and west. The Schwartzwald is covered with extensive forests, and abounds in minerals and metals. This, like the other chain to which reference has been made, diminishes in height towards the north; it has its longer slope into the valley of the Danube. The defiles are difficult; the most important unites the valley of the Sarine, an affluent of the Rhine, with that of the Donau; and this is met by another, from the valley of the Kinsig, at the junction of the three sources of the Donau. To the north of this the Schwartzwald forms the watershed between the smaller affluents of the Rhine and the Neckar; that of the Donau its affluents from the left, which is continued in the Rauhé Alp, or Alps of Suabia, for seventy miles, having an elevation of from 1640 to 3280 feet, and culminating in the Hohenberg, which attains an elevation of 3369. Like the watershed of the south-west already described, the summits of these mountains form plateaux from fifteen to twenty miles in breadth; unlike that, however, they have their longer slopes to the south, are more barren, and not dissimilar are the Steegerwald and Fichtelgebirge, the continuation of the Suabian Alps to the east, the elevation of which is not as great, scarcely attaining to 3000 feet, excepting at the culminating point, Ochsenkopft, on the south, rising above 3400 feet, between the sources of the Maine and the Naab, the Saale and the Eger; from whence the Frankwald extends north-west, the Erzgebirge north-east, and the Bohmerwald, forms the continuation of the valley of the Danube to the south-west. The line of the Steegerwald appears detached from those of the Rauhé Alp and Fichtelgebirge towards the north-west, separating the valleys of the Neckar and the Maine, and reaching those of the Wernitz and Altmuhl.

The Bohmerwald extends for 150 miles, having its longer slope towards the Danube; it culminates in Heidelberg, near the source of the Regen, at 4616 feet. Savage in aspect, and covered with forests, the principal defiles of these mountains connect the valleys of the Eger, the Beraun, the Moldau, with those of the Naab, Regen, and the Danube; the latter river approaching within about ten miles of the sources of the Moldau, at Linstz; between the last two, for a distance of 100 miles, these mountains are only traversed by foot-paths; and the evils of a military government are apparent in the fact recorded by Lavallée, that the Austrians have broken up from twelve to fifteen miles of all the roads leading across them into Bavaria. From the defile near Linstz, the Mocherisches Gebirge, or Moravian Mountains, stretch for 150 miles more to the north-east; these are not dissimilar in character to the Bohmerwald; both have abundant deposits of iron and coal, as well as other useful metals and minerals, and the former were once noted for their mines of gold and silver. The Moravian mountains culminate at an elevation of 4285 feet. The principal defiles are those which connect the valleys of the Lischnitz and Kamp, affluents respectively of the Moldau and Danube, into which the latter, a small stream, flows between those of the Sizava and Iglava, affluents of the Moldau and Morava, and between the March, or Morava, and main source of the Elbe.

To the north of the Morava, the mountains which surround Bohemia meet on the east in the knot of Sneeberg. as they do to the west in that of Oksenkopft. Sneeberg rises 4784 feet above the sea; from it the Sudetes extend to the south-east for about 100 miles, separating the basins of the Morava and Oder; they have been considered a prolongation of the Reisengebirge and mountains of northern Bohemia, have the same character, and attain an elevation of from 3280 to 3940 feet; the principal lines of communication across them are between the sources of the Morava, the Oppa, a feeder of the Oder, and those of the Vistula.

Another knot, known as the Jablunka mountains, unites the Sudetes to the Carpathians; the extension of this between the rivers Morava and Waag is indeed known as the western Kleine, or Little Carpathians; these extend, as has already been noted, till they nearly meet the spur of the Styrian Alps. The Carpathian mountains extend nearly 700 miles, and may be thus divided: the western Carpathians. from Mount Wisoky to Mount Krivan; the central, from thence to Mount Bisztra, enclosing the sources of the Theiss; and the eastern, from Mount Bisztricksora to the third defile of the Danube, surrounding the valley of the Maros; the culminating point of these is the peak of the great knot of Tatra, called Lomnitzerspitz, which rises 8779 feet above the sea level; Lavallee gives an elevation of 19,187 feet to the culminating point of the eastern Carpathians, and Mount Ruska has been estimated as 9900 feet in height. The western and eastern portions of this chain are more elevated and thickly massed than the central, by which comparatively easy access is obtained into the valleys of the Vistula and Dneister, which are separated by a spur from the main chain, projecting to the north-west. The principal passes are, on the west, one over the northern extremity of the Jablunka mountains connecting the valleys of the Waag, the Oder, and the Vistula, and one over the eastern spurs of Tatra connecting the valleys of the Donaiec and Hernad, affluents of the Vistula and Theiss; in the centre, one between the valleys of the Wisoka and Brodrog, affluents of the same rivers; another, connecting the Ungh, an affluent of the Brodrog, with the Dniester, and the Saan a considerable affluent of the Vistula: and on the east the Borgo, by which access is obtained from the main sources of the Theiss, called the Samos, to those of the Moldava and Bistritz, tributaries of the Sereth; on the south, the most important pass is that of the Rotherthurmer, over which there is an excellent road by the valley of the Aluta; the main watershed lying to the north and west, between the feeders of the Maros and Temes and the Aluta; and besides these, the Gimes pass opens into the country south of the Sereth; the Thorzburg unites the upper valley of the Aluta with those of the Alonitz and Jalonitza; that of the Tergova opens on the defile of the Lower Danube; while the Volkan unites the valleys of the Maros and Schil; these latter, however, rather appertain to the spurs than to the main chain of the Carpathians.

These mountains, called also Krapacs, surround the basins of the north-west affluents of the Danube, forming three sides of a quadrangle, the greatest length of which is from north-west to south-east, and throwing out spurs between their feeders; of these, the Kleine Krapacs on the west, and the mountains of Konigsberg, between the Waag and the Graan, are thrown off to the south and west from Tatra; on the east, two massy but magnificent spurs nearly surround the sources of the Theiss. Detached groups are also observable, as that of Medves, culminating on Mount Matra, which attains an elevation of 3300 feet between the valleys of the Theiss and Graan. Although not as elevated as the mountains of the primary watershed, these are distinguished for the grandeur of their outlines and sublimity of their scenery; their basis is of igneous rocks, principally granite, interspersed with gneiss, hornblende, and a variety of volcanic substances; they have mines of the precious metals, of copper, lead, mercury, and rock-salt; their sides are clothed with fruits, and the valleys produce abundant crops of grain; the vine also flourishes on their southern slopes.

5 *The Secondary Affluents.*—Assuming the Inn to be the principal source of the Danube, the Donau may be considered as next in importance; its main source is the Berge, which rises in the Schwartzwald, at an elevation of 2850 feet; with this, two small streams, the Brigach and one which rises from the castle-yard of Donaueschingen, unite in a large marsh below that place, and from thence flow through a narrow and abrupt defile, the slopes of which are thickly wooded, in a north-easterly direction. The affluents from the right are the Ablach, by which entry is first gained into its valley; the Ostract, noted for its swampy and impracticable banks, situated among hills and marshes; the Keiss, also marshy; these are comparatively but small streams.

The Iller, however, is a river of some importance, which, falling from the northern slopes of the Vorarlberg, flows through a wild valley for about forty miles, and then through a level country, and after forming many channels and numerous islands, and receiving several small affluents from the left, falls into the Danube at nearly a right angle to its course; its entire length is estimated at eighty-five miles. The Gunz, Mindel, Sazam, and Schmutter are streams flowing parallel to the course of the Iller, and falling into the Danube between it and the Lech. At the junction of the Iller with the Danube, that river is 1400 feet above the sea, and 108 feet in width. The Lech has its main source in the Arlsberg, and flows through a very wild and narrow valley for about forty miles in direct distance, with a north-easterly course, and from thence trends north through a wooded and mountainous country, which gradually opens on the left to a low and extensive plain, while its bed is overhung by a steep escarpment on the right; its course is estimated at 140 miles, in the last fifty of which the river changes its character, divides in anabranches, forms numerous islands, and expands to a mile and a-quarter in width. Here it receives the Westact from the left, which, falling from the northern extremity of the spur which divides the Iller from the Lech, has a course of eighty miles, and receives two affluents from the south-east. The Lech is also, in its lower course, skirted by the Schmutter and Oder; it is not navigable; and being in its upper course a torrent, its lower is subject to violent floods.

The Paar, Ilm, Abens, and Gross-laben are streams of from thirty to fifty miles in length, which fall into the Danube from the hills which extend round the valley of the Isar. The country through which they flow is low and marshy, and of rectangular shape, and the hills which form them project towards the spurs of the Bohmerwald which surround the valley of the Regen. The plateau of Rohr extends between the Abens and Gross-laben to the Danube, and presents its steep escarpment to the north-west; it is to be considered as a prolongation of that which forms the east bank of the Iller, in its middle course.

The Isar, rising in the north face of Mount Solstein, has its upper course through a wild and deep defile among impracticable mountains; its middle course is through a mountainous, but more open and well-wooded country, here it widens and becomes studded with islands, and receives several affluents, one especially of importance from the left; lower down it has a more easterly trending, and receives the Ammer, which has a course of seventy-five miles, from the left. The lower course of the Isar is through a marshy valley, and it forms numerous islands by its anabranches; the country on the left is low, but on the right the river is commanded by heights. Most of the affluents of the Isar spread into lakes, the principal of which, the Ammer, is ten miles long by four broad. Between the Isar and the Inn, the Fils, a river of little importance, has a course of seventy miles. Of the affluents of the left bank of the Donau, the first eight are merely torrents; of these, the Egge joins the main stream nearly opposite the confluence of the Iller. The Wernitz, a small stream, descends from the heights of Schillenberg.

The Altmuhl is the first of importance; it flows from the slopes of the

Steigirwald, in a south-easterly direction, for about half its course, and then trends eastward, nearly parallel to the Danube. In the first part of its course it is a torrent, and flows through a rugged valley; in the second, like most of the affluents of the Danube, it flows through marshy and low lands. Its total length is estimated at 125 miles, and it falls into the Danube nearly opposite to the defiles of Abach.

The Naab rises from three sources in the Fichtelgebirge and Bohmerwald; it has a course of seventy miles, through stony valleys, is navigable, and receives the Fils, or Vils, from the right; it joins the main stream close to the mouth of the Regen, and nearly opposite that of the Inn. The Regen has its rise in the Bohmerwald, and flows in a direction opposite to that of the main stream, through a very contracted basin, by which access is obtained into Bohemia; suddenly turning to the south, it falls into the Danube after a course of eighty miles. The Ills, a torrent flowing from the Bohmerwald, is the only affluent of the left bank remaining to the upper basin of the Danube.

From the confluence of the Isar the Donau becomes navigable, and is about 328 feet in width; above, it flows through a continuous defile; below, an extensive and fertile plain opens on the right bank; here it widens, is covered with well-wooded islands, but still pressed by mountains on the left bank. lower down its course becomes very sinuous, and the elevations appear alternately on either bank; this character is maintained to the defiles of Abach; from hence to the defile which closes the upper basin of the Danube, after its confluence with the Inn, the rugged slopes of the Bohmerwald close upon its left bank, while the plains already described about the lower course of the Isar open widely on the right.

After the confluence of the Inn and the Donau, the united stream soon expands and divides between islands, acquiring a breadth of 2625 feet; subsequently it contracts to 656, and again expands to 1213 feet; here it is rapid, and navigation dangerous, and its banks are subject to serious inundations; here also the valley expands, and the river forms anabranches, encircling large islands, as already noticed.

Eight torrents, of from fifteen to twenty-five miles in breadth, descend from the mountains of Bohemia to the main stream. The first important affluent of the left bank is the Kamp, which flows through a deep and well-wooded valley; its upper course is winding, its middle parallel to that of the main stream, and its lower at right angles to it. This stream falls into the Danube opposite the mouth of the Trazen, and its length is estimated at seventy-five miles.

The Gœllerbach, though it has only a course of twenty-five miles, is important, as its valley opens communication with the eastern part of Moravia.

The March or Morava, has its principal source in the Sneeberg, from whence it flows to the south and east; till, pressed by the spurs of the Jablunka mountains, its course is turned to the south and west; but bending round their extremity, it gradually resumes its original direction, and falls into the Danube, just above the defile formed by the approach of the Styrian Alps to that chain. The upper valley of the Morava is rugged and mountainous, and it receives accessions to its waters from many torrents and small streams in its middle course; it receives from the right the Thaya, its principal affluent. This river is formed by two streams, which rise in the east slopes of the Moravian mountains; its valley, at first narrow and precipitous, gradually extends, and is interspersed with marshes and woodlands, through which the river finds its way by numerous channels; in its middle course it receives the united waters of the Iglava and Schwarza, of which the Zwittava and Littawa are also affluents, the former having a course of fifty-five miles, rising among the hills to the north, the latter a small stream flowing through lakes and swamps from the east. The Iglava is a large and important stream, opening communication with Bohemia, and has a course of about 100 miles. The estimated length of the Schwarza is eighty, of the Thaya 130. The Morava also receives from the right the little stream, Russbach, which falling from the heights of Wagram, traverses the March field. The lower course of the Morava is through extensive marshes, interspersed with well-wooded undulations, and before entering the Danube it divides into numerous branches and channels.

The Waag descends from the mountain knot, Tatra, and confined between the long spurs of the Carpathians, the Jablunka, and Konigsberg mountains, its middle as well as its upper course is very tortuous and rapid, and has no affluents except mountain torrents; it joins, or perhaps rather is joined by, the Neuhœsel, the anastomosing branch of the Danube which forms the island Grosse Schutt; in its lower course it is subject to violent inundations, and its entire length is estimated at 200 miles.

The Neuhœsel also receives, near its junction with the Danube, the Neutra, which flows through a plain, and has a course of about eighty miles.

The Graan has its rise in the south slopes of Mount Dumbier, which rises 6500 feet above the sea; it has a course of 125 miles, and receives one affluent from the left, which flows through the valley formed by Mount Schemnitz. The Ipolz or Eypel, rising in the Medves mountains, has a course of ninety-five miles, and is navigable for about thirty-five; it has several affluents; falling from the south slopes of Mount Schemnitz, it unites with the main stream just above the defile formed by the approach of the spurs of the Carpathians to the Bakonywald.

Throughout the whole of its southern course the Danube has no affluent of the left bank worthy of notice; the Theiss, flowing nearly parallel to it for above 150 miles in a direct line, at an average distance of forty-five, though the courses of both are very sinuous. This river and its affluents drain the entire basin formed by the central and eastern Carpathians. In its course from north to south, the Danube flows in a broad channel, sending out anabranches, and forming numerous islands; here its extreme elevation above the sea scarcely exceeds 300 feet, and its fall is only three inches in a mile; its depth may be estimated at twenty feet, and its breadth as averaging 6000; one island (Czepel) formed by it is above thirty miles in length.

The Theiss has its principal sources about the Borgo pass, in immediate proximity to those of its most important affluent, the Maros. In the high mountain valley formed by encircling spurs of the Carpathians, the waters of the Szamos, Bistriz, and other streams unite, and bent northward by the Buchgebirge, an extension of the Reuss mountains, issues on the plains in a north-west direction, where other affluents add their tributes to the stream, and about forty-five miles in a direct line from where it issues in the valley, it receives the waters of the Theiss from the right, the sources of which are in close proximity to those of the Sereth and Pruth: twenty miles lower down, turning at a sharp angle, it flows westward, and receives the waters of the Brodrog, an important affluent from the north, formed by the junction of the Ung and other streams, which fall from the south slopes of the central Carpathians, and give access to the corresponding valleys of the Vistula and Dniester. Trending south, the Theiss now receives the Hernad, from the north-west, which is formed by the junction of the Tareza and Sajo, the head waters of which have their rise in the knot of Tatra and the Konigsberg mountains, and are in proximity to those of the Waag and Graan on the west, as well as the Donaec and its affluents, which unite with the Vistula to the north; this river has an estimated course of 120 miles; the upper portion of its stream is rapid, the lower sluggish, like all the affluents of the Theiss; in its lower course it separates into two parts, encircling an island thirty miles in length. The south watershed of this river is formed by the Medves mountains, from the south and east slopes of which several small streams fall into the Theiss; the most important of these is the Zagyra, the numerous sources of which encircle Mount Matra; after its junction, the main stream has no affluents from the right; on the left it has the Koros, formed by the junction of three streams of that name, having their rise in the western termination of the spurs of the Carpathians, which enclose the upper valleys of the Szamos and Maros; it receives one affluent, the Err, from the right, which is connected towards the north-west with the Theiss by an anastomosing branch. The Koros may have a course of about 200 miles.

The Maros, or Marosch, has its rise in the south flank of the Carpathians, and its upper course is through an elevated plateau of above 100 miles in length from north-east to south-west; surrounded by their projecting spurs, its position is very remarkable; for while, after issuing from the plateau, it affords access to the valley of the Aluta, and so with the lower plain of the Danube, its lower course unites it with the Theiss, and the affluents of the right bank of the Danube above the defile formed by the approaching spurs of the Carpathian and Balkan mountains, which it may, therefore, be said to turn. The principal affluent of the Maros is the Kukel, in its middle course, which rises from two sources of that name in the mountains of Transylvania; this river unites with the Theiss by three principal branches, enclosing a triangle of fifty miles from apex to base, and thirty miles on the base line; it has a course of above 400 miles.

The length of the Theiss may be estimated at 600 miles, for two-thirds of which it is navigable, and for the greater portion for vessels of 300 tons' burden; after the junction of its principal streams, it flows sluggishly through extensive morasses.

The Danube has three other small affluents on the left, in this basin—the Bega, Temes, and Karasch; of these, the Temes is the larger, and flows through a considerable lake at Csakosah.

Through the tremendous gorge called the Iron Gate, the accumulated waters of the Danube rush with fearful rapidity into the plain encircled by the Balkans and Carpathians, to the south and north-west; here it encircles the island of Orsova, which commands the pass: and from hence its numerous branches spread and intersect the plain, in inextricable confusion, channels and islands often extending ten and twelve miles in width; it flows first to the south-east, and then takes an easterly course for above 200 miles; then, bending at right angles to the north, it receives the waters of the Pruth and Sereth, and then stretches out its many arms eastward to the Black Sea.

The affluents from the left are numerous: the principal in its easterly course are the Schyl, Aluta, and Dombritza; of these, the Aluta is the most important, opening the communication with Transylvania by the Rotherthurm pass. The Jalonitza falls into the main stream in its northern course; and its head waters afford communication with those of the Aluta, which latter cannot have a course of less than 200 miles; but of all the rivers falling from the Carpathians our knowledge is very unsatisfactory.

6 *The Sereth and Pruth.*—These rivers, turning the northern flank of the Carpathian mountains, and opening communications with the lower course of the Danube, from Poland and Russia, are distinct in character from its other secondary affluents. The Sereth has its sources in Mount Czorna, opposite those of the Szamos, and has a course of 250 miles, in a south-east direction; it receives the Bistriz, Sutschava, Moldava, and Tatros, as affluents from the right, and the Birlat from the left; the former have their sources in the eastern Carpathians, near those of the Theiss and Brodrog; and the latter from the lower eastern spur which divides the valley of the Sereth and Pruth. The Moldava gives its name to the district, and has a course of above 100 miles. The Pruth, like the Sereth, comes down from the eastern slope of Mount Czorna; it has a course of 360 miles, and receives numerous small affluents, which intersect the country between it and the Sereth; the largest of these is the Baghui, described as 'a long chain of muddy pools.'

From the junction of the Pruth, the course of the Danube is ill defined; it reaches the sea, however, by three principal mouths—those of the Kilia, Sulina, and St. George, the delta formed by them being above forty-five miles in length and breadth; this, with the country immediately surrounding, is frequently inundated. On the north, the drainage is received into large lakes and morasses; on the south, however, a range of low hills occupies the angle formed by the Danube, and sheds its drainage to the south-east, principally into Lake Ragem, or Rassem, more properly an inlet of the sea, of irregular triangular shape, about thirty miles in extreme length, and twenty in breadth. The Danube is navigable as high as the confluence of the Iller, for vessels of 100 tons; and its mouths, of which the northern is the most considerable, were accessible to those of the greatest burden until neglected by the Russians. Now that they are in the possession of the English and French, they will doubtless be again rendered available for the purposes of commerce without delay. The entire course of the river may be estimated at above 1700 miles; in direct distance, 1000.

7 *The Valleys of the Danube.*—It has already been noticed that the primary and secondary watersheds, nearly meeting at three points, divide the course of the Danube into four parts.

The first, or upper basin, is a plateau of pentagonal form, 1640 feet above the sea, well wooded and fertile, extending 210 miles from north to south; and the same distance from east to west from the extreme limits of its watersheds. From the confluence of the Iller to that of the Inn, the direct distance is 135 miles, but by the course of the river a triangle would be formed on that base, having its apex at the mouth of the Regen, and distant from the mouth of the Iller eighty-five, and from that of the Inn sixty miles; and few portions of the surface of Europe have more historical importance than this, which has been the scene of contest between the northern and southern, the eastern and western powers, respectively, from the earliest times.

The second basin of the Danube, into which it enters by a formidable defile, surrounded on all sides by mountains, is extremely irregular in its features; it is fertile, and rich in mineral products. From the confluence of the Inn to that of the Morava, is 140 miles in direct distance; but on the line of the Ems the valley cannot be estimated at more than fifty miles in breadth; the direct distance between these points is forty-five miles; and this portion of the valley assumes the aspect of a series of defiles, from the bold spurs which are prolonged from the mountains of Styria to the bank of the river: on that of the Leitha and Morava it extends to 100 miles; and here is the most fertile, beautiful, and salubrious portion of its course. In this basin the southern boundary is composed of rugged mountains, giving it an Alpine character; the mean elevation may be 5000 feet.

The third basin comprises nearly half of the whole area drained by the Danube and its affluents; raised scarcely 400 feet above the sea, with marshes extending over above 9000 square miles; a large portion also being arid, sandy and barren; its climate is damp and cold; nevertheless, it is rich in flocks and herds, and the hills in minerals, corn, and wines. From the sources of the Brodrog on the north, to those of the Morava in the south, is in direct distance more than 350 miles, and from the pass of the Semering to that of Borgo about the same distance. The lower valley of the Theiss is more than 150 miles in extent from north to south, and above 100 from east to west.

The lower plain of the Danube, surrounded by deep and rugged mountains, is level, and in great part marshy; it is fertile in produce of every kind: here has been the entrance for the great waves of migration which, setting in from the steppes of the Caspian, have deluged central Europe, and the history of which may be read in the physical character of the basin of the Danube.

CHAPTER XII.

OF THE EAST AND NORTH OF EUROPE.

§ 1. The watersheds of north-east Europe.—2. The rivers of the south.—3. The rivers of the north.—4. The Scandinavian peninsula.

THE *Watersheds of north-east Europe.*—The north-east of Europe consists of an extensive plain reaching from the Carpathians to the Oural mountains, and from the Baltic to the Black Sea; indeed, more properly it may be said to extend round the Baltic, and to be bounded on the south-east by the Caucasus, and on the north-west by the mountains of Scandinavia; it will in either case exceed one half the entire area of Europe, from the rest of which it is as distinct in character as in position, the outlets of its principal rivers being to the south-east, and the larger portion according with the north of Asia. The following dimensions are given by Lavallee:—from Akerman, at the mouth of the Dniester, to Cape Waigatch, 1988 miles; from Bromberg on the Vistula to Orokaia on the Oural, 1491; from Cape Apcheran to North Cape, 2112 miles; these distances, given in English miles, afford some idea of the extent of the country, but not of the peculiarity of its position; this is more clearly seen in the proportionately small extent of the base by which it is united to the rest of Europe, which from the mouth of the Teligoul, at the north-east angle of the Black Sea, to that of the Vistula, at the south-east angle of the Baltic, may be estimated at 650 geographical miles, while the longer boundary between it and Asia, from the northern extremity of the Caspian to the Gulf of Kara, does not probably exceed 1350. Situated between three seas, with navigable rivers flowing into each of them, having a coast line on the Caspian of about 500 miles in direct distance, on the Black Sea and Sea of Azov 350, and of nearly 1000 on the Baltic, the commercial and political importance of this country is very considerable; and if it were under influences which permitted the development of the talents and industry of its inhabitants, it must be the centre of commerce between north-west Europe and Asia, as the Danube is the natural outlet of central, and the Mediterranean of southern, Europe; this would be much facilitated by the inconsiderable elevation of the watersheds which separate its southern from its northern rivers. Originating in Mount Sloiczek, between the sources of the Dniester, Vistula, and Theiss, an irregular and broken spur extends to the north-east between the basins of the Vistula, Niemen, and Duna to the north, and the Dniester and Dnieper on the south, which gradually sinks into, and is lost in the plain, so that when their troughs are filled in the rainy season, the waters of these rivers become blended: between the sources of the Duna, or Niemen, and the Dnieper, it appears again in a plateau of small elevation, scarcely attaining 1000 feet in elevation, its culminating point being at Parcewitz, which is estimated at 1055 feet above the sea; this extends still north-east, and insensibly rising, joins the Oural mountains. A similar plateau, but of less elevation, extends south-east and north-west between the Dnieper and Dniester, which is connected with the Wihorlet mountains, a spur of the central Carpathians, but the distinct line of watershed is lost between the secondary sources of the Dnieper and Vistula.

The more elevated portion assuming dome-like shapes, and being covered with forests, is known as the Valdai hills; these are of argillaceous formation, based on granite; the plateau which connects them with the Oural rises to the east and north, in an irregular calcareous chain, which may be considered as an extension of the Oural mountains, towards which the plateau of Chemokonski stretches eastward, and unites with them in a knot, from which the waters flow in every direction to the Icy Sea, the White Sea, the Black Sea, and the Caspian: from hence the Ourals, under the name Poya, extend to Cape Waigatch.

The Oural, or Ural, mountains run nearly north and south under the 60th meridian of W. longitude; their northern extension must be sought in the island of Nova Zembla; and their southern, round the sources of the river of the same name, between Lake Aral and the Caspian; their average elevation may be 1000 feet, but they culminate in Konjakofskoi Kamen, under the 60th parallel of N. latitude, at an elevation of 5397; a little from the north of which a spur is thrown out to the north-east, separating the gulfs of Obi and Kara, while another extends north-west round the Petchora to the promontory of Kamen-nos; the former is, however, the more important, rising above 5000 feet, while the latter scarcely reaches 1000. The portion of the Ourals about their culminating peaks is covered with dense forests; to the south there is less wood, but the valleys are fertile and well watered. These mountains, composed of crystalline and slaty rocks, abound in minerals and metals; iron is worked in large quantities, and the yield of gold was until late years among the largest from any part of the world.

From the north-west, the range of heights which occupy the centre of Russia are met by the extended spurs of the Scandinavian mountains, which, while between the Icy Sea and the Baltic they attain an elevation of above 4500 feet, gradually subside towards the east to 700 and 300 feet; notwithstanding their identity is obvious, by the primitive rocks of which they are composed; they form the watershed between the Gulf of Bothnia and the White Sea, and spread over a country abounding in small lakes and morasses, interspersed with sandy steppes.

2 *The Rivers of the South.*—The Dniester has its principal sources in Mount Sloiczek; its main stream has a general south-east course; it receives numerous affluents both of the right and left, the former, falling from the slopes of the Carpathians, rapid; the latter sluggish, and forming chains of small lakes. Of the former, the principal is the Styr, by the valley of which communication is gained with the head waters of the Brodrog and the Theiss. In its middle course, approaching within about eighteen miles of the Pruth, the Dniester has no affluents of the right, until, in its lower course, it receives the Kobotta and other small streams; the country between its mouth and that of the Danube is occupied by the Kageluk or Koujalnik, having a course of about 100 miles, and falling from the southern extremity of the watershed between the Pruth and Dniester, which in their middle course is well defined. Of the affluents of the left, the most important are the Sered and Podhorce. The length of the Dniester in direct distance may be 400 miles; its windings may extend to 100 more; its navigation throughout is impeded, though from different causes; its upper course is over a shallow rocky bed, among well-wooded hills; its central through fertile valleys, abounding in corn, cattle, and timber; its lower through vast plains producing only pasture for cattle, interspersed with lakes and marshes: the climate in each varies with their character. The mouth of this river forms a deep elongated lagune, twenty miles in length by five in breadth, connected with the sea by two very narrow channels. The mouth of the Koujalnik also forms a lagune of similar character, and between them the Solenoe lagunes extend along the coast for twenty miles.

Beyond the Dniester, the Koujalnik, Telegoul, and other smaller streams, are lost in the morasses and lagunes which extend on the shores of the Black Sea, between that river and the Bug, or Boug. This is a large river, flowing parallel to the course of the Dniester, and having its origin in the southern slopes of the plateau which separates the basins of the Dniester and Dnieper. The principal affluents are the Kadima, or Kodyma, on the right, and the Siniouka on the left; the latter, with its branches, draining a considerable area. The Bug is 350 miles in length, and falls into an estuary, prolonged to the south, in the Gulf of Kherson, extending about twenty-five miles in length, and being five in breadth at its mouth; into this estuary the Ingul also flows, which has a course of 150 miles, to the east of the Bug.

The Dnieper, notwithstanding its magnitude, must, with those already enumerated, be considered among the tertiary rivers of Europe, having its source in the Valdai hills and the marshes to the south, in which the Bug, the secondary source of the Vistula, has also its rise; the same rule being observable in these as has already been noticed with respect to primary rivers.

The main sources of the Dnieper, surrounded by the well-wooded slopes of the Valdai hills, flow, deeply imbedded, through a fertile country, varied with numerous acclivities, and it maintains this character till it is joined by its secondary source, the Pripetz, from the west; it is above 300 feet in breadth about 100 miles from its source, where it becomes navigable; in its upper course it receives, among other affluents, the Drutz and Beresina from the right, and the Soj from the left; these, and especially the Beresina, which has its rise in the marshes of Dokchitsy, flow through a country of morasses and swampy forests; this is a broad, deep, and rapid river; has a course of 200 miles, and a considerable affluent, the Svislotch, from the right, on which bank the ground is more elevated. The Soj is a navigable river, with a course of 240 miles.

The Pripetz, the secondary source of the Dnieper, flows through the swamps of Prujain, and has its sources in immediate proximity to those of the Bug, as already noted, its principal streams, however, fall from the northern slope of the plateau; its main stream is formed by the junction of the Seluez and Goryn, which receives from the left the Styr, Przypec, and Jusiolda. The morasses in this valley may extend above 200 miles in length, from east to west, and 100 in breadth from north to south. The Dnieper receives no other affluents of importance from the right. The principal of those from the left, the Desna, the sources of which are in immediate proximity to those of the Don, and which may probably be the main stream of the Dnieper, is formed by the junction of two principal branches, and has a course of about 500 miles, through the greater portion of which it is navigable; after its junction with the Dnieper, that river takes a south-easterly direction for above 200 miles, in the course of which it receives the Soula, Korol, and Samala from the left; here it attains a breadth of 4593 feet, and turning south, it is precipitated in rapids for forty-five miles over a rocky bed, and becomes studded with islands; it then trends to the south-west, and its mouth is an extended estuary studded with islands, forming, in fact, what would, under other circumstances, be the delta of the river; here it receives on the right the Ingoulitz from the north; this is a considerable stream, having a course of above 200 miles. In direct length, the Dnieper is 623 miles; its windings increase that distance to more than double.

The river Don, encircled by the Oka and surrounding secondary sources of the Volga, notwithstanding it appears insignificant beside the greatest of European waters, is a river of much importance, and drains a large area; rising in the small lake Ivanow, it flows in a south-east course, as if to add its waters to the main stream of the Volga; but when within twenty-five miles of that river, it changes its course to the south-west, a granitic range extending from the Caucasus interposing, which also diverts the Volga itself from its southern course, and turns it towards the Caspian Sea. A considerable depression is indeed observable between this range and the main chain of the Caucasus, which is occupied by Lake Bolchoi Ilmen, the river Manich, which carries its surplus waters to the Don, and the Kóuma, which flows into the Caspian; but its geological character gives unmistakeable evidence that it must be considered as an extension of the primary watershed. The Don has a circuitous course of nearly 1000 miles, though the direct distance from its source to its mouth is less than one-half; it receives two affluents, the Sosna and the Donetz, the larger and most important, draining the fertile district of the Ukraine on the right; those on the left are more numerous, and include the Varonetz, Khopper, Medvietza, Sal, and Manich: to the latter reference has already been made; it has a course of about 300 miles, one-third of which is through lakes and marshes. The waters of the Don are strongly impregnated with chalk, and its bed is formed of chalk and mud; its upper course is through a hilly and fertile country; its left bank is, throughout its lower course, frequently overflowed; shoals aud islands are frequent in its channel, which is therefore only navigable in spring, when the waters are highest; it enters the Sea of Azov by several mouths, and its delta extends fifteen miles from the apex on a base of ten.

The slope of the Caucasus to the north presents a country of great beauty and fertility; the mountains broken by rich valleys abounding in corn, wine, and fruits, the former cultivated at an elevation of 8000 feet; and the plains at their base producing large herds of cattle; the Kouban and the Terek, however, are the only rivers of which it can boast. The Kouban is a rapid river, rising on the north-west defiles of Mount Elbruz, after receiving many small affluents, after a course of nearly 400 miles falls into the Black Sea to the south of the eastern peninsula, which separates it from the Sea of Azov; its effluence is in a lagune, twenty miles long and ten broad; and two other lagunes, having together as considerable an area, occupy the mouth of the isthmus. The Terek is also a rapid river, with numerous affluents, having a course of above 300 miles. The Kouma to the north has a course of nearly equal length, but flowing through a lower country might connect the Sea of Azov with the Caspian by the course of the Manich.

The mountain range of the Caucasus has already been partially described; its summits are round or flattened, and culminating 18,000 feet above the sea, its eastern portion is always covered with snow, as far as 40° 30′ west longitude: about the sources of the Kouban it sinks rapidly, terminating in rounded chalk hills to the west, and limestone cliffs toward the sea; it is composed chiefly of secondary rocks to the north, with volcanic rocks interspersed, though it contains no active volcanos. Minerals and metals, especially iron, copper, lead, and it is said coal, are plentiful. Of this region, however, we know less than of many much more distant and less valuable portions of the earth's surface.

Separated from the Caucasus by the Strait of Kertch, having an average width of seven miles, but much contracted by shoals and sand-banks, lying between the Sea of Azov and the Gulf of Perekop, a deep indentation of the north-west angle of the Black Sea, and attached to Europe by the narrow isthmus not exceeding six miles in breadth, from which the gulf takes its name, is the peninsula of the Crimea; of a quadrangular figure, extending from east to west 150 miles, and from north to south 100, it shows its affinity to the Caucasus in the mountain range which extends along its southern shore; this may have a linear extension of 100 miles, and be in breadth about seven, culminating near the centre in Tchatyr-dagh, 5050 feet above the sea; this does not rise in lofty peaks, but is flattened at the top, has a precipitate fall to the sea, and presents on the south side many small but beautiful and fertile valleys, assimilating in character, climate, and productions to those of Italy or Greece. The extension to the east forms a peninsula thirty miles in length, united to the larger mass by an isthmus about ten miles long and as many broad, between Kaffa Bay in the Black Sea, and that of the Arabat in the Sea of Azov; through this the chain of elevation is extended to the north-east angle. The north slope of the mountains is prolonged to Perekop, and presents at their base extensive sandy and, in summer, arid plains; these, however, are capable of producing abundance of grain, and now sustain numerous herds of cattle. Its streams, often dried up in summer, are unimportant, the largest, formed by the junction of the Salghyr and Karasu, may have a circuitous course of eighty miles.

From the Dnieper to the Don, and round the north extremity of the Sea of Azov, a dreary, monotonous plain extends for nearly 100,000 square miles, which at present supports only cattle, and a scanty nomad population; though there can be no doubt that it would amply reward the labours of the husbandman.

The Volga takes its rise in the Ural mountains, and is separated from the rivers of the north and from the Don by the plateaux of central Russia. The best known source of this river is, as usual, its secondary source, which has its rise in the slopes of the Valdai hills, at an elevation of 800 feet above the Black Sea, and 875* above the mouth of the river in the Caspian. The main source must, however, have an elevation considerably greater, as it has its rise in the central and highest portion of the Ural mountains, under the 60th parallel N. lat.; this, under the name Kama, receives numerous affluents, both from the right and left, and flowing through Permia, unites with the north-west streams in about 55° N. lat., under the 60th meridian W. long. Of the affluents of the Kama, the Valka, on the right, has a course of 500 miles; and the Bielava, on the left, rising from two sources, is of as great extent. The course of the Kama may be estimated at 1500 miles. One source of the north-west stream of the Volga is in Lake Seliguer, in the Valdai hills, 550 feet above the sea. The western stream receives numerous affluents; the principal are, on the right, the Oka and Sowra; the former has a course of 650 miles, for the greater part of which it is navigable, through the most fertile part of Russia; it receives several affluents, one of which, the Moskowa, gave its name to the ancient capital of the country; the latter has a course of about 400 miles. On the left are, the Tertza, Molovga, and Sheksna; the former has a course of above 100 miles, and is in close proximity to Lake Ilmen; and by it communication is established between the Caspian and the Baltic; the second, which has a course of 250 miles, is also connected with the Ladoga; the latter flows from Lake Bielo, and communicates with Lake Ladoga and the Dwina. The Samara is the only affluent of importance which the Volga receives after the confluence of its two principal streams.

About the secondary sources of the Volga, the same facility for water communication is observable, which is remarkable, in north-east Asia and North America, and which is also found, though to a smaller extent, in Sweden and Norway; it is, in short, the distinguishing characteristic of the northern slope of the continents towards the Icy Sea; but is perhaps nowhere more strongly developed than in the basin of the Volga: that river is navigable for vessels of five feet draught of water from the confluence of the Samara to that of the Sheksna—which has its rise in Lake Biloe Ozero, about fifty miles south of Lake Onega, with which it communicates; it is twenty-five miles long by twenty broad, and of considerable depth—and below that point for vessels of considerable burden; but its course is impeded by sand-banks, and is very subject to changes: the Kama is navigable almost to the base of the Ourals.

This great river, known also by the Greeks as the Rha, and by the Tartars as the Adel or Idel, is of importance as being the natural means of communication between the Caspian and Black Sea; its basin may be called Russia proper; the western portion of its upper valley is fertile; the eastern comparatively barren, but abounding in mineral wealth; its middle course, from the junction of the Samara, when it trends to the south and west, is through an open but desert country for 300 miles, when, suddenly turning to the south-east, it receives the Sarpa, which has a course of 200 miles, from the south, and continues, in that direction, its lower course through swamps and morasses; it is said to enter the Caspian by seventy mouths, and has throughout its lower course anastomosing branches; its delta may extend more than fifty miles, and has numerous islands beyond it. At the junction of the Oka, the Volga is 4600 feet in width, but lower down is narrowed between steep banks; at Kasan, not far from its confluence with the Kama, it is only 600, and about half-way down its middle course 1200; in the time of floods, above the delta, its waters extend fifteen miles; its entire course may be estimated at 2000 miles; its waters are frozen during five months of the year.

The Oural, falling from the south extension of the mountains of the same name, forms the nominal boundary between Europe and Asia; its course may be estimated at about 800 miles, for two-thirds of which it may be esteemed navigable; it has two principal affluents, the Ilek and the Sakmara,

* If the Caspian be, as determined by the Russian Survey, 102 feet below the Black Sea, this estimate must be altered accordingly.

the latter having a course of above 300 miles. The upper valley of the Oural corresponds with that of the Bielaya—is mountainous, and abounds in minerals; its lower course, through sandy and marshy steppes, corresponding to those which extend to the east and south, towards the Lake Aral.

3 *The Rivers of the North.*—Returning to the secondary watershed of central Europe, the Vistula occupies a position in the north similar to that of the Dniester in the south, but is a much larger and more important river; it has two principal sources, one formed by the junction of the San with the Vistula, and the other by the junction of the Narew with the Bug. The former comes down from the north slopes of the Carpathians; the latter originates in the marshes on either side the central plateau, from which the Dnieper flows to the south-east, and the Niemen to the north-west. In its upper course the Vistula, called by the Germans Weitzel, receives the Pilica, a river of considerable size, from the left; the San, which receives several affluents, has a course of 250 miles; below the junction of these rivers the Wieprz, on the right, and the Baurz, on the left, are the most important affluents.

The Bug has its watershed in the spurs which extend from the Carpathians, round the sources of the Dniester; and here the Pultew, one of its affluents from the left, if not its principal source, has its rise; its course is north and north-west for above 300 miles; its principal affluents are the Muchariec, which opens a communication with the west sources of the Dnieper; and the Narew, which some consider the main stream, but which has only a course of about 200 miles. Below the junction of the Bug and Vistula, the principal affluent is the Oukra. The Vistula falls into the Baltic by several mouths, through a country of morasses, intersected by canals, which are subject to great changes, the extreme western mouth having been formed in 1840. The entire course of the river is estimated at 530 miles, for the greater portion of which it is navigable.

The two eastern mouths of the Vistula open into the Frische Haff, a lagune, or rather inlet of the sea, separated from the Baltic by a tongue of land thirty-eight miles in length by one in breadth, but communicating with it by a channel half-a-mile in width; its entire length may be estimated at fifty-seven miles, and its breadth at twelve miles: it is nowhere more than twelve feet deep; it receives, besides the waters of the Vistula, those of the Pregel and Passarge. The eastern and western mouths of the Vistula are twenty-five miles distant from each other; and the point from which they diverge about the same distance from a line joining them; the entire area must not, however, be considered as delta formation.

The Passarge and Pregel drain the district intermediate between the Vistula and Niemen; the former has its sources in the north slope of the watershed of the secondary affluents of the Narew; it is a small and unimportant river, flowing in its upper course through a deep, narrow, and well wooded ravine; the latter is formed by the confluent streams of the Angerap and Pissa. The Angerap drains the Maner-see and other lakes of eastern Prussia, as the Pisch, a small affluent of the Narew, does the Spirling-see and those which surround it; this latter lake is eleven miles in length. The principal affluents of the Pregel are the Dista on the right, and the Alle on the left; it has a course of 120 miles, and its basin is estimated at the same area as that of the Thames.

The Bobr, and other affluents of the Narew, on the right surround the sources of the Pregel and interlock with them and with those of the Niemen; this river has its origin in the marshes of Dolguinowski, having its principal sources overlapped by those of the Dniester; and the Sczara, one of its principal affluents on the left, affords communication with the Pripetz, the principal affluent of the Dniester. The Sczara flows through marshes, and its banks are well-wooded. After its junction, the main stream flows through a deep gorge formed by the northern extension of the hills through the southern defiles of which the Beresina flows to the Dnieper. At the junction of the Svieta, of which the Wilia is an affluent, the Niemen is 656 feet in breadth, and below this point flows through a level marshy country, receiving several affluents; it is here also called the Memel; its course is north-west, and estimated at 400 miles, nearly throughout the whole of which it is navigable; it enters the Kuritsche Haff by several mouths, the principal of which are the Rass or Russ, and the Gilge; like those of the Vistula, these extend for twenty-five miles. The Kuritsche Haff extends for fifty-three miles along the coast, separated throughout its whole length by a narrow tongue of land about half a mile in width; its greatest breadth may be twenty miles and its depth twelve; the channel by which it communicates with the sea is 300 yards across. Between the Kuritsche and Frische Haffs a quadrangular tract of land, twenty miles in length and breadth, extends into the sea, rising towards the centre; surrounded by marshes, communicating both with the Pregel and the Kuritsche Haff, it may be almost considered as an island.

The Duna, also called the Southern Dwina, has its sources in the lakes of the Valdai plateau, near those of the Volga and Velikaja, on the north-east; it flows for more than one-third of its course to the south-west along the base of the plateau, then taking a north-west course it receives the Oula, then the Drissa from the right, also the Nilja and Desna from the left, besides others of less importance. Above the angle formed by its change of course, the breadth of the Duna is 394 feet, near its mouth above 2000, but it expands immediately to nearly 4000; it is shallow, and its streams impeded by ledges and rocks, but it is nevertheless navigable nearly throughout its entire course, which may be estimated at 450 miles.

Between the Duna and Memel, the land projects to the north round the Gulf of Livonia in breadth about seventy-five miles, through which the little river Windau flows into the sea. The district between the Gulf of Livonia and that of Finland, is principally occupied by Lake Peipus and the streams which flow into and out of it; this lake, called also Tschouds kœ Osuro, is about seventy-five miles long by thirty-five broad; it forms two basins: the southern, known as Lake Pskov, is estimated as twenty-three miles long by twelve broad, and receives the waters of the Velika from the south-east; this is broad and rapid, and has a course of 160 miles: the northern basin receives the Embach, Kosa, and other streams, and discharges its surplus waters by the Narva or Narowa; its banks are composed of morasses, swamps, forest, and sandy wastes; it is deep, navigable, and abounds in fish. The Narva has a course of forty miles, but is only navigable for a short distance. The district of Esthonia, lying between Lake Peipus and the sea, is low and marshy, the surface sandy, on a substratum of rock, which appears on the coast, and forms numerous islands; it is covered with pine forests.

The basin of the Neva, which extends into the Gulf of Finland, is very extensive; its waters all accumulate in Lake Ladoga; it includes Lake Ilmen on the south, Lake Onega on the north-west, and the lakes in the centre of Finland on the north-east; and drains an area of 400 miles from north to south, and 300 from east to west; it is bounded on the north by the granitic spurs already noticed, which reach from the Scandinavian mountains, through Finland, extend to the south-east between the rivers, falling into the Arctic Sea and the head waters of the Volga, and form the coast of the Gulfs of Bothnia and Finland; and on the south by the projecting plateaux of the Valdai. The lakes of Finland are extremely irregular in form, and are but little known, extending over a surface of above 100 miles square, divided by narrow strips of rocky land, and probably connected with each other; the most important of these is Lake Samia, which may be fifty miles in extreme length by thirty in breadth, but like the rest of irregular shape, and discharges its surplus waters by the Woxen into Lake Ladoga.

The central receptacle for the waters of this basin, Lake Ladoga, is the largest lake in Europe, being 124 miles long by 75 miles broad; its area is above 6000 square miles, and contains many islands; its shores are low, but nevertheless it is subject to terrific storms; its depth is very unequal; it receives about sixty rivers and streams, the principal of which are those flowing from Lakes Onega and Ilmen. Lake Onega is 140 miles long by 35 broad, and has an estimated area of 3500 square miles ; its shores are rocky and deeply indented; it has numerous islands and shoals, rendering navigation difficult, but is not liable to such violent storms as its sister lake ; it receives the waters of ten rivers, the principal of which, the Vodsa, has its sources in several lakes, one of the same name to the north-east being thirty miles long by twelve broad; the river has a course of 120 miles; the Vytegra flows into it from the south, 450 feet above the sea. Lake Ilmen is thirty miles in length by twenty-five in breadth, and receives the Lovat, Msta Pola Chelon and several other rivers ; the first connects with the Duna, and has a course of 175 miles ; the second has a course of 250, and communicates with the Tvertza, an affluent of the Volga. The surplus waters of Lake Ilmen are carried by the Volkhov into Lake Ladoga ; it flows with a rapid current in a direct north-east course for 130 miles ; is deep and navigable, except when its stream is broken by rapids ; but has no affluents.

The Neva is rather a strait than a river ; its length being only forty miles, and its breadth 1500 feet, it appears too small a chanuel for the delivery of so large an area of water as the basin of Lake Ladoga and its tributaries, and it is therefore not remarkable that it should be subject to terrible inundations ; it is fifty feet deep, receives several small rivers, which are partially navigable; its waters are frozen for six mouths in the year; it opens into the extremity of the Gulf of Finland, across which extends the island of Kronstadt.

From the north slope of the watershed of the basin of Lake Ladoga, several lakes discharge their waters into the Icy Sea, and the deep indenting arm of the Bieloe More, or White Sea: of the former, Lake Enara, having an area estimated at about 700 miles, has its outlet in the Patsjoki River ; the Kola is the outlet of the smaller lakes, near which is Lake Imandra, which may be sixty miles in length from north to south ; of the latter, the chain of lakes which extend to the south, under the names Kordo-zero, Piavo-zero, and Topo-zero, which is fifty miles long, by eight broad, and the others still larger; these unite at either end with the White Sea ; also Lake Koutno, through which the river Kem flows to the sea ; and Vygo-zero formed by the waters of the River Vygl. The rivers which fall from the north slope of this watershed are the Onega, the Dwina, the Mezen, and the Petchora: the first a rapid river, broken by falls, rises in Lake Latcha, and has a course of 250 miles ; the second, the northern Dwina, drains a considerable area, and is formed by the confluence of two streams, the Soukhona and Witchegda; the former rises on the north-east slopes of the Valdai, near the sources of the Volga, and flows north-east for 150 miles, when it is met by the latter, which has as large a course in the opposite direction, through a low inundated and almost desert country ; from this junction the direct course of the river may be 200 miles. As the Soukhona opens communication with the Neva and west sources of the Volga, so does the Witchegda with the Kama and eastern sources of that river, and is also in close proximity with the sources of the Petchora. The Dwina is four miles wide twenty miles from the sea, which it enters by several mouths, is deep and rapid, but has only fourteen feet of water over the bar at the entrance ; its priucipal affluent from the right is the Pineda, having a tortuous course of 300 miles ; from the left the Vaga, in length about 250 miles ; and in its lower course the Emtza.

The country encircled by the Petchora and Dwina is drained by the Mezen, which has a course of 400 miles, and the principal affluents of which are the Peya on the right, and the Vatchka on the left.

The Petchora drains the north-east slopes of the Poyas, which, as already noticed, form the connecting link between the Ourals, the easterly extending spurs of the Scandinavian mountains, and the Valdai Hills, by which they are again united to the Carpathians. The upper course of this river is very irregular and tortuous, and it receives many affluents ; in its middle course it turns to the north, and bending eastward in its lower course enters the Arctic Ocean by an extensive estuary studded with islands; its principal affluents are the Oussa on the right, and the Ijma, which has a course of nearly 200 miles, on the left.

The slope of this watershed to the Arctic Ocean is one vast inclined plain, an expanse of deserts, steppes, rocky wastes, forests, and morasses; here seed time and harvest are confined within a space of sixty days, and the inhabitants are almost dependent on the rein-deer for sustenance.

The west slope to the Gulf of Bothnia is similar in character to the northern, but less extensive; its rivers are small, and usually drain lakes and morasses, of irregular and uncertain shape; the most important of them is the Ulea, having a course of seventy-five miles, and draining the lake Uleatrask, thirty-five miles long by ten broad; the Kemijoki on the north drains a considerable, but almost constantly frozen area; the Kumo and others to the south are not important.

4. *The Scandinavian Peninsula.* The point of junction between the watershed of north-east Europe and that of the Scandinavian peninsula lies between the head-waters of the rivers Muonio or Tornea, which falls into the Gulf of Finland, and the Tana which falls into the Arctic Ocean, a spur, as already noticed, from the Scandinavian Mountains, which, culminating about 1800 feet above the sea, extends north and south more than 1242 miles. To the north the mountains are less elevated, but extend their numerous spurs west, north, and north-east, to the extremity of the continent, culminating about 3700 on the north coast, at the North Cape 1161, and on the eastern spurs at 3690 feet above the sea. The southern extension has a threefold division, the Koelen on the north, the Dovrefield in the centre, and the Langfield on the south; this preserves its integrity as far as the south-west extremity at Lindernaes, but a series of plateaux, known as the Seves Mountains, extend from it to the south-east, and form the framework of the more southern portion; the first culminates in Sulietelma, about 6000 feet;* the second in Schnaehettan, approaching 8000 feet; and the third in Skagesloestinden, above 8000 feet. This mountain range covers more than half the eastern peninsula, which may have an average breadth of 200 miles; it is formed by plateaux of small extent, varying from twenty-eight to thirty-five miles, and of from 1500 to 3250 feet in elevation, from which the mountain peaks rise, and between which the rivers and torrents descend through precipitous and rugged chasms to the sea; the mean elevation of the whole is not much above 2000 feet. The short slope of the mountain is presented to the west, the axis of the chain being about fifty miles from the ocean; the principal valleys are therefore on the south and east sides, none of them extend much above 200 miles. These mountains abound in lakes, which in some instances connect the waters on different sides of the peninsula. The coast is broken by deep indentations, called fiords. The snow line varies from about 1000 feet at the extreme north, to 5500 feet in Lat. 61°; about $\frac{1}{38}$ portion of the surface is covered with perpetual snow, and on the south and in the centre vast glaciers descend into the valley, that of Folgefonden, in Lat. 60°, to within 5100 feet of the sea level. The climate of this peninsula is much more mild than that of the eastern part of Europe; the snow is on the ground from March to November, and the summer sufficiently warm to ripen grain, the cultivation of which extends to 70° N. Lat., in ten or twelve weeks. The varieties of the fir tribe, which cover a great portion of these mountains, reach, under the 60 parallel, 4000 feet elevation, and extend north with the arctic circle; the birch flourishes to the extreme north, and the oak is abundant in the southern districts. The similarity between this country and the opposite coast of the Atlantic in some respects has already been noted.

The rivers of the Scandinavian peninsula are scarcely more than torrents

* The calculations vary thus, 5956, 6178, 6180, &c.

locked up in ice during the winter; some few, however, are worthy of notice: of these, on the south and east slope, are the Tornea, which has its western source within twenty miles of the fiords opening from the western coast into the North Sea, and flows through Lake Tornea, which may be twenty miles long by five broad, it falls into the head of the Gulf of Bothnia, and has a course of about 250 miles, in which is a remarkable cataract called Julhae; the Sulea, formed by the confluence of two streams, draining chains of lakes, the southernmost of which occupy the slope of Sulietelma, and having a course of above 200 miles; the Pitea, also falling from the same mountains, of a similar character and nearly the same length; the Skelleftea or Skvenka, draining the Stor Afvan and Horn Afvan Lakes in a course of 150 miles: the Umea, formed by the confluence of the Windel and Umea, draining several lakes, among which the Stor Umea is twenty-five miles long by six broad, and having a course of nearly 200 miles; the Angerman, which has many affluent streams, and drains a considerable area; the Indals, which issues from a chain of lakes and pools extending north-west for 100 miles along the base of Silfiedlen, the principal of which is Lake Storsion, opposed to those lakes and streams which fall into the Gulf of Trondheim; and the Dal or Dala, arising from two principal sources, the eastern and western, flowing to the south-east through numerous lakes, and broken by cataracts, has a course of more than 250 miles; it is navigable at the mouth, which is widely expanded, and to the south of which small streams are collected in the lake or fiord of Maelar, a deep and irregular inlet of the sea, extending more than seventy miles from the Baltic, and ranging in breadth from five to twenty-five miles, and having at its mouth numerous islands.

The drainage of the south-east of the peninsula principally accumulates in Lakes Wetter and Wener. Lake Wetter, the smaller of the two, is in length about seventy-five miles and an average breadth of about ten; its height above the sea is 295 feet: it receives the waters of the Motala river, which again issue from it on the south-east, and find their way through a succession of lakes, of which the largest is Lake Roxen, to the Baltic. Lake Wener, of very irregular shape, may be estimated as about eighty miles in extreme length by forty-five in extreme breadth, and is divided into two basins by projections of the land from the north and south near the centre; the southern of these is known as Lake Dalbo; its area is estimated as containing above 2000 square miles, and it is 147 feet above the sea; it is not so deep as Lake Wetter, scarcely reaching 300 feet, while that has a depth of nearly 500 feet; its shores are deeply indented, and it receives more than thirty streams, of which the Klar or Klara, from the north, is the principal; this river has one source in Lake Fæmund, near the sources of the Dal; this lake is about thirty miles long by three broad. Lake Wener communicates with the Kattegat by the Gotha, a river navigable throughout its course of fifty miles, except at its effluence from the lake, where it is broken by the falls of Trolhætta.

Westward of the Klara and Lake Wener is the River Glommen, which falls from the angle at the projection of the two southern spurs of the Scandinavian chain, into that formed by the extension of the basin east and west in the straits of the Kattegat and Skaggerack which surround the peninsula of Denmark to the south. The Glommen is the largest river of Scandinavia, and rises in the plateau of the Dovrefield and slopes of Schneehettan, seventy miles south of Trondheim; its affluent, the Vermen, brings to it the surplus waters of Lake Miosen, which is fifty miles long by ten broad, and receives the Langen River from the north-west; this river has an irregular course, broken by numerous falls and rapids, of about 300 miles; its valley river is the most extensive in the peninsula, extending 215 miles in length, and known as the Osterdal; that of the Langen is the most fertile. The lower course of the Glommen is through several large lakes, and it surrounds, near its mouth, a considerable island.

The streams of the south-west are, in character as in position, intermediate between those of the east and west coasts of the peninsula; perhaps those most worthy of mention are the Skem, the sources of which spring from glaciers and accumulate in mountain lakes, from one of which pours the Maan River, which at the Rinkanfos precipitates itself into a chasm 513 feet in depth. The Nid and the Torrisdals are of similar character.

On the east slopes of the peninsula there are no rivers, but their place is supplied by the deep inlets or fiords formed by the defiles of the mountains extending into the sea; of these the more important are Bukki fiord and Hardanger fiord to the south, the latter remarkable for the glacier of Folgefund, already noticed, and the Voring foss, a cataract nearly 900 feet in height, formed by one of the mountain streams which fall into its north-east extremity, about eighty miles in direct line from the sea. Drontheim fiord is the most important in the centre of the western coast. To the north they are very numerous. Tys fiord stretches towards the waters of the Tornea and Ulea, and Porsange fiord opens towards the extreme north. The coast is, in short, a labyrinth of waters, dividing rocky islands, inlets, and winding deep among the projecting rocky spurs of the mountains; of this, as of all the coasts, more particular notice will be taken when attention is directed to the oceans. The most important of the islands are the Lofoden, which project in a south-west direction from those which cover the coast to the north.

CHAPTER XIII.

SECONDARY WATERSHEDS AND RIVERS OF THE NORTH.

§ 1. The watersheds of northern Europe.—2. The secondary rivers.—3. The peninsula of Denmark.

THE *Watersheds of Northern Europe.*—These originate, as already noticed, in the two great mountain knots at the east and west of the Bohmerwald and the Carpathian mountains; on the west at Schneeberg the sources of the Morava, Oder, and Elbe, are in close proximity; on the east at Oksenkopft, the tributaries of the Elbe are as closely connected: extending from Schneeberg 125 miles east and north, between the sources of the Elbe and the Oder, the Reisengebirge confines the upper valley of the former river, at the entrance defile of which they are met by the Erzegebirge, stretching from the south-west for about 100 miles from Oksenkopft: the latter chain as it is the shorter is also lower, culminating at about 4000 feet, while Reisenkoppe, in the former, has an elevation estimated at about 5400, and is the highest mountain in Germany.

The depression between the Riesengebirge and Jablunka mountains opens communication between the main valleys of the Oder and Morava: the principal passes across that chain are between the sources of the Neiss and Bober, affluents of the Oder, and the Adler an affluent of the Elbe, and between the sources of the smaller affluents which join those rivers on the north and south of the defile from which the latter issues from its upper basin: these are all rough and wild, intersected by ravines, and the whole chain has a rugged and severe character; the gorge which separates it from the Erzegebirge is formed by precipices 2597 feet high, therefore the latter may be properly considered as an extension of it, and the upper valley of the Elbe as surrounded by mountains and formed by the separation and reunion of the secondary chain of north Europe.

On the east the Thuringerwald is a continuation of the Frankenwald, which throws out spurs extending for 50 miles among the head waters of the Weser; the heights of this chain, covered with forests, are grouped and massed with little regularity, and separated from each other by narrow valleys; it is connected to the west with the watershed of the lower basin of the Rhine by the Rhonegebirge, which separates the sources of the Weser and the Mayn; it is rugged and sterile, culminating at about 3000 feet. The Vogelbirge extends the watershed further west for about thirty miles; from this, four spurs have their origin—the Eggegebirge, which, culminating between the sources of the Lenne at about 2300 feet, is lost to the north-west in gentle undulations, which separate the Ems and Weser; the Westerwald, between the Sieg and the Lahn, composed of plateaux, which nowhere reach 3000 feet in elevation; the Taussengebirge, between the Lahn and the Mayn, of about the same elevation, but of more marked character, and appearing to be a continuation of the Hundsruck from the opposite side of the Rhine valley; and the Spesshardtwald on the south, which though it only attains about 2000 feet in elevation, is rugged in character, and appears to be extended between the valleys of the Neckar and Mayn in the Oderwald, and connected to the east and south, with the more prominent watershed, the Steiggerwald and Rauhé Alp, being almost detached, the communications with the valleys of this chain are rather between than across them.

The Thuringerwald has its north slope opposed to the south slopes of the Hartz mountains, a confused and irregular chain, covered with forests, abounding also in mineral wealth, extending for about 50 miles north-west and south-east; it culminates in the Brocken, at an elevation of 3658 feet above the sea; it is composed of grauwacke and clay-slate on a basis of granite; iron, copper, lead, and silver abound; these mountains separate the valleys of the Weser and Elbe; and from their northern slope originate the affluents of the lower basin of the former river. The Teutonbergerwald may be considered as extending the axis of the Hartz mountains to the north-west, and separating the basins of the north from those of western Europe; by some writers these are considered as extensions of, or outliers from, the Thuringerwald, the Eggegebirge, and western spurs of the Vogelbirge, but the strongly marked lateral valleys of the Lippe and Unstruth, and the origination of the Ems and Aller in their northern and western valleys, seem to mark them as distinct; the rectangular connecting links are scarcely definable, but must be sought in the line of the head waters of those affluents of the Weser and Elbe by which direct and easy communication is obtained between their main valleys. The Teutonbergerwald is of small elevation; from it, as well as from the Hartz, the watershed of the country is marked by low undulating hills extending to the dunes of the sea coast.

2 *The Secondary Rivers of Northern Europe.*—The Oder has to the Vistula and rivers of north-east Europe much the same relation that the Dniester has to the Dnieper and rivers of the south-east; it connects the wide, extended, low, and slightly developed plateaux, woods, plains, and morasses of the east, with the more highly developed and well-marked watersheds and valleys of the north and west.

The Oder has its principal sources in the slope of the Riesengebirge, confused and irregular spurs from which extend between the valleys of its affluents; the most marked is the Eulengebirge, between the Neiss and Bober; another also extends between the sources of the Oder and Vistula, but soon sinks in low hills which disappear among extensive plains, without any marked or distinct watershed. The valley of the Oder communicates with that of the Morava by three principal passes at its principal sources, its affluents on the left communicating with those of the Elbe, as already noticed; the upper course of this river is through extensive forests; the Neiss of Glatz may be its most considerable source, though it is usually considered an affluent of the left; it rises in the north-west slopes of Schneeberg, and is important for the mineral wealth of its valley, and has a rapid course of about 100 miles to its confluence. If the Neiss be not the principal source of the Oder, the Oppa must be considered so; it rises in the south-east slopes of the same great knot of mountains, and has a course of about sixty miles to its confluence with the Oder, which rises in the depression between the Riesengebirge, or rather its eastern extension, the Sudetengebirge, and the Jablunka mountains; this portion of the chain obtains the name Geisenker, on account of that depression being very apparent.

The other affluents of the left in the upper basin of the Oder are the

Westritz and Katzbach, those of the right are numerous but unimportant, the larger portion of the basin of the river on the east being occupied by its principal affluent the Wartha. Below the confluence of the Katzbach the character of the river changes, the lower basin being an extensive plain, and the river flowing between low and sandy banks, frequently anastomosing and changing its course, and forming marshes and lakes, and at its mouth extending in the Dammersche-zee, a sheet of water fifteen miles long by two broad, which again opens into the Stettiner-haff, a lagune or inlet of the sea, similar in character to the Frische and Curitsche-haff already noticed; it is thirty-seven miles long by twenty-five broad, covers an area of 200 square miles, and has from twelve to eighteen feet depth of water; it communicates with the sea by three mouths, the Devinou, the Iwine, and the Peene, enclosing the two marshy islands, Wollen on the east, and Uzèdom on the left.

The principal affluents of the Oder, in its lower course, are on the left; the Bober, which receives the Quiess, and other affluents, has a course of above 100 miles; the Neiss, of Gœrlitz, which has a course of about the same length, and affords communication on the west with the Spree; the Ucker, or Ocker, and the Peene, are small rivers, draining the marshy country south of the Spree and fall into the Stettiner-haff: the principal affluent of the right is the Wartha, which is indeed its secondary source, and nearly as large as the main stream; it rises in the heights between the Oder and Vistula, has a very circuitous course through a low marshy country, and has two important affluents—the Prosna, on the left, which has a course of above 100 miles; and the Netze, which, in its upper course, flows through a chain of marshy lakes, from south to north, and opens communication with the Braa, an affluent of the Vistula, which approaches within fifteen miles of it from the opposite direction; both streams then bend suddenly at right angles, and the Netze takes an easterly course to join the Wartha. This river has a winding course of above 200 miles, and receives a considerable affluent—the Kuddow—from the right, the course of which is parallel to that of the Braa. The Wartha, after the confluence of the Netze, forms many anabranches through marsh lands for twenty miles, which again unite and form a small lake at its confluence with the main stream.

The Oder has a course of nearly 500 miles, and is navigable to within its upper basin for barges of fifty tons' burden; the country between it and the Vistula, near the coast, is a sandy flat, intersected by small streams, which extend themselves into lakes over the marshy level surface: the climate is damp and cold, the soil sterile; but there are extensive pastures, and grain is partially cultivated. From the Stettiner to the Frische-haff the distance is about 150 miles. Not dissimilar in character is the country between the Oder and the Elbe, but it is more marshy, and the lakes and streams falling into the Baltic are larger; it is extended to the west in the island of Regen, separated from it by a channel averaging one mile in width, and containing 361 square miles, being in extreme length thirty, and in breadth twenty miles; here the coast becomes abrupt, and the shores of the island are very deeply and irregularly indented.

The sources of the Elbe are, as already noticed, in the Reisengebirge, near its culminating point, in opposition to those of the Oder and Morava; the principal rises from thirty springs; the most southern, the Elbe brunnen, is 4500 feet above the sea; the Moldau, however, has a greater length, before the confluence of their waters, and might be considered the main stream. The upper course of the Elbe is through a narrow and wild valley; its direction is first south, then west, and finally north-west; its first affluent from the left is the Adler, which flows from the south face of Schneeberg; in its western course there are few affluents, and those not important; but in its northern it receives the Moldau, which, descending from the culminating heights of the Bohmerwald, has its secondary source within about ten miles of the main stream of the Danube, nearly opposite the mouth of the Traun; it has, however, previously had a course of 735 miles, parallel to the mountains, from north-west to south-east; but then, turning suddenly to the north, it continues that direction to its confluence with the Elbe. The Moldau is a deep and rapid stream, flowing through, and receiving its numerous affluents from, narrow valleys formed by spurs projecting from the Bohmerwald; of these, the Beraun, on the left, which drains the south-west of the upper valley of the Elbe, and opens communication with the Naab in its lower course, and with the Regen; the Woltawa, also on the left, and the Lorschnitz and Zasawa on the right, are alone important. Below the confluence of the Moldau, the Elbe receives the Eger, an important affluent, draining the southern slopes of the Erzgebirge, from the left; it descends from the south-east of the Ochsenkopft, and its sources are in immediate proximity to those of the Saal, the Mayn, and the Naab. The Eger has a course of above 100 miles, and has several small affluents. The only affluent of the Elbe, in its upper course from the right, is the Iser, which falls from the Reisengebirge, and flows through a very wild valley, from north to south, for about sixty miles.

The basin of the Upper Elbe is of quadrangular shape, extending 100 miles from north-west to south-east, and rather more in the opposite direction; it forms an enclosed plateau, intersected by spurs from the surrounding mountain chains, forming narrrow valleys; it is well wooded, fertile in parts only, but rich in minerals; the climate is cold, the mountains being covered with snow during the greater part of the year, but the vine is occasionally cultivated; the main elevation is nearly 1000 feet; the Elbe issues from it, through the narrow and deep gorge of Spandau, as already noted.

On leaving its upper basin, the Elbe flows nearly north-west for eighty miles, in direct distance, to the confluence of the Elster; in its middle course, the affluents of the right and left banks have very different characteristics; those on the right, as has already been seen, flow through low, marshy lands, and have communication with the affluents of the Oder; while those on the left descend from the Harzgebirge, and the watersheds of the upper course of the Weser; on the right, the principal is the Schwartz Elster, which has a considerable affluent, the Rodir, from the left; those of the left are the Mulda, which flows from the north slope of the Erzgebirge for 125 miles, nearly parallel to the main stream, through a valley rich in minerals, receiving considerable affluent streams; the Saal, which has its rise in the Ochsenkopft, and flows through a deep valley, to the confluence of the Unstruth, a considerable affluent, having from the left a course of above 100 miles, and receiving affluents from the Harz and from the Thuringerwald, the most important of which is the Gera, from the left; the most important affluent of the Saal on the left is, however, the Elster, which, rising in the Erzgebirge, receives the Pleiss, a marshy stream, from the right, flows through a level valley, forming many anabranches, and has a course of above 100 miles.

The lower course of the Elbe is through a level marshy country, on the right full of lakes and marshes; on the left, approaching within fifty miles of the Weser, having a better defined watershed; the affluents of the left are small; the Obre, the Ilmenau, and the Oste, falling into the estuary of the main stream, may be noted; the Havel, which rising in the small lake Käbelich, has a course of 175 miles through lakes and marshes. The course of the Elbe to the confluence of the Spree is from north to south, thence from east to west; the Spree, its principal affluent, if it be not the more important stream, as its superior length and elevation of source would suggest, descends from the Reisengebirge, near the sources of the Schwartz Elster, receives several small affluents in its upper course, but in its lower frequently anastomosing, forms marshes, lakes and islands; its length must be above 200 miles. After this junction the united streams of the Havel and Spree receive the waters of the Nuthe from the left.

From the confluence of the Schwartz Elster to that of the Havel, the Elbe takes a serpentine course, from thence it flows north-west to the sea; here it receives the waters of the small rivers which drain the lakes of Mecklenburgh;

of these lakes the most important are the Muritz and Schwerin; the former is nineteen miles in length, and connected with many others; the latter fourteen, and its waters communicate both with the Elbe and the Baltic; in like manner Lake Ratzburg, the surplus waters of which are carried to the Baltic by the river Trave, is connected to the south with the Elbe. From the Elbe brunnen to Konigstein, below the defile of Spandau the river may have a fall of 4000 feet, below that point not 500, and assuming the direct distance in the former to be 100 and in the latter 250 miles, the averge fall would be in round numbers forty feet in the one, and six inches in the other, contrasting thus very decidedly the districts through which they flow.

From the defile of Spandau to the mouth of the Elbe is, in direct distance, 250 miles; the length of the river, including windings, is more than double; it is navigable from the confluence of the Moldau, but its bed is encumbered with sandbanks; its estuary, fourteen miles wide at the mouth, affords passage for vessels drawing fourteen feet of water to the mouth of the river; its stream throughout its lower course is sluggish, the greatest elevation of its bed not reaching 150 feet.

The Weser is formed by the confluence of the Fulda and the Werra, the latter is the principal source, and, rising in the northern slopes of the Frankenwald, flows north-west at the base of the Thuringerwald, has a serpentine course of 150 miles, through the greater part of which it is navigable, and receives several small affluents. The Fulda, which rises in the Vogelsberg, has also a tortuous course from the south-west of about 100 miles, for the greater part of which it is navigable; its principal affluent the Schawlen, from the left, rises in the Eggegebirge, and with its affluent, the Eder, also from the left, drains a considerable valley. The upper basin of the Weser is picturesque and, in the valleys, fertile, irregular in outline, and well wooded; it abounds in minerals, especially iron.

After the confluence of the two principal sources, the Weser receives from the left the Dimel, which flows through a district similar to that drained by the Fulda, it has no other affluent of importance on that side but the Hunte, which drains the southern slopes of the Teutobergerwald and the marshes of Oldenburgh, flows through the Dummer lake, and after a course of about 100 miles, joins the estuary of the main stream: on the right the Aller, formed by the junction of the Leine and Ocker, is the only affluent, the basin of the Weser being in its lower course not more than seventy-five miles broad. The Leine has its sources in the northern slopes of the Hartz and the depression between those mountains and the Thuringerwald in close proximity to those of the Unstruth; and has its principal affluent the Innerste from the right, which rises in the north-west valleys of the Hartz, close to those of the Ocker. This river may have a direct course of 100 miles, for twenty-five of which it is navigable; it approaches within fifteen miles of the main stream of the Weser, where the interval is occupied by Lake Steinhuder, which is only five miles long by three broad, yet valuable for its fisheries.

The Ocker, if considered an affluent of the Aller, may have a course of sixty miles, having its southern sources in the defiles of the Brocken, and its eastern in the plains, through which flow the smaller affluents of the Elbe from the left. The Aller, flowing through the same marshy district, has a course of about forty miles, and from the confluence to that of the Leine is about thirty miles, in direct distance; from thence to the confluence with the Weser, twenty.

The Weser has a course of about 300 miles, and is navigable nearly to its source for boats, but only for a short distance for vessels of any burden; those drawing fourteen feet water may enter its estuary, which is twenty-four miles wide at the mouth.

3. *The Peninsula of Denmark.* To the north of the Elbe, in its lower course, is the district of Holstein, made insular by the Eyder and Trave; the former connecting the North Sea with the Baltic, the latter the Baltic

with the Elbe, as already noticed. The Eyder flows in a narrow serpentine stream across the isthmus, which is here forty miles in width from Keil Bay to the mouth of the river; the sources of the river being not more than seven miles distant from the bay. This district, which may be seventy-five miles in length by fifty in breadth, is studded with numerous small lakes, and affords abundant pasture for cattle; beyond it projects to the north-west the Peninsula of Denmark, which, with the islands appertaining to it, must be considered as the prolongation of the watershed between the rivers Elbe and Oder; it may be in extreme length 200 miles, and in breadth 90 miles, the highest point, which is near the intersection of these lines, does not much exceed 500 feet. The southern portion, called Schleswig, is narrow, in one part not exceeding thirty miles; but here the large islands of Funen and Zealand stretch towards the south point of Sweden, while the promontory and island of Fehmern extends from the north-east angle of Holstein towards Laaland, Falster, and Moen, which complete the group. The northern portion, Jutland, is of most irregular shape, indeed nearly divided by an arm of the sea, Liim Fiord, which extends its ramifications in every direction, forms large lakes and surrounds islands, one of which is twenty miles long and ten broad, and having its mouth in the Kattegat, is only separated at its extremity from the North Sea by a narrow strip of sand, through which the sea sometimes forces its way. The coast of Denmark is indented by other fiords, those on the east stretching deep into the land; those on the west forming lagunes: the soil is fertile, abounds in pasturage, and the eastern portions are wooded: the climate is moist and cold, yet milder than the parts of Germany to the south. The islands do not differ essentially from the Peninsula; Zealand, the largest of the Danish islands, is about seventy miles in extreme length, and fifty in breadth, but from its very irregular shape does not contain more than 6700 square miles of surface; Funen may be thirty-five by thirty; its area not much exceeding 1100 square miles, yet it has a river, the Oden-zee, thirty-five miles in length; the three smaller islands extend north-east, and south-west, and south-east and north-west, in either direction about forty-five miles.

CHAPTER XIV.

THE RHINE VALLEY AND ITS RIVERS.

§ 1. The watersheds of western Europe.—2. The Rhine and its sources.—3. The secondary watersheds of the west.—4. The Aar.—5. The affluents of the Rhine.—6. Rivers of the valley of the Lower Rhine.

THE Watersheds of Western Europe.—The watersheds of the west, from their proximity to, and parallelism with, the primary watershed of Europe, are more easily described than those of the north-west, if a circular direction be assumed for the one, then the other will have the same direction with a greater radius; or if, more accurately, a linear extension be taken, then the secondary chains of the north-west will appear parallel to the primary, having their extension in the secondary and tertiary systems of the north, as already described, and their transverse axes also parallel; thus the mountains of Greece to the south, and of the Bohmerwald, Thuringerwald, and their northern extensions, will be at right angles to the principal axes of both the primary and secondary systems; but the secondary mountains of the west will be parallel to the transverse axis of the main chain on that side of the continent, and nearly parallel to the other transverse axis: generally the slight convergence which is apparent is to the south and west.

The connexion of the watersheds of western Europe with those of the north-west and the islands, especially with Scandinavia and Great Britain, is not at first sight very apparent, but it becomes more so when considered in detail, and especially when the geological structure is taken into account; and the same may be said of those of the south and west, where the great peninsular mass seems to have almost as intimate relation to Africa as to the rest of Europe. Indeed, one great characteristic of European orography, is the separation of its watersheds from those with which they appear naturally continuous, and this, as it has been seen exemplified in the description of its rivers, is not less remarkably so in those inland seas, the Black Sea, the Mediterranean, and the Baltic, between which so large a portion of the surface is included. The direction of the watersheds of the west of Europe seems to have been influenced materially by the upheaval of the transverse axis of the primary watershed which connects it with the secondary system to the south; and the two great rivers of the west, the Rhine and the Rhone, in their middle and lower courses cut off the watersheds of the west from those of central Europe; and thus while the superior watersheds are continuous, we find the inferior separated by the rivers, and their continuity only observable without reference to them; and this of necessity, otherwise the rivers would have no outlet, for these waters would change their characters, inundate their upper basins, and become lakes, not having any outlet, like so many in Asia.

It has been noticed that the Rhine has its sources in the great central watershed of Europe; and that while its more eastern are interlaced with those of the Danube in its middle course, and with those of the lower valley of the Po, the western are cut off from the southern and western spurs, which separate the valleys of the Po and the Rhone. The primary watershed of the Rhine has thus far already been described in its general features, and may therefore the more naturally be taken first.

2 *The Rhine and its Sources.*—The two principal sources of the Rhine are in Mounts Maloia and St. Gothard, the Upper and Lower Rhine respectively, the Hinter and Vorder Rhein of the Germans; while the Glenner, which has been called its middle source, a term also applied to one source of the Lower Rhine, has its rise in the northern slopes of the Splugen; these names are, however, very indefinite; the whole of the valley of the main stream of the Rhine might with more propriety be termed the Upper, and that of the Aar, and the lake districts, the Lower: the former has its rise in the Rheinwald glacier, in the north-west of Mount Septimer; the latter from the gorge of the Ober Alp, at an elevation variously estimated, but which may be assumed as about 8000 feet. With the Lower Rhine, the Glenner, which has its rise in the little lake Toma, unites; it has a longer course than the Upper Rhine, of nearly thirty miles to their confluence, from whence the united streams flow in a northerly course for above forty miles to the Boden-zee. The higher Rhine flows through the terrible defile called the Via Mala. The middle Rhine traverses a rugged valley surrounded by glaciers. The junction of the stream forms also the point of communication between the passes over the Splugen and St. Gothard, and at about ten miles beyond this point the elevation above the sea is not 2000 feet, so rapid is the declivity; from hence it is partially navigable to the lake. Pressed closely by a wall of rocks on the left, the river receives no affluents from that direction; but on the right, numerous streams flow into it from defiles opening at right angles to its course.

The Boden-zee, called also the Lake of Constance, is about forty miles in extreme length by ten in breadth; it is 1250 feet above the sea, and has a depth of near 1000 feet; the shores are for the most part flat, but at its western extremity a promontory extends to the south-east, separating the long narrow extension of the lake to the north from a small lake connected with the main water by a narrow strait, through which the Rhine flows. These are respectively Uberlingen and Nuter-zee, or Lakes of Uberlingen and Zell; the latter is ten miles long by four broad, and contains the island Reichnau. The Boden-zee has its length from north-west to south-east. The Rhine issues from Lake Zell in a westerly direction, and here a spur from the Alps, which forms the limit of its upper basin to the south and separates it from its affluent, the Thur, projects toward the Schwartzwald, and over the terrace thus formed the river precipitates itself 100 feet, in the falls of Schaffhausen, which may be considered the limit of its upper basin; here turned southward, it receives the Thur, which has a course of seventy miles, and of which the Sitter, which flows from the See Alp, is an affluent; the Soss, or Soess, and the Glatt, which flows from the Griffen-zee; and again trending westward, the principal affluent of its upper basin, the Aar. These flow through precipitous and well wooded defiles nearly parallel to the main stream, from the northern slopes of the basin of the Aar, and form links of connexion with its second basin, or what might more properly be called the basin of its secondary sources, which is occupied by the river Aar and its tributaries, and extends 150 miles from east to west, and sixty from north to south; its western watershed is formed by the extension of the primary watershed to the north-west, by the secondary watershed trending north-east, and by the heights which connect them. This watershed must therefore be noticed before entering on the consideration of the course of the river.

3 *The Secondary Watersheds of the West.*—It has already been noticed that from the knot of St. Gothard two lofty and massive spurs extend to the north-west and south-west; the latter containing the highest summit of the Alps, and separating the sources of the Rhone and the Po; the former containing peaks scarcely less elevated, and separating the main sources of the Rhone from those of the Aar. The elevations to the south exceed 15,000 feet, in Mount Blanc and Mount Rosa; those to the north exceed 14,000, in Mount Furca and the Finster Aar horn. Perhaps a more general and comprehensive idea of the western extremity of the primary watershed of Europe may be obtained by considering the line of waterparting from Mount St. Gothard to Mount Rosa, having its centre in Monte Leoni, and the passes of St. Gothard and Simplon separating it on either side from the northern and southern masses, as a base, extending north-east and south-west for about forty-five miles, from the ends of which lines are projected, parallel to each other, of twenty and forty miles respectively, north and south; so that, from the extremity of the north, a line will fall perpendicularly on the angle formed by that on the south. Thus, the Finster Aar horn will be from Mount Rosa thirty-five miles, from St. Gothard twenty, from Mount Blanc sixty-five, while the latter mountain will be forty from Mount Rosa and eighty from Mount St. Gothard; the intersection of the diagonals will be in the upper valley of the Rhone, near the junction of its two sources, and they will be respectively in the direction of the valleys of those streams. The northern of the western prolongations of the great central mass of the Alps, although not the most considerable either in elevation or extent, is that along which the main line of waterparting is found. These mountains are called the Swiss or Bernese Alps; and form in one respect the first, at any rate the second, glacier system of Europe; for if inferior in number to those of Mount Blanc, the glaciers of the Bernese Alps are of greater extent, the entire area being estimated at 190 miles, or double that of the glacier system of Mount Blanc; here have been enumerated twenty-five glaciers, seven on the northern, thirteen on the north-east, and five towards the south, averaging above one mile in width. The great Aletsch glacier, on the south, has an area of about thirty square miles.

The line of waterparting here is extremely irregular, but has a general direction nearly north-west, extending from the Finster Aar horn to the Jungfrau; the granite peaks of the former tower over the Valais, while the snowy cone of the latter crowns the bold defiles of the Lauterbrunnen. From this line, of which the Watcher horn is the centre, three separate glacier systems are apparent, in the order already named, those of the south, the Lotsch, Aletsch, and Vietsch, being united together in the great *névé* in the northern slopes of the Jungfrau, and surrounding the rugged peak of the Aletsch horn; while those of the north are divided from each other by a transverse line of rocky peaks extending northward from the Finster Aar horn, and culminating in the Shreck horn and Wetter horn; those of the Grindelwald on the north-west, and of the Aar on the north-east, with those of Gauli and Rosenlaui between them, extending in each direction about seven miles from the Finster Aar horn, as a centre. The passes through this region are few, elevated, and very difficult, traversed only by mules and active pedestrians. At the extreme north, near the head of Lake Leman, the Col dent de Jamau, 4872 feet above the sea level, turns the flank of the chain, and gives access from the valley of the Lake to that of the Saanen; which latter also communicates with the upper valley of the Rhone, by the Col de Gittenhaus, where the river bends at right angles beneath the southern spurs of Mount Diableretz, which culminates 10,190 feet above the sea; and round and on the northern slopes of which the two sources of the Saanen have their rise—the Col de Gemmi, 7404 feet, connecting the valleys of the Rhone and Lake Thun; the Col de Grimsel, 8402; and the Col de Furca, 8714, connecting the upper sources of the Rhone with the valleys of the Lakes Brientz and Lucerne. From this northern division the head waters of the Aar have their origin, and from hence irregular spurs ramify in all directions, surrounding the Lake of the Forest Cantons, or Lucerne, and those of Zurich and Thun on the north-east and south-west; and separating these again from the larger valleys of Lakes Leman and Neufchatel, on the west, and the Boden-zee on the north-east, besides numerous other lakes occupying inferior valleys: thus all, Lake Leman alone excepted, add the tribute of their waters by the Aar to the Rhine. The continuation of the watershed from the Jungfrau trends more to the south; its western extremity is Mount Diableretz, as already noticed; and this is connected with the Jura, the great secondary watershed of western Europe, by the semi-circular chain of the Jorat (the French appellation for the entire range being here localized), which does not rise 4000 feet above the level of the sea; its northern slope extends in the fertile valleys which open on Lake Neufchatel; its southern and more rapid forms the northern cincture of Lake Leman; to the north-west of which it unites with the main chain of the Jura, which extends for nearly 150 miles between the Rhine and the Rhone, from where the former trends north, after its confluence with the Aar, to where the latter turns at a sharp angle round its southern extremity.

This range of mountains, which culminates in its eastern heights, Mount Molesson being 6588 feet, Mount Reculet, 5643, Mount Tendre, 5538, and Mounts Doli, Chasseron, and Chasseral, all above 5000; extends north-east to south-west and south, in six parallel chains, enclosing lateral valleys, covering nearly forty miles in breadth; these diminish in elevation towards the west, the eastern having a mean height of above 3000 feet, while the western does not reach 2000, and sinks gradually in the plateaux which bound the valley of the Saone: on the south they bend towards the projecting spurs of the transverse chain of the Alps; on the north-east they are separated from the Schwartzwald by the Rhine gorge, but their principal extension is towards the north, where they form the Vosges mountains, and separate the Doubs from the Ill, affluents respectively of the Rhone and Rhine, and originate the secondary rivers which flow through the extended valleys of northern and western Europe.

The geological formation of the Jura is oolitic; its principal characteristics gypsum, marble, and alabaster, and in the south asphalt; it abounds in iron and mineral springs; its pastures are rich, and its woods luxuriant in their growth, extending over the summits of the mountains. The routes across the Jura open chiefly in Lakes Leman and Neufchatel, and on the central courses of the Rhine, traversing the chain for the most part at right angles to its axis: the most northern lies between the northern angle of the Doubs and the sources of the Ill and Moselle: the central from the north and south of Lake Neufchatel to the waters of the Doubs; and by the source of the Ain, from Lake Leman to the lower valley of the Doubs, this crosses five distinct ridges: the southern from Lake Leman, to the valleys of the Ain and Rhone. The Jura and the Bernese Oberland, and the connecting chain of the Jorat, form the cincture of the basin of the Aar.

The connexion between the Vosges and the Jura appears in the Ballon d'Alsace. Here, at the Gap of Béfort, is the communication between the Rhine and Rhone and the valleys of the west; and the gorge of Valdieu connects the basins of those rivers. The Vosges mountains extend from the Ballon d'Alsace to the confluence of the Moselle with the Rhine: the southern extremity culminates 4688, and Mount Guebwiller 4300 feet above the sea, and the centre, in Mount Donon, approaches 3500; to the north, about the sources of the Lauter, they are much less elevated, but rise again beyond that river in the Hardtwald; and between the Moselle and Nahr, in the Hockwald, both rising to near 2000 feet. This range terminates in the Handsruck, at the confluence of the Moselle with the Rhine, being above 150 miles in length and about forty in breadth; it consists of rounded summits, hence called ballons, above the general line of elevation, having no precipitous defiles, but valleys opening to those of the main rivers, and affording easy communication between them: the eastern slope is much shorter than the western; both are covered with forests, and abound in minerals and rock-salt.

The southern extremity of the Vosges is connected by Monts Faucilles, the Sickle Mountains, with the Plat of Langres, which extends to the north in the wooded heights of Argonne and the Ardennes, between the Maas and the Oise on the west, and the Moselle on the east; the latter stretching towards the rugged volcanic mass of the Eifelgebirge, which with the Teutobergerwald and Hartz mountains, may be considered the tertiary ranges of north-west Europe; the western range of Argonne forms the most advanced terrace of the Vosges, and spreads its numerous undulations around the sources of the Oise and Scheldt, extending between the latter river and the Somme. On the south, from the Ballon d'Alsace, the Vosges are connected by the Côte d'Or with the Cevennes; these, covered for the most part with forests, abound in limestone, marbles, gypsum, coal, iron, and are noted for the luxuriant growth of the vine. The Cevennes extend round the sources of the Loire and Garonne, trending south and west towards the Pyrenees; they culminate in Mounts Lozere and Mezen, which are respectively 5794 and 4884 feet above the sea, and from their centre the Forez chain, reaching to nearly 5000, extends between the Loire and its affluent the Allier, and is connected with the volcanic plateaux and domes of Auvergne, which, raised 2789 feet above the sea, is studded with extinct craters, of which the principal, more than forty in number, extend from north to south for eighteen miles; the culminating points are the magnificent cone of Mount d'Or, 6188 feet in elevation, Cantal 6093, and Puy de Dome 4806; the rugged sides of these mountains, formed of basalt and scoriæ, present scenes of most picturesque beauty and, not unfrequently, of sublimity; the valleys are of great fertility.

It will be seen from the above details that the secondary mountains of the west of Europe are tolerably well defined and continuous in their outlines, and separate the valleys of the Rhine and Rhone, throughout the breadth of the continent, from those of the secondary rivers which flow at right angles to them.

4 *The Aar.*—This river, from the extent of its basin, is more important than its length would indicate; it has four principal sources, each connected with an important chain of lakes: of these the eastern, which is separated from the sources of the Rhine by the projecting spur of the Dodiberg, rising 11,765 feet, has its rise in the irregular defiles of its northern slopes; under the name Linth, flows by Lake Wallenthal, which also receives the Seez, into Lake Zurich, from whence issuing, it is called the Limmat, and flows with a tortuous course to its confluence with the Aar, about fifteen miles from the lake; just below the lake it receives the waters of the Sill from the left, which flows through a narrow valley extending fifteen miles parallel to that of the lake. Lake Wallenthal or Wallenstadt is ten miles long by two broad, 1385 feet above the sea, and 500 feet deep; the shore on the north side is precipitous, varying from 2000 to 3000 feet in height. The Lake of

Zurich is twenty miles long, two miles broad, and divided into two parts, at about a quarter of its length from the east, by a promontory, reaching from the south to within half a mile of the opposite bank; this division is called Lake Rapperschwyl, and is often frozen in winter. The surface of the Lake of Zurich is 1342 feet above the sea.

The second source of the Aar is formed in the north-east defiles of the St. Gothard; here two streams rising, the one about 8000 and the other 7500, unite at the Hospital, 6976 feet above the sea, receive another from a small lake in the Ober Alp, and turning to the north, rush into the Gap of Uri, a cavern 262 feet long, and through a perpendicular chasm crossed by the well-known Devil's Bridge, and fall into the Lake of the Four Cantons at its south-east extension, known as Lake Uri; the fall of this river within this distance of about twenty miles has been estimated at 4500 feet, but it must apparently be more than 6000, for the elevation of the lake above the sea is not much greater than that of Zurich, being 1380 feet. This lake, called also the Lake of Lucerne, is of very irregular shape, extending for more than twenty miles in length with an average breadth of two miles; it has at the west end two deep indentations to the north and south, which extend ten miles, and give it a cruciform shape at that extremity; the southern receives the River Aa, which flows from Lake Lungern and traverses Lake Sarnen, which is the larger of the two and about three miles in length; the northern, the Muotta-Thal and the waters of Schwaum Lake. The southern and eastern portions of the Lake of the Cantons, especially the Bay of Uri, are of a sublimely wild and savage character; the waters vary from 300 to 900 feet in depth. The Reuss, on leaving the lake, flows through a very narrow valley about thirty miles in length, to its confluence with the Aar; it receives the little Emmen on the left, which has one of its sources in a lake on Mount Pilate; and the surplus waters of the Zuger-see, or Lake of Zug; this Lake is about ten miles long by two broad, and 1361 feet above the sea: it receives the Lorze from the north, which flows from the small Lake Egri on the east.

The two other sources unite to form the river known as the main stream of the Aar; the one rises in the angle at the junction of the Jorat with the Jura Mountains, the other in the glaciers of the Finster Aar horn, about 100 miles distant from each other. The Aar collects its head waters from the northern spurs of the St. Gothard, the Grimsel, and the Finster Aar horn, and the elevation of its sources must be estimated by that of the glaciers; it takes a north-west course through the Valley of Hasli until it falls into the Lake of Brienz, distant about fifteen miles from the pass of the Grimsel; this lake is in length about eight and in breadth about two miles; it is nearly 2000 feet above the sea, and has from 500 to 2000 feet depth; it is surrounded by mountains which pour their torrents into its waters. After traversing the lake of Brientz, the Aar flows through Lake Thun, which is more than ten miles in length, and averaging two in breadth; it is 1896 feet above the sea; its western shores are low and fertile, its eastern irregular and picturesque: it is about three miles from Lake Brienz, and receives from the south the united streams of the Simmen and Kander. On issuing from the lake, the Aar flows in a very circuitous course to the north-west, receiving the Seine, which, bordered by the heights of Berne, has its course parallel to the main stream; and the Saane or Sarine, a stream partially navigable, which flows from the northern slopes of the Diableretz, and about thirty miles from the extremity of the lake is joined by the Thiele from the Lake of Neufchatel, in which the waters of its western sources have been collected, and which flows through Lake Bienne to its confluence with the Aar.

The Lake of Neufchatel extends for above twenty miles, at the base of the Jura; it is about four miles broad, and its area is estimated at ninety square miles; it is 1430 feet above the sea, and its depth does not reach 500 feet; its banks are gently undulating and beautiful, and it receives the waters of several streams; the most important is the Orbe, which issuing from Lake des

Rousses, flows through Lake des Joux, about seven miles in length and famed for its beauty, and after a course of 30 miles in direct distance, enters Lake Neufchatel at the south-west extremity; the Broye, after a course parallel to the lake throughout its entire length, traverses Lake Morant and falls into its north-east extremity; this small but beautiful lake is about seven miles long by three broad: the Reuss falls into the centre of the lake from the western slopes of the Jura. Lake Bienne is distant about three miles from Lake Neufchatel; it is ten miles long by three broad; its elevation above the sea 1419 feet; its depth 400; and it contains the small island St. Pierre.

After the confluence of the Thiele the Aar flows in a north-easterly direction at the base of the Jura, to its junction with the Rhine, nearly fifty miles in direct distance; in this course it receives the Emmen from the right, which rising in the mountain of Brienz, flows for forty-five miles through the Emerstal, one of the most beautiful and fertile valleys of Switzerland; the Suren discharging the surplus waters of Lake Sempach, four miles long by one broad, and nearly 1700 feet above the sea; and the Aa, flowing from Lake Baldeck, three miles in length, and 1530 feet above the sea; and through Lake Hallwyll, five miles long by one broad; and being joined by the Reuss and the Limmrat, besides a few smaller streams, the united waters, flowing over a rugged rocky bed, join those of the Rhine at right angles, about the centre of its course from the Boden-zee to the point from whence it assumes a northerly direction nearly opposite the mouth of the Wutach, which flows in a circuitous course from the western slopes of the Feldberg, from which also the Wiesen flows to the south-west, to join the main stream at the commencement of its northern course, while the Birse falls from the northern extremity of the Jura in the opposite direction. It will be observed that both the spurs from the mountains on the north and south project towards each other, and the transverse valleys open into each other in the direction of the chain of the Jura, and of the valley of the Aar; the Rhine valleys, and those of the Thiele and the Reuss, uniting them at nearly right angles. The extreme sources of the Rhine being 175 miles apart, of this distance, as has been seen, 125 is occupied by the sources of the Aar, which are more than sixty in direct distance from its mouth; it has been remarked that both its principal source and embouchure are under the same meridian (about 8° 15′ east); it describes an arc of a circle of about 250 miles, from which the chord is distant 100 miles. The volume of water which the Aar brings to the united stream is greater than that of the Rhine, and it might therefore have some claim to the superiority; but the west valleys of the Aar are more open, more insular, less intersected by mountains, and in transverse direction to the principal watershed, showing their inferior origin. The whole of the upper valley of the Rhine is, however, a land of mountain and flood, of which by far the larger portion is inaccessible except to the chamois and the hunter.

The climate of the upper valley of the Rhine is, as might be expected from the proximity of the glaciers and eternal snows of the high Alps, severe in winter, and from the reflection of the rays of the sun often extremely hot in summer; the variations are rapid; winter lasts about six months in the west, but longer in the east: the inferior limit of perpetual snow is about 8500, but the glaciers descend to 3400. The vine ripens its fruit at an elevation of 2000 feet; barley, roots, and herbs at 4000; the slopes of the hills and mountains are covered with timber, oak and beech on the lower slopes, larch and birch above; the pine reaching an elevation of 6700, and the rhododendron and other flowering plants, the edge of the snow. Iron is abundant; lead and zinc are found in the Grisons; mineral springs are numerous; coal is found in the west. The chamois and vulture still have their homes in the tops of the mountains.

5 *Affluents of the Rhine.*—The Rhine, where it issues from its upper valley and takes a northerly course, is 755 feet above the sea, and 550 feet broad; here it changes its character, and instead of flowing with the rapidity

of a torrent over its rocky bed, it winds among islands, and throws out ana-branches; and before entering its lower course attains, at the confluence of the Erft, a width of 2300 feet. The river in this part of its course is well-known for the beauty and fertility of the valley through which it flows, and which for about 150 miles is shut in by the wooded slopes of the Vosges and the Schwartzwald.

The principal affluents on the left are, the Ill, which descending from the northern slopes of the Jura, has a course of 100 miles, nearly parallel to the main stream, is navigable for sixty, and receives several small affluents, and opens water communication with the west of Europe; the Moder, which rises in the Vosges, from two sources, has an easterly course of thirty miles, and falls into the main stream just below the confluence of the Ill; and the Lauter, which, rising in the valleys of the Hartzwald, has a course of near fifty miles, besides the Seltzack and other small streams which rise in the northern extremity of the Vosges on the south of the Lauter and the Queist, which fall, with other minor affluents, from the slopes of the Hartzwald to the north.

The affluents of the right are the Elz, which flows from the defiles of the Black Forest in a tortuous north-west course of thirty miles; the Kintzig, which has the same origin and direction, and falls into the main stream, nearly opposite the mouth of the Ill; the Renchen; and the Murg, which flows through a narrow and irregular defile of Mount Kniebis, and has a course of about forty-five miles to the main stream, which it joins nearly opposite the mouth of the Seltzack.

The middle course of the Rhine is by some authors considered as extending to the confluence of the Lippe; there is, however, a marked difference in the character of the basin of the river above and below the confluence of the Neckar: above, the only considerable affluent has a course nearly parallel to the main stream, and the affluents having their courses at right angles are small; below, large rivers turning the flanks of its former watershed, drain their reverse slopes and have basins of considerable area, enclosed on the east by the secondary chains of northern Europe, and on the west by those which have been just described as extending from the Jura and Vosges, and forming the watersheds of the secondary rivers of the west. The middle course of the Rhine, therefore, is divisible into two parts, but they are scarcely to be called basins; the valley of the river itself being still contracted, the basins of which it receives the drainage belonging to its affluents, of which in this, which might therefore be called the lower middle course of the river, the first is the Neckar from the right.

The Neckar rises from several sources in the Schwartzwald and Rauhé Alp, having a north and north-westerly course, and which, forming three principal streams, unite about thirty-five miles from its confluence with the Rhine; its main source is within fifteen miles of that of the Donau; and takes a north-east direction until the junction of the Fils, which has a course of thirty miles from the Rauhé Alp, when it trends northward, and receives the Jaxt from the right; this rises in the same mountain, and has a course of nearly forty miles; the Enz, from the left, then unites its waters, which rise from two principal sources in the north and east slopes of Mount Kniebis, and flows in a tortuous course at the base of the Schwartzwald for about seventy miles. The Kocher, the most important affluent from the right, joins the main stream about fifteen miles below the mouth of the Enz; rising in the north-west flank of the Rauhé Alp, it has a tortuous course from north-east to west, of about the same length as the Enz.

The extreme sources of the Neckar are about eighty miles apart; its course is above 200 miles; but it is shallow and difficult of navigation; it is separated from the Mayn at its sources by the Steigerwald, and at its mouth by the Odenwald; but their inferior affluents of the left and right respectively—the Kocher and Tauber—have not a very well-defined watershed. The sources of the Neckar, as already noticed, open communication with the valley of the Danube.

The Mayn, or Main, is the second most considerable affluent of the Rhine, and affords communication with the upper valleys of the Elbe and Danube, and by its westerly course opens the centre of Europe to the north and west; its principal source is in the Ochsenkopft, and its basin is formed by the Rauhé Alp, the Steigerwald, and Fichtelgebirge on the south, and by the Frankenwald, Rhongebirge, Spessartwald, and Taussengebirge on the north: its upper course, which is surrounded by the watershed of the Altmuhl on the south, and confined between the Fichtelgebirge and Steigerwald, is here due north for about fifty miles from its south-western source, the Rednitz, formed by two streams, the principal of which is the Rezar, from the west, and which, after the confluence of the Pednitz from the east and north, is known as the Regnitz, and receives some affluents from the left; of these, the most important is the Aitsch, the sources of which are close to those of the Altmuhl; this is indeed the main stream, and is navigable to its confluence with that from which it receives its name; from which point it assumes a westerly course; it has two sources, the Red and White Mayn, and receives the Itz and Bannach from the southern slopes of the Thuringerwald.

The Mayn continues in a westerly course for about thirty-five miles, and then trends suddenly to the south, follows that direction for about twenty-five, and then trends north-west for nearly thirty, to its junction with the Saall, which, rising from several sources in the Rhongebirge, Kreusberg, and Spessartwald, has an irregular course of above seventy miles; here pressed to the south by the Kreusberg, it flows round the base of those hills, receiving the Tauber from the south, which has a north-westerly course, parallel to that of the main stream, for seventy miles; and again flowing north and west for thirty miles, it receives the Kintzig from the north, and assuming a southerly and westerly direction for about forty miles, joins the Rhine under the fiftieth parallel of north latitude, and here that river takes the same direction until the confluence of the Nahe, which, with its affluents, the Glau and Simmer, in a course of sixty miles, for twenty of which it is navigable. drain the semicircular congeries of valleys formed by the Hartzwald and Hochwald, the northern extensions of the Vosges; and from its confluence, the Rhine takes a north-westerly direction along the base of the Hundsruck, and now receives the Lahn from the right, just before the confluence of its most important affluent, the Moselle; this river flows through a mountainous country for 100 miles, and opens communication with the south-western sources of the Weser.

The Mosel, or Moselle (Mosella), rises in the Faucilles mountains, near the Gap of Béfort or Belfort, and flows north and north-west between the heights of the Ardennes and the north-western spurs of the Vosges, in a winding course, between undulating banks, through a verdant valley; gradually trending northward, it receives the Meurthe from the right, and changing its character, flows in a rocky channel through a mountainous and well-wooded country, and joins the Rhine after a course of nearly 300 miles, for 240 of which it is navigable. The confluence of the Meurthe is about 190 miles from the mouth of the river; this stream rises in the Vosges, and has a course of about seventy miles; but the other affluent of the right, the Saar, or Savre, is the most important; it also rises in the Vosges, having its principal source in the north-western slopes of the Grand Donon, and its secondary in the Hartzwald, close to those of the Lauter and Nahe. The Saar has a tortuous and rapid course of 150 miles, for twenty of which it is navigable; the Seille, also from the right, has a course of sixty miles; the other affluents of the Moselle are from the left, and are formed by the confluence of the Alzette and Sure with the Erens and other small affluents, which have their rise between the Ardennes and the Eifelberg, from the south-western slopes of which the Kyll also descends to the main stream.

After the confluence of the Moselle, the Rhine flows in a broad, deep, and unbroken stream, between bold hills, through a fertile and well-watered country, receiving several small affluents both from the right and from the left; of the former, the Sieg is the most worthy of notice, which flows round the base of the Siegberg, and has a course of eighty miles; like the Sieg, the Wied and Wipper flow through a country remarkable for its iron works, in which its principal wealth consists; of the latter, the Erft, which, rising in the northern slopes of the Eifelberg, flows parallel to the main stream for forty miles, and then turning north, joins it after a course of more than sixty miles, affording access to the basins of the Moselle and Maas. From the confluence of the Erft, the extended lowlands about the lower course of the Rhine and Maas commence on the left bank of the river, the right being still hilly, and consisting of heaths and sandy tracts, traversed by the valleys of the Ruhre, Lenne, and Emsch, the united streams of which enter the Rhine some twenty miles below; the course of this river is 130 miles, and it drains a considerable area, opening communication with the valley of the Weser.

The only affluent which the Rhine has in its lower course, and which assimilates much with those just enumerated, is the Lippe; but it has its sources in the irregular connexion which exists between the Eggegebirge and the Teutobergerwald, and drains a valley which is shared, in its upper course, by the sources of the Ems, and opens on the great level which extends from the Elbe to the limits of the basin of the Scheldt. The Lippe has a course of 110 miles, and is a considerable stream, but not of much advantage to internal communication from its want of depth.

The Rhine, in its lower course, becomes an intricate network of 'endless streams,' or canals, intersecting the level country in every direction; it has, however, two main branches; that to the north-west retaining the original name, and that to the south-west being called the Wahal: this latter, in its course of forty-five miles, forms many considerable islands, uniting with the Maas by many branches; from that river, however, it separates again, but unites with it finally after enclosing the island of Bommel. The waters of these rivers, raised thirty feet above the surrounding country, are retained by vast dykes, which enclose rich meadows.

On the right, the main stream of the Rhine bifurcates and joins the Over-yssel; this is, however, by some considered as a canal cut by the Romans. The Yssel rises in the western extremity of the watershed which separates the Lippe from the Ems, from which also it receives affluents on the right; it has a course of eighty miles, and falls into the Zuyder-zee. Below the bifurcation, the Rhine, flowing parallel to the Wahal, again divides, the northern branch still retaining the name Rhine, while the southern obtains that of the Leck; and then again subdividing, surrounds the island of Ysselmonde, and is called Neder-yssel. The Leck joins the Maas in a course of thirty-five miles, and the space between it and the Wahal is called the Betaw. Diminished now both in breadth and volume, the Rhine creeps along until a branch called the Vecht, separating to the right, thirty-five miles from the North Sea, falls into the Zuyder-zee; and the waters of the channel, which still maintains its original name, not having sufficient force to keep open a way to the sea for themselves, were, for above 1000 years,* lost in the sand, until the hand of man opened and maintained the mouth by which they now find their way to the North Sea.

The total length of the Rhine is estimated at above 350 miles in direct distance; by the stream above 700; the area drained by it at 65,280 square miles; its delta is more extensive than that of any other European river, and is connected with that of the Maas and even the Scheldt. The navigation of the Rhine is everywhere difficult, in the lower course from the want of fall and the number of its channels; in the middle from the islands; in the upper from its rapidity and rocky bed; it is not important above the falls of Schaff-

---

* See Lavallée's *Military Topography* dates given, 839, 1807. A.D.

hausen: estimating the elevation of the source as 8000 feet, and that of the point where it issues from its upper basin as 755, it has a fall of above 7000 feet in seventy miles direct distance; of this eighty is gained at the falls of Schaffhausen, below the Boden-zee. A higher estimate has, however, been taken; Lavallee gives 9967 feet as the elevation of the source in the Ober Alp, and 2021 at the junction of the Vorter and Hinter Rhine, or 7245 feet in a direct distance of twenty-five miles: below the Boden-zee he estimates the elevation at 1335; at the lowest level of the upper basin, 771; at the junction of the Ill, 463; and at Koln, above the confluence of the Wipper, 121, or about one foot in a mile throughout the course from that point. These figures appear, however, exaggerated, if the level of Lake Constance, given by Johnston, be more accurately estimated at 1250 feet.

6 *Rivers of the Valley of the Lower Rhine.*—The entire country between the Rhine and the Weser is low and level, the larger portion of the surface occupied by extensive moors; the undulating ground about the sources of the Lippe being barren heath, and the coast as barren sand; but rich strips of alluvium border the watercourses, and the portions drained by canals become capable of supporting cattle; much of the country is below the sea level, and is protected by numerous dykes. The outline of the coast therefore varies much: the inroads of the sea will form deep bays, and these again, dyked out and drained, are recovered from it to the use of man. The Ems flows through this district, receives the Werse Haase and Leda from the right, and the Aa from the left, near its mouth, draining Bourtanger moor; and, after a course of 160 miles, falls into Dollart Bay, which was formed by an inroad of the sea in the year 1277. The Hunse, a small river, also drains the same moor, and in a course of fifty miles to the north-west falls into the Lauer-zee, between which and the Zuyder-zee a sandy tract projects about fifty miles into the sea, the distance between the Zuyder-zee and Dollart Bay being about the same. The Vechte, rising between the Ems and the Lippe, has a circuitous course of eighty miles to the north-west angle of the Zuyder-zee, and the Yssel receives the Ahe, Berkel and other affluents, which extend its course to nearly 100 miles. The Zuyder-zee, formerly a lake, was united with the sea by the bursting of the dykes in 1282; the numerous islands which extend round its entrance are all the evidence remaining of the extent of the catastrophe; it is in extreme length forty-five, and in breadth thirty-five miles; and forms at its south-eastern extremity the deep inlet called the Y, which communicates with Lake Haarlem; there are four small islands in the zee. Haarlem Lake, now draining by English engineers, was thirty miles in circumference, and resulted from an inundation in the sixteenth century.

The Mass, Maese, or Meuse, may almost be considered an affluent of the Rhine, rising in the Plat of Langres, at the northern angle formed by the junction of the Faucilles mountains; losing itself underground for four miles, it reappears in a narrow valley between the two heights of Ardennes, and becomes navigable; and after a very tortuous course enters a defile between rocks 400 feet in height, and flows through a succession of narrow precipitous gorges, after which the country opens with sandy heathy hills, and the river, receiving the waters of the Sambre from the south-west, assumes a north-westerly course; here, as on the right of the Rhine, iron abounds: and through the level flat at the base of the hills the river makes a semicircular bend to the north and west, and flows through extensive marshes parallel to the Rhine. Below the island of Gorkum, formed by the two branches of the Wahal already noticed, the Meuse divides, enclosing within its arms numerous islands. The southern arm is the more considerable, and it flows through the Biesboch, or Red Forest, a tract formerly fertile, but destroyed by an inundation in the seventeenth century; and below this again the stream divides, forming the island of Overflakkee; the southern arm uniting with the waters of the Scheldt. The most northerly stream retains the name Meuse, and also divides, forming the island of Ysselmond; its northern branch uniting with the Leck. The three principal mouths of this river are the Maas on the north, the Flakkee in the centre, and the Greveling on the south, its course may be estimated at nearly 450 miles, of which three-fourths are navigable.

The affluents of the Meuse are, on the right, the Chiers, a considerable stream flowing between high banks among the Ardennes for fifty miles; the Semoy, which in its upper course flows through deep defiles, and has an entire length of 100 miles; the Ourthe, which rises in the northern extremity of the Ardennes, a wild country of ravines and thickets, called Hohe-venne, through which it flows for eighty miles, being navigable for fifty, as are its affluents the Ayvaille and Vesder; and the Roer, which rising in the Eifelgebirge, flows round the base of the Hohe-venne through deep defiles among irregular hills; it is a considerable and rapid stream, and separated from the Erft by a long spur of the Eifelgebirge, from the northern extremity of which the Neers flows through the low marshes of Gueldres to join the Meuse in its lower course. The Roer, or Rhur, has a course of near 100 miles, and from the rapidity of its upper stream is subject to violent inundations. The Niers, or Neers, has a course of sixty.

The affluents of the Meuse on the left are the Viroin (rising from two sources in a plateau 1289 feet above the sea), the Bar, and the Sambre; this latter is the most considerable affluent of the Meuse, and opens communication with the Seine and Scheldt; it is navigable nearly throughout its course of 100 miles, but receives few and unimportant affluents. It is deep, and has a very tortuous course; it is surrounded to the south-west by the heights which extend from the Ardennes westward, and from the watershed of the Scheldt. The country on the right bank of the river is hilly, wooded, and traversed by many streams. The other affluents of the Meuse on the left are the Jaar, or Geer, which flows for thirty miles through the lowlands; the Dommel, which has its sources in the marshes of Peer, flows through a swampy country, and receives numerous streams in its tortuous course of forty-five miles; and the Merke.

The Scheldt, or Schelde, is the last river of importance belonging to the lower basin of the Rhine, and the congeries of streams and canals which find their way through the Low Countries to the North Sea; it rises in several streams from the north and west slopes of the watersheds of the Somme and Sambre. This river, in its lower course, expands to a breadth of above 1500 feet, and flowing in a broad deep stream between embankments, divides and, with its branches, encircles the islands of Walcheren and South and North Beveland, forming the great delta of Zeeland: the East Scheldt, passing between the islands of South Beveland, and Tholen, and North Beveland, and Schouwen, and having effected a junction with the Meuse, enters the North Sea by an embouchure of seven miles in width: the West Scheldt separates into several branches from the islands of Vlaaderen and Zeuwsh, and its embouchure is nine miles broad. The mouths of the Scheldt are opposite to those of the Thames, and its broad and deep stream is more favourable for communication than the more uncertain waters of the Rhine, its valley has been, therefore, the abode of commerce for ages, and may be reckoned among the most populous parts of the world. The course of the river may be estimated at above 200 miles, throughout the greater part of which it is navigable, and its affluents connect it with the valleys of the Somme, Seine, and Meuse in several directions—those of the right are the Rouelle, the Haisne, the Dender, which has a course of forty miles through a coal district, and the Roupel; this is the most important affluent of the Scheldt, and is formed by the confluence of three streams, the Senne, which has a course of fifty miles; the Dyle, which rises in the heights of Fleurus, has also a course of fifty miles, and is navigable for twenty-two, to the confluence of the Deiner; and the Nethe, which is formed by the confluence of two streams of the same name, denominated the Great and Little, respectively, from their junction; this stream is navigable for eighty miles to the Roupel. The courses of the Senne and the Dyle are parallel, and between them lies the forest of Soignies, extending above twelve miles, and intersected by ponds and marshes.

The affluents of the left are the Sensée, which connects the Lower Scheldt with the Lower Scarpe; the Scarpe; and the Lys which descends from the heights bordering the sea, and after pursuing an easterly course, turns to the north and flows parallel to the Scheldt; its length is about 100 miles, and it receives several small affluents; of these the Deule is the most important, as affording communication with the Lys and the Aa, two small rivers, which, with the Yser, complete the drainage of the basin, which extends 250 miles along the coast.

CHAPTER XV.

SECONDARY RIVERS OF NORTH-WEST EUROPE.

§ 1. The connexion of the watersheds of north-western Europe.—2. The secondary rivers of north-western Europe. The Seine.—3. Rivers of the southern watershed of the Seine.—4. The Loire.

THE connexion of the Watersheds of North-Western Europe.—The Plat of Langres, the mountains of Argonne and of Morvan, extend in a semicircular direction, having the diameter of 150 miles from north to south, round the sources of the Seine, the northern extremity trending towards the watershed of the Scheldt; while the southern, attached to the Cevennes by the Côte d'Or, throws out spurs to the north-west, towards those heights which limit the basin of the Seine to the south, and in their extension westward, parallel to the coast of England, form the south boundary of the English Channel.

The plateau of Laugres consists of elevated plains, neither separated by deep valleys, nor varied by elevated summits; its height is estimated at 1640 feet; to the south, however, the Côte d'Or rises in bold heights, crowned with woods, and having their sides covered with vineyards; these culminate at about 2000 feet above the sea (Le Tasselot is estimated at 1969 feet), and to the west and north the mountains of Morvan separate the upper basins of the Seine and Loire; these are scarcely worthy the name, their greatest elevation being about 600 feet, and must be considered as the subsidence of the secondary watershed to the west, which stretches gradually to the north-west, towards the plateau of Orleans and the Bocage, hilly and well-wooded districts, forming the eastern extension of the mountains of Bretagne; these are more worthy the name, although their elevation does not exceed 1300 feet, being rugged in outline, and composed of primitive rocks extending into the Atlantic; they form the peninsula of Bretagne, which presents two bold extensions, that of Mont Arree on the north, and Mont Noire on the south, which enclose a deep indentation of the sea, into which the little river Aulne falls from the western fork.

2 *The secondary rivers of western Europe—The Seine.*—The Seine rises in the Côte d'Or at an elevation of 1463 feet, and in its upper valley receives numerous affluents; the main stream may be considered as formed by the confluence of the Seine and Marne, and is continued under the former name to the English Channel.

The priucipal affluents on the left are the Yonne, rising in the plateau of Chateau Chinon, it has a course of 150 miles, for 100 of which it is navigable; its principal affluent is the Armançon from the right, having a course of about 70 miles; it receives also the Cure and Serain. These affluents, rising in the northern slope of the Morvan, flow through a district deeply intersected and traversed by numerous streams opening on the lower course of the Yonne; here the soil is clay, but fertile, and the slopes of the hills are covered with vineyards. The Loing, the next important affluent on the left, has a course of about seventy miles, rising in the depression already noticed, between the extensions of the secondary and tertiary watersheds of north-west Europe, offers easy connexion between the valleys of the Seine and Loire.

The country at the source of this river is sterile, intersected by barren hills and pools of water, without communication, and the chain of wooded heights rising to the west in the angle formed by these rivers, stretches north and south, about fifty miles. This is the plateau of Orleans, which extends northward in the forests of Fontainebleau.

The principal affluent of the right in the upper basin of the Seine, is the Aube, which descends from the plateau of Langres and flows in a semicircular course at the base of the southern slopes of the hills which separate it from the Marne; it has a course of ninety miles, for about thirty of which it is navigable; in its upper course its right bank is elevated, the left is, however, low and marshy, as is the district through which it flows in its lower course. The Yères is the only other affluent worthy of notice before the confluence of the Marne; its length is about fifty miles.

The Marne also rises in the plateau of Langres, and flowing above 200 miles, for the most part parallel to the upper course of the Seine, joins that river where their united waters assume the north-west direction, which is maintained throughout the rest of their course to the sea.

The entire length of the Marne is about 225 miles; it receives from the right the Ornain and Ourcq, and from the left the Grand and Petit Morain; the former has a course of above fifty miles, the second, which affords connexion with the main stream by canals, only of thirty. By the valley of the Marne and its affluents, access is obtained to the basins of the Meuse, Moselle, and Rhine.

The semicircular tract lying at the base of the plateau of Langres, between the Seine and the Marne, though undulating, is sandy, cold, and barren; to the west, however, the valley opens on rich clay land, which is highly productive; about the sources of these rivers good timber is found, and iron ore is abundant. The upper valley of the Seine and Marne is a circular basin of about 100 miles in diameter; its eastern districts are among the most barren, its western among the most fertile, in Europe; this is nearly level, and extends into the basin of the Oise.

The Oise is the largest, if it is not the only considerable affluent of the lower course of the Seine; it rises in the western Ardennes, and opens communication between the basins of the Seine and Scheldt, the Sambre and the Somme; it has a course of about 110 miles. The upper valley of this river is well wooded and fertile; limestone abounds, as do corn and cattle in the lower; it flows through a gently undulating and open country; but its principal affluent, the Aisne, which rises among the western terraces of the Argonne, flows through a country rendered difficult by woods, marshes, and ravines, as does the Lette, an inferior affluent of the Oise; nevertheless, the Aisne opens communication with the Meuse; it receives the Aire, the Vesle, and many smaller streams, and is in length 120 miles. The district between the Marne and Aisne may have an average breadth of thirty miles; a spur of wooded hills projecting from the Argonne, separates their upper course, the lower opens on the plain, which extends about the points of junction of the three great sources of the Seine.

From the confluence of the Oise the Seine has a course of about eighty miles in a direct line to the sea, during which it receives several small affluents, the most important of which are the Essonne, which rises in the plateau of Orleans, and has a course of about fifty miles through a highly fertile district, and the Eure, rising in the plateau of Courville, having a course of above 100 miles from the left. The lower valley of the Seine is of great beauty and fertility. The river reaches 500 feet in width before the junction of the Oise; its entire length exceeds 400 miles, and it is navigable for 350, but its mouth is obstructed by dangerous sandbanks; it enters the sea by an estuary seven miles wide, from the mouth of which large vessels ascend to above thirty miles in direct distance.

To the north of the Seine the Bresle, the Somme, the Authie, and Canche flow into the English Channel; of these the Somme is alone of any importance; its basin is formed by encircling hills, not exceeding 500 feet in elevation, and it does not extend above seventy-five miles in length by forty-five in breadth, but it is of much fertility, and opens a direct passage into the centre of the basin of the Seine by the valley of the Oise, as well as with that of the Scheldt; hence its historical and commercial importance. Its entire length exceeds 100 miles.

3 *Rivers of the Southern Watershed of the Seine.*—The rivers which have their rise in the extension of the southern watershed of the Seine are the Toucques, which has a course of fifty miles, and is navigable for twenty; it rises in the northern slopes of the Bocage, as does the Orne, which has a course of seventy miles, but is only navigable for about seven: the Vire, which flows from the same slopes for sixty miles, and is navigable for twenty: the Douve, which receives several affluents, one of which, the Taute, is navigable for fifteen miles, the Sienne, which has a course of forty miles, the Silune and the Couesnon, having a course of about fifty miles, and is navigable for ten, rise among the granite rocks of the interior of La Manche, and unite with the sea in the sandy coast of the deep bay which terminates the north-west coast of Europe.

The southern watershed of the Seine assumes more importance when considered as the northern and eastern limit of the great basin which extends into the Bay of Biscay, than when simply considered as separating the valleys of the Seine and the Loire. This basin, extending from north to south 300 miles, and above 500 from east to west, is quadrangular in form, its eastern boundary stretching from the slopes of the Mediterranean to the plateau of Orleans, is above 250 miles in length, its southern, on the line of the Pyrenees, 550, and its northern, from the plateau of Orleans to Ouessant, nearly 300. As, however, it is divided into two parts by the extension westward of the mountains of Auvergne, which form the southern limit of the basin of the Loire, and as, with this exception, the watersheds of that river are the reverse slopes of those of the Seine, that river may properly come next in order of description.

4 *The Loire.*—The river Loire has its sources in the mountains of Auvergne, of Charolais, and the Côte d'Or, and its course is naturally divided between two valleys, where, turned by the plateau of Orleans, it flows westward to the sea; each of these may be about 200 miles in length, the upper extending about 100 miles in width, the lower opening from the sources of its northern to those of its southern affluents, about 200. The principal source is in the Gerbier de Jones, at an elevation of 3940 feet, and the river flows through deep defiles, among the extinct volcanic cones of Auvergne; it receives from the right the Furens, which, descending from Mount Pilate, affords connexion with the valley of the Rhone; the Arroux, flowing from the slopes of the Côte d'Or, over a rocky bed, but nevertheless navigable for above ten miles; the Nièvre, which is navigable for about the same distance, and has a course of twenty-five miles; and from the left, the Lignon, rising in Mount Forez, and several other small streams above the confluence of the Allier.

The Allier rises in Mount Lozère, which has an elevation of above 4500 feet; it has a course of above 200 miles, and is navigable for 150; rising in so mountainous a country, it is subject to inundations, and its affluents are scarcely more than rivulets; of these the more important are the Dor and Sioule. The upper basin of the Loire is divided into three parts, the basins of the Upper Loire, of the Allier, and of the united streams; the general course of all is north and west. The basin of the Allier is the more contracted, shut in between the basaltic precipices of the Puy de Dôme; its valleys, however, are fertile, and the vegetation celebrated; it abounds in mineral products, in coal, antimony, lead, iron, marble; it has numerous mineral springs, those of Mont Dor being the most noted. The chestnut-tree attains here a magnificent development, and its nuts afford food to many of the inhabitants of the poorer districts. The basin of the Loire, extending from north to south 150 miles, and having the valleys of its affluents opening into it from the south, east, and north, is of a more varied character on the south and west, and assimilates more indeed to that of the Allier; but on the south, on the slopes of Mont Mezin, which attains an elevation of 5794 feet, and of the northern extension of the Cevennes, in the Margerides, and the mountains of Charolais, its character varies; much of this district is comparatively sterile; coal and gypsum are found here, and the vine is cultivated; but to the north, on the wooded slopes of the Côte d'Or, that important plant flourishes in the greatest luxuriance, as the southern exposure affords a better climate, and the soil is more fertile. The upper courses of the Loire and Allier are very rapid; after the confluence of those rivers, the united stream flows for eighty miles through a narrow valley, not averaging above ten miles in width, the upper part being less fertile and much covered with wood; here it receives no affluent worthy notice, but at the angle formed by the change in its course, below the plateau of Orleans, connexion is obtained with the valley of the Seine; in the lower course of the river the affluents are of more importance, and extend their ramifications in every direction; the more important on the left are:

The Loiret, which rises from two sources; one of these forms a basin about sixteen yards in diameter, and is only seven miles distant from the main stream; although this river has a course of only ten miles, it is navigable to its source, and affords water power and carriage to the manufactories situated on its banks;

The Cher, which descends from the north-west spurs of the mountains of Auvergne. Like the Allier and Loire, in its upper course, this river is subject to violent inundations; it has a semicircular course of ninety-five miles, and is navigable for about fifty; it has several affluents, and flows through a well wooded and fertile country;

The Indre, which has a course of above 100 miles, and is navigable for forty-five, through a level and fertile country, some portions of which are, however, swampy; the vine flourishes, and with cattle and agricultural products form the wealth of the district;

The Vienne which, descending from the plateau Millevaches, flows in its upper course through a narrow and deep valley for fifty miles from east to west, from thence it assumes a northerly direction for about eighty more, to the confluence of the Creuze, and then bending westward for about thirty more, joins the main stream; its eastern course cannot be less than 200 miles, and has two important affluents; the Clain on the left, which opens communication with the valleys of the Charente and Gironde to the south, and which, though it has a course of above sixty miles, is navigable only for five; and the Creuze on the right, which, rising in the mountains of Limousin, flows for nearly 150 miles through a rugged and sterile country, and is navigable for the last ten miles of its course; it receives several affluents, the principal of which is the Gartempe, which has a course of 120 miles; none are however important. The other affluents of the Loire from the left are the Thoué, the Sèvre-Nantaise, and the Boulogne; of these, the second is of some importance, having its rise in the plateau of Gatine, which forms the watershed between those affluents of the Loire and the small streams which flow into the sea, between the mouth of that river and the Charente; it flows with great rapidity in a deeply excavated channel through the rugged wilds of La Vendée, it has a course of seventy miles, and is navigable in its lower course for boats only; its most important affluent, the Maine, has a course of about thirty miles.

The streams falling from the opposite slope of the same plateau into the sea, are the Sèvre-Niortaise, with its affluent the Vendée, the Say, the Vie, and the Falleron; the former has a course of about sixty-five miles, which is navigable for some distance. Besides those already mentioned, the Erdre, also an affluent from the right, joins the main stream opposite the mouth of the Sèvre-Nantaise, has a course of about forty-five miles, and is navigable for sixteen; its waters afford communication with those of the Vilaine. The remaining affluent of the Loire from the right is the Mayenne, and is formed by the confluence of three streams, the Mayenne, the Sarthe, and the Loir; the former rises in the southern slopes of the Bocage, and flows through a broken country, not dissimilar to that through which the Sèvre-Nantaise flows; but, as its name implies, more wooded and indeed more fertile; it is navigable for about eighty miles, and is above 100 in length; the Sarthe has a course of about 140 miles, is navigable for seventy-five; it rises in the hills which form the watershed of the Orne to the north; to this river the Loir is affluent; it has a course of 150 miles, is navigable for above sixty, and has its source in the little lake of Cernay; after the confluence of the Sarthe, the united stream is called the Maine.

The Loire in its lower course, which is between continuous lines of fertile terraces, is shallow, yet it is equally subject to inundations with the upper course, and dikes and barrages are constructed to confine the waters, which, under ordinary circumstances have been found sufficient, though many were destroyed in the flood of 1846. It forms several islands, of which, perhaps, those of the port of Nantes, and Indret, near the mouth of the river, are most important; the navigation is obstructed by sandbanks, yet vessels of 300 tons can enter its mouth, and vessels of 200 ascend to the confluence of the Sèvre-Nantaise, to which point also the tidal wave is perceptible; its length may be estimated at 550 miles, and it is navigable for above 400. The small rivers which flow through the extension of the basin of the Loire to the north are, the Vilaine, Blavet, Odet, and Aulne; these have their rise in the southern valleys of the peninsula of Brittany, a country of forests, wastes, and granite rocks; the former has a course of above 100 miles and is navigable for eighty, it receives the Ille and Oust, and opens communication with the valley of the Loire by the Erde, and with the Aulne on the north-west; this latter, as already noticed, falls from the western fork of the tertiary watershed of Western Europe into the harbour of Brest.

CHAPTER XVI.

WATERSHEDS AND RIVERS OF THE SOUTH AND WEST.

§ 1. The watersheds of the south and west.—2. The Garonne.—3. The Nivelle and Adour.

THE *Watersheds of the South and West.*—The line of waterparting between the rivers of the west and the south of Europe is very tortuous. It has been already traced from St. Gothard, along the peaks of the Bernese Oberland, the line of the Gemmi, the slopes of the Jorat, to the most elevated of the parallel ridges of the Jura, and to the centre of the water communication of the west, where the upper valleys of the great rivers meet round the plateau of Langres; from thence, above the vine-covered sides of the Cote d'Or, the well-wooded Lyonnais and Charolais, among the rocky heights of the Cevennes, and the volcanic cones of Auvergne, to the rugged peaks of the Pyrenees, culminating in the east in that of Corlitta. A well-defined limit is, however, placed to the secondary chains of the west, and the continuity of the line is broken by the gorge of Narouz, of which the elevation is only 620 feet; from thence the range of the Corbières stretches to join the Pyrenees. This does not attain a greater mean elevation than 1000 feet; but its culminating point, the peak of St. Bartholomew, reaches 7654, and forms the northern limit of the basins of the Tech Tet Gly and Aude. A spur called the Albères limits the valley of the Tech, and the mountains of Bareges in a similar manner form the eastern cincture of the basin of the Nivelle and the Adour; here are more lofty peaks, that of Cambelle rising 9843 feet, and the mean elevation being 6500 feet. In the north, however, the decrease in elevation is very rapid, and the spurs of this chain present only gentle undulations between the valleys of the Adour and Garonne.

The Pyrenees, by some distinguished as the Continental Pyrenees from the Cantabrian mountains, or sierras of the Asturias, on the west, extend for 250 miles, from Cape Creux on the east, to Cape Figuier, or to near Fuentarabia, having a mean altitude of near 8000 feet. Of this chain the great mass is near the centre, to the east and west of which it is composed of two lines, running parallel, the one overlapping the other, rising from the south in successive terraces, but sloping more gently to the north, spurs extending on both sides from transverse valleys, those on the north more open, those on the south more rugged and difficult; while from the centre the great transverse range which crosses the Peninsula extends to the south, throwing out its massive spurs to the east and west. On the east, the spurs projecting into the valley of the Ebro are remarkable both for extent and elevation, the most easterly extending like a wall along the coast, and with the opposing spurs of the Sierra Penagolosa confining the middle course of the Ebro and its affluents within an extensive basin; while the eastern extremity of the chain sinks close down to the waters of the Mediterranean.

The main line of the Pyrenees is formed of arid and precipitous rocks, covered with snow and ice, but not presenting vast glacier fields like the Alps, nor are the culminating points nearly as lofty, but they are not less mountainous in their character. Three peaks rise to an elevation of 11,000 feet and upwards, viz., Nethou or Maladetta, Posets, and Perdu; three more attain to about 10,000, viz., Vignmale, du Midi, and Canigou; these, as in other cases have been similarly observed, project from the great mass of the chain, and are found rising above its southern slopes.

If we divide the Continental Pyrenees into central, eastern, and western, we shall find but few passes over the first, and those only to be traversed by mules; the principal of these connect the sources of the Adour and Cinca with those of the Arriége and Sègre.

In the eastern Pyrenees the most important pass is the Col Pertus; it is passable at all seasons, and is the great eastern high road. This, however, is turned by the two converging lines of communication by the valleys of the Lech and Let, the gorge of La Perche, and the Boulou.

In the western Pyrenees, one leading through the gorges of Bellatti and Maga, the former over the main chain to the valley of the Nivelle; the pass of Roncevaux, or Roncevalles, by the gorge of Ibanetta, at an elevation of 5750 feet, along the crest of the mountains, and that of Confranc; these are practicable for carriages. The total number of passes is estimated at fifty, and among the more elevated are Port d'O 9843 feet, Breche de Roland 9500, Estaube 8402, Tourmalet 7143, Gavarni 7654.

The central mass of the Pyrenees consists of primitive rocks, of which granite and schist form the larger portions. Connected with these are found the earlier limestones; but the secondary rocks superimposed upon them occupy a far more extensive area, consisting chiefly of clay, slates, and limestones, while below these the inferior ranges are formed of oolite and chalk.

Iron, copper, lead, gold, and silver have been worked in the Pyrenees. Some of their streams are even yet argentiferous; and they are remarkable for a vast deposit of rock salt. In the valley of Cardona, mineral springs are abundant, and fine marble is quarried in several localities. The elevation of the snow line is about 8000 feet; the pine tree flourishes at 10,000 feet, and maize is cultivated at 3280. In the upper valleys there is occasionally excellent pasturage, and in the more elevated portions of the chain, and on the limits of the snow region, both the bear and the lynx are still found. The extension of the chain to the west, usually known as the Maritime Pyrenees, commences at the gorge of Goritty, where a spur stretches to the north, limiting the south-east angle of the Bay of Biscay; these subdivide into the Gallician, Asturian, and Biscayan Sierras; they are, even as yet, little known. The elevation must, however, be considerable, as many of the higher peaks rise above the snow line; and the Pena di Peneranda is estimated at 8038 feet.

The gorges which cross these mountains are few and difficult; that on the west connecting the valley of the Minho with the harbour of Corunna; one connecting the valley of the Duero with that of the Ovia and Nora, rivers or rather streams, falling into the Bay of Biscay; and a third over the Sierra Regnosa, connecting the upper valleys of the Ebro and Duero with the harbour of Santander; to the east again, there are the gorge of Salinas, the high road from Spain into France, and the pass of Goritty.

The northern slope of these mountains extends 300 miles from east to west, but has only a breadth of thirty-seven miles, and the greater portion of this surface is covered by spurs projecting towards and into the sea. There is, however, a considerable area of pastures, and the forests are extensive.

Some streams, scarcely to be called rivers, flow rapidly down this slope to the sea, through fertile and beautiful valleys. These are, the Nalon, formed by the confluence of the Ovia and Nora; the Ansa, the Deba, which rises in the gorge of Salinas; the Orola, the Ovia, which rises in the gorge of Gorittz; and the Bidassoa, which, descending from the gorge of Maya, flows through the valley of Bastan, and enters the sea near Cape Figuier. An island is formed at its mouth, which, with the entire course of the river, has become famous in the wars between France and Spain.

2 *The Garonne.*—The ancient Garumna, with its confluent the Dordogne, unites to form the Gironde, the extensive estuary of which is one of the most remarkable features on the western coast of France.

The Garonne, rising in the valley of Aran, flows through a deep and narrow valley in a semicircular course, until it assumes an uniform north-westerly direction, through its central and lower basins. The upper basin is a mountainous forest region, abounding in pasturage and mineral wealth.

The affluents of the Garonne from the left are, throughout its course, few and unimportant: the Save, Gers, Baise; but those of the right are considerable, both in number and extent.

The Salat, which may be considered the secondary source of the Garonne, rising in the angle formed by the junction of the Lower Cevennes with the Pyrenees, has a course of sixty miles, and is navigable for twenty. The Arriége falls from the peak of Corlitta, and flows through a narrow valley hemmed in by mountains. The Ern, a small river, having its course parallel to the main stream; and the Tarn, which, rising in the wood of Armes, on Mount Lozere, at an elevation of 2526 feet, afterwards flows in a deep bed through a fertile plain in a course of 220 miles; its affluents are the Aveyron, on the right, and the Agout on the left: the former is to be noted for the quantity of detritus brought down by its waters. The Lot, also rising in the Cevennes, has a course of 250 miles through an agricultural district, but its bed is obstructed, and navigation difficult: its affluents are the Fruyere and Selle.

The Dordogne, formed by the confluence of two streams, the Dor and Dogne, flowing from the volcanic heights of Mount Dor, has a course of 225 miles, and is navigable for 150; after its confluence with the Garonne, the united stream is about 4600 feet in width, and here the flood tide assumes the character known as The Bore, locally denominated Mascaret; it has numerous affluents, the principal of which are the Cère, the Vezere (navigable for twenty-five miles), and its affluent the Corrèze; and the Lisle, which flows through an extensive valley, and is navigable for seventy-five miles. The central basin of the Garonne and Dordogne may be above 100 miles from north to south, and fifty from east to west; it is composed of broad valleys, undulating hills, well-wooded plateaux, and is rich in corn and wine. The lower basin, which may have about the same extent, presents barren wastes of sand, dreary landes, and shifting dunes, which, as in Egypt, Cornwall, and other similar coasts, make regularly progressive encroachments; a few plantations of pine have withstood the invasion, and here and there a few marshes and oases of verdure break the monotony of the landscape. Marshy bogs and salt lagunes extend along the sea shore. This river is the medium of communication between the south of France and the Mediterranean, by the Canal du Midi; in its upper course, its velocity has been estimated at 164 feet per minute; at the mouth, its breadth is above 2500 feet, and its depth seventy-five feet. After the confluence of the Dordogne, the stream, now called Gironde, forms an extensive channel, intersected by islands and sandbanks, varying in breadth from two to nine miles, but is only three miles wide at its mouth. It is in length forty-five miles.

3 *The Nivelle and Adour.*—The former of these, falling from the Pyrenees into the Bay of Biscay, is a torrent; but its name is too well known for it to be omitted. The latter is a more considerable river, with several affluents. Descending from the Pyrenees on the south, its basin is encircled to the east and north by the Barèges mountains, which gradually descend into the landes of the Garonne. The river flows at the base of the semicircle thus formed, and its affluents flow parallel to its course. The central basin partakes of the character of that of the Garonne, the valleys being fertile, the hills affording rich pasturage, and being productive of wine. The lower basin also, like that of the Garonne, consists of unproductive plains, while the upper basin is an Alpine region of mountain, flood, and forest, crowned by the snows of the Pyrenees.

The Adour descends from Mount Tourmalet, 6300 feet above the sea, flows through the valley of Campan, where it is 1670 feet above the sea, which it reaches after a course of 175 miles, for seventy of which it is navigable; it has numerous affluents, those of its upper basin are torrents. The more important are the two named Luy, torrents flowing parallel to the main stream throughout the greater part of its course; the Gave (*i.e.* Water) de Pau, descending at its source in the cascade of Gavarnie, 6748 feet above the sea; it receives the Gave d'Oleron, and has a course of 100 miles; the latter stream is formed by the conflux of the Gave d'Aspe and Gave d'Opan, each having a course of thirty miles; the Bidouze, though a torrent in its upper course, is navigable for twelve miles; the Joyeuze; and the Nive, the most important of all, which descends from Mount Orgulo, though small it is deep and rapid, navigable for twelve miles, and receives the Bayunza, is separated from the Adour by plateaux extending from the Barèges; these are all on the left. Those on the right are few and unimportant, except the Midouze, which is formed by the confluence of the Midou and Douze; the former has a course of forty-five miles to the confluence of the streams, and their united waters about twenty miles to the main stream; they are navigable for twenty-five miles.

CHAPTER XVII.

THE SOUTH-WEST PENINSULA.

§ 1. The Spanish Peninsula.—2. The watersheds.—3. The rivers of the west. 4. The rivers of the east.

THE *Spanish Peninsula.*—The Iberian Peninsula, familiarly and not improperly known in this country as the Peninsula, as being not only the nearest but the most important Peninsula in Europe in respect of Great Britain, extends between lat 36° 1′ and 43° 45′ north lat., and 3° 20′ and 9° 30′ west long.; its continental boundary is 225 miles; its diagonal 621; the development of its coast line 1615 miles, and its superficial area above 175,070 square miles. Few portions of the earth's surface are more singular in their character.

2 *The Watersheds.*—The Pyrenees on the north, as already described, and the Alpujarras, or Sierra Nevada, on the south, form mountain barriers, presenting steep faces to the sea, and connecting them a watershed, irregular both in direction and elevation, stretches in a general northerly direction; indeed, the two points of junction with those chains are almost exactly due north and south from the eastern extremity of the one to the centre of the other at the sources of the Ebro; thus dividing the Peninsula into two parts, the one nearly rectangular, having its greatest length from north to south, the other triangular, having for its base the eastern Mediterranean coast.

This watershed is formed by mountains, which assume a sinuous course, and rise from plateaux varying in elevation from 1300 to 2000 feet; above the rugged sierras raise their snow-capped peaks; below vineyards and cornfields, rice, maize, and olives, the products of the temperate and tropical zones, are found side by side; while in the lower valleys the latter prevail. Wherever there is water there is verdure, where it is wanting the country is an arid waste, a sandy or a rocky desert.

On the south the Alpujarras extend from the Atlantic Ocean and Cape Gata in a slightly curved line from east and west for 150 miles; and here are the most elevated summits in the Peninsula; the Cerro de Mulhacen 11,675; and the Pic de Veleta 11,387 feet in height, which are separated by the Corral de Veleta, a fearful chasm. These heights intercept the rain clouds from the ocean, and cause the rainfall on the central plateaux not to exceed ten inches annually; by this the fertility of the valleys is, however, much increased, and probably they may be estimated among the most beautiful as well as the most fertile on the surface of the earth. The limit of perpetual snow on these mountains is 9500 feet. At the south-western extremity the isolated rock is projected which forms at once the key and the limit of the Strait of Gibraltar; it is three miles in length, and nearly one in breadth; it rises abruptly on three sides to the height of 1600 feet; its more prolonged slope being towards the west. The rivers of the southern slope of the Alpujarras are scarcely worthy the name. The Guadiaro, however, which flows into the sea eleven miles east of Gibraltar, has a course of forty miles; the elevation of its source must be above 5000 feet. The Guadaljore and Almeira may also be mentioned. These mountains are rich in minerals, especially in lead; their sides are clothed with olives, chesnuts, and the lower slopes with orange groves.

Between the Alpujarras and the Pyrenees, three chains, parallel to each other and to these, stretch from the central watershed to the west, forming the well-defined basins of the Guadalquiver, the Guadiana, the Tagus, and the Ebro. The first of these, the Sierra Morena, presents for the most part barren rounded masses, which culminate at Aracena, 5500 feet above the sea. The southern slope presents rich, well-watered, and deep valleys, for the most part uncultivated; it is crossed by two principal passes, as well as by the formidable defile "Despena Perros," which communicates with the Guadiana. The length of this chain may be 250 miles, its breadth fifty. The second of these chains is attached to the central watershed by a level, slightly elevated, and extensive plateau, which affords free access from the head waters of the Guadalquiver to the Guadiana; the Sierra de Alcaraz thus connects the Sierra Sacra, which joins the Alpujarras with the Sierra Cuenca to the north. This chain extends 350 miles, and occupies the entire country between the rivers, being in breadth about fifty miles; its course is very irregular, and it culminates near the centre in the Sierra Guadalupe, at an elevation of 5250 feet; its western extremity reaches the sea on the southern bank of the Tagus. The Sierra Monchique, which forms Cape St. Vincent to the south, seems from its contour to belong more properly to the extension of the Sierra Morena, if it be not considered as distinct from either; it culminates at 5000 feet. The upper valley of the Tagus is open to that of the Guadiana, as that is to the valley of the Guadalquiver. The central watershed is here continued in a semicircular direction from the Sierra Cuenca by the Sierra Albarracin, which indeed may be considered as the centre of divergence of the chains on the south. Here the head waters of the Tagus, the Xiloca, the secondary source of the Ebro, the Guadalaviar, and Xucar, are in close proximity; from hence, also, the Sierra Molina stretches to the north-west, though separated by a depression which gives access to the valley of the Duero from the lower sierra; it is very precipitous and rugged. The pass over this chain is 5250 feet in elevation, but the culminating point is farther west in the Sierra Guadarama, which nearly reaches 9000 feet, and is crossed by the gorge of the Lion, above 4500 feet in height. This chain is separated from the still more lofty peaks of the Sierra Credos, which attain to 10,500 feet, by the Sierra Avila, of little elevation indeed, but barren and desolate, by which passage is opened with the centre of the valley of the Duero. The Sierras of Creda and Gata are remarkable for the boldness of their southern slopes. The former is crossed at the gorge of Banos; the latter is partially detached, but unites at the west with the Sierra Estrella, which, culminating at 6500 feet, sinks gradually to the south and west, extending in the mountains of Cintra and Torres Vedras, to Cape Roca, and forming the northern limit of the mouth of the Tagus. The rugged shores and wild valleys of the Sierra Estrella afford access only in one direction to the valley of the Duero, and present therefore an almost impassable barrier.

The central watershed to the north of the Soono Sierra is formed by the Sierras Moncayo and Occa. The former rises nearly 10,000 feet, decreasing gradually to the north, the latter scarcely exceeds 5000, beyond which again there is a depression. Between the head waters of the Ebro and Duero, in their northern sources, there are the elevated plains which connect it with the Sierra Reynova, the centre of the Pyrenees; the two valleys are connected by the defile of Pancobo.

On the east, the Sierra Almanza separates the Segura from the Xucar, between which river and the Ebro the Sierras Cuenca and Alborracin send out irregular spurs, which enclose the valley of the Guadalaviar. One of these, the Sierra Penagolosa, extends northward along the coast to the Ebro, contracting the valley of that river on the south, as a spur from the eastern Pyrenees does on the north.

3 *The Rivers of the West.*—The Guadalquiver (Wad-al Kebir, or Great River of the Moors; the Bœtis of the ancients), has its rise in the depression between the Sierra Nevada and the Sierra Sacra, from two sources in the opposing slopes; its upper course is through a rugged and sterile country, but lower down the valley opens and becomes fertile, and its lower course is through a level and highly productive country; on approaching the sea, however, it forms three channels, by two anastomosing branches enclosing islands, named respectively major and minor. Here the alluvial deposits afford the richest pasturage for cattle. Thirty-seven miles from the sea a desert tract called the Marisma, commences, and to the north this is extended over a surface of 150 miles. The length of this river is above 250 miles. It is navigable above its confluence with the Genil.

The affluents of the Guadalquiver are numerous, but very important. Those on the left, in its upper basin, flow from the slopes of the Alpujarras, and are mostly saline; of these, the Genil, or Xenil, and its affluent the Loxa, which has a course of about 120 miles, demand notice. On the right, the Guadalimar, and its affluent the Guadarmena; this river is shallow, but rapid, and has a course of seventy miles from its source in the Sierra Alcarez. The Guadiel and other torrents come down from the ravines of the Sierra Morena; of these, the Huebla may be mentioned.

This basin is rich in minerals, mercury, silver, lead, and salt; it has marble quarries, and supports numerous herds of the finest horses, cattle, and sheep; it is, however, comparatively uncared for by an indolent and decreasing population.

As connected with the basin of the Guadalquiver, the river Guadalete should be noticed, which, rising in the northern slopes of the Sierra Ronda, flows through the plains of Xeres into the sea, to the south of the former river, after a course of seventy-five miles; to the north, also, the Tinto, an inconsiderable stream, enters the sea.

The Guadiana (Anas) must not be confounded with a small affluent of the Guadalquiver on the left; it has its sources in the Sierra Alcaraz, near those of the Guadalimar, on the south, and in the mountains of Toledo and the Sierra Cuenca on the north; the southern source is in marshy lagunes; it is afterwards lost underground, but rises again thirteen miles lower down, in numerous boiling jets, called "the eyes of the Guadiana;" from hence it flows in a deep, full stream, through a comparatively sterile country, till its course is interrupted and made tortuous by spurs from the mountains, which limit its basin; by these it is gradually turned to the south, and before entering the sea has a slightly easterly trending. In the first part of its course this river flows through a very narrow defile, round the base of the western extremity of the Sierra Morena; its basin river, though uncultivated, is not, especially in its middle course, unfertile; it is navigable for thirty-five miles, and its entire course may be estimated at nearly 400. The principal affluent is the Zuja, famed for its quicksilver mines; the torrent, Albuera, however inconsiderable in size, will not be forgotten in history. On the right, the affluents are for the most part small; the Ginguela is, however, of importance, if it be not considered as the main source of the river. The southern source of this stream, called the Reuss, rises in a marsh, from which the Xucar flows in the opposite direction to the Mediterranean. The Ginguela has several affluents.

The Tagus, Tajo, or Tejo, rises from several sources, in the amphitheatre formed by the Sierra Alborracin; its upper course, in which it receives numerous small affluents, is through a barren, arid country, incapable of producing anything but stunted pasturage and shrubs. The middle course of the river, where its sources unite, is more fertile, until, forty miles below, its basin is contracted by spurs from the mountains on either side; its course is now through a rugged, barren country, its bed contracted, and its stream rapid and broken; below it expands, being 300 yards wide 100 miles above its mouth; in its lower course it forms numerous channels and islands, and then expands into an estuary five miles broad, but again contracts to two at its mouth, which is crossed by a bar. The entire length of the Tagus may be estimated at 500 miles, for eighty only of which it is navigable, to the entrance of the mountain regions, below its central basin.

The affluents of the Tagus on the left are, for the most part, inconsiderable torrents; but the Sever and Zatas in the lower course should be noticed. The latter rises near the northern bend of the Guadiana, and has several affluents, flowing through a desert country; those on the right are more important, viz., the Xarama, or Jarama; the northern source of this river is formed by the confluence of that stream with the Henarez; it receives the Mancanarez from the right, and has a course of sixty miles; the Guadarama, which rises in the sierra of the same name, at an elevation probably exceeding 4000 feet; the Alberke; and the Alagou, a stream of some consequence, as opening communication with the valley of the Duero, and flowing through the depression between the Sierra Gaeta and Sierra Credos; its principal affluent is the Xente; the Zezere, which rises in the defiles of the Sierra Estrella, and flows through a wild and mountainous country; and the Alenquer, which flows at the foot of the mountains between the Tagus and the ocean to the north, and the Alcantara, a rivulet important as flowing through Lisbon, the capital of Portugal.

The Sadao, or Saldao, which rises in the Sierra Mouchique, and drains a small coast basin between the Guadiana and Tagus, has a course of above 100 miles, for forty of which it is navigable: it falls into the Bay of Setubal.

The Duero, or Douro, rises in the lagunes, and in the semicircular plateau at the base of the Sierra Moncayo; here, on the most naked and lofty parameros, surrounded by gloomy mountain fastnesses, it flows in a deep and narrow bed, until, at its confluence with the Pisuerga, its numerous sources are united at the limits of its upper basin. This river rises in the plateau of Reynosa, in close connexion with the sources of the Ebro; of its numerous affluents, the most important are the Arlanzou and Esquera on the left, and the Carrion on the right; its course may be estimated at 150 miles. Above its confluence with this principal source, the Duero receives the Eresma from the left, which has its rise in the Sierra Guadarama, at an elevation probably approaching 5000 feet; and, with its affluent, the Ajada, flows through a very wild district. The upper basin of this river, which may be 100 miles in length, and the same in breadth, is dreary and monotonous in its character, and in it some of the affluents of the middle course of the main stream take their rise.

The affluents of the middle course of the Duero are on the left. The Tormes, which falls from the Sierra de Credos, a considerable stream, which has a course of 150 miles; and on the right the Sequiera, which opens communication with the Pisuerga; the Eyla or Elsa also, which rises in the sierras of the Asturias, and collects from their southern valleys numerous affluents: of these, the Torio and Tuerto may be noted. The upper basin of this river has an elevation of 2500 feet, and its length may be estimated as above 100 miles. In its middle course, the Duero, headed, as it might be said, by the spurs from the mountains of the Asturias, turns to the south at a right angle, so that its affluents on either bank falling into it at right angles are parallel to the other portion of the course of the river, which thus forms a triangle, having its base eighty, and its eastern and western sides sixty and forty-five miles respectively. The country through which it flows is still barren and rugged.

In its lower course the Duero receives on the left the Agueda and the Coa, which both fall from the Sierra Gata, and are separated by the plateau of Fuentes d'Onoro; both are rapid, have precipitous banks, and flow through a mountainous country. The Sabor, Tua, and Tamego are small streams on the right.

This river brings down, in its rapid course, a vast quantity of detritus from its upper basin, which accumulates at its mouth in sandbanks; its course may be estimated at about 400 miles; but it is not navigable for more than seventy-five miles. The district of vineyards commences fifty miles east of its mouth.

Two small basins open to the sea to the north and south of that of the Duero; on the latter, the Mondego, which, rising in the northern extremity of the Sierra Estrella, in its upper course receiving numerous torrents, and flowing through a rugged and extremely difficult country, but navigable in its lower, through the plain of Biera, falls into the sea near the cape of the same name, after a course of 130 miles; between it and the Duero, the Vouga, a torrent with a course of sixty miles, falls into the Bay of Aveiro; on the former, *i.e.*, to the north of the Duero, the Cavado and other streams flow through a beautiful and very fertile country; and beyond, the Minho stretches its very irregular and remarkable basin, which, divided naturally in two parts by projecting spurs from north and south, presents above a country of mountains, and below one of plains. Of this river, the upper basin is again capable of division into the basin of the Upper Minho, on the south, and of the Till, its affluent on the north, surrounded on all sides by the spurs of the Western Pyrenees, which intersect the country in rugged sierras; the head waters of the former open communication with the valley of the Eyla, and of the latter with the sea coast, at the north-western angle of the Peninsula.

After the junction of its two sources, the Minho bursts through the mountain barriers, and issues in a small circular basin, from which again it seems to force a passage to the open and fertile plain below: it enters the sea about fifty miles north of the Duero, after a course of about 150 miles. To the north of the Minho is the unimportant torrent, the Ulla.

4 *The Rivers of the East.*—The rivers of the eastern coast of the Peninsula correspond to those of the western, except that the sources of the Xucar and Ebro cover those of three rivers, on the opposite slope, those of the Guadalaviar being overlapped by them. The most southern of these rivers, the Segura, rises in the northern slopes of the Sierra Sagra, and its valley is separated from that of the Guadalquiver by a sierra of the same name; it has a tortuous course of above 150 miles, and receives several affluents, among which may be named the Guadelentin, Quipar, and Madera, from the right; and the Sangonera and Mundo from the left. The upper basin of this river is distinct in character from the lower, the former being a

mountainous desert region, the latter consisting of fertile plains through which numerous canals fed by its waters have been constructed.

Xucar, or Jucar, rises in the Sierra Cucnca and Sierra Alborracin from two principal sources, which flow in contracted parallel channels from north to south for about 100 miles, when the westernmost and principal stream bending eastward receives the waters of the Cabriel, by which name the other source is known. The easterly trending of this river is caused by the projecting terraces of the Sierra Almanza, which separate its valley from that of the Segura. The upper basin of the Xucar is not so well defined as those of other rivers in the Peninsula, blending with the eastern slopes of the central plateaux, but the course of the Cabriel is tortuous, and its basin more extended. The total course of this river cannot be much less than 200 miles; its lower course is like that of the Segura through rich plains, to which it supplies by canals the necessary means of irrigation. Near the mouth of the Xucar are the lagunes of Albufera, the largest of which is eleven miles long by four broad, and communicates with the sea by a narrow channel.

The Guadalaviar has its source in the eastern spurs of the Sierra Alborracin; its upper course is through deep gorges, its lower through fertile plains, but its valley is throughout contracted, and it has no affluents worthy of notice; its total length may be above 125 miles.

The Palencia is a small river between the Guadalaviar and Ebro.

The Ebro, the ancient Iberus, which gave name to the Peninsula, is, indeed, its most important river; its waters, with those of the Duero, almost unite the Mediterranean to the Atlantic, though not by any practicable channel, for its rocky bed and impetuous torrent entirely prevent its navigation; its very irregular and rugged basin we may divide into three parts. Rising like the Duero in the Sierra Reynosa, its course is barred to the south by the continuous heights of the Sierra Oca and Sierra Moncaya; its upper basin is contracted by the Sierra Oca and spurs of the Pyrenees, and is entered only by the defile of Pancorbo, but a few paces broad, and winding between precipitous rocks. The affluents received in this basin are mere mountain torrents, insignificant in size, yet many of them famous in story, and among them the Zadorra will not be forgotten. Below the second basin is more extended, opening to the north and south, and admitting the waters of the Xalon, or Jilon, which rises in the Sierra Alborracin, and with its confluent the Xiloca, or Jiloca, drains a considerable area, and has a course of about 100 miles from the right; and the Aragon, with its affluent the Arja, which has neither so large a basin nor so long a course, from the left; on which side also the Gallejo joins the main stream; and here the irregular spurs projecting from the Sierra Alborracin and Sierra Penagolosa obstruct its passage to the sea, and with those from the Pyrenees on the north, form a series of defiles, of which that of Las Armas is the most formidable. The Ebor also receives the Huerba, Almonacid, and Guadalupe from the right, and the Segré from the left. The Segré, the ancient Sicoris, descends from the Gorge la Perche, and itself a torrent, accumulates in its narrow and irregular channel the waters of several others; after the confluence of the Cinca, a river of the same character which joins it from the right, it becomes a considerable stream; its course may be 150 miles; it has its sources in the southern defiles of the most lofty and massive of the Pyrenees, and opens to the valley of the main stream by difficult passes.

The lower course of the Ebro is obstructed by the detritus brought down from its upper basins, and an extensive delta has been formed at its mouth; but although the navigation is thus impeded, it is secured by canals throughout two-thirds of its length, which may be nearly 350 miles.

Beyond the Ebro the Lobregat, a considerable stream, the Tordera Ter Fluvia, and Monza drain the transverse valleys formed by spurs from the Pyrences, the angle between which and the Ebro is covered by them.

The eastern slope of the Peninsula differs from the western as presenting much less barren country in proportion to its area; the lower valleys of the rivers are of surpassing fertility.

CHAPTER XVIII.

THE RHONE VALLEY.

§ 1. The southern extension of the primary watershed.—2. The upper valley of the Rhone.—3. The Saone.—4. The lower course of the Rhone.—5. Rivers of the lower basin of the Rhone.

THE Southern Extension of the Primary Watershed.—From the western bastion, so to speak, of the central watershed of Europe, it has already (p. 314) been noticed, that an extension of the chain is found to the south and north, and here the most elevated summits were observed. The Pennine Alps stretch for 100 miles from Mont St. Gothard to Mont Blanc, (the culminating point of Europe, rising 15,810 feet above the level of the sea,) here thirty-four glaciers, extend over ninety-five square miles; the largest is the well-known Mer de Glace. Mont Rosa rises 15,208 feet and Mont Cervin between them, 14,850.

The principal passes of the Pennine chain are the Gorge of the Simplon, leading from the upper Rhone valley to the basin of the Lago Maggiore and the river Ticino, extending for thirty-eight miles at an elevation of 6592 feet below Mont Leone. The Great Saint Bernard, between the extended spurs of Mont Blanc and Mont Cenis, affording access from the valley of the Dranse to the northern source of the Doria Baltea at an elevation of 8150 feet; as that of the Little Saint Bernard, to the south of Mont Blanc, does with the western sources of the same river at an elevation of 7076 feet; and they unite at the confluence of its sources in its upper basin.

Two important spurs stretch from Mont Blanc to the north and north-west; the one between the Dranse of the Valais and the Arve, limits the valley of the Rhone to the west, and changes its course nearly at right angles, this is a massy and rugged range, traversed by difficult gorges, and culminates in the Dent du Midi at 10,771 feet; it divides at its northern extremity and forms the basin of the Dranse of Savoy, extending towards the eastern and northern extremities of the Lake of Geneva: the other also dividing, extends on the north along the valley of the Arve to the Rhone, approaching the Jura from the opposite side, and on the south along that of the Isére, thus enclosing the valley of the Fier: the latter range is known as the Banges.

The Grecian Alps extend southward from Mont Blanc, forming a semi-circle round the sources of the Isére, of which the diameter is above forty miles from the Little St. Bernard to Mont Cenis; they culminate in Mont Iséran at 13.275 feet, and from this as a centre, spurs diverge between the sources of the Isére on the west, and the affluents of the Po on the east; to the south the pass of Mont Cenis separates them from the Cottian Alps. This is one of the most important passes of the western Alps, as giving access to the centre of the upper basin of the Po; its elevation above the sea is 6775 feet.

The Cottian Alps stretch in a south-easterly direction from the extreme western spurs of Mont Cenis to Mont Viso, a distance of nearly forty miles. Mont Genevre culminates about the centre of the chain at about 11,800 feet; while Mont Viso, at the southern extremity, rises 12,585. The passes over this chain are those of Sainte Genevre, which connects the northern sources of the Durance with those of the Doria Repaira; it has an elevation of 6560 feet; and the Gorge d'Alvires, connecting the middle source of the Durance with the Clusone. The line of the Cottian Alps is extended to the north-west between the Arc and Romanche, stretching to the Isére; it culminates in Mont des Trois Ellions at 12,735 feet, while spurs of considerable importance are thrown off to the south-west, between the Drance, Drac and Durance. That between the Drome and Drac is most elevated, culminating at Mont Olan 13,819 feet, and Mont Pelvoux de Vallonise 13,450. That between the Drance and Durance is less elevated, its highest point being Mont Ventous, which does not rise much above 6400 feet.

The maritime Alps extend from the Col d'Agnello, which separates them from the Cottian Alps, to the Gorge of Cadibon, where the chain of the Apennines commences, in a semicircular direction round the principal sources of the Po; the chord of the arc may be estimated at about sixty miles; they culminate on Mont Longet at an elevation of 10,350 feet; but the declension of the chain is very rapid towards the south and east. The passes are the Col d'Agnello, 10,650 feet above the sea, carried along the southern slopes of Mont Viso and connecting the Durance with the Vraita; the Gorge d'Argentiere and Col de Roburent, connecting the Durance with the Stura; the Col de Tende, connecting the southern source of the Stura with the Roya, which falls into the Mediterranean to the north of Monte Ceppo, the extremity of a southern spur from the centre of the maritime Alps, which approaches closely to the sea; this pass has an elevation of 5880 feet; the pass of Nava, 3150 feet in height, connecting the Aroscia and Tanaro; and the pass of Cadibon, 1608 feet only in elevation, which leads from the Gulf of Genoa to the valley of the Bormida. It may be questioned whether this chain should not be considered as extending to the pass of Bochetta, at the source of the Orba, or else as limited further westward at the Col de Tende, or the Col de Roburent; but custom, frequently the proper result of local knowledge, has determined otherwise.

2 *The Upper Valley of the Rhone.*—The valley of the Rhone divides naturally in three parts. The basin of the upper Rhone to the east, that of the Saone to the north, and of their united stream to the south; the former is one of the best known mountain valleys, and, it may be added, one of the most beautiful in the world, and at the same time one of the most sublime. Hemmed in between the Bernese Alps on the north and the Pennine chain on the south, this valley, the Valais, extends about ninety miles in length, and from fifteen to thirty in breadth.

The Rhone rises in the eastern extremity of the Valais, in the Rhone Glacier, between Mont Furka and Mont Grimsel, at an elevation of 5750 feet; its course is to the south and east for nearly seventy miles, and then trending suddenly round the base of the Gemmi, north and west, until it falls into the Lake of Geneva; at the angle thus formed its elevation is 1575 feet, showing a fall of nearly sixty feet to a mile. At this angle, the Dranse, an inconsiderable torrent, falls from the slopes of the Great St. Bernard into the main stream; and here the upper valley of the Rhone may be said to terminate, for its upper course is naturally susceptible of a threefold division.

As the first is the Valais, the second is principally occupied by the Lake of Geneva, Lake Leman, or Genfer-see. This lake, of a lengthened crescent shape, extends in length from east to west forty-five miles, and in greatest breadth of its area is estimated as eighty square miles; it is 1230 feet above the sea; and its greatest depth, near its eastern extremity, is 985 feet. It is traversed by the Rhone, and receives the waters of above forty small streams. Of these, the more important are the Dranse, which has a course of twenty-four miles, and falls into the lake near the centre from the south, and the Venage.

From the open basin of the lake, separated only by the low elevations of the Jorat from Lake Neuchatel, the Rhone, trending to the south, and closely pressed by spurs from the Alps and by the range of the Jura, flows with rapid stream through an irregular and rugged channel. It is these mountains which form as it were the buttresses which support the basin of Lake Leman from the west, and, after forcing its way through them, the river turns abruptly to the north-west, and then again south-west and west to its confluence with the Saone.

In this part of its course the affluents of the Rhone are the Arve, which has its source on Mont Blanc, at an elevation of 3658 feet. Its upper basin is the valley of Chamouni; it has a course of forty-two miles, is impetuous, and subject to inundations; the Fier, and its confluent, the Cheran; the former flows through the lake of Annecy, which is nine miles in length, two in extreme breadth, and 1242 feet above the sea; from the junction of this stream, the Rhone is navigable; the Bourguet, which traverses the lake of the same name, also called Chatillon, which is eleven miles in length and two in breadth, and noted for its beauty; and the Guier, which descending from the Banges, flows through a difficult country. The valleys of all these streams radiate from Mont Blanc as a centre. On the right, the only affluent is the Ain, which, descending from the reverse slope of the Jura, flows at the base of that chain, which, rising to nearly 6000 feet above its left bank, presents rugged heights, down which torrents precipitate themselves into the river. On the right bank is an undulating table land, separating it from the Saone. This is not, strictly speaking, a navigable river, though for fifty miles its waters are made available, during the spring freshets.

3 *The Saone.*—This river, the secondary source of the Rhone, rises in the plat of Langres, and its basin communicates with those of the Rhine, Moselle, Seine, and Loire, between which it is situated, and the watersheds of which are common to it; its source has an elevation of 1332 feet, its length about 225 miles, for 175 of which it is navigable; its course is slow and placid, and in strong contrast to the turbulence of the Rhone. Flowing from north to south, at the base of the Côte d'Or and mountains of Charolais, the Saone has only rivulets for affluents on the right bank; on the left it has several small, but only one important, affluent, viz., the Doubs, which rises in the Jura, at an elevation of 3123 feet. Its upper course is through a mountain valley, winding, rapid, and interrupted by cascades, one of which, at Morteau, has a fall of eighty-eight feet; flowing at first from south to north, it turns abruptly, and assumes a southerly course to its junction with the Saone. Its length exceeds 200 miles; it receives the waters of the Savoureuse from the gap of Belfort, at the point of junction between the basins of the Rhine and Rhone, of the Loire, and other smaller streams.

4 *The Lower Course of the Rhone.*—Below the junction of the Saone the Rhone receives some small affluents from the slopes of the Cevennes, the Doux, Eyrieux, Gier, and Onveze; the Ardeche, which is fifty miles in length, navigable for eight, and remarkable for its natural rock bridge at Pont de l'Arc; and the Garde, or Gardon, the impetuosity of which in its upper course not unfrequently causes inundations in the lower.

The affluents of the left of the Rhone, in its lower basin, are the Isére, which falls from Mont Iséran, and receives one affluent from the Little St. Bernard pass, and another from the opening of the Rhone valley to the south-west; its course through its upper basin, the Tarentaise, is north-west, but bending at a right angle, it assumes a south-west course to the junction of the Romanche, from whence its course is westerly to the Rhone. The Arc is the principal affluent of the Isére, it also has its rise in Mont Iséran, and flows at the base of Mont Cenis, in a parallel course; it may, perhaps, be rather esteemed a confluent; its length is forty miles, if considered an affluent. The entire length of the Isére may be estimated at 150. The Drac and Romanche, two torrents, unite their waters, which rush, swollen by numerous other mountain streams, through the deep ravines of the spurs thrown out at the junction of the Cottian and Grecian Alps. They may both be about forty miles in length. The Drance has a course of sixty miles, but is not navigable.

The Sorgues rises in the Vaucluse fountain in Mont Ventoux, which has an elevation of 6250 feet, receives the Ouveze and Nesque, and differs so much from the preceding affluents, that it is navigable throughout its entire length of twenty miles; it enters the Rhone by two mouths. The Durance, a more important affluent, drains the whole western slope of the Cottian Alps, its northern source being to the north of Mont Genevre, and its southern in the south-western spurs of Mont Viso. Its two northern sources are the torrents Guizanne and Clairet, which unite at an elevation of 4250 feet above the sea. From hence its course is south-west, and then due south. At the junction of the Buech, the elevation above the sea is 1572 feet, and from thence its course is from east to west. Here its bed is wide, shifting, and shallow, obstructed by sandbanks, but to a certain extent navigable for above 100 miles: its entire course is above 150. Its principal affluents are the Guil, from the pass of Abries, which has its course through a frightful gorge; the Ubaye, which has its source in Mont Viso, and flows through the valley of Barcelonette, at an elevation of 3800 feet; and the Verdon, which has a course of 100 miles.

From the junction of the Saone, the course of the Rhone is from north to south; it becomes a deep and rapid stream, 1500 feet in breadth. Below the junction of the Durance, the river divides into two branches, flowing south-west and south-east; the latter is the Great Rhone. These again subdivide; the former into the Little Rhone and the Dead Rhone, the latter into the Old Rhone and Great Rhone. The island enclosed between these two branches is called La Camargue; it is deltic, of triangular shape, twenty-six miles long by eleven in main breadth, of extreme fertility, and producing from its marshes salt, naturally, in large quantities. The fall of the Rhone, as compared with its length, is greater than that of either of the other primary rivers of Europe. In direct distance, its length is 285 miles; the extreme length 650, of which it is navigable 325 miles.

5 *Rivers of the Lower Basin of the Rhone.*—Some small rivers occupy the extension of the lower basin of the Rhone, to the east. The Arc, the Argen, which is navigable for nearly forty miles; the Var, a rapid, turbulent, formidable stream, subject to terrible inundations, rises in Monte Cameleone, and, with a course of sixty-five miles, falls into the Mediterranean. It is 2500 feet wide at the mouth; and the Roya, which descends from the Col de Tende; its connexion, as well as the other rivers to the east, is with the valley of the Po.

To the west of the Rhone: of these the Vistre, Lez, and Hérault flow from the Cevennes, the former being connected with the Little Rhone. The Aude, Gly, Tet, and Tech, rise in the spurs of the Pyrenees. The former has a course of 125 miles, receives many small streams, and falls into the lagunes of Sigean and Agde. The three latter are mountain torrents, but the plains at their mouths are level and marshy, and through them are spread a network of canals, both natural and artificial. They have courses respectively of forty-five, sixty-five, and forty-five miles.

CHAPTER XIX.

THE VALLEY OF THE PO AND ITS RIVERS.

§ 1. The Apennines.—2. The upper course of the Po.—3. The middle course of the Po and the Lake district.—4. The southern spurs of the primary watershed.—5. The lower course and delta of the Po.—6. The rivers of the extension of the basin of the Po.

THE Apennines.—This chain of mountains, opposed to the Pennine chain, from which it is distant about 100 miles, naturally divides into two parts; that which with a general easterly trending forms the northern limit of the Gulf of Genoa, and that which from the source of the Magra assumes a southerly direction, which is maintained throughout the whole peninsula of Italy.

The Gorge of Cadibon, at the sources of the Bormida, has already been stated as the point from which customarily the Apennines are said to have their commencement, being separated by it from the maritime Alps, as already noticed, p. 338; these, however, seem rather a continuation of the Apennines than of the Alps, or, if appertaining to the latter, then the chain of the former would more naturally commence at the Bochetta Pass to the north of the Bay of Genoa. From the Gorge of Cadibon to Mont Orsaro in Carrara, may be seventy-five miles. In this portion of their course the Apennines send out short spurs to the north and south, the former melting away insensibly into the plain, the latter presenting buttress-like formations to the sea, with a mean elevation of 5000 feet: these mountains are comparatively barren, their valleys, perpendicular to the main axis, are not of great extent; they are passed by the Gorge of Bochetta, 2549 feet above the sea, already noticed; that of Montebruno opening the valley of the Trebbia to the shores of the Gulf; and of Pontremoli, connecting the sources of the Magra and Tara; while the road of the Corniche carried along the shores of the Gulf, and terminating at the pass of Bochetta, opens communication with the lower valley of the Rhone.

From the sources of the Mara to those of the Tiber, the Apennines have a south-easterly trending for about 100 miles, and here they have greater solidity, and attain their northern extreme culmination in Mont Cimone at 6976 feet above the sea; within this distance there are the gorges of Mont Cimone; from the valley of the Serchio to that of the Secchia that of Fiumalbo; from the middle course of the Arno with the Panaso, and of Pietra Mala between the northern source of the Arno and the valleys of the Idice and Savena; this is the principal road from the valley of the Po into the peninsula, and has an elevation of 3294 feet.

The more southerly course of the Apennines is through the peninsula for above 350 miles, from whence, trending westward, they pass into Sicily; they attain their greatest breadth near the centre, about the head waters of the Siben, where they culminate in Mont Corno, 10,154 feet above the level of the sea: while Mont Majello, an out-lying peak near the eastern coast, rises 9130 feet.

The structure of this chain is for the most part calcareous, though limestone predominates at the extreme north, and primary rocks at either extremity in Piedmont and in Calabria; limestone also forms some of the more beautiful valleys of the central portion of the chain: it is poor in minerals; its most remarkable productions being the marble of Carrara on the north, and the saline deposits of Cosenza on the south: extinct volcanoes present themselves in many places, especially on the north, at Voltore; to the south, is the only active volcano on the continent of Europe, Vesuvius.

The Apennines do not exceed the level of perpetual snow, though the head of Mont Corno is only bare in summer; their summits are for the most part bare and rugged; below 3200 feet their sides are covered with luxuriant semi-tropical vegetation—orange, citron, olives, and palm trees: perhaps the main feature of the chain may be justly considered its continuity.

2 *The Upper Course of the Po.*—This river, the Padus or Eridanus of the ancients, rises in the eastern precipices of Mont Viso, at an elevation of above 6500 feet, in immediate proximity to the sources of the Durance, and flowing first to the south and by east to north, and then again by east to south, takes a double course formed by two semi-circular arcs, having diameters of about seventy-five miles, and giving to the upper basins of the Po a length of about 125 miles; while its breadth, from the sources of the Dora Baltea on the north to those of the Bormida on the south, will exceed 150.

The steepness of the southern and eastern slopes of the Alps gives great rapidity to the upper waters of the Po and its northern affluents, and therefore, on arriving at the level plain at the foot, they are subject to serious inundations; the course of the river becomes tortuous, its stream sluggish, obstructed by shoals and sand-banks, and forming numerous channels; this character becomes apparent even in its upper basin, at the eastern extremity of which the river attains a breadth of about 1500 feet.

The affluents of the upper basin are on the right: the Vraita, the Maira, and the Grana, which uniting together, fall into the main stream; the former rises in Col d'Agnello, and opens a passage into France. These are separated from the Tanaro, the next affluent of the river from the right, by the heights of Montferrat, which, projecting from the maritime Alps, obtrude themselves on the course of the Po and turn it northward, as already noticed, and fill the second semi-circular arc; and while the Tanaro collects the streams which fall from the southern slope, the main stream flowing round those to the north does not receive any affluent from them

The Tanaro passes along the diameter of the semi-circle above alluded to, in an irregular north-east course. This is a considerable stream, rising in the Col de Tende, and having a course of 125 miles, for forty of which it is navigable: it has several affluents, some of which are considerable; on the left the Eleno and the Sterra, and on the right the Bormida, formed by the confluence of two streams of the same name, and the Orba. The basin of the Tanaro wears the aspect of an elevated plain intersected with deep valleys.

The Scrivia and Coppo traverse a fertile country, and fall into the Po on the limit of its upper basin. The affluents of the left are, the Clusone, which rises in Mont Genevre, and, receiving one affluent from the pass of Abries, falls into the main stream after a course of about fifty miles.

The Doria Riparia, also rising in Mont Genevre and connecting the passes of that mountain with those of Mont Cenis at the Pas de Susa, it is divided from the Doria Baltea by the smaller affluents, Stura and Orca.

The Doria Baltea rises from two sources in Mont Blanc, and which open the passes of the Great and Little St. Bernard, communicating with the upper valleys of the Rhone and Isére: it receives numerous torrents, and has a rapid course over a deep and rocky bed.

The Seria, which has its sources in the southern declivities of Mont Rosa; it is a stream of considerable size, but unimportant, as not opening communication across the Alps; it receives the Cervio from the right. The upper course of this river is through a wild mountain valley, its lower through a flat country, through which it forms anabranches, and is connected with the other affluents on the right and left by canals; its extreme length may be estimated at eighty-five miles: it is the stream intermediate in character as in position between the upper and middle basins of the Po.

3 *The Middle Course of the Po and the Lake District.*—Projecting spurs and terraces from the Apennines approaching the banks of the river in its middle course, throw off streams from their flanks to the east and west, of these the Curona, the Staffora, and the Fidone are the principal, they are deep, turbulent, and rapid, and flow through a fertile but broken country.

The Trebbia has its rise in the angle formed by the easternmost of these spurs and the main chain in the gorge of Monte Bruno; it has numerous affluent streams, divides in several channels, extends to a mile in width, but is everywhere fordable, and often dry in summer; its inundations, however, make serious inroads on the country through which it flows: its length exceeds fifty miles.

The Taro rises in the pass of Pontremoli. The Crostolo and the Secchia, rising on the mountains of Carrara, unite in their lower courses by numerous anastomosing branches: the latter has a course of seventy miles.

The middle course of the Po may be estimated in direct distance as about eighty miles, and here the southerly trending of the Apennines opens extensive plains to the south and east; on the north, the character of the valley is very different, projecting spurs of the Alps enclosing the middle basin of the river on the east, and forming long narrow valleys, for the most part occupied by lakes famous for their beauty. The first important affluent on the left is the Ticino, or Tessino, the ancient Ticinus, which, rising from two sources in Mont St. Gothard and the Splugen, connect with those of the Rhine and the Aar: their united waters fall into the Lago Maggiore, which receives also several other streams, of which the most important is the Toccia, from the pass of the Simplon. The Tresa on the left brings to it the surplus waters of the Lake of Lugano. This lake, situated nearly 200 feet above Lake Maggiore, is of a very irregular shape, stretching its arms to the north-west and south-east among lofty, abrupt, but well-wooded precipices, by which it is enclosed; it is of great depth; its length may be estimated at sixteen miles, and its average breadth at two.

Lago Maggiore, the Lake of Locarno, the Verbanus of the ancients, as it is one of the largest, as its name implies, so it is one of the most beautiful in Italy, not less so from the character of its shores than from its islands: its length is forty miles and its average breadth two; it divides into two arms at the southern extremity; its depth is estimated at 300 fathoms in some places, and it is 700 feet above the level of the sea.

On leaving the lake the Ticino becomes navigable, flows through a level, fertile country, divides in branches, and forms many islands, and after a course of 125 miles its deep, broad, and rapid stream joins that of the Po.

In the southern watershed of the basin of Lake Lugano, the Olona and Lambro, two large rivulets, have their rise, become confluent in the valley, and again united by numerous anastomosing branches, at length join the main stream; the numerous channels thus formed make the country between the Ticino and Adda extremely difficult.

The Adda, the next important affluent of the Po from the left, has its sources in the Ortler Spitz, and in closer connexion with those of the Inn and Adige: in its upper course it flows through the Valteline, a valley fifty miles in length, by from four to twenty in breadth, opening to the south and west, and which affords communication between the Tyrol and the central plains of Italy. The Adda enters Lake Como about ten miles from the mouth of the Maira at its northern extremity, which flows from Mount Maloia; in its valley the roads from the Maloia and Splugen unite.

The Lake of Como is in length, nearly fifty, but in extreme breadth only eight; to the south it divides into two long arms stretching to the south-east and south-west, the former continuing the course of the Adda, the latter obstructed by the mountain from which the Lambro takes its rise; these, separated by the mountainous promontory of Bellagio, are about fifteen miles in length; its waters are of great depth, and it is subject to violent storms. The south-east branch is called the Lake of Lecco, and from it the Adda debouches in the valley, and about fifteen miles lower down receives from the left the Brencho, a torrent from the southern slopes of the mountains of the Valteline; and in its lower course the Seria, also from the left, having its rise in the same watershed.

The Adda is a very deep and rapid stream; its right bank is open, but the spurs from the mountains encroach on the left; its length may be estimated at 100 miles, exclusive of the lake.

The unbroken chains of mountains which form the southern boundary of the lakes are crossed but by one road, that from the western arm of Como and Lake Lugano; and the parallelogram formed by these with the rivers Ticino, Adda, and the main stream of the Po, is the central and most important portion of the valley of that river.

As between the Ticino and the Adda, so between the Adda and the Adige, the affluents of the main stream fall from the southern watershed of the upper valleys of those rivers, they having, as has been noticed, their sources in immediate proximity. Of these the Oglio is the most considerable; it descends from Mont Tonal, flows through the wild and rugged Val Canonica, opening from the gorge of Apriga, it then traverses Lake Iseo, which is fifteen miles long by two broad and above 900 feet deep, its shores are highly picturesque, and in most parts extremely fertile. In its lower course the Oglio flows parallel to the main stream; here it receives a considerable affluent, the Mella, which flows through Val Trompia, and lower down a still more important affluent, the Chiese Clusio, which, rising in the southern spurs of Mont Adamiello, flows through Val Sabbia, and traverses Lake Idro. The Val Sabbia is a dangerous defile, and opens on the lake, which is only seven miles long by two broad, yet 400 feet deep. The Chiese has a course of seventy-five miles.

4 *The Southern Spurs of the Primary Watershed.*—From the Chiese, the character of the northern watershed of the Po alters entirely, no longer rising precipitously from the level plain, but extending into and intersecting it by bold and elevated spurs. The first of these extends between the Adda and Adige, stretching to the south from the Ortler Spitz. This may be considered the south-eastern extension of the bastion which supports the eastern extremity of the central watershed, and which, though less clearly defined than that on the western, is still sufficiently well marked.

The southern spurs, culminating in the Gavio and Tonal, at an elevation respectively of 11,750 and 10,975 feet, extend westward along the Valteline and Lake Lecco, and culminate in Mont Tresero, 11,820 feet above the sea; here is the pass of Apriga, already noticed. The majestic wall of the Tonal, to the east, with its impassable rocks and glaciers, is turned, by the recently constructed road over the Stelvio Pass, over the southern extremity of Mount Ortler, connecting the upper valleys of the Adda and Adige at an elevation of upwards of 9000 feet; and a mountain path over the Tonal has been also converted into a passable road, and another pass extends westward to the basin of Lake Idro.

To the east of this remarkable chain lies the upper valley of the Adige, shut in by another chain of equal importance, though not of as great elevation, on the opposite side. This commencing in the Noric Alps, between the sources of the Eysach and Drave, is known as the Cadoric Alps, having a mean elevation of nearly 6000 feet; it culminates in Mont Marmolata, at 10,500 feet, and Cunà d'Arta, 9200, and terminating in Mont Moregno, having an elevation of 6500 feet. Two spurs are thrown off from the chain enclosing the sources of the Drave and Brenta; through the latter, the frightful defile of Sugana uniting the valley of the Brenta with that of the Adige.

The Mincio and Lake of Garda, the Benacus of the ancients, may be considered as intermediate between the middle and lower basins of the Po, and assimilates in character to both. Rising in the southern slopes of the Tonal, under the name Sarca, it falls through a very wild valley into the lake, which is near forty miles long by ten in extreme breadth, and near 1000 in depth, enclosed by mountains, excepting on the south, where the promontory of Sermio extends into it. It is still less irregular in shape than any other of the Italian lakes; it is only 230 feet above the level of the sea. In its middle course, the Mincio forms the three marshy lakes of Mantua, and encircles between its branches and a canal the island called the Seraglio. The Mincio, though of little breadth, is rapid, and being used for the purposes of irrigation, can be rendered deep enough either for navigation or defence. It is commonly navigable from Mantua, and has a course of about forty miles. The eastern shores of the lake are only five miles from the Adige, which, in its middle course, runs parallel throughout the whole length of the lake.

5 *The Lower Course and Delta of the Po.*—Sending out numerous branches, and constantly ravaging its course, unless where confined by earthworks, the Po, in its lower course, forms a network of channels, surrounding islands and connected by canals, both natural and artificial, too intricate for description. Three main channels, however, separate from each other about half-way between the Mincio and the sea. That to the north, termed Po della Maestra, forms several mouths, the principal of which are Delle Telle and Di Goro, the latter of which approaches closely to the mouth of the central channel, the Po de Volans, which in its upper course is connected with the lower course of the Po de Goro by the Canal Bianco. The southern channel, called the Po de Primero, stretches far to the south, and receives the waters of numerous small streams which flow from the northern face of the Apennines.

At the point of divergence of these channels, the river is nearly 4000 feet in breadth, and from thence it flows through troughs, partly natural partly artificial, raised high above the surrounding country; more than sixty feet near Ferrara, where the river is on a level with the towers of the city. This district is, in short, one vast alluvial deposit, which has, since historical times, extended many miles into the Adriatic; few rivers have, for their size, so extensive a delta; the rapid increase of the land on the sea has been estimated at above 200 feet yearly. The formation of new channels for the waters of the river, and the accumulation of deposit at their mouths, have contributed to render what formerly were the more important channels now useless; this is the case with the Volano and Primaro, which now surround vast marshy lagunes, separated from the sea by a slight embankment of sand which its waves have heaped up; the double action of the river and the sea has formed banks and shoals stretching above thirty-five miles from north to south, and about twenty-five from east to west; these will, no doubt, within some no very lengthy period of time, increase to islands, and limit the mouths of the river, as has happened with similar shoals, recorded by the ancients, at the mouth of the Danube.

The only affluents of the lower course on the right, worthy of mention, are the Panaro and Reno; the former, also called Scultenna, rises in Monte Cimone, and is joined by canals with the Secchia and Reno, it is navigable for a considerable part of its course of seventy-five miles; the latter, rising in the eastern spurs of the same mountain, receives several tributary streams: its course has been directed into a canal, called the Benedictine Fosse, by which its waters are carried into the Po de Primaro, which is by some considered as a natural extension of its channel; but in this country, where man has been fighting for ages to preserve the land from the inundations of the river, that which is partly natural and that which is altogether artificial cannot easily be distinguished, nor is historical knowledge of the ancient channels to be expected when the country is so entirely intersected, and where, but for the interference of man, they must be constantly changing.

The Reno has a course of seventy-five miles, but is only navigable for twenty-five. The other affluents on the right are, as already noticed, insignificant, though numerous. On the left there is but one, the river Tartaro; the stream of the Adige intercepting the waters which flow from the southern face of the Alps.

The entire course of the river may be estimated at about 350 miles, for 280 of which it is navigable for barges and steamers.

6 *Rivers of the Extension of the Basin of the Po.*—Between the southern mouth of the Po and the promontory of Ancona, more than ten considerable streams fall from the Apennines into the Adriatic. The nearest to the affluents of the great river is the Lamone, which has a course of fifty miles, as has the Ronco, at the mouth of which more than two miles of ground have been added to the coast. The Metauro is of about the same magnitude. On the north, however, the rivers of the extension of the valley of the Po are far larger and more important. Of these, the first and principal is the Adige, which seems at first sight intended for an affluent of that river.

The upper course of the Adige, or more properly the Etsch, is through the triangular valley, or congeries of valleys, extending from the sources of the Drave to the Inn, about seventy-five miles, and from the main sources of the river to the debouché, into the valley of the Po; it rises in the southern face of the gorge of Rescha, and its upper valley communicates with the gorge of Tschirf and with the Stelvio Pass; its upper course is south-east, east, and north-east, but suddenly bending at a right angle, it assumes a south-easterly direction to its confluence with the Eysach, where it has the name Adige, and whence it takes the south-westerly trending of that stream throughout the remainder of its course among the mountains. The Eysach is in some respects the more important source of the Adige; it descends from the gorge of the Brenner, and, receiving the Rienz from the gorge of Toblach, unites with the Etsch to form the Adige. The confluence of these streams is at the junction of the passes from the Valteline, the Tyrol, and Styria.

Before this junction the bed of the Eysach is 2024 feet above the level of the sea; from this point the stream becomes navigable, has a sinuous course, encloses many islands, flowing between low banks until it receives the Nos from the right, the valley of which opens communication across the Tonal; here the banks become steeper and the stream more rapid, and it receives the Lavis from the left; and a pass opens to the source of the Brenta. The Adige, pressed in by mountains, flows in its middle course through a narrow valley, winds round the base of Mount Baldo, and enters the plains of Lombardy in a broad, deep, and rapid stream: it now bends to the east, round the base of the extended spurs of the Alps, having on its right bank a district of marshes and rice fields, which reach as far as the Mincio; in its lower course it forms numerous channels, and, like the Po, finds its way to the sea with difficulty; it is connected by canals with that river, and has a course of 220 miles.

The Bacchiglione rises in the heights which form the southern limit of the upper valley of the Adige: it has a course, generally south-east, of about fifty-five miles, at first through a bold and well-defined country, but afterwards, like its fellows, through swamps and marshes, and loses itself in the Venetian lagunes.

The Brenta rises in the mountain gorges to the east of the Adige: in its upper course it flows through Lake Lerico and the Val Sugana, and then descending in the plain, creeps tortuously to the lagunes; much of its lower channel is maintained artificially; its original course apparently having been towards the Bacchiglione, with which it is still connected; its present mouth is called Brenta Magra; it is navigable throughout its lower course, and its entire length is near 100 miles.

The lagunes at the mouths of these rivers extend for above twenty-five miles, with an average breadth of five: they are very shallow, separated from the sea by numerous islands, forming almost a continuous causeway or embankment, which, from the mouth of the Piave, stretches to the south-west for seven miles; this river, rising in the Carnic Alps, to the south of the gorge of Toblach, from two sources, flows in a wide and shallow bed in its upper course, between the spurs from the mountains; in its lower, through marshes; it has one affluent in its upper course, the Cordevole, and one in its lower, the Sile, both from the right.

The Livenza, the Tagliamento, and the Isonzo, ought perhaps rather to be considered as occupying the upper part of the basin of the Adriatic, than as belonging to the extension of the valley of the Po, but their importance is scarcely sufficient to justify any prominence in noticing them: it may be sufficient to say that the two former rise in the Carnic Alps; of these, the Tagliamento is the larger, having a course of 100 miles, but it is only navigable for ten: both have irregular courses among marshes from many channels, and issue in lagunes.

The Isonzo rises in the southern slopes of Mount Terglou, and flows in a tortuous course through deep defiles and amidst lofty mountains; it receives several affluents; the Idria, famous for its mines of quicksilver; the Wippach, descending from the gorge of Adelsberg, both on the left; and on the right the Torre, which, with its affluent the Natisone, joins the Judri, and their united streams flow into the Isonzo in its lower course. This river is broad, deep and rapid, and forms a natural limit between Italy and Istria; some small streams occupy the space between it and the Tagliamento; these three rivers have considerable deltas, and the coast is lined with lagunes and covered with islands.

CHAPTER XX.

PENINSULAR ITALY.

§ 1. The watersheds.—2. The rivers of the west.—3. The rivers of the east.—4. The lakes.

THE Watersheds.—The chain of the Apennines leaving the basin of the Po, passes through peninsular Italy, and culminating near the centre, divides towards the south in two chains, forming the cincture of the gulf of Otranto and of the basin of its tributary streams; and stretching southward in the peninsula of Calabria, and eastward in the promontory of Otranto. At the point of separation of these chains, the head waters of the Tanagro on the west, of the Ofanto on the east, and of the Bradano and Vasento on the south, are in close proximity; numerous spurs are thrown off to the east and west, the principal of which forms the watershed between the Arno and Tiber; detached elevations are also frequent, of these the best known is Vesuvius, a volcanic cone rising 3950 feet above the sea, and extending, with its inferior cone, Mount Somma, in an arc of eight miles; this latter is a precipitous mass of porphyry and tufa, the principal elevation being composed almost entirely of lava and scoriæ; the crater has a diameter of above 1500 feet, and is 500 feet deep; forty-nine eruptions have been recorded from this mountain since the year 79.—(See *Phys. Geo.* page 273.)

The Apennines divide the peninsula unequally to the north, affording space on the western slope for considerable rivers, while on the east torrents leap abruptly into the Adriatic; but on the south, having Mount Volture, the point of divergence of the two chains, exactly midway between the two seas; the eastern slope is therefore, for the most part, extremely irregular in its contour, wild, rugged, and unproductive; the western no less famed for its beauty than its fertility.

2 *The Rivers of the West.*—Of these the first is the Magra, which after a course of thirty-five miles falls into the sea to the east of the gulf of Spezzia; next the Serchio, with a course of fifty-five miles, and then the Arno, rising in the south near the sources of the Tiber, which flows at first in an opposite direction; both in their lower courses flow to the west, and thus inclose an area of about 140 miles long by sixty broad, better known, perhaps, and more important in the world's history than any portion of the world's surface of equal size.

Like the other rivers of Italy already noticed, the Arno, in its upper course extremely rapid, has its lower course without sufficient fall, is therefore subject to inundations, and has its waters regulated by canals and embankments.

The Arno rises in Mount Falterona, at an elevation of 4444 feet; it has several affluents; of these are the Sieve, Pesa, Elsa, and Era. The Chiana emerging from the ancient marshes of the same name, is by some considered a bifurcation, but it is rather an affluent, as the stream of the same name to the south is of the Paglia, by which it joins the Tiber.

The entire course of the Arno may be estimated at 150 miles; it is navigable throughout nearly the entire length of its western course; its principal junction with the sea is effected by an artificial channel.

The district between the Arno and Tiber is drained by several streams; the Cecina, Ombrone, Albegna, Fiore, Marta, and Arone; of these the Ombrone is the principal, having a course of seventy-five miles; of this river the Orcia is affluent. The length of the others is less than fifty miles, but the Marta is of importance as carrying off the surplus waters of Lake Bolsena, which is ten miles long by eight broad, and lies among richly-wooded hills; in it are three small islands. The Arone, a small stream, carries off the surplus waters of lake Bracciano, which has a circumference of twenty-two miles. To the north of the Ombrone is the lagune of Castiglioni, which receives the waters of several small streams; it is about ten miles in length.

The Tevere, Tiber, or Tibris, rises in Monte Comari, to the east of the sources of the Arno, and flows with a southerly course for nearly 150 miles before it trends to the westward; it joins the sea by two mouths, enclosing a small deltic island, the Insula Sacra of the Romans. In the spring its stream is rapid, and turbid with yellow deposit from the mountains: as already noticed, it is connected with the Arno by its affluent the Chiana; its principal affluents are the Topino, Nera and Teverone from the left, and the Nestore and Nepi from the right. Of these, the Nera has a course of sixty miles, and is noted for its beautiful cascade at Marmora above Terni; the Tiber is navigable when its stream is full to the confluence of the Nura. The Teverone, or Anio, has a course of about fifty miles; this river supplied ancient Rome with water. At Tivoli the Teverone forms a beautiful cascade of eighty feet in height. The Tiber is said to receive the waters of above forty affluent streams. The country on the coast, between the Arno and Tiber, is called the Maremna; it is an extensive plain, continued to the south in the Campagna of Rome and the Pontine marshes, and having an extent of above 200 miles; of this, the northern portion, the Maremna, has in many places become sterile from neglect; efforts have, however, lately been made, with success, to drain it; that to the south, the Campagna, is of extraordinary fertility, but like the Maremna, and even more severely, its inhabitants suffer from the terrible malaria. This disease, now so fatal, does not appear to have severely touched the inhabitants of those districts when they were well cultivated and populous. Of undulating surface, drained by numerous small streams, and producing spontaneous vegetation, the Campagna wants only an industrious population to restore it, in process of time, to its former condition; it is at present used mostly for pasturage. The Pontine marshes are about twenty-five miles long by ten broad: they can now scarcely be called by that name with propriety, except in the more northern portions, the canals, now nearly completed, having sufficiently effected their drainage. Like the Campagna, they are used principally for pasturage. The general slope being eastward, the lowest portion of the district is inland, and from it the mountains rise suddenly: these form the southern watershed of the upper waters of the Garrigliano, which, like the Tiber, to which its sources have close proximity, has a south-easterly course. This river, the ancient Liris, has a course of seventy-five miles, and receives the waters of the Cora and Sacco united from the right, and of the Melfa and Rapido from the left.

The next important stream is the Volturno, which has a course of nearly 100 miles, and receives several affluents, the principal of which is the Calore from the south, which receives also the Tamaro from the right and the Sabbato from the left.

To the south of the Volturno is the ancient Campagna Felix, stretching in a level tract for forty miles in length by twenty in breadth, varied only by the cone of Vesuvius and the low, undulating ridges which stretch towards Cape Miseno; it is of undiminished fertility in corn and wine.

The streams which fall from the southern slope of the watershed of peninsular Italy are little more than torrents, and frequently dry in summer; they are the Crati, which with other streams drains the forest of Sila, the Sinno, Agri, Salandretta, Vasento, and Bradone; the country through which they flow is irregular and rugged, producing little but pasturage.

3 *The Rivers of the East.*—The shortness and irregularity of the eastern slope of the peninsula confines the streams which drain it to small areas; of these the Ofanto, the ancient Aufidio, on the south, has a course of seventy-five miles, and the Candelaro of forty-five; the latter has at its mouth a considerable lagune and important salt works.

To the north of Cape Gargarno the Biferno is important, as opening direct communication between the Bay of Naples and the Adriatic; its length may be about forty-five miles. The Pescara and its confluent the Aterno have their sources north-west and south-east, at about fifty miles apart, between the head waters of the Tiber and Carrigliano, and flowing in opposite directions, have, after their confluence, a course at right angles to their upper courses; the length of the united stream is about thirty miles. This river is important, as affording communication with the Velino by the gorge of Androcco, which is again connected with that of the Carrigliano by the gorge of the Tagliacozza. There are also the Vomano, Tronto, and Chienti.

4 *The Lakes*—The peninsula of Italy has lakes contained in their own basins, and having no outlet; hence their valleys have become the more important in history as centres of communication; of these, the lakes of Perugia, the ancient Trasimenus, and that of Fucino, are the most important; the former especially, from its proximity to the head waters of the Tiber and Arno; it has a circumference of thirty miles, has three islands, and is surrounded by hills covered with forests of oak and chesnut; the latter is between the sources of the Aterno and Carrigliano, and is ten miles in length.

CHAPTER XXI.

GREECE.

§ 1. The watersheds of the north.—2. The rivers of the west.—3. The rivers of the east.—4. The isthmus and the Morea.

THE Watersheds of the North.—Greece may be described as a massy promontorial extension from the primary watershed of Europe, terminating in a peninsula of corresponding magnitude; formed by the projection of numerous and irregular spurs, its coasts are deeply indented, and the lines of its capes and promontories carried onward into the sea in numerous islands; from Mount Kernitza, the point of junction with the Italian Alps, its western extremity, and the mouth of the Bosphorus, its eastern, the distance may be estimated at 650 miles; while a perpendicular line drawn from this base to the southern extremity, Cape Matapan, would be 375 miles in length.

The western extensions of the primary watershed from Mount Kernitza to the Black Sea, has been already described (p. 286); it remains to notice the spurs projected to the south which form the watersheds of Greece Proper. From Mount Scardo an unbroken chain of mountains, called Agrafo, the ancient Pindus, which culminates 8950 feet above the sea on Mount Mezzoro, and Tymphrestus stretches to the entrance of the Corinthian Gulf, of which it forms the limit to the north, the ancient Antirhium. About seventy-five miles to the south of Mount Scardo there is another knot, Mount Zigos, from whence spurs are thrown out to the east and west, forming the ancient Cambunian mountains, on the west extending to the Acroceraunian promontory near Cape Linguetta, and on the east to the coast chain which forms the limit to the plains of Thessaly towards the sea, and which extend round the Gulf of Volo, marked by the culminations, Olymbo, Kissovo, and Zagoro, the ancient Olympus, Ossa, and Pelion, the former rising 9750 feet above the sea. From Mount Zigos the chain extends southward for about the same distance to the ancient Othrys, Mount Hellovo and Varibovo, which stretches eastward to the shores of the Gulf of Volo, and culminates in Geraco or Gura Vouno, 5570 feet above the sea, and all but meets the western extension of Pelion, Mount Bordzoia, the ancient Tisæus. Parallel to this, Mount Aninos, the ancient Œta, culminating in Katabothra and Aninus, which have both an elevation of more than 7000 feet, extends from Tymphrestus, forming the southern watershed of the valley of the gulf of Molo, which extends into the channel of Talanda, the ancient Eubœan Sea; and nearly parallel to this again, but with a more southerly trending, Lyakoura, Paleo Vouno or Zagora, and Elatea, the ancient Parnassus, Helicon and Cithæron, rising respectively 8000, 5000, and 4600 feet above the sea, form the watersheds of the south-east, and the promontorial extension of Cape Colonna, the ancient Sunium; while from the latter those spurs extend which connect by the isthmus the mainland with the Peloponnesus. From Mount Zigos two spurs extend to the west and south; the one nearly parallel to Pindus, forming the eastern watershed of the valley of the Gulf of Arta, the ancient Ambracia; the other more irregular, trending north and south, and broken into several smaller spurs, which stretch towards the northern shore of the gulf of Arta and the coast opposite Corfu, the ancient Corcyra.

The eastern range is remarkable for its continuity and solidity; it must approach closely 10,000 feet in its culminating point, but has much less average elevation; it is but little known; the defiles by which it is crossed are, one leading from the Drin to the Vardar, immediately to the south of Mount Zigos; another from lake Ochrida, at the southern sources of the Drin to the southern sources of the Vardar; a third connecting the valleys of the Beratino and the Nazilitza; a fourth a little lower down.

2 *The Rivers of the West.*—On the north and west the mountains approach so closely to the sea that there are no rivers; but the valleys are occupied by the sea, and the mountains are prolonged in islands, which cover the coast for about 120 miles south of the peninsula of Istria. The first river worthy of notice appears to be the Kerka; this has a course of sixty miles, and two affluents, the Knin and Dernis; it has considerable falls, but below them is navigable for large coasting vessels. Below this, Cape della Planees forms a corresponding projection to the peninsula of Istria, and below this again islands extend almost to the gulf of Cattaro, notwithstanding we find here a considerable river, the Narenta, having a course of at least 150 miles: here also is the Trebintitza, which flows parallel to the coast, but has no outlet. Below the gulf of Cattaro we find the Bajana, which, rising in lake Plava in the Missava mountains, has a course of about sixty miles, in which it forms the lake Scodra, or Scutari; it has a considerable affluent, the Moracca, from the right. The Drin, which rises from two sources, as already noticed, about 120 miles apart, known as the White and Black Drin, the latter flows from lake Ochrida, which lies between lofty mountains, and is about eight miles long; the Drin has a course of about 100 miles. From the outer slope of the western watershed of the Black Drin, several torrents fall into the sea; the Mati, or Mathis, the Scombi, and the Ergent or Beratino, may be named; this latter, indeed, has its sources to the east of lake Ochrida; it is estimated at 130 miles in length.

The Poro or Vojuzza, the ancient Aous, falls from the northern extremity of Mount Pindus, and near the point of divergence of the transverse chains already noticed has two considerable affluents: the Diznitza on the right, and the Argyro Casto and Soutchitza on the left; it may have a course of 150 miles; near its mouth, the coast is covered with lagunes; its southern watershed is extended from Mount Zigos to Mount Chimæra; from its outer slope several small streams unite their waters in the lake or lagune of Butrinto or Vivari, which is about five miles long.

To the south, the Calamas flows through a fertile country for more than 100 miles; it receives several affluents, the principal of which is the Karanitza. From the right, this river has its principal source in the eastern watershed of the lake of Janina, which lies enclosed in mountains 2500 feet above the sea, and the waters of which are said to unite themselves with those of the Calamas by subterranean channels. This lake is five miles long by three broad; and between the valley of Janina and Mount Zigos the river Arta has its rise. This river flows through a narrow valley, and has no considerable affluent; its length may be above sixty miles, and it falls into the gulf of the same name, the present mouth being two miles to the east of the old one; it is navigable for fifteen miles, but its entrance is impeded by sand-banks. This gulf is the ancient Ambracian Gulf, and it also receives the waters of the Liris, which may have a course of thirty-five miles; to the north of this is the Mavro or Mauro Potamo, a rapid torrent with an irregular and tortuous current, flowing through a wild and rugged country.

The Aspero Potamo, the largest river on this side of Greece, rises among the southern spurs of Mount Zigos; it has a course of above 100 miles, at about one-half its length it is above 150 feet broad, and at its mouth in the rainy season, a mile and a-half; it does not receive any affluent of importance, though on the right in its lower course it receives the surplus waters of lakes Castro and Vrachori, the latter being about six miles in length.

All the rivers of the western slopes of the Greek region are little better than mountain torrents, most of them dry during part of the year; they flow through hollow valleys, among broken and rugged mountains, in some places still covered with forests.

3 *The Rivers of the East.*—The southern slope of the Emineh Balkan presents some considerable streams, all of which, however, flow into the Ægean Sea, or Archipelago, the south-east extension of the watershed of the country towards the Bosphorus being too close to the shore of the Black Sea to leave room for more than one considerable stream; and this is also the case with the coast of the Sea of Marmora, for the chain is continued south and west into the Thracian Chersonese, and then nearly surrounds the basin of the Maritza, the most easterly river flowing into the Ægean.

The Maritza, the ancient Hebrus, rises in Mount Egrisou, and its head waters open communication with those of the Isker and Nid, by the passes of Souli and Kis Derbend, as also with the head waters of the Kara Sou, from which it is separated throughout the rest of its course by the continuous rampart of Despoto Dagh; this forms a natural barrier between Thrace and Macedon, covered externally by the fosse of the Kara Sou, and separating the fertile plain of Roumelia from Greece proper. The Maritza has a course of above 250 miles; it receives the waters of two considerable streams near the centre of its valley; the Tondja on the left, and the Arda on the right; below these, two others, the Salsdere and Tekedere, join the main stream, and swelling the eastern feeders of the Tondja, open communication with the shores of the Black Sea; all these are confined within the upper basin of the Maritza by the spurs of Despoto Dagh, which press closely on the river, and leave but a narrow channel for its waters; its lower course of about forty miles is through the level country which extends along the coast of the Ægean.

To the west of the Maritza is the Kara Sou or Mestus, which flows through a narrow valley for about eighty miles, not receiving any affluent; its mouth is opposite the island of Thasos; still further westward is the Struma, also called Kara Sou, the ancient Strymon. This river has three well-defined basins, the upper encircled by mountains, but affording communication with the valleys of the Maritza, Vardar, and Isker; the middle basin widens, and in the lower it flows through a lagune, called lake Tikinos; its valley is fertile, and was formerly noted for its mineral wealth; its course may be 150 miles. Irregular spurs from the Balkan separate the Struma and Vardar, and project into the sea a massy promontory, the ancient Chalcidice, from which three peninsulas extend, surrounding the gulfs of Monte Santo and Cassandra, and separating them from those of Contessa and Salonika; the most eastern is the famous Mount Athos, now Monte Santo; the whole country, so famous in ancient story, is all but devastated.

The Vardar and Indje Mauro, or Nazilitza, flow into the gulf of Salonika. The upper course of the Vardar, formed by three considerable streams, is a succession of rapids; after their confluence it flows through a fertile and beautiful valley; the Vistritza, a confluent of the lower course of the Vardar, flows through a lake of the same name; the Vardar has a course of about 175 miles; the valleys of the affluents of this river open communication between the Ægean and Adriatic by the valleys of the Drin and Poro, while its main source is in immediate connexion with that of the Morava; it must therefore always have considerable political and commercial importance. The Indje Mauro, or Nazilitza, has one of its sources in lake Castoria, which may have a diameter of five miles; this river has a rapid and irregular course of nearly 100 miles.

To the south of the Indje Mauro, and separated from it by the chain of the Camburnian Mountains of the ancients, is the Salembria, the ancient Peneus, the river of Thessaly, which has its main sources in the south-eastern slopes of Mount Zigos, and its secondary source in Mount Gura Vouno, part of the ancient Othrys, about seventy-five miles distant, north-west and south-east; it finds its way to the sea through the narrow defile of Tsampas, the ancient Tempe, between Olymbe or Lacha, and Kissova, the ancient Olympus and Ossa. Few valleys exceed this in natural beauty and fertility; it is surrounded, as has been noticed, by mountains; its natural outlet is not, however, by the Salembria, but by the gulf of Volo, to the south, between which and the valley of the Salembria, lies lake Carlas, the ancient Bœbeis, which is nearly ten miles in length, receives several small streams, but has no outlet for its waters. There are many such lakes of small size within this region, a consequence of the irregular and broken surface of the country.

The Salembria has several affluents, the principal are the Fanari from the south-west, the Saranta Poros, the Eurotas of the ancients, with the Sataldje, the ancient Apidamus, which may perhaps be rather considered a confluent, and its affluent, the Emicassuos or Phœnix, from the left.

The Hellada, the ancient Sperchius, flows through a narrow valley between Othrys and Œta into the gulf of Molo or Zeitoun; leading from this valley along the coast round the termination of Œta, is the pass of Thermopylæ; it is about five miles in length, and the principal part covered by a morass. The Hellada has a course of above fifty miles.

South of the Hellada is the valley of the Mauro Potamo, or Gavrios, the ancient Cephissus, flowing into Lake Topolias, or Copais, which has no outlet for its waters except by subterranean channels, both natural and artificial. This lake varies much in size with the season; when at its highest, its length is about sixteen miles, and its breadth eight; it is, however, frequently in summer only a marsh, and is still famous for its eels; it is 1000 feet above the level of the sea. The Cephissus has a course of above fifty miles; and the lower portion of its valley, as well as the shores of Lake Copais, were famed for their fertility. The other Cephissus, near Athens, in Attica, has only a course of about twenty-five miles, and is an insignificant stream; the Asopus, which flows into the channel of the Negropont, has about the same length. The promontorial extension of Attica round the gulf of Egina, the Saronic Gulf of the ancients, presents no valleys sufficiently large to form rivers.

4 *The Isthmus and Morea.*—The isthmus of Corinth, which connects the peninsula of the Morea, or Peloponnesus, with the promontorial mass of northern Greece, is about twenty miles long, and varies in breadth from four to eight; its northern limit is formed by a transverse spur, the ancient Geraneia and Oneia, which extends across it from the extremity of the extension of Mount Cithæron to the south-west, now known as Mounts Polkorouni and Makriplai. On the south the Morea spreads to the west round the gulf of Corinth, and on the east along the Saronic Gulf, here forming a promontory thirty miles long by fifteen broad, the ancient Argolis, to the south of which is the gulf of Nauplia, anciently of Argolis; it is from the head of this gulf that the mountains which form the framework of the peninsula diverge in six distinct chains, the directions of which are marked by six promontorial extensions from the principal mass; these terminate respectively in Capes Skyllo, Malio, Matapan, Gallo, Tornese, and Papas, known to the ancients as the promontories Scyllœum, Malea, Tœnarium, Acritaz, Chelonites,

and Araxus. The range, of which the former is the extremity, was anciently called Arachnæus, now Sophico; it is of inconsiderable elevation; it extends eastward from Mount Cyllem, the central point of the whole, about fifty miles, from which to the south Mount Mallivo, the ancient Artemisus, and its extension, Mount Zarax, form the coast line on the east, and limit the plain of Arcadia and the valley of the Eurotas on the west; Mount Chilinos, the ancient Croniûs, extending westward, bends southward round the valleys of the Kokla and Pirmatza, the ancient Colus and Pamissus, and throws out a spur to the south, between the latter river and the Eurotas, now called Pentidaclytan, the Taygetus of the ancients, which culminates on Mount St. Elias 8000 feet above the sea. This range may be fifty miles long, and the more western, known as Mount Tetrasi, the Ægaleus of the ancients, forty from Cyllene to Cape Malio, is ninety miles. The western range extends from Cyllene about sixty miles, throwing off a spur to the south round the river Igliaco, the ancient Peneus, and to the north to the promontory of Drepanon, and the ancient Rhium, at the entrance of the Gulf of Corinth; it is known as Olonos, the Olonela of the ancients, and by other local names.

The principal river of the Morea is the Rouphia, the ancient Alpheus, which has a course of above 100 miles, and several considerable affluents, which drain the entire area of the plateau of Arcadia: its southern sources and those of the Klitor, its confluent from the Nare, about fifty miles apart. The upper course of this river is irregular, broken, and rapid; the plain about its lower course is of great fertility. The next in importance is the Ires, or Eure, the ancient Eurotas, but it has only a course of fifty miles, and does not receive any considerable affluent; its valley is also remarkably fertile.

CHAPTER XXII.

ON THE VEGETATION OF EUROPE.

1. General view.—2. The northern region —3. The central region.—4. The southern or Mediterranean region.

GENERAL *View*.—It has been noticed (P. G., p. 330) that the vegetation of the European continent is naturally distributed over three regions: 1. Of the saxifrages and mosses; 2. Of the umbelliferæ and cruciferous plants; 3. Of labiatæ and caryophyllæ; and occasional short notices of the vegetable products of different portions of this division of the great eastern continent have been interspersed here and there in the course of its description. As, however, the recent labours of botanists, especially of Schouw, in classification and localization have presented this subject to us as nearly complete, so far as its geographical application is concerned, it may be well to append here a general statement of the results of their labours, which have been lately presented to us in a popular form by Mr. Henfrey. (*The Vegetation of Europe*. Van Voorst.)

In the division of Europe for botanical purposes, perhaps it might be more easy to separate the mountains, table lands, and plains, and in this case there would be:—

1 *a*. A southern principal mountain chain, the Alps, and continuations east and west.

b. A central highland, the German, Bohemian, and Carpathian mountains.

c. A north-west highland, the mountains of Scandinavia and Great Britain.

d. A south-west highland, the Spanish peninsula.

2 *a.* The plateau of Spain.
b. The plateau of Bavaria.
3 A great plain extending from east to west, and bounded by the central and northern highlands.

Besides these, there are the plains of France, Lombardy, Hungary, and the Danubian Principalities, more properly to be considered as the lower portion of river basins, differing therefore in character from the great northern plain.

The distribution of vegetable life depending on position, soil, and temperature, including under these heads position, both vertical and horizontal; soil, whether natural as of rocks in situ, or of that formed by their collected *débris:* and temperature, both with respect to heat and moisture. Of the second, a general outline has been given in the chapter introductory to the Descriptive Geography of Europe. (p. 283.) Of the third, in its general relation to the temperature of other parts of the earth's surface, sufficient information may be found in the chapters on Meteorology, in the physical portion of this work; but it will be necessary, with special reference to the vegetation of Europe, to add to what has been there said. The first must of course be a local consideration.

With respect to the temperature of Europe, viewed in this aspect, it may first be noticed that a line, indicating a mean temperature in January of 32°, or corresponding to the freezing point of water, would pass along the western coast of Norway from the island of Stadtland, through Bergen to Amsterdam, cross the Danube near Passau; the Save near Brod; and skirt the south bank of the river, from Widdin to Sistova; passing out at Varna, crossing the Black Sea to the mouth of the river Rioni. This may be called the line of normal temperature of European winter. To the south of it we find the western portions, Belgium, France, part of Bavaria, Spain and Portugal, Italy, Dalmatia, part of Croatia, Turkey and Greece; to the north the Danubian provinces, Russia, Hungary, Arabia, Sclavonia, Bohemia, Northern Germany, Holland, Denmark, Sweden and Norway. It should, however, be observed that, with respect to other portions of the world, as the general thermic normal—*i. e.*, the lines of average temperature for the latitude—passes along the eastern shores of the Black Sea to the mouth of the Don, within the chain of the Caucasus, does not extend westward beyond the meridian of 37° east, and then assumes a north-east direction round the source of the Volga, nearly the whole of Europe has a winter temperature above the average due to its latitude; while, as the thermic normal of July just touches the western coast of Portugal throughout its entire length, and then passes through the Irish Channel and across Great Britain, from the Solway to the Firth of Forth, Ireland and part of Scotland are the only portions of Europe in which the summer temperature is below the average. It will be seen, also, on inspecting an isothermal map, that the winter and summer isotherms, or lines connecting places having an equal temperature, have a tendency to assume contrary directions, the former especially in the north falling from north-west to south-east; the latter, excepting in the north-east, rising from south-west to north-east. These lines cross each other, and their points of intersection will be found to the north of Cadiz; and at Malaga, in Spain; at Bordeaux, Rochelle, near the Land's End, the mouth of the Maas, at Bergen; near Lake Mioren, Linsall, and Umea, in Sweden; and, omitting those further north, to the east of Lake Ilmen, at Tambow, near Saratov, and Kiev, in Russia; to the east of the Sea of Azov; near Zabatz, on the Save; near Passau, on the Danube; and to the west of Messina, in Sicily; this, the most southern intersection is of the lines of seventy-seven and fifty, and corresponds to that of Malaga, while the more northern at Umea, is of the lines of twenty-four and fifty-nine; the former intersecting that of seventy-seven to the east of the Caspian, and showing very clearly that all the countries within these limits have great heat in July; notwithstanding the cold in

January. The greatest extremes are found on the east near the Caspian; the most equal temperature, on the Atlantic sea-board.

With respect to moisture, it may be observed that almost the whole of western, northern, central, and eastern Europe, lie within the limits of the autumnal rains. These differences are, however, observable. In the centre and on the north-east, the rain-fall is comparatively little throughout the year, being below fifteen inches in Prussia, Poland, and Russia, and rising to twenty-five inches to the south and west; in the north-west, and south-east and south-west, the average is greater, varying from twenty-five to thirty inches; but in the south-west of Norway, the north-west of Scotland, the south of Ireland, the south-west of England, the north-west of France, and west of Portugal, as throughout the whole length of the Swiss Alps, the average is thirty-five inches; the increase is on the western slopes of the mountains; the table-land of Castile is an exception, the average there being ten inches; the south-western extremities of Spain, Portugal, Sicily, Italy, and Greece, lie within the limits of the prevalent winter rains, and are, the former excepted, comparatively dry.

Ireland, the Scandinavian mountains, the Balkans, the Alps, the Pyrenees, and the Sierra Nevada are within the limits of the snow line, either from elevation or position; the Carpathians, Apennines, the mountains of Corsica, and Etna, in Sicily, are just without it. On the north, the elevation of the line may be stated roughly as 2000 feet above the sea; on the south, 10,000. Glaciers are found in the Scandinavian mountains and in the Alps; 'indications of them' in the Carpathians and Pyrenees.

With these preliminary considerations, a more particular description of the three regions into which Europe has been divided botanically, may be entered upon.

2 *The Northern Region.*—This may be divided into the Scandinavian peninsula, and the great northern plain.

The Scandinavian mountains are for the most part composed of primitive rocks, of which gneiss predominates; the longer slope towards the east has a continental climate; the shorter to the west a maritime; the mean temperature on the one being about 42°; on the other 44°. The winter is however 5° warmer on the east, being protected on all sides from the extreme cold of the Arctic regions, but the summer is 1° colder. The following examples give some idea of the relative temperatures of different parts of this district:—

	Mean Temp.	Winter.	Summer.
Stockholm	42°	25°	62°
Drontheim	40	23	59
Umea	35	14	57
North Cape	32	23	43½

The difference of latitude 12°, Stockholm being in 59½°; the North Cape 71°; and Drontheim and Umea about 64°. At the latter place mercury has been frozen, indicating a temperature 36° below zero.

The seasons in Scandinavia are not dissimilar from those usually found within the same latitudes; the long days in summer bringing on vegetation with great rapidity. The eastern side is drier than the western; the annual rain-fall at Stockholm being seventeen and a half inches, and at Bergen seventy-seven and a half; but these are probably extreme cases. The snow line in the south has an elevation of 5300 feet, and in the north of 2300. Forest trees abound throughout the peninsula. The most prevalent are the birch, which reaches 70° of north latitude, the Scotch fir 69°, the spruce 67° on the west, but on the east 69°. Of others, the hazel reaches 65½° on the west, and 63° on the east; the lime 64° on the west, and 63° on the east; the elm 63° on both.

In elevation, three zones are discernible—of the conifers, of the birch, and of Alpine plants. The limits of the two former are, in the south 2800 and 3500;

and in the north 700 and 1500. The latter ascends to the edge of the perpetual snows, consisting of dwarf birch, bright-coloured perennial flowers, Iceland and rein-deer moss.

Of the cereals, barley is cultivated as far north as 70°, at an elevation of 800 feet under the 67th parallel, and of more than 2000 under the 60th. Rye will ripen at 67° on the west, and 65½° on the east; oats at 65° on the west, and 63½ on the east, but are not much cultivated beyond the 60th parallel.

In southern Sweden, a district of lakes, and where sedimentary rocks form a considerable portion of the surface, the same flora is found, with the addition of the beech and oak to the forest trees; the former reaches 58° on the west, and 56½° on the east. Here three districts may be characterized: of East Gothland, the eastern portion of which presents a luxuriant vegetation, while the beech is predominant in the west; of West Gothland, in which pine forests are found on the coast; and South Gothland, where the pine is succeeded by the beech, with the elder and honeysuckle. The eastern islands being of calcareous formation, have a flora approaching to that of the Austrian Alps. Here orchises are found in abundance. Oeland is stony and comparatively desert. Passing into Finland, we find the average temperature of Abo 23° in winter, 60° in summer, while the mean is 40°, the annual rain-fall being twenty inches. The forests consist of Scotch fir and birch, with oak as far north as Biorneberg, in latitude 61½°. Here the difference in the seasons is greater than in the Peninsula; the annual mean temperature lower, and rain-fall less; the causes influencing these conditions are distance from the great regulator of temperature, the Ocean; proximity to a frozen sea on the west, and a frozen continent on the east; the eastern side is therefore colder than the western.

In Lapland, on the Swedish side, the three zones already noticed may be still distinguished, but these may here be subdivided with advantage. In the coniferous region there is a lower zone of vast swamps and sandy tracts, with corresponding vegetation of water plants, abundance of sedges among dark and gloomy woods, the plains being covered by creeping plants. Above, the spruce fir predominates, and attains a greater development and elevation than the Scotch fir in the Alps, in the hot, moist, and confined valleys. The forests here are dense, and there are extensive marshes; and this region occupies the lower hills and more elevated plains to an elevation of 1400 feet, above which pine forests are found on the sides of the mountains, but in the valleys the spruce attains a greater elevation.

The region of birches has also been subdivided, but it is to be observed that the betula glutinosa mixes with the betula nana in the upper districts, dwarfed and stunted, but attaining considerable development in the lower. The general extreme elevation of the birch may be stated at 2100 feet. Throughout Lapland the summer vegetation is peculiarly rich and luxuriant, the flora being, in consequence of the continued heat of the short summer, composed largely of plants naturally belonging to more southern regions. This is particularly the case in the Alpine region, where vegetation can scarcely be said to reach the snow line, few of the elevations being so high. On the east of Lapland the vegetation approaches in character that of Siberia. On the west, as in Norway, there is a maritime region, which is not found in the east, and which is characteristic of its flora. The difference of temperature is also in every respect considerable, of which the following comparison is afforded:—

	Annual mean.	Winter.	July.
Nidarosia	40°	19½°	64½°
Island of Mageroe	32	22	40

The maritime region extends, though not continuously, being broken by the deep indentations of the numerous fiords, to the most northern point, and is characterized by maritime plants commonly found in more southern latitudes.

Attached to Finland on the east and south lies the great plain of Russia, surrounded for the most part by land, having no maritime influences but from the Black and Caspian Seas; its climate and productions are continental. The temperature of its different parts may be seen from the following table:—

	Elevation.	Latitude.	Annual.	Winter.	Summer.
St Petersburg	. . . . .	60°	38½°	16°	62°
Moscow	484 feet	56°	38½°	11°	66°
Kazan	120 ,,	56°	36½°	11°	63°

From which it will appear that Moscow has the winter of the most northerly part of Europe, with the summer of France; to which it may be added that at Kazan mercury sometimes freezes, and that the shores of the Sea of Azov and banks of the Volga, at its embouchure, are frozen every winter. Throughout this region the rain-fall is very unequal, twenty-one inches is given as the average at St. Petersburg, while on the south it is recorded that rain has not been seen for twenty months, but in wet years it often saturates the deep clay soil so as to interrupt agricultural labour. In summer there is often neither rain nor dew, the soil cracks, and vegetation withers; possibly 6½ inches might be taken as a mean, if an average in such a case could be useful. The prevalent winds are from the east and north.

In Arctic Russia the spruce forests are scarcely seen; but a zone of low birches and willows is succeeded by dwarf birch and Arctic ericaceæ; with these the continuous turf ceases, and is replaced by isolated tufts of ranunculus, saxifrage, or grass, the ocean being bounded by an extensive, low and desert tract of country.

To the south of this region, the provinces of northern Russia are characterized by dense forests of pine and spruce, with occasional groves of alders and birch, the former usually indicating the limit between cultivation and the wilderness. These are interspersed with occasional plants of aspen, mountain ash, and wild cherry. A subdivision may, however, be made here with advantage: the clayey and marshy lowlands, which are found on the old red sandstone formation, produce spruce, intermixed with aspen and alder; the low hills of sand and diluvial deposit bearing the Scotch fir and birch, and in this district open heaths are also found. In the bogs of the clayey lowlands of Northern Russia, two vegetable formations are also distinguished, the one where the bog, properly so called, is covered with turf, and produces the cranberry, stunted birch bushes, willows, &c.; the other, in which the bog moss is not found, the bottom is firmer, and the characteristic vegetation is formed of sedges and cotton grass, while water-lilies float on the surface of the pools. Throughout this portion of Russia the rivers form deep channels in the plain, their valleys presenting two terraces; the upper, about fifty feet below the forest, is usually cultivated; its surface is undulating, and its hollows occupied by swampy meadows; the lower horizontal, covered by the inundations of the river, and affording fertile meadows. The course of the river is on the right side of the valley, immediately below the steep escarpment of the upper terrace.

In Central Russia the pines and firs decrease, and the aspen forms dense and extensive forests, as does the birch; these are replaced by the oak, ash, and lime, with an underwood of hazel and thorn: of these, Jaroslaw, 160 miles north-east of Moscow, is the northern limit: the characteristic difference between Northern and Central Russia is, however, that in the former the forest, and in the latter the open country, occupies the larger area. The forests have, however, been extensively destroyed both in Central and Northern Russia; formerly forests of larch and Russian cedar were frequent to the west of the Dwina, but are now only found to the east in the government of Wologda, on the river Suchonà, which, with its confluent, the Jug, forms the Dwina, and is now the principal route from Wologda to Archangel; the stems of the fir and aspen attain an altitude of from 100 to 150 feet, and the birch not unfrequently of 100.

In Central Russia the magnesian limestone begins to predominate over the old red sandstone of the north; and on the south, the new red sandstone and mountain limestone form a marly soil, which, with calcareous marl, cover extensive areas. The influence of geological formation on botanical development is well marked here, for with the calcareous soil the central region of vegetation encroaches on the northern, while, where opposite geological conditions prevail, as between the Dwina and Dnieper, the northern region extends towards the south.

As Northern Russia is characterized by the predominance of coniferous trees, and the Central by deciduous trees, the steppes of the south are no less distinctly defined; but the district of the Ukraine, where the calcareous rock still presents itself, is not dissimilar in the character of its vegetation to Central Russia. Oak, lime, aspen, poplar, ash, and maple form the forests, the undergrowth being hazel, but southern forms are abundant under the influence of a milder temperature. The peculiar characteristic of the flora of Southern Russia is, however, the result of the deep black mould which covers the alluvial deposit resting on the calcareous and tertiary formations; this protects the plants which grow in it from the long droughts of summer, and favours the growth of those species the roots of which strike deep into the soil; hence the character of the forest trees, and the gigantic development of several herbaceous plants, thistles, and umbellifers, the number and size of the fungi which specially characterize the flora of the Ukraine. The northern limit of this black earth is Tchernigsa on the Dnieper, and from thence passes north-east to Simbersk on the Volga.

The more southern vegetation is marked by the predominance of fruit trees and the absence of forests, which are only found in the swampy hollows and river bottoms; in these the oak is most abundant; this is the characteristic of the country about and to the south of Kiew and the Desna; while to the south the steppe, covered with dry grass and straggling herbs, of which the most remarkable are gigantic thistles, stretches from the foot of the Carpathians along the shores of the Black and Caspian Seas into Asia; about the latter it has a saline character; through these unvaried plains the rivers flow in channels often above 100 feet deep, fringed with reeds; but in their lower course their deltas and islands, and especially those of the Dnieper, are covered with a vegetation of the most extraordinary luxuriance, the numerous branches of the rivers flowing between forests of oak, elder, poplar, and aspen.

The peninsula of the Crimea partakes throughout its larger portion in the character of the country from which it projects. The range of limestone mountains running along its southern coast, and presenting their longer slopes to the north, divides it into two distinct botanical regions; on the northern, the beech is the most considerable forest tree; on the south, the Corsican pine covers the declivities of the mountains from a height of 3000 to 6000 feet, and the arbutus is found; here the vine, olive, laurel, pomegranate, and all southern European fruits flourish; the vine is also cultivated on the northern slope, but for this the climate is scarcely fitted; the more common fruits, however, are cultivated with success.

To the northern division of Europe belong also the countries on the southern shores of the Baltic; these are attached to the great eastern plain by the marshes and forests of Lithuania and Poland. This district has its surface rising generally from the North Sea to an elevation of about 1000 feet; of this the larger portion lying below the level of 300 feet, is formed of alluvial deposits, above which is a terrace of stratified rocks, rising from 300 to 500 feet, and above this another terrace, attaining an elevation of 1000. This latter is found about the upper basin, and forms a zone round the Hartz Mountains. The intermediate terrace is formed on the edge of the stratified rocks in Westphalia, Osnaburg, and Brunswick, while the lower plain extends from the shores of the North Sea to those of the Baltic, including the heaths of Luneberg and the geest of Altmark. The upper terrace is formed of rugged limestone and argillaceous strata, which determine the character of its vegetation, the lower plain has also two characteristic features; the argillaceous marsh once covered with forests of deciduous trees, and the geest, a sandy formation, apparently once a sea bottom, originally covered with heaths, it is now almost everywhere cultivated, and is bounded by the calcareous marshes of the coast. Along the western coast arenaceous tracts are spread; the dunes by which it is protected being held together by grasses and creeping plants, while the marsh presents a rich growth of grass, bordered with maritime plants. More inland are found dry heaths and damp peat mosses; where heath alternates with cotton grass and bog moss, and the country is remarkable for the poverty of its flora, having scarce twenty indigenous plants; but cultivation has in many places clothed the country with woods as well as ordinary agricultural produce. Higher still, as in Brunswick, on the more undulating surface of the plain, a richer flora presents itself; here the north-west, west, south, and south-east parts are covered with luxuriant woods of beech on the limestone, chalk, and sandstone hills; of oaks, birches, and firs, by the help of man, on the sandy and argillaceous elevations; the birch and fir flourish in the plains, and the alder in the lower grounds, amid the fens and moors, which produce abundance of coarse hay.

3. *The Central Region.*—Surrounded and traversed by mountain ranges, the flora of this region must be distributed, as it must be subdivided accordingly. It may, however, first be noted, that the sandy level landes stretch out to the sea from the base of the mountains of Auvergne and the Cevennes; while the plains of Franconia, Bohemia, and Moravia, separated from each other by the Bohmerwald and the Moravian mountains, have an elevation respectively of about 900, 500, and 600 feet, and the plain of Hungary of 250. These are separated from the western mountains and plains by the deep passes of the Rhine and Rhone, the connecting point being at the Gap of Belfort near the Faucilles mountains.

The temperature of this district may be gathered from the following data:—

	Latitude.	Annual.	Winter.	Summer.
Bordeaux	45°	57°	43½°	71°
Carlsruhe	49	51	34½	66
Prague	50	50	31	67
Vienna	48	50	31	68
Pesth (500 ft.)	47½	51	31	70
Clermont (1344 ft.)	46	51	36½	64

To this it may be added, that at Vienna the difference between summer and winter temperature is 36°, in Paris 26½°, in Bordeaux 28°, and that the temperature of Clermont shows a diminution equal to one degree to every 220 feet.

The annual rain-fall is twenty-four inches in the west of France, at Prague fifteen and a half, at Pesth, eighteen; in all cases the increase is considerable on the mountain chains and valleys. The Carpathians alone of all the mountains of Central Europe can be said to reach the snow line; but the Jura and Cevennes, with the Riesengeberge and mountains of Auvergne, are covered with snow during a great portion of the year.

Throughout this district, although on its borders are found additions from the northern and southern floras, and there are, as might be expected, considerable differences apparent in different localities—as for instance in the west of France, where, in consequence of the mildness of the winters, southern plants attain a considerable northern extension—yet, as a whole, the character of the flora may be considered as uniform. The western coast of France is occupied by extensive heaths, with occasional woods of the Aleppo or coast pine. The hills and mountain ranges of France are covered with woods of beech and oak, with chesnut in the lower and warmer localities. The German forests are chiefly of fir, the prevailing forms being the Scotch and silver fir, and the Norway spruce giving them a gloomy character, and often affording local names, as the Black Forest; but beech and oak are also found, and the chesnut flourishes in the valleys of the Rhine, Maine, and Neckar. In the Carpathians the dwarf pine and Norway spruce cover the upper slopes, and the beech the lower elevations.

The mountains of Auvergne rise from a plateau 3000 feet above the sea; here the prevailing tree is the Scotch fir, but the ancient lava streams are clothed with beech woods; the willow grows by the water-courses, and the ash in the pastures: the smaller plants indicate both the elevation of the district and a relationship to the flora of the Upper Rhine; rye is the grain in common cultivation, but barley, oats, and even summer wheat, are found on the sides of the mountains at a greater elevation, and hemp as high as 3300 feet: the mountain ash, and many sub-Alpine plants, attain here a vigorous development; above, the silver pine reaches 4000 feet. The region above the plateau is, however, most remarkable for its pastures, composed principally of Alpine grasses; on the Puy de Dome only sub-Alpine plants are found, but on the Puy de Sancy, at an elevation of 6300, the snow gentian and other true Alpine plants have been gathered; the only Alpine shrub is the dwarf juniper.

On the Jura, the lower region extends to about 1300 feet; the vine and maize are extensively cultivated, as are the cereals and fruits. The oak is the prevailing forest tree, but the beech forms extensive woods, and the walnut is plentiful; on the Swiss side the oak is less abundant, and the spruce fir is found. The middle region rises to 2300 feet; here the vine is very rare, maize more sparingly cultivated, but the other cereals common; fruit trees, also usually found; the prevailing forest tree is the beech, but oak forests are not wanting; the walnut is occasionally met with, and on the east, pine forests are found. In the mountain region, at between 2300 and 4300 feet, these conditions undergo a change; wheat is but little cultivated, barley and oats become the prevailing grain, but are not found higher than 3600 feet; fruit trees do not extend above 3300, and the vine and maize disappear altogether with the walnut tree; the oak is rarely met with; the beech, now seldom forming forests, mingles with the spruce fir, now the prevailing tree, and the pine becomes abundant; and sub-Alpine plants are found. In the upper region the pine is the prevailing forest tree, with which the spruce is interspersed, but the former does not extend itself above 4600 feet; with it, the smaller plants found in forests disappear, and the prevailing species are sub-Alpine. In the sub-Jurassic regions of France, Switzerland, and the Rhine valley, which on the east do not much exceed 1500 feet in height, and on the west are not so high, the character of the vegetation depends on elevation, soil, and exposure; in all parts of it the cultivation of the vine is common, and excepting where low flat plains intervene, the vineyards of this region may be considered as connected with those of the lower regions adjoining it. The western side of the Jura seems to be in this respect superior to the eastern. Vineyards are also found between the Jura and Vosges; on the southern slopes of the latter, and in the Rhine Valley; in Alsace, from Basle to Schaffausen and to Constance; between the latter places the elevation, from 1300 to 1500 feet, renders the produce inferior.

The vegetation of the Swiss basin is characterized by pine forests. These are occasionally interspersed with beech, less often with spruce or oak; and plants similar to those of the districts of the Lower Rhine, are found on the plains of Eglisau, round Lakes Bienne, Neufchatel, and Morat, in the basin of the Lake of Geneva, and occasionally near the rivers; and the districts extending by Zurich, Neufchatel, Lausanne, and Geneva, most nearly resemble the lower region on the west side of the Jura.

The vegetation of the Vosges contrasts with that of the Jura as much as its geological structure; here are found 'ballons,' or domes of granite, surrounded by crystalline and sandstone rocks; on the former fir, on the latter beech woods prevail; and among the beech, oak and birch are scattered · the presence of the birch affords a characteristic difference, but the difference between the smaller plants of the Jura and Vosges is even more striking. Passing from the one to the other, the broom appears with other plants, denoting a colder and less fertile soil; heath and fern cover extensive tracts. and plants characteristic of wet soil are found in abundance; forests of spruce mingled with birch appear, and everywhere ferns, mosses, and lichens, while the sub-Alpine region approximates closely in its flora to that of the Alps. The species common to the Jura and Vosges are found in the latter at less elevations, as are those common to the Alps and Vosges. The vegetation of the Vosges appears to be closely allied to that of the Black Forest; but here the lower temperature and greater moisture remove the flora still further from that of the Jura, which is, however, continued in the Suabian Alps, where the chief characteristic difference is found in the presence of Germanic species, and in the plateau being covered with sandy tracts corresponding to those already described lying farther north. Of Central Germany, only a general notice can be given; and this may suffice, for notwithstanding the numerous local variations, the general character of the flora is still maintained. With a soil based principally on sandstone and limestone, is found vegetable life due apparently to a more southern latitude, and this is especially observable in the deep lateral valleys, as of the Saal, where the walnut flourishes with the almond, peach. quince and vine; and the woods present a great variety of species: oak and beech are abundant, hornbeam, aspen, lime and ash, with the sycamore are found, and birch, though less frequently. The vegetation of the undergrowth is no less varied and luxuriant, consisting of hazel, maple, hawthorn. guelder-rose, and other plants of the same character, with honeysuckle and lilac; on the sandstone, the characteristic vegetation is the pine, the Scotch fir predominates, the silver fir is usually found single; the spruce fir prevails in the Thuringian forests. The valleys are clothed with alders, willows and black poplars, while the lower slopes of the hills are covered with fruit trees.

On the Hartz mountains, the tree limit is remarkably low; the spruce, the natural limit of which should be 4500 feet, does not here attain a greater elevation than 3300; the beech, which should reach 4250 feet, does not exceed 2000; and while the lower slopes of these mountains correspond in their vegetation to the surrounding plains, the summits present a sub-Alpine, and even an Alpine, flora.

On the plains of Bavaria we find igneous rocks forming a large portion of the subsoil, but on the left bank of the Danube the secondary formations are extended to the river, and far to the east; here the prevailing forest tree is the Scotch fir, alders and willows fringe the water-courses; the lime flourishes on the low hills. The common crops are rye, wheat, barley, oats, and potatoes; water plants are very numerous.

The flora of the Carpathians is not well-known, the only explored portions being the western and northern. The mountain region is characterized by the beech, which attains about the same elevation as on the more northern Alps, but the walnut only reaches 1325 feet, and generally woody plants do not ascend so high. Their place is, however, supplied by herbaceous plants of gigantic size; and the meadows produce an extremely rich pasturage. The vine is not cultivated at an elevation exceeding 900 feet, but grain and orchard fruits extend themselves higher up than in Switzerland, and a large breadth of barley and rye is cultivated; these circumstances indicate a warmer, i. e., a more continental climate, which is confirmed by the character of the sub-Alpine and Alpine plants; the limits of the former are very distinctly marked; the dwarf pine extends above 5500 feet; and round the Alpine lakes the vegetation is extremely luxuriant; the reverse is, however, the case in the Alpine region, which in its sterility approaches that of Lapland, indeed, few mountain ranges present such rugged and barren summits, on one of which, Krivan, only ten flowering plants could be found.

The flora of the Carpathians is remarkable for its local diversity, which is, however, easily to be attributed to the exercise of neighbouring influences. The slopes towards the north and east are clothed with luxuriant forest growths, which present a striking contrast to the flora of the great eastern plains.

4 *The Southern Region.*—The range of the Alps forms the natural limit between the central and southern regions, and consequently partakes, in its vegetation, of the characteristics of both; its course, elevation, &c., have already been described, and it has been also noted that the great mass of its summits are formed by crystalline rocks, principally granite and mica slate, below which granular limestone, and the more recent formations, especially mountain limestone, the most abundant of all, are found

Table of comparative temperature.

	Latitude.	Elev., feet.	Annual.	Winter.	Summer
Avignon	44°		39°	42½°	74°
Marseilles	43½		58	47	68
Milan	45½		55	36	73
Geneva	46	1275	50	35	63
Peisenberg	48	3281	42	29	58
St. Gothard	48	6841	30	17	43½
St. Bernard	46½	8148	31	18½	43½

From this it may be observed that the south-western slope of the Alps has a high mean, and comparatively little variation. On the plain of Lombardy, on the contrary, the climate is more continental, it being preserved from the influence of the sea breezes by the chain of the Apennines. At Milan, the highest recorded temperature has been 93¾°, the lowest 5°. At Geneva the mean temperature is lower than at Paris, though the latter is 3° farther north, but having by the valley of the Rhone a south-west exposure, the winters are mild. Peisenberg has the mean temperature of Stockholm, but a milder winter and cooler summer. At the St. Gothard and St. Bernard the mean temperature is lower than at the North Cape; and the summit of Mont Blanc has probably a temperature of only 5° above Zero. Of the névé, glaciers, and snow-line of the Alps, full notice has already been taken. The rain-fall on the southern slope of the Alps is very considerable, viz., from fifty to sixty inches, and in Friuli 100. This results from proximity to the Mediterranean, for, on the west and east sides, it is, as has already been seen, less.

The warmth and comparative equality of temperature at the western foot of the Alps has been noted; this, with its peculiar position, shut in on every side but the south and south-east, gives the Mediterranean coast of France a peculiar flora; there, as well as on the Maritime Alps, orange, myrtle, cactus, dwarf palms, and the predominance of leguminosæ, give it a distinct southern character; the Aleppo pine and olive attain to 1400 feet, the evergreen oak to 1800, from which limit to 3800 there are no trees, but the green lavender and box supply their place; the beech region extends from 3800 to 5500, in the upper part mingled with pine, which predominates above 5500 an extends to 6000, above which is a region strictly Alpine; and here the sam plant characterizes the vegetation which is found in the island of Borneholme just above the sea. The northern slopes of the mountains commence with the region of the evergreen oak.

Of the Alps generally, it may be noted that the lower elevations, about the base, rise above 1500, and above these is found a zone of chesnuts which extends to 2500; in the deep valleys of the south, however, this tree attains an elevation of 1000 more. In this region the vine and maize are cultivated; the beech zone extends from 2500 to 4000 feet on the south, and from 2000 to 4000 on the north, yet not unfrequently less elevated on the south than on the north. This is the zone of deciduous trees, which is marked with greater regularity on the Alps than on the German mountains: the cherry and ash attain about the same elevation as the habitation of man. The cereals depend for their growth, perhaps, more on position than elevation, and under favourable circumstances, as where comparatively level valleys are found, often attain a great height. The zone of the coniferous trees extends to 5500 feet on the north, and to 6500 on the south; the Scotch fir is least common. Intermixed with these, and above them, the Alpine pastures spread their luxuriant grasses and brilliant flowers; and here the flora is as rich as it is poor in the fir woods of Scandinavia; and it may be added, that while the crystalline rocks are covered with the more abundant vegetation, the calcareous afford the greater variety of species.

In the Alpine zone the dwarf birches of the Scandinavian mountains are replaced by rhododendrons, and these are often intermingled with dwarf pines; a dwarf growth of alder is, however, not unfrequently observable; and immediately on the edge of the snow, and buried under it, excepting for the short summer, are found small rhododendrons and azalias, with abundance of the saxifrage, gentian, primrose, and ranunculus; and where the rocky cliffs rise out of the perpetual snow on the Central Alps, at an elevation of 10,360 feet; on Mont Cervin, at 10,461; on the Col de Geant, at 10,578; and on Mont Blanc, at 10,680; and on Mont Rosa, at 11,352, individuals of different species of those plants have been found; and between 8500 and 10,000, thirty-three different species, of which twenty-four occur in the Pyrenees, and the rest in the north of Europe, have been estimated.

The continental character of the vegetation of the higher Central Alps is shown by the following comparisons: the spruce there predominates over the Scotch fir; the latter prevails in Scandinavia, the former in Russia; the limit of the beech is low, but it is abundant on the shores of the North Sea, and is only found in the south of Russia: the limit of the vine is comparatively elevated, as is that of the cereals; and it has been supposed that in the absence of the heat, in other places required for these plants, light in some measure supplies its place; the dryness also of the atmosphere influences these conditions to a great extent, while vegetation is much favoured by frequent precipitations, which result from the contact of clouds with the cold surfaces of the névé and glaciers. The higher elevations of the Alps become thus clothed with verdure when corresponding elevations on lower mountains are barren and desert.

The Spanish peninsula, cut off from the rest of Europe by the Pyrenees, might be expected to have a peculiar flora; and its mountains differ as much from the Alps and the Scandinavian mountains in their vegetation as in their geological formation, for though granite groups and other crystalline rocks are found, it is principally on the east; clay-slate and oolite being the more extensive formations.

The temperature of these mountains may be imagined from the following data, however confessedly imperfect:—

	Latitude.	Elev., feet.	Annual.	Winter.	Summer.
Perpignan	$42\frac{1}{2}°$	—	60°	$45\frac{1}{2}°$	75°
Dax	$43\frac{1}{2}$	—	57	44	69
Mont Louis	$42\frac{1}{2}$	5195	$43\frac{1}{2}$	$31\frac{1}{2}$	57

It may be observed, that while the climate at the east end, near the Mediterranean, is milder, the difference of the seasons is less at the west. At Mont Louis the mean temperature slightly exceeds that of Stockholm, as has been observed of Peisenburg, the winter being warm and the summer cooler; but Mont Louis is more than 2000 feet higher above the sea level.

The vegetation of the Pyrenees is extremely rich and varied, being composed of plants found in most other parts of Europe, with some peculiar to them; below the Alpine zone the distribution of trees may be thus stated: the chesnut reaches 1400 feet; the oak 5000; the beech from 2000 to 6000; the spruce, fir, and yew from 4500 to 6000; the birch, common on the Alps and Scandinavian mountains, is wanting here, but the Scotch fir, characteristic of the latter, forms the zone above the spruce in the Pyrenees.

The Alpine zone commences at 6000 feet, and is marked in its lower limits by stunted Scotch fir and rhododendrons; the latter attain to 6900 feet, above whose limit, though the pasture is covered with numerous flowering plants, the dwarf juniper is the only shrub; above 8400 perennial herbaceous glacial plants alone are found. We observe here the Arctic-European flora, and a portion of that of the southern mountains of the peninsula, mingling with species peculiar to the locality.

The peninsula of Spain, as already noted, is a country of table-lands and mountain ranges; it has few and comparatively unimportant low-lands in Catalonia and Arragon, on the sea coast at Valencia, and in Portugal; but the mass of the country has a mean elevation of 2000 feet; Madrid, in the centre, is 1995 feet, and Granada, on the south, 2560 feet above the sea: in the absence of more sufficient data, the temperature must be estimated from the following table:—

	Latitude.	Annual.	Winter.	Summer.
Lisbon	38½°	62°	52½°	71°
Madrid	40½	59	43½	77
Gibraltar	36	68	59	77

This, however, will afford but little information with respect to other localities; generally, however, it may be noted that the valleys between the transverse ranges open to the west, south-west, and south-east, and that the interior table-lands are protected from the influence of the sea to the north and south by high and continuous ranges of mountains, of which that on the south is the highest, rising 11,464 feet on the Cerra de Mulhacen. The peculiarities observable are that the continental climate is found at a much greater elevation than usual; as for instance, at Madrid, at an elevation of 2000 feet, where the extremes may be estimated as 105° and 15°, and the annual rain-fall at nine and a half inches, while at Lisbon it is twenty-eight; a zone of perpetual snow is found both to the north and south, in the former not exceeding 2000 feet, but broader in the latter; some of the higher plateaux are covered with snow during five months of the year, and present verdant pasturage in the spring. The mountains of the peninsula are formed principally of primitive rocks; the plateaux of sandstone. The southern maritime districts of Spain are characterized by a luxuriant and strikingly beautiful vegetation of trees; there are found the cork oak, the ilex, and other evergreen oaks; the laurel, myrtle, and arbutus, besides the cypress and stone pine; aromatic shrubs, sage, thyme, and rosemary abound, with brilliant and sweet-scented bulbous plants, the hyacinth, narcissus, and others of the same character; while the dwarf palm affords a link to unite them with the Tropical flora. The mountains on the north present forests of oak, with birch, Scotch fir, spruce, beech, and ash; in the south, principally of chesnut.

The cereals include not only those common to other parts of Europe, but maize, rice, and millet. The vine flourishes everywhere, especially about Oporto, Xeres, and Malaga; the olive and orange on the south and west coasts; figs, almonds, and mulberries are found in profusion, and the cotton plant and sugar cane are cultivated successfully in the south.

Seldom, perhaps, could a greater contrast be found within 100 miles than that presented by the vegetation of the Asturian and Andalusian provinces of Spain; both are exposed to oceanic influences, both protected on one side by lofty mountains, but the latter is open only to the warm and dry winds from Africa, the former to the moist and colder winds from the Northern Ocean; and consequently the vegetation approximates in character to that of Central and Western Europe; the trees are principally deciduous: chesnut, oak, beech, &c.; heath and furze cover the lower crests of the mountain ridges, and verdant meadows complete the likeness, which more nearly resembles the flora of the south-western counties of England than perhaps any other part of Europe; allied to the southern flora by the chesnut and evergreen oak, the latter, however, comparatively rare and poorly developed; the absence of conifirs and cistaceæ is remarkable · ferns are abundant everywhere, and in this the north-western districts of Spain afford a remarkable contrast to the north-eastern, which are distinct, not only on account of the different exposure but from the soil, which is composed of slate and marl, interspersed with rocks of breccia, with sandstone spurs from the mountains on the north, which are covered with Scotch firs, as the breccia is with the same tree, as well as oak and ash, and copses of box and maple, interspersed with mountain ash, holly, and shrubby beeches, and carpeted with verdant turf.

The western portions of the coast of the peninsula are not dissimilar from the southern in their vegetation; even as far north as Valencia, olives, figs, citrons, and oranges abound, and the date palm is found; rice is cultivated; the tamarisk grows near the sea, and the aloe and cactus on the rocks, the latter attaining a very considerable size. The Aleppo pine and apple of the Dead Sea are also found on this coast: on the mountains of the Sierra de Chiva, which culminates 6000 feet above the sea, the aloe and cactus characterize the vegetation for 500 feet, with the algaroba, or St. John's bread-tree, the dwarf palm, and arborescent heath; these latter extend to 2000 feet; and in this zone is found the feather grass, which affords material for sandals, baskets, &c &c.: from 2000 to 4000 feet the slopes are principally barren, but the juniper, ash, and evergreen oak are found; from 4000 feet to the summits isolated pines, with a vegetation like that of northern Europe, and on the higher peaks an approach to an Alpine vegetation.

The valley of the Tagus is remarkable for the luxuriance of its woods of palm, elm, lime, beech, and oak; and the flora is allied to that of the chalk districts of England and the centre of Europe; while in that of Monchique, the huge stone pines, chesnut and cork trees, the Eastern rhododendron, lemons, oranges, and southern fruits, intermixed with the American agave, the ferns of Madeira, and pelargoniums of Africa, show that here the continental and maritime climates are in harmonious proportion. In Granada, on the southern slopes of the mountains, the great and long-continued precipitation both in autumn and spring, with the continuous drought of summer, afford a great variety; the autumnal rains produce liliaceous plants; annuals are in flower throughout the winter; the spring rains produce numerous flowers, and June and July herbaceous compositæ, umbelliferæ, and labiatæ; while August and September are the winter months of vegetable life. The warm region, with its characteristic southern vegetation, extends only 2000 feet upwards; here cereals require irrigation, but ripen in May and June. At the foot of the coast chain, in the alluvial plain of Malaga, the sugar cane, cotton, sweet potato, and date palm are found; the agave is naturalized; and there the white poplar is the only indigenous tree; above, the cork oak and pinaster characterize the vegetation of the plateaux: the most remarkable plants are the cistaceæ; and in this the southern and central floras of the peninsula present no analogy to any other portion of Europe; for here two evergreen regions are apparent, the one similar to those of Italy and the south-east of Europe; the other more like what is found in the Crimea and parts of Asia Minor, and presenting close analogy to that of parts of California and Central America; and this appears to be caused by the extreme dryness of the climate, for which, in Europe, it is remarkable.

On the southern mountains, the region between 2000 and 5000 feet is assimilated to that of the central plateau; brooms and cisti are abundant; the pinaster ascends as high as 4000 feet; the evergreen and cork oaks to 3000, followed by the Pinsapo fir and Alpine oak, which extend to 6000; the ash from 3000 to 5000 feet; the elm from 2000 to 4000; the black poplar from 2000 to 5000; and the stone pine as high as 3000.

The region next succeeding corresponds to that of central Europe, and is marked by the predominance of coniferous trees, especially the Scotch fir; these appear formerly to have covered even the tops of the mountains. The decadence of woods throughout the peninsula, even on the central plateaux, appears a well-established and historical fact, and one which must have exercised much influence in producing the present state of things. The upper region has a zone of Alpine shrubs reaching to 8000 feet, and above that of Alpine perennial herbaceous plants.

The ridges of the centre of the peninsula connecting the mountains of the north and south, and dividing the western and central plateaux from the valleys of the east, present varieties in accordance with the geological formation, for the most part assimilating to central Europe, the Scotch fir being the prevailing tree. The plateaux may also be classed according to their soil, and are principally of clay, gypsum, sand, or granite; the former is found mostly to the south of Madrid, the second to the north and west, having this peculiarity, that it becomes indurated by heat: limestone is found in the Sierra Cuenca, at the north and east; while gypsum extends with saliferous formations to the south and east. The clay, sandy, and granite soils are alike remarkable for the extent of surface covered with tomillares, or thyme plants, which in the latter attain an elevation of 4000 feet, but a very large portion of the surface of the peninsula may be considered as almost destitute of vegetation.

The peninsula of Italy is in its local flora the most favoured portion of Europe: Spain on the one hand, and Greece on the other afford, it is true, trans-Atlantic and Eastern forms of vegetable life, but the climate of Italy is more favourable than either for its development, and consequently vegetable life is there most abundant and most vigorous.

The peculiarities of the orography of Italy have already been noticed (Chaps. XIX., XX.); botanically the Apennines divide the peninsula into two regions, but the southern portion has its own characteristics, as have the detached mountains, especially those of volcanic origin; and although presenting striking contrasts, the valley of the Po and plain of Lombardy must not be separated from the Italian region; the latter affording comparison with the plains of Pisa, Naples, and the Campagna at Rome, as well as of Apulia on the Adriatic. The characteristic rock of the Apennines is limestone, generally compact in structure and grey in colour, but in some places highly crystalline, and presenting statuary marble of fine texture; primitive rocks are not, however, wanting, especially in the north and south. Volcanic formations are found chiefly at Vesuvius; the effects of earthquakes are noticed, especially in Calabria. Italy has numerous lakes of great size and importance; on the north, with the exception of the Po, the rivers are comparatively small; extensive marshes are found on the western coast of the peninsula, and the delta of the Po is of great extent.

The following table will afford comparative estimates of temperature:—

	Latitude.	Annual.	Winter.	Summer.
Milan	$45\frac{1}{2}°$	55°	36°	73°
Bologna	$44\frac{1}{2}$	57	36	76
Florence	$43\frac{1}{2}$	59	44	75
Nice	$43\frac{1}{2}$	60	49	$72\frac{1}{2}$
Rome	42	60	47	73
Naples	41	63	50	75

It may be further remarked that the valley of the Po has a continental climate; here the winters are colder and the summers hotter than the due average; the winters become considerably warmer after the northern Apennines are passed, and the effect on the vegetation is very perceptible to the eye: to the south also, the temperature of the autumn is greater than that of the summer, and this becomes especially perceptible in Sicily, where, at Palermo, the month of September is the hottest in the year, the annual mean being 64°, the winter 52°, and the summer 75°, in 38° of latitude; and it will be observed that the summer mean is not so high as at Bologna $6\frac{1}{2}$ degrees further north, at Catania, the mean temperature of July and August is estimated at $80\frac{1}{2}°$.

The rain-fall, especially on the southern slope of the mountains, is very considerable; at the foot of the Alps, fifty to sixty inches; on the northern face of the Apennines it may be about twenty-five inches; on the south much more; in Sicily about twenty. The eastern slope of the peninsula has less rain than the western; summer rains are only abundant in the plain of Lombardy; snow is rarely seen south of Naples, excepting on the mountains, where it remains the greater part of the year, especially on the Abruzzi and Etna, but the line of perpetual snow is not reached.

The region of Upper Italy, or Lombardic region, extends from the Sesia to the Adige on the southern slopes of the Alps, and as far as the river Po; the influence of the warm and moist south-east winds not extending beyond the former river, excepting in the valley of Aosta. Brescia appears to be the point where the vegetation of the valley of the Po changes; it is in the marsh and rice grounds that the southern vegetation is most observable, but it extends even into the Tyrol, and more especially into the valleys of the lakes, and this proportioned to the eastern exposure, elevation of surface, and reflection of heat from the mountains; thus, round Lake Orta there are no traces of a Mediterranean flora; on the islands of the Maggiore the agave flourishes; round Como the olive attains an elevation of 1600 feet, and the vine of double that height above the sea; while in the basin of the Lake of Garda the orange ascends to 1200 feet, and the olive to 2000.

The whole of continental Italy has suffered much from the loss of its former extensive woods, and the different lake floras may have been united by Mediterranean trees clothing the lower slopes of the mountains. Where they remain on the sides of the mountain, the chesnut, evergreen oak, and stone-pine, are characteristic of the vegetation among the trees; and the odoriferous syringa among the shrubs, with bay, olive, and cypress. Lower down the sycamore, Italian beech, white-blossomed oak, with vines, mulberries, and pomegranates, the myrtle, and the box, while the olive and citron extend to the sea coast.

The flora of the district round Naples may be taken as affording an extreme type of that of the peninsula. The climate here is exceedingly variable, 16° of Fahrenheit being not an uncommon fall or rise during the day. In the months of January and February the thermometer has been observed 11° below freezing point, and on the mountains of the Abruzzi even more. Yet snow seldom lies on the lower lands. The summer comes on with great rapidity; the autumn and winter are warm and moist, and large quantities of rain not unfrequently fall on the coast.

M. Tenore has divided the Neapolitan district into ten regions:—

1 Of maritime plains. These are mostly marshy, covered with stagnant pools, having no trees but willows and poplars, and presenting a rugged growth of hemlock, tamarisk, and juniper. The maritime plants common to north-western Europe are here found.

2 Of the Mediterranean plains. These are sandy or argillaceous, with an undulating surface. Here are found the elm, maple, and mulberry, and the characteristic herbaceous plants are those of central Europe.

3 Of the lower hills. This extends from 300 to 900 feet, the soil still argillaceous or sandy, but not unfrequently mixed with volcanic products, in which, when disintegrated, the common fern flourishes. Here are found the southern trees—the evergreen oak and stone-pine, while the laburnum, and other leguminous trees, characterise the vegetation, and above this extends the regions—

4 and 5 Of the upper hills, in the 1° zone, in which the flora has a Jurassic character, and the trees approximate to those on the western slopes of that chain; the southern plants are represented by the under shrubs. In the 2° the conifers prevail, and the shrubs approximate to those of Northern Europe, this extends to nearly 2500 feet.

6 Of the mountains. This region is one chiefly of pasturage.

7, 8, and 9, are Alpine regions presenting a comparatively scanty flora, with a few wild shrubs, &c.

10 The glacial region, confined to a few isolated points in the Abruzzi.

Mr. Henfrey more simply distinguishes five zones:—

1 The maritime; 2. Of evergreens, extending to above 1000 feet; 3. Of chesnut, reaching to 3000 feet; 4. Of beech, to 3500; 5. Of Alpine, or perhaps rather sub-Alpine, vegetation.

The variety of elevation, soil, and exposure, present as great variety of vegetation in the Abruzzi. The orange and citron will not flourish, nor will the mulberry or vine; while on the southern coast silk, wine, citron, and orange are the natural products of the country. Here the sugar cane was cultivated, which will not grow at Naples; but there the camelia and plants from the Cape of Good Hope, New Holland, and Japan, grow in the open air; but American plants, as they are familiarly called—rhododendrons, kalemias, and azaleas, do not succeed.

In the island of Ischia, and at Castellamare, plants are found under the same parallel; and not half a degree of longitude apart from each other species are found indigenous characteristic of an Alpine and tropical vegetation.

All the conditions desirable for the development of a southern flora are found better fulfilled in Sicily, but even here the northern vegetation is not excluded, and is found beside the sugar cane, banana, date, and agave. The vegetation of this island presents four distinctly marked regions. 1. Of maritime plants. 2. Of cultivated plants, marked by the limit of the cultivation of the vine at 3300 feet on Etna. 3. The wooded regions extending to 6200, and above that, 4, A sub-Alpine region. The first is found to the south, and is limited both in extent and productions. The second is the characteristic of the country, and it is in this that the gardens and fields exhibit the vegetation of the south in luxuriance: here the orange, citron, lime, &c., extend to 2000 feet in elevation, though the date does not flourish much above 1500; the fig is fruitful above 2000, and cotton is found at an elevation of 1300. The cactus and prickly pear, lupines, asphodels, and asparagus, with the euphorbiæ, are characteristic of the inferior vegetation. The woods of Etna consist principally of oak, the ilex ascending to 3800 feet, the beech prevails between 3000 and 6000 feet; the birch, most rare in continental Italy, between 4750 and 6600; the pine between 4000 and 6200; the broom, peculiar to this locality, extends as high as 6000 feet, and when cultivated becomes a tree, which in its pendent flowers and leafless branches, seems the link between this flora and that of New Holland; the sub-Alpine region has a very poor flora. The chesnut trees of Etna, so remarkable for their size, are probably the result of cutting down the original growths, and allowing numerous shoots in close proximity to rise from the stools. A contrast appears between the wooded region of Etna and that of the Alps worthy of notice, the limit of that region upward being the same; the chesnut and beech attain an elevation 1300 feet higher on Etna than on the southern slopes of the Alps, as do also the cereals and the olive; here, too, the ordinary distinctions are not observable, and trees usually characteristic of different regions, as the beech, birch, and Scotch fir, are found together; while in the Alps the beech fails before the Scotch fir, which in Scandinavia does not attain nearly so great an altitude, thus marking strongly the modifications resulting from a southern latitude.

Dalmatia is the botanical link between Italy and Greece. On the south and west, the mild winters favour the early development of vegetable life; the almond blossoms in January; on the coasts are found the olive, arbutus, laurel, oleander, and stone pine, indicating the predominance of Mediterranean types; above, in the zone of forests, however, the flora is more nearly allied to that of central Europe, presenting the sycamore, oak, and beech; the woods do not rise higher than to 3000, and the Alpine flora commences at a low limit. The peninsula of Greece has a colder climate than that of Italy; here, however, accurate data are wanting, but in Candia, at Canea, lat. 35½, the mean annual temperature is only 1° higher than at Palermo, 2½ further north, the winter mean being 54½°, or 2½ degrees higher, and the summer 78, or about 3; the rain-fall is considerably less; the thermometer occasionally falls 16° below freezing point, and snow, though rare in the lower lands, lies throughout the year on the mountains, yet the orange, citron, and prickly pear flourish in the Morea, the latter being used in Messenia for hedges; the orange and citron penetrate even as far north as Thessaly, and the olive reaches 41° north latitude on the coast of Macedonia. The west coast should be warmer than the east, Corfu producing the opuntia and date, neither of which is found in the vale of Tempe; on the west coast the olive, myrtle, orange, and citron abound, but at no great distance the vegetation changes for that of Central Europe; on the sea-shore also, the stone pine and pineaster flourish, and by the rivers, the oriental plane and oleander; the ilex and other evergreen oaks, limes, and horse chesnuts are the prevailing forms in the woods of middle altitude; while higher up the chesnut, northern oak, yew, and Scotch fir are principally found; but throughout Greece the woods are disappearing, more especially in the Morea.

The flora of southern Greece is closely allied to that of Italy, varied with African and Libyan forms, and the islands present transition series.

CHAPTER XXIII.

AFRICA.

§ 1. Historical sources of our knowledge of the interior.—2. Information to be expected.—3. The boundaries and limits.—4. The coast line.—5. The watersheds.—6. The orographical classification.—7. Classification of rivers.—8. Of the geological formation.

HISTORICAL Sources of our Knowledge of the Interior.—That Africa, nominally the land of Ptolemy, should still remain a *terra incognita* to geographers throughout the larger portion of its surface, may appear strange, unless we consider the unity of the Mediterranean region, the relation of its shores, and their separation, by the surrounding ridge of its basin, from the continental masses of Asia, Europe, and Africa, the latter never having been known to Europeans beyond its coasts, on which, as has been noted in the *History of Maritime Discovery*, they had made settlements, and erected forts for the prosecution of trade, latterly reduced to two staples, gold dust and slaves, the latter, it is to be hoped, shortly to be superseded by that of palm oil.

The information afforded by Ibn Batuta and Covilham scarcely extended beyond the Mediterranean basin, that of the former being limited by the chain of Atlas, and of the other by the valley of the Nile; and the object for which that of the latter had been collected, viz., the opening a passage to India, having been accomplished by the circumnavigation of the continent, and the attention of the maritime nations of Europe being for the time fixed on India and China in the east, and America on the west, inquiry into the character of the interior of Africa was postponed for a century and a half, until the conquest of Timbuctu by the Emperor of Morocco directed attention to the wealth of that city, as the emporium of trade, especially in gold; and in 1618 a company was formed in England to attempt to open communications with Timbuctu, by way of the river Gambia, and their agent, Captain Thomson, ascended that river for some distance, but he being killed by the natives in 1620, Captain Jobson was sent out, who returned safely, after attaining a higher point in the navigation of the river than his predecessor; yet, notwithstanding, no further attempt was made until 1723, when the African Society, under the presidency of the Duke of Chandos, sent Captain Stubbs up the same river, who ascertained that the Gambia had not any connexion either with the Senegal or Niger. After this, again the spirit of discovery in Central Africa slept for some time, though towards the close of the century, James Bruce, of Kinnaird, now deservedly celebrated as one of the most noted on the list of modern travellers, had reached the sources of the Bahr el Azrek, or eastern head waters of the Nile, in the year 1770, and became intimately acquainted with Egypt and Abyssinia, and the connexion of those countries with Arabia; and in 1793, Mr. Browne, penetrating into Darfur, obtained information respecting the Bahr el Abiad, or western source of the same river; but in the interval an association was formed for the express purpose of promoting discovery in the interior of Africa, and John Ledyard, an American by birth, who had sailed with Cook, and afterwards made a pedestrian journey into Siberia, was sent to Cairo, to join the caravan of merchants and traders to the centre of Africa, but he died at Cairo, in 1789. Mr. Lucas, who had been for a long time vice-consul at Tripoli, undertook to penetrate from thence into the interior, but failed in consequence of an insurrection of the Arab tribes, and the information he obtained, though in itself useful and important, tended only to obscure, instead of elucidating, the geography of the continent; and Major Houghton, even less successful in his endeavour to open out the country to Europeans by way of Morocco, lost his life in the attempt. In 1795 the old route of the Gambia was again attempted, and Mungo Park, a Scotchman, and of the medical profession, notwithstanding a captivity among the Moors in Ludamar, succeeded in reaching the Niger, and followed the course of the river to Silla, but being destitute of means for the further prosecution of his discoveries, he was obliged to return home. To extend what Park had so well begun, Frederick Hornemann, a German, was sent out in 1797, by way of Egypt, though Fezzan. He appears to have reached the Niger, and died of sickness, as did Mr. Nicholls, who attempted to penetrate the interior from the Bight of Benin. In 1804, Park started again with a large and well-organized party, by the way of the Gambia, to trace the Niger to its source. He succeeded after many difficulties in reaching the Niger, on the banks of which he built a vessel, in which he descended the stream, until, in a quarrel with the natives, he was killed at the rapids of Boussa. Roentgen, a German, was also killed in the attempt to penetrate into the interior from Morocco; and the Swiss Burkhardt was carried off by dysentery, before even the years of probation which were necessary to fit him in his own estimation for the work, were expired: but Adams and Riley, American seamen, who had been cast on the coast by shipwreck, obtained much useful information, visited and described Timbuctu. As Sir Joseph Banks and Mr. Beaufoy had given the original stimulus to African discovery, so Sir John Barrow maintained it, and by his influence it was principally that in 1816 Captain Tuckey and Major Peddie were sent out in command of two expeditions; the former proceeded up the Congo, but fell a victim to the malignity of the climate, as did the latter, who never reached the proposed scene of his labours. He was succeeded by Captain Campbell, and he again by Lieutenant Stokoe; but these also died, without being able to get beyond the confines of the Toulah country, in their endeavours to reach the Niger. In 1818 Mr. Joseph Ritchie was appointed vice-consul to reside at Murzuk in Fezzan, and in company with Captain Lyon, reached that place, where he died, and Lyon returned in 1820. Their places were, however, more than supplied by Dr. Oudeney, Captain Denham, and Lieutenant Clapperton, who reached Murzuk in 1822, and early in the following year were the first Europeans who saw Lake Chad. Denham also crossed the Shari, and reached the east coast of the Chad; Clapperton and Oudeney proceeding westward, the latter died at Murmur; the former reached Sokatu, on the river Quarama, an affluent of the Niger, which at its junction has a southerly course, in the country of the Fellatahs, and with Denham returned safely in 1825; immediately after which Clapperton undertook to penetrate to Sokatu from the coast, which he succeeded in doing, crossing the Kong Mountains, and reaching Boussa on the Niger, where he obtained information respecting Park's death. This expedition was, however, fatal to the enterprising and successful traveller; but his mantle fell on his servant, Richard Lander, who with his brother John left the coast of Guinea in the spring of 1830, and early in the summer reached the Niger, and traced the course of the river to its embouchure in the Bight of Benin. The channel by which they reached the sea was known to the Portuguese by the name Nun, to the English as Brass River. The extensive delta of the Niger was now indicated by the numerous mouths by which it communicated with the Bight of Benin. The confluence of the Chadda was also observed; but the light canoes in which the brethren made their adventurous voyage were unfit for its ascent. In this expedition they were taken prisoners, and narrowly escaped being sold as slaves; in a subsequent one, Richard Lander perished in a skirmish with the natives. Two years after, an association having been formed for the purpose at Liverpool by Mr. McGregor Laird and others, two steamers were fitted out to explore the Niger: they reached the Nun in the autumn of 1832, and from the lateness of the season suffered severely from sickness. In the year following Mr. Laird returned, and Mr. Oldfield, with Lieutenant W. Allen, explored the Chadda, which was not found to flow through so rich or fertile a country as the Niger, though large commercial cities were found on both.

During this time two expeditions had been made from the north and west. Major Laing crossed the desert from Tripoli to Timbuctu in 1826, but was murdered as he was proceeding westward. René Caillie, a Frenchman, one of the most fortunate of African travellers, succeeded in reaching Timbuctu in 1828 from the coast of Senegal, and from thence travelling northwards arrived at Tangier in safety.

The southern promontorial extension of the continent had hitherto remained almost unknown.* In the middle of the seventeenth century the Dutch had formed a colony at the Cape of Good Hope, and the Boers in search of pasturage had penetrated as far as the Sniewberge; and from Robben, who wrote in 1706, to Sparrman and Le Vaillant, as well as subsequently, after the conquest of the colony by the English, from Barrow, we have accounts of that country and its inhabitants, whether Kaffirs or Bosjesmans, as well as its natural productions. It was not till the commencement of the nineteenth century that the Sniewberge range was passed; and Messrs. Trotter and Somerville discovered the Orange River and visited the capital of the Bechuanas. Dr. Lichtenstein and Dr. Burchell also gave most valuable accounts of those people and their country; but Dr. Campbell, a missionary, passed through it, and attained a more northern limit, which was in 1835 exceeded by Dr. Andrew Smith, who penetrated as far as the southern tropic, and explored the source of the Orange River.

The displacement of the Kaffirs by the Zulu tribe led to the knowledge of the Natal district, and to the emigration of Boers into it. To Captain Gardiner and his followers much of our knowledge of this country is owing; indeed, of late years English missionaries have done more to open the interior of Africa than any other persons. Of the coast, however, our knowledge is based on Captain Owen's surveys; but in 1837 Sir J. Alexander penetrated on the eastern side into the territories of the Damaras, as far as the river Kuisip and Walvish Bay under the southern tropic. In the same year Mr. Holroyd and Dr. Rüppell visited the provinces of Semen, the Tacazzi, with the Blue and White streams of the Nile, the former penetrating into the desert of Kordofan; he was followed by MM. Ignaz Palmé and Russegger; while M. d'Abbadie explored Abyssinia, a knowledge of which country was further obtained by MM. Dufoy and Aubert, as well as M. Rochet d'Hericourt; and still farther by Dr. Beke; while MM. Lefevre, Petit, and Dillon gave

* B. Diaz in 1492 discovered, and Vasco de Gama in 1496 doubled the Cape.

itineraries in Tigre; the Baron de Wrede visited Shoa; and in 1841 Major Harris explored that country on a mission from the government of British India; Messrs. Arnaud and Sabbatier, under the auspices of the Pasha of Egypt, ascended the White Nile; and Messrs. Krapff and Isenberg, missionaries, penetrated into the heart of the kingdom of Shoa.*

In 1841 a great attempt was made to explore the river Niger, by steam-vessels, from its mouth. This expedition, however, though conducted, as was supposed, under every possible advantage by Captains Trotter and Allen, did not succeed in ascending as high as the previous expedition of Lander and Becroft; but the following year Captain W. Allen, in one of the vessels belonging to the expedition, explored the Cameroons or Dualla River and the Bay of Amboises, or Ambas. In 1845, Mr. Cooper Thomson journeyed from Sierra Leone to the country of Futtah Jallo; and Mr. Duncan from Cape Coast to Whydah, and thence to Dahomey and Abafudiah.

At this time attention having been drawn to the eastern coast by the labours and researches of travellers in Abyssinia, and scholars at home—among the latter, especially Mr. McQueen and Mr. Cooley—Mr. Leigh visited the mouth of the Zambeze river, and Lieutenants Barker and Cruttenden the north-eastern horn of Africa, the ancient Regio Cinamomifera; and in 1849, David Livingstone, a missionary, with Messrs. Oswell and Murray, reached Lake Ngami, in 20° 20′ south lat., subsequently discovered another large lake, 200 miles to the north-west, and pushed their researches as far as 17½° south lat.; while Messrs. Rebman and Kraff, starting from Mombas, described two mountains covered with perpetual snow under the same parallel to the west; on the south, M. Gassiot explored the country to the east as high as the Limpopo; and Mr. F. Galton proceeded towards Nourse river as far north as Odonga in lat. 18° south on the west coast; he further explored the country to the 21st meridian east long., while Livingstone had reached 26° 50′ on the same parallel, and Stanislas Magyar, a Hungarian, had arrived still nearer the Equator; Mr. Andersson, extending the exploration of Mr. Galton, crossed the country to Lake Ngami; but it remained for Livingstone, following the track of native traders in slaves, to cross from the Atlantic to the Indian Ocean. In the north, Richardson, Overweg, Barth,† and Vogel, with Church and Macguire, have traversed the countries north, west, and south of Lake Chad, traced the course of the Niger already explored by Park, and extended Denham's route to Yola on the Chadda. Drs. Baikie and Hutchinson with Mr. May have successfully ascended the Niger and the Chadda.

2 *Information to be Expected.*—The existence of mountains covered with perpetual snow, to the south and east of the head waters of the Nile, would seem, if correct, to confirm the accounts of ancient geographers, and lead to the conclusion that the watershed of the continent of Africa is better defined than has hitherto in modern times been supposed.

It may be assumed, without hesitation, that the centre of the promontorial southern extension of the continent is a vast basin, imperfectly drained, occupied by lakes, marshes, &c., and producing large rivers, especially towards the east. This basin, surrounded on the east and south by the earlier rocks, appears to be on the west shut in by ranges of moderate elevation and later origin; these connect with the Kong Mountains to the north which seem to continue their trending west and north, to join the Atlas range, and then surround, to the west, another basin, though of different character to the southern, being arid and barren for the most part. What we have yet to

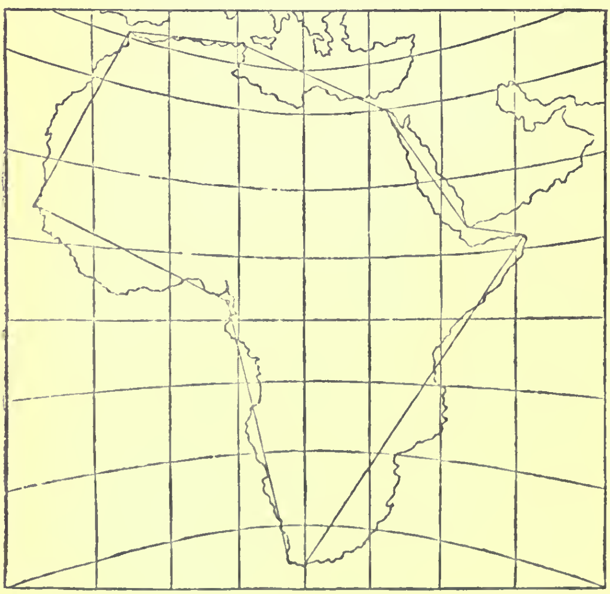
* A detailed account of all expeditions to Abyssinia and Shoa, previous to that date, will be found in the President's Address to the Royal Geographical Society for 1844.

† Barth also reached Timbuctu, but made no astronomical observations.

learn of the general features of this singular portion of the world's surface, is the line of separation between these basins; and probably this is not difficult to determine from the general outline of the continent, and by analogy with other continental masses.

The great eastern horn of Africa would suggest the extension of spurs from the principal watershed in that direction; the great lateral extension of the continent on the north, and the knowledge of the parallelism of the Atlas and Kong Mountains, would leave us little doubt that as one so the other must be connected with the principal watershed by perhaps lower, but still continuous elevations; and from these considerations, as well as from the considerable altitude attained by mountains on the coast near the Bight of Benin, it may be assumed that a well-defined watershed of very considerable elevation separates the southern and northern basins, and connects the ranges of the eastern and western coasts. This, if found correct, will give new interest to Africa in its physical relations with other parts of the world; but whether it be so or not, at any rate we know enough to see that the map of Africa must be entirely re-constructed.

3. *The Boundaries and Limits.*—Africa is bounded on the north by the Mediterranean Sea, on the east by the Red Sea and Indian Ocean, and on the west by the Atlantic; it is united to Asia by the Isthmus of Suez, in breadth about seventy miles, and approaches, at the Strait of Gibraltar, within twenty miles of the south-western point of Europe, and about the same distance from the south-western point of Arabia, *i. e.* Asia. Cape Palmas is distant from Cape St. Roque, the nearest point of South America, 1759 miles; the Cape of Good Hope is distant from Cape Horn 3591 miles; and Cape Agulhas from Tasman's Head, Van Dieman's Land, 4576; Cape Guardafui from Cape Comorin, 1567. It may be as well to add, in consideration of the great eastern continent as a whole, that the Cape of Good Hope is distant from North Cape 6364, and from Cape Navarin 8970 miles.



The angles of the normal figure of Africa corresponding so nearly with the extreme points of the continent, no comparison is needed; the latitude and longitude of these are as follow:—

Cape Guardafui	11° 50′ north,	51° 16′ east
Cape Agulhas	34° 49′ south,	20° ,,
Cape of Good Hope	34° 22′ ,,	18° 29′ ,,
Fernando Po	3° 48′ north,	8° 43′ ,,
Cape Verd	14° 43′ ,,	17° 34′ west
Cape Tangier	35° 47′ ,,	5° 48′ east
Cape Bon	37° 4′ ,,	11° 3′ ,,
Suez	29° 58′ ,,	32° 34′ ,,
Bab-el-Mandeb	12° 41′ ,,	43° 27′ ,,

The superficial area of Africa, as given in the portion of this work devoted to *Physical Geography*, is 10,550,000 miles, the mean 11,048,000.

4 *The Coast Line.*—The intersection of the lines forming the eastern coasts of Africa makes an angle of about 30°; the coast of the Red Sea trending south and east, and that of the Indian Ocean south and west; from the Cape of Good Hope to the Cameroons the direction is nearly north north-west, from thence nearly west to Cape Palmas, from which it describes nearly an arc of a circle to Cape Non, thence north and by east to Tangier, east and by north to Cape Bon, east and by south to the Isthmus of Suez.

The proportion between the area and coast line, according to Professor Ansted's calculation, would be 811; according to Professor Guyot's 623; between the normal figure and the coast line only 1037. The principal projections and indentations of the coast are at the eastern angle, which, measured on the shore of the Arabian Gulf to Cape Guardafui, is 8°, or 480 geographical miles; the Bight of Biafra about 3°, or 180 miles; and the Gulf of Gades, which, measured from Cape Bon to the south-western angle, is about 4°, or 240 miles.

The linear extension of Africa is, from Cape Agulhas to Cape Bon, 4342, and from Cape Verd to Cape Guardafui, 4008 geographical miles.

5 *The Watersheds.*—The lines of the watersheds of Africa have already been faintly sketched, and, excepting on the north-west and south, there are as yet no materials for more definite description of them.

On the coast of the Red Sea the Arabian chain, extending along the lower course of the Nile parallel to the Libyan chain, the buttress of the Great Desert, may have a general elevation of about 4000 feet, and culminate about 6000; the elevation of Meinfayah, near the centre, has been given as 5946 feet above the sea. To the south of the Red Sea the elevation increases, near the strait of Bab-el-Mandeb, the culminating point, Alequa, being given as 10,308 feet above the sea; and in the interior, about the sources of the Atbara, it is still more considerable, Abbajaret being estimated at 15,000 feet; between these mountains and Kilmanjaro and Kenia, supposed to reach 20,000, there may probably be a depression, but the central chain, of which they are the outlying or projecting peaks, cannot, it may be supposed, be less than 15,000 feet in elevation; nevertheless of the mountains on the eastern coast, as yet, we cannot be said to have any satisfactory information.

On the south, the principal range is the Sniewberge, which culminates in Spitzkop, at 10,250 feet above the sea. Table Mountain at the southern extremity has an elevation of 3582 feet, and projects in the Cape of Good Hope, which rises 1000 feet from the sea; while several distinct ranges form buttresses to vast terraces, rising gradually to the principal elevation, the longer slope being to the north.

Of the mountains of the western coast of the promontorial extension of Africa, we know as little as of those of the east; but the culminating point of the Cameroons mountains, about the river of that name, falling into the Bight of Biafra, is said to reach an altitude of above 13,000 feet; it may be supposed, therefore, that these, and the mountains of Lupata, on the south and east, are spurs from the central elevation, indicated by the supposed snow-covered peaks west of Mombas; and the former may be the nucleus of the coast ranges, which, continued to the west in the Kong mountains, are not unlike those of the Cape of Good Hope in character; many of the peaks are said to reach the snow line, and cannot, therefore, have less elevation than 15,000 feet. Nor, indeed, is the chain of Atlas, so much nearer home, very much better known; the more elevated portions are to the west, and it appears to run in parallel lines, united by transverse spurs, from Cape Nun to Tripoli, and may be considered as connected with the Libyan system of Egypt; secondary ranges extending on the west through Algieria to Cape Bon, and on the east through Cyrene to the opposite angle of the Syrtis. This chain culminates in Morocco at 12,789 feet, not, indeed, reaching the snow line, but having an elevation as compared with it, according to that of the Carpathians, Apennines, and Corsican mountains; it may well, however, turn out on further examination, that higher elevations have yet to be discovered. Of the mountains of Senegambia, and of those which form the watershed between the Senegal and Niger rivers, and extend in the peninsula of Sierra Leone, nothing is known; they probably form the connecting link between the Atlas and the Kong ranges: from the size and character of the rivers which flow from them, their elevation should be considerable.

6 *Orographical Classification.*—With so little information as we possess as to the extent, continuity, or elevation of the mountain ranges of Africa, it would be useless to attempt any orographical classification. It may however be remarked with reference to the entire eastern continent, that as the divided ranges of the primary mountains of Asia seem to collect in the primary ranges of Europe to the north, and to the south in Africa, the secondary ranges of Egypt may in like manner unite in a central watershed, which separating again to the west may, by its spurs, surround the Great Desert, and on the south be continued in the coast to the Cape of Good Hope.

7 *Classification of Rivers.*—As the classification of rivers, according to the system hitherto pursued in this work, depends on and results from the classification of the watersheds, and the one is impossible to our present amount of knowledge, the other must be also.

In reference only to Africa, considered separately and not as a division of the eastern continent, the Nile might be considered a primary river, as possibly might some of the rivers of the north-east coast and those which flow into Lake Chad from the south and east; while the Senegal, Niger, Zambeze, Coanzo, Congo, and Orange rivers would all be secondary, as would the smaller streams which lose themselves in the Sahara; while those of the Gold Coast, Benguela, &c., would perhaps be tertiary; as these latter are small, and as the only primary river of any consequence is the Nile, if even that is to be so esteemed, the hydrology of Africa is characterized by the importance of its secondary streams, differing in this from Europe on the one hand, and from Asia on the other. This inference, as well as that drawn from consideration of the orography, seems borne out in a great measure by that which follows.

8 *The Geological Formation.*—This seems as simple as the outline, if we are entitled to form an opinion of the whole from the parts which we are acquainted with. These are principally Egypt, Abyssinia, the Cape colony, the Atlas and its subordinate ranges; and from our knowledge, slight as it is, recently indeed more enlarged with reference to Egypt and the southern extremity, it may be concluded* that 'the oldest rocks (whether crystalline, gneiss, or clay-slate, here and there penetrated by granite) form a broken coast fringe' around the Cape colony from east to west, are surmounted by sandstones of the Silurian system, and these again overlaid by carboniferous strata: all dipping inwards as to a central basin. The older crystalline rocks also extend through Abyssinia from the coast of the Red Sea, and cross the valley of the Nile below Nubia; on these limestones rest, and form the eastern limit of the valley of that river; while to the west sandstone predominates, but surrounding some of the oases, limestone presents itself, and its pre-

* Sir R. Murchison's Address to the Geographical Society, 1852.

sence may account in some measure for their fertility. In the Atlas as well as the Kong range, argillaceous rocks seem to predominate; but as in the east, whether to the south or north, so in these the earlier rocks will doubtless appear, and the eruptive rocks be found obtruding through fissures in the more recent strata. On the east between the Limpopo and Zambeze granitic rocks predominate, and near the latter basaltic rocks are found. As the geological character of the countries on either side of the Red Sea is analogous, so no doubt it is in those opposed to each other at the Strait of Gibraltar: both peninsulas, Arabia and Spain, may indeed be considered as physically African, rather than European or Asiatic; although it must not be forgotten that districts of similar character extend along the southern coast of the latter continent, and even across the valley of the Indus.

CHAPTER XXIV.

THE NILE.

§ 1. The principal watershed.—2. The secondary ranges of the west.—3. The sources of the Nile.—4. The valley of Egypt.—5. The Delta.

THE principal Watershed.—To the slight sketch which has already been given, but little can be added. The limestone ranges extend from the Isthmus of Suez to the cataracts of the Nile, where the primitive rocks are found, especially the well-known Syenite, but between these is a district of recent sandstone; the extreme northern limit, from whence the limestone ranges trend towards the isthmus, is Jeb-el-Mokattem; these present to the valley abrupt precipices, rise in rugged and broken masses, in some places 2000 feet above it, and are intersected by deep transverse ravines.

In the district between the Nile and the Red Sea, the centre is an elevated plain, the slope to the latter being one-third longer than that to the former, in about lat. 28°. Granite and other primitive rocks appear between the limestones of the coast and of the river valley, and pass into the interior; the highest peak here is El Ghorib, rising 6000 feet, and composed of primitive rock, to the south of which the Jeb-el-Munum Fiyah has an elevation of 5000. Sir Gardner Wilkinson represents both the sandstones and limestones as resting on clay; but this probably applies to the western districts alone.

The Abyssinian mountains rise by three successive terraces from the Red Sea, and attain an elevation of not less, possibly more, than 12,000 feet; a large portion of them are of schistose formation, and the eruptive rocks are frequently protruded in the mountains of Tigre; the superincumbent strata are much distorted, and generally have an abrupt and precipitous appearance. They are however in many places covered with verdure, and in this as in the former, they assume considerable resemblance to those of southern Asia. The mean elevation may be above 8000 feet; the mountains to the south have, however, as already noticed, a greater elevation, Abba Jarrat rising 15,000, and Mount Buahal 14,364 feet.

2. *The Secondary Ranges of the West.*—These, like the extension of the principal range to the east, are of limestone and sandstone, presenting a short slope, or rather an abrupt escarpment to the valley of the Nile, and extending into the Great Desert at a very inconsiderable angle with the horizon, though the surface is diversified by slight elevations and depressions. The superficial strata seem to have a thickness of about 100 feet, water not being found at a less depth.

Passing to the north-west through ancient Cyrene, these ranges, increasing in elevation, enclose isolated but most fertile valleys, which seem to correspond not slightly with the oases of the desert. Here, apparently, the continuity of the chain of mountains is broken; but to the west it is renewed, and extended into the ranges of Atlas, as already noticed.

The parallelism and precipitous character of the ranges on both sides of the Nile valley give it the appearance of having been formed by disruption.

3 *The Sources of the Nile.*—These are principally two; but one of these at least owes the fulness of its waters to the junction of several streams. The Bahr-el-Abiad, or White River, is by most geographers considered as the more important, possibly because its sources are unknown; it should, however, according to the theory adopted throughout this work, be the secondary source, rising in the depression between the primary and secondary chains of mountains: and Mr. Cooley, in his work on 'Claudius Ptolemy and the Nile,' gives sufficient reasons for this conclusion. The results of the expeditions sent to examine this river, by the Pasha of Egypt, as well as by missionaries, lead us to suppose that in its middle course it forms a succession of extensive marshes, stretching from west to east; but that after being joined near the tenth parallel by a considerable affluent from the east, where its course becomes northerly, its stream is deeper and more rapid, occasionally spreading to a mile in width; the navigation is, however, interrupted by sandbanks, which form a bar at its mouth, where it is about 500 yards broad; its confluent stream, the Blue Nile, being nearly 800, with a greater volume, and more rapid flow of water.*

The sources of the White Nile seem to lie in the mountains of Komberat, from whence it has an easterly course, and flows through a rocky channel, broken by cataracts.

The Blue Nile, Bahr-el-Azrek, is a stream of altogether different character. Strong and impetuous throughout its course, it overpowers the waters, and has thrown up a bank of sand across the mouth of its confluent stream; in its upper course it is called Abai or Abawi, and after flowing through Lake Dembea or Tsana, assumes that by which it is better known. This lake, lying in about 12° north lat., and 37° 15′ east long., may have an area of 1200 miles; its length from north to south may be above fifty miles, and its breadth about half its length; its elevation above the sea is 5750 feet; it contains several islands; on the south and east the mountains which limit its basin rise 12,000 feet above the sea, to the west not probably more than 9000, and the sources of the Blue River are in a marshy plain; below this portion of the watershed of its basin probably, however, other streams may be found to flow into the lake, on leaving which the Blue River is 200 yards wide; but soon narrowing, the waters descend in a series of falls through a cleft in the volcanic rocks, so rapid in declivity, that at fifty miles from the sources of the river it is said to be 6000 feet below them, while its course among the mountains of Abyssinia must be more than 500 miles, during which it receives numerous affluent streams, especially from the mountains on the right; in its lower course it has a considerable affluent, the Jabous, probably the same as the Maleg of the Portuguese, and the Dedhesa of Dr. Beke.

The point of confluence is in 15° 34′ north latitude, and 32° 30′ east longitude; from thence the river trends northward, and rushing through a narrow gorge between mountains of but little elevation, bends again to the east, and flowing through extensive plains, receives a considerable affluent, the Tacazze, or Atbara, the ancient Astaboras; from the right this river has more than one source in the mountains of Larta, and flows through the country of Tigre in a general north-west direction, joining the main stream in 17° 45′ north latitude, which, from thence to the Mediterranean, a distance of 1350 miles, has not another affluent, a remarkable but not altogether singular case among rivers, as has been usually asserted.

The great bend of the Nile, which commences at Assouan, the ancient Syene, nearly under the nineteenth parallel, assumes first a south-westerly

* It should, however, be noted, that a conflicting account gives the White Nile a depth of from three to four fathoms, and a breadth of from three to four miles above the point of confluence.

direction for 120 miles, and then trends north-west for as many more; throughout this course it flows in a narrow channel; and to the south of the twentieth parallel falls over a ledge of granite rocks, forming what is known as the third cataract or rapid; from hence to the second is in direct distance about 130 miles, and from thence to Philæ, where at the first cataract the lower course of the river commences, about 150; throughout this middle course the banks of the river are either formed of the rock which limits its valley, or of sand extending to the rock, and consequently incapable of supporting vegetable life, nor, indeed, is the course of the river very dissimilar in character below this first cataract.

4 *The Valley of Egypt.*—It has already been noticed that the valley of the Nile appears like a cleft in the mountains; in no case is this of greater breadth than about ten miles; while in the upper districts of Egypt it is much less. Throughout the entire length of the valley, accumulations of sand have formed strips of desert country at the base of the ranges by which it is limited, and these being above the head of the water, even during inundations, do not afford opportunity for the labours of the husbandman. On leaving the granite district which indicates the edge of the Nubian Desert, the river divides and forms several islands; of these, Elephantine is the largest and the last; its position has always given to this island considerable political and commercial importance. Formed of granitic rock, it owes the abundance and beauty of the vegetation which has obtained for it the name of the 'Isle of Flowers,' to the alluvial deposit with which the waters of the river, during their rise, have covered it; it is nearly one mile in length, and a quarter in breadth, and is, excepting at the southern extremity, covered with gardens interspersed with mulberries, acacias, dates, and sycamores; at the south point the bare rock rises above the river, and as this island was the favourite quarry of the ancient Egyptians, it is more than probable that its present fertility is the result of the reduction of its original level by the transfer of its rocky surface to the temples, sepulchres, and pyramids of Lower Egypt.

Of the fertile districts of the Nile valley, that of Faioum or Faium, more properly Phiom, *i.e.*, the Lake, is the most remarkable; it has not unaptly been named the Garden of Egypt. Situated on the edge of the Nubian Desert, under latitude 39½°, it is still subject to the inundations of the river; Lake Mœris was formed by gigantic embankments extending across the valley; these have recently been discovered and surveyed by Linant, the lake El Quorn, or Birket el Quorn, formerly supposed to be Lake Mœris, seems to have been used to receive the overflow of the lake. The Bahr El Jusuf, or Canal of Joseph, extends from the Delta southward for above 150 miles, and is connected with the lake at Faioum, and numerous other canals intersect the country in every direction where irrigation is possible.

The characteristic vegetation of the valley of the Nile is found in the cereals, gourds, and leguminous plants; of trees, the acacia, date palm, and sycamore; the papyrus and lotus among the water plants. Of animals, the most characteristic of the country are the crocodile, hippopotamus, buffalo, and jerboa; of birds, the vulture, stork, pelican, and ibis; quails are very numerous; the insects of this country are still its plagues, especially the locust and mosquito; bees also abound, and their products are of much importance in the social economy of the inhabitants.

5 *The Delta.*—That any difference of opinion respecting the origin of this vast alluvial deposit should exist, appears not a little singular. That it has been formed like the deltas of other rivers, which have derived their names from this, cannot for a moment be doubted; and although here as elsewhere (as already recorded of the valley of the Indus), local and temporary alterations may have been the result of earthquake action, or other causes, yet the constant increase and extension of the land about the mouths of the Nile must be mainly, if not entirely, attributed to the action of the waters of the river, especially during the inundations. The apex of the Delta is in lat. 30° 7′, from which point to the sea its length is about ninety miles, and it may

have about the same breadth. As in other deltas, so in this, the channels by which the waters of the river connect with the sea have frequently changed; the eastern and western branches, *i.e.*, those of Damietta and Rosetta, being in breadth 800 and 1800 feet respectively, are now the most important; those of Bourlos and Dibe less so. Even the Indian accounts give the site of Memphis as the original limit of the valley and the shore of the Mediterranean, and all below that point may, in the language of the Father of History, be well termed the gift of the river. The depth of the deposit varies from thirty feet at the extremities, to six inches. From the first cataract to the sea the average fall is two inches to a mile, and the mean velocity of the current three miles an hour; the annual rise of the waters, due to the periodical rains and melting of the snows on the Abyssinian mountains, commences in June; in September the whole delta is submerged, and in November the inundation has subsided. The rise of the water in Upper Egypt may be estimated as on the average thirty feet; in Lower Egypt as twenty-four.

The shore of the delta is lined with lagunes characteristic of such formations, like those of the delta of the Po; a bank of sand, thrown up by the action of the sea waves, first creates lagunes, gradually turns them into lakes, which in process of time become filled with the deposit which can no longer be carried out to sea. The principal lagunes of the Nile delta are those of Menzaleh Bourlos, Etko, and Maræotis; the former, which receives the waters of the Pelusiac and Tannitic branches of the Nile, is fifty miles long and nearly one-half as broad, but very shallow; its fisheries are still famous.

To the west of the delta are the famous Natron lakes; these, eight in number, are situated in a valley to which they give name among the secondary ranges at the edge of the Libyan desert; they abound in crystallizations of natron, or carbonate of soda and sea-salt.

CHAPTER XXV.

SOUTHERN AFRICA.

§ 1. Watersheds of the south.—2. Rivers of the south and west.—3. Rivers of the south and east.

WATERSHEDS of the South. — South Africa has already been described as a country of terraces buttressed up by continuous mountain-ranges, trending, for the most part, in the same direction as the coast. These terraces rise gradually from the sea to the summit of the ridge known as the Roggeveld, Niewveld, Sniewberg, or Stormberg mountains, which, continued to the north and east in the rugged ranges of the Mathlamba or Quathlamba and Drachensberg, pass into those of Mozambique, the ancient Lupata, or back-bone of Africa; but the greater volume and more constant supply of the waters in the river of Natal, would lead to the conclusion that the main watershed of the central portion of Southern Africa lies far to the west, and that, therefore, a considerable depression exists between the mountain ranges of the south and the principal watershed, the outlying peaks of which appear, as already noticed, near Mombas.

The mountains generally present a steep face towards the south, but slope gradually towards the interior, so much so, indeed, that even on the northern side of the highest range the elevation of the mountains is not perceptible. The culminating points are most probably to be found near the sources of the Orange River, attaining, probably, to an altitude of 12,000 feet; the Compass Berg, in Graaf Reynet, rises 10,250. The Orange River district forms an elevated plateau, which slopes gently "from the summits of the Mathlamba range into the Kabhini desert, and the barren plains of the Bushman

Karroo, and the granite wastes of Namaqua land," while to the eastward it gradually changes into undulating grassy plains, which, as they approach the coast, and become well watered, are covered with luxuriant vegetation.

In journeying from the Orange River to Natal, the traveller arrives suddenly and unexpectedly on the edge of the Drachensberg, looking down on the Natal colony, 5000 feet below him; and so, in passing from the Roggeveld, he as suddenly overlooks the Great Karroo, from which the peaks of the Winterhoch and Zeuerbergen do not appear of more than half their proper altitude.

The summit level, passing along the ranges already named, may be estimated at from 7000 to 8000 feet above the sea; and to the south, between it and the Roggeveld, Niewveld, Zwartbergen, and Cold Bokkeveld ranges, which culminate to the east in Compass Berg, already mentioned as attaining an elevation of 11,200 feet.* The northern branch of this range, taking a semicircular sweep, and joining the Stormberg, passes off to the north-east, while a southern spur approaches the coast, forms the ranges known as Zwagenhoch, Boshberg, Winterberg, Katberg, and the Amatola and Buffalo heights, and finally is lost in the rugged coast district of Kaffraria. These ranges culminate in the Great Winterberg, at 7610 feet above the sea. The average height of the plateau which they enclose may be 2500; here are the fertile valleys of the Sniewberg and Zwagenhoch, the head waters of the Great Fish River, the Kat, and Burneen rivers, and further east, at a higher level, the North Victoria: on the west, the Great Karroo extends its surface of red clay, thinly covering a substratum of blue clay slate, diversified by irregularly interspersed elevations, and intersected by abrupt hills and ridges. To the south of the Cold Bokkeveld is a plateau of greater elevation than the Karroo, but not of great extent; in the same line, other similar small plateaux of considerable elevation are found, and to the south of these is a narrow plateau, not extending more than twenty-five miles in breadth, and gradually narrowing to the eastward into a mere step or terrace; its limits are the Great Zwartzberg and Winterhoch, which extend westward and southward in the mountains of the Cardon pass, the Drachenstein, Zondevend, Langeberg, and Outeniquas mountains, which gradually subside towards the ocean at Plattenberg bay: here are the sources of the Oliphant, Warm-Bokkeveld, and Boschveld rivers.

The southern and lowest plain is a marshy, level tract of sand, broken by fertile valleys, as at Caledon and Swellendam, and the Outeniquas land; here is also the forest of Zitz Kamma, and this plain extends between the coast and Buffalo range into Kaffraria; in Natal it is limited by the Roodeberg, and there, and in the Zulu country, spreads out into a rich champaign of the highest agricultural capability. The upper plateau is drained, as has been noted, by the Orange River and its numerous tributaries; and these, in their upper courses, are plentifully supplied with water, but in the lower, often for years, present nothing but chains of pools.

It must not, however, be supposed that all these plateaux are irretrievably barren and desolate, on the contrary, the watercourses are fringed with willows, and the verdure of all is most luxuriant; and the lengthened north-east slope from the western watershed presents fine prairie land. After heavy rains even the Great Karroo evinces the fertility of the greater portion of its surface in rainy seasons; it has, however, tracts entirely destitute of water, and, therefore, at first irreclaimable by man. Deserts also are found on both sides of the Orange River, but the eastern districts are generally fertile.

Forests are not found in the west; in the south, the Zitz Kamma, in the district of George the cedar woods on the Cedar Mountains, and on Largeberg, are all that can be noted. The Tsi Kamma forests are very extensive, and

* From the height of this mountain it might be supposed that the superior range has an elevation of not less than 15,000 feet, unless, indeed, it be the nucleus from whence the various chains diverge.

the kloofs of the Mulesberg, Boschberg, and the Amatola mountains are well wooded, and afford valuable timber, as do the forests of Kaffraria; but in all cases these are only found on the southern, or coast escarpments of the mountains, the interior and more gentle slope being invariably destitute of timber, unless the willows skirting the principal watercourses deserve that name; and this is the case with the principal grazing districts, as Beaufort, Graaf-Reynet, Colesberg, Albert, and the Orange River sovereignty.

Of the mountains of the south, the Sniewberg may be taken as a type: it is formed principally of sandstone strata, lying in nearly a horizontal position, and thus presenting, on the southern escarpment, the appearance of a gigantic wall of Cyclopean architecture, an appearance remarkably developed in the Oudebergen, where the rock appears at the top, rising about forty feet, like a low tower or bastion; the portion of the Sniewberg, however, which is denominated Kakaberg, is broken into beautiful valleys, covered with grass, and interspersed with clumps of forest trees, among which many rare and beautiful birds are found.

A distinction is, however, observable between the sandstone and sedimentary rocks and the granitic ranges: the former are, however, the characteristic features of the orography of Southern Africa; the latter prevail on the Khamies, Paarl, and Blue mountains, as well as on Lion's Head and Table mountains.

2 *Rivers of the South and West.*—The most important river of the southern extremity of Africa, is the Orange, or Gariep, which rises in the Mathlamba range at a considerable, though unascertained, elevation. As this range attains an altitude of 10,000 feet, the sources of the river are not probably of less elevation than 6000; in its upper basin, the streams are confined within very narrow channels, and it is here called the Black River, from the colour of its waters; it flows in a south-westerly direction through the valley formed by the ranges of the Mathlamba for more than 100 miles, receiving the affluent waters of numerous mountain torrents, and issuing by a narrow pass, is increased by the waters of the Kraai, and then, trending west and north-west, by those of the Caledon, about 250 miles from its source. To this point it is known as the Nu Gariep, and here the river is 930 feet broad, but only two and a half deep, and flows in a channel the banks of which rise twenty-five feet.

The Caledon, or Mogokarre, is a rapid stream, and in summer its waters are on a level with the banks, and often twenty feet deep; it attains a breadth of 300 feet, and receives some considerable affluents. Of these, the Tlotse, and Saule, or Little Caledon, deserve notice; the latter, called by the natives Putiatsana, possibly the Antelope River, rises from two sources in the Basutos country; its waters are pure and limpid, their bed being very hard; it is noted for the peculiar fish inhabiting its waters. The Caledon is more than 200 miles in length, and its waters vary in colour from yellow to brown, and even deep black.

From the junction of the Caledon, the Gariep flows for 150 miles in a north-westerly direction, and receives the Ky Gariep, known also as the Yellow or Vaal river, from the north. This river has also numerous affluent streams from the south: the Wilge; the Eland, a fine clear stream, flowing in a rocky bed in which pebbles are abundant, especially agates; the Mull, and the Liebenberg, all rising in the Wittenberg mountains; also a wide and rapid, but usually fordable tributary, the Mooi, which winds through an extensive valley. The Vaal is also called the Likwa, and from its junction the river takes a south-west direction, receiving the waters of the Rhinoster, Vals, Boralla, Zand, Vet, Hart, and Riet; from the mouth of the Vaal to the sea may be 550 miles. Lower down the river, in its westerly course, three streams unite on the left: the Visch or Hartebeest, the Zac, and Great Riet, which have their rise in the northern slopes of the Niewveld and Roggeveld mountains; and on the right the Fish Borradaile Oanop or Oup, flows through the Namaqua land, rising in mountains which, though attaining an elevation of 5350 feet above the sea, are to the east of the western watershed.

In addition may be mentioned the Makaling, or River of Aloes, which, flowing from north to south, is a tributary of the Orange River; and the Namagari, which may, perhaps, be esteemed the principal source of the Vaal; it receives a considerable affluent, the Enketuane, from the south, and from the point of junction changes its original brown colour to the yellow which gives name to the Orange River, and which is derived from the sand which is brought down by its upper waters and mixed with the calcareous formation through which it has its middle course. The Sea-cow river is important as collecting the waters of the northern slopes of the Sniewberg and Roodberg, although it is rather a chain of enormous and very deep pools connected by canals than a river; its banks are covered with reeds, and abound in game.

The Orange River, especially in its middle and upper course, is broken into many beautiful falls, and is remarkable for the fertility of its banks; the upper course is through rugged mountains, the lower through arid plains, where its course is marked by the willow and mimosa trees which fringe its banks; its length must exceed 100 miles. Agates, opals, cornelian, and jasper are found in abundance in its bed. Its lower course is also obstructed by falls, and its mouth by a bar, which make it entirely useless for commercial purposes.

The next important river of the east is Oliphant River, which rises in the southern extremity of Cedarberg; this is by some considered as more properly to be called Elephant River: it has a broken and irregular course of about 150 miles, but is never deficient in water, and can be navigated by small craft for twenty miles from its mouth; it has several considerable affluents, the most important being the Hantam and Doorn.

The Berg river flows from the north of Cape Town into St. Helena Bay; its volume of water is so considerable, that until lately it was crossed by a floating bridge.

3 *The Rivers of the East.*—Of these the first is the Breede, which, falling from the southern slope of the Warm Bokkeveld, the watershed of the Oliphant River, in its upper course runs parallel to the Berg; its affluents are the Kex and Zondereinde; it is a considerable river, but its navigation is impeded by a bar at its mouth, but this has never less than twelve feet of water, and the river is accessible for vessels of that draught for forty miles from the St. Sebastian Bay.

The Guaritz drains a large area; it has its principal source, the Gamka, in the Niewveldberg; this has a considerable volume of water, and is remarkable for the beauty of the flowers found on its banks. It is joined by the Oliphant River on the left, and lower down the united streams receive the Taw from the right; it is a weak stream in summer, but in winter is rapid, and considered very dangerous. One of its affluents, the Dwyka, *i.e.*, mouse-coloured, is so named from the grey sand which forms its banks; it has not much water, but is about 100 yards in breadth.

The Gamtoos or Kamtoos also rises in the Niewveldberg, but has its eastern source, Buffalo River, in the Sniewberg; it is a considerable stream, and navigable, but a bar, dry at low water, obstructs the mouth. The Buffalo or Buffaljagt is a deep and rapid stream, flowing over a stony bed; its banks are clothed with acacias.

The Bushman River rises in the eastern slopes of the Compassberg, and falls into Alysa Bay; it is a considerable river, but receives no affluents of importance; the scenery of its valley has been thought worthy of notice.

The Great Fish River rises in the eastern spurs of the Sniewberg; it has a tortuous course, but its affluents are not considerable: one of them, the Brak, is, however, a considerable stream, and often impassable, and being obstructed by a bar of shingle at the mouth, spreads into a considerable lake: the quantity of water which this river presents is very variable, at one time it is little better than a string of pools, at another it has risen seventy feet;

like the other rivers, it has a bar at its mouth, but there is never less than seven feet of water upon it. The banks of this river, formed of stiff blue clay, descend gradually from the elevated plains on either side; on the east it is fringed with wood; there are hot and petrifying springs on the right bank; its course may be estimated at nearly 250 miles.

The Keis Kamma has a course of about seventy-five miles, and its entrance is impeded not only by a bar, but by the surf which beats over it, and the rocky reefs which extend from it.

The Kei rises in the western slopes of the Stormberg; it may have a course of 150 miles; it has two affluents of the same name. Passing northward the short slope of the Mathlamba mountains and Drachensberg, present numerous small rivers; of these the St. John is the largest; its native name is Umzimvubu; its affluents are principally from the left, and fall from a projecting terrace of the mountains, which is buttressed up by the Little Quathlamba range, from the northern side of which the Umzimyate, or Tukela river, draws its important southern affluents. The St. John may have a course of 150 miles, and is navigable for small vessels, but the other rivers between it and the Tukela are much smaller; this latter stream has probably a greater length, and drains a more considerable area; its principal source is also called the Umzimyati, or Buffalo, but it may be said to be formed by the confluence of three rivers, the Umzimyati on the north, the Tukela, or Utukela, in the centre, and the Mooi, or Impafane, on the south; the Tukela has numerous affluents; coal is said to abound in its basin; the north-eastern sources are in close proximity to those of the Umpoota, which falls into the southern extremity of Delagoa Bay, the intermediate semicircular space being occupied principally by the St. Lucia river.

Of the territory drained by these rivers it may be noted that it has three natural divisions—that of the coast, which is adapted to the cultivation of cotton, and the productions of sub-tropical climates; the thorn-land, on which the mimosa is the prevailing shrub; and the forest and open districts of the hills and table lands; this latter is well watered, and affords plentiful supplies of timber; many of the mountains here are of basaltic and porphyritic formation, but, as to the south, sandstone prevails.

Further north and on the eastern coast our knowledge is very limited. The Limpopo, a considerable river, rising in the northern extremity of the Drachenberg, has first a northerly and then an easterly course, and possibly falls into Delagoa Bay; English river, an estuary in this bay, receives the waters of several streams, is navigable for large vessels for forty miles, and for boats 200; beyond this the great Zambeze, or Leambye, so lately described by Dr. Livingstone, drains a large area between 10° and 18° south latitude, flowing from the eastern slopes of a table-land, from the north and west of which the Congo and Coanza have their rise also, and enters the Mozambique Channel by several mouths, extending over nearly seventy-five miles of coast, from the Luabo* to Quilimane; one of these mouths is navigable, and good coal is reported as found on its banks.

This river does not flow from Lake Ngami, as had been thought, but it seems more probable that this lake has no outlet for its waters. It is situated under the twentieth parallel, is thirty miles long and fifteen broad, 3713 feet above the sea, and receives the waters of several streams, among which the Tioughe has a long and tortuous course from the north and west through a marshy country; its banks are swampy, but covered with luxuriant vegetation.

To the north of the Zambeze, near the tenth parallel, is the larger Lake Nyassi, the Sea, through which a considerable river flows, which may possibly be that which reaches the sea near Quiloa; it is the Lake Maravi of the ancient maps. Further northward, the mountains approach nearer

* Dr. Livingstone's party has just entered this river from the sea to ascend, *via* Tete, into the interior.

the coast, yet there are still some considerable rivers which have their rise in the High mountains already noticed, but of these we have little satisfactory information; the more northern probably have their sources in close proximity to those of the Nile. Besides the lakes already mentioned, others exist northwards as far as the equator, and it seems probable, as has been hinted already, that the centre of the southern tropical region of Africa is an extensive marshy district, in which the rivers originate which flow both east and west into the Indian Ocean and into the Atlantic. Burton and Speke have penetrated nearly 500 miles into the interior from Zanzibar, without having seen the mountains or the lake. A well-defined watershed, however, extends from the valley of the Orange river between the sources of the rivers which fall into Lake Ngami, and the Norse river, which enters the sea to the north of Cape Frio: between the Norse and the Orange river is the Swakop, which has its channel from 800 to 1000 feet below the general level of the country.

CHAPTER XXVI.

RIVERS AND WATERSHEDS OF THE WEST AND NORTH.

§ 1. The Congo.—2. The Niger or Quorra.—3. The Senegal and Gambia.—4. The watersheds and rivers of the north.—5. The Central Basin.

THE *Congo.*—Of the watersheds of this coast nothing is correctly known; of the rivers as little. From the Walfish Bay to the Coanza the coast is almost *terra incognita.* This may, however, be said of it, that with the basin of the Congo its character changes altogether, resembling rather the districts of the eastern coast, having abundant vegetation, resulting from a most fertile soil combined with a hot and moist climate; yet of this great river, abounding as its valley does with natural wealth of all kinds in abundance, we know little more than that it is said to have its rise from two principal sources, the northern of which originates in a lake; that ninety leagues from the sea it is still four miles wide, but lower down, about 140 miles from the mouth, it forms rapids between cliffs of slate; these form the table land at the base of the mountain ranges, in which the sources of the river must be looked for; and the plain above is fertile and healthy. In the lower course of the river the banks are clothed with luxuriant vegetation; it is here a broad, very deep, but not very rapid stream, overflowing its banks in summer, and inundating the surrounding low lands.

2 *The Niger or Quorra.*—While the Congo has a westerly course, the Niger, Joliba, or Quorra has at first an easterly, to the north of the Kong Mountains, among the western extensions of which it is supposed to have its sources, at an elevation considerably below 2000 feet; but it is probable that other sources than those of which Laing heard, and which form the Joliba, exist to the north and east, and that the principal source is the Alimar. Like the Congo, its upper waters are navigable for vessels of considerable size; and it also forms rapids in passing through the defile which separates its upper from its lower basin: its valley is broad and fertile, often inundated by the waters, which in one place form a considerable lake, called Debo, and lower down bifurcate, forming extensive insular tracts: its navigation is, however, impeded for more than 100 miles in its passage through the mountains: in its lower course it forms many branches, stretching through an extensive delta to the sea, the principal of which are the New Calabar, Nun, Bonny, Forcados, and Benin. The river varies from one to five miles in width, may have a course of more than 2000 miles in length, and a basin exceeding that of the Nile in area; the principal affluents are the Sakkatu and Chadda. The influence of the tidal wave is said to extend about 120 miles from the sea, below the mouth of

the Chadda, formerly thought to flow from Lake Chad, but now proved to derive its waters from the central watershed already referred to: it is equal in breadth, but not in depth, to the parent stream; this affluent is from the left, as are the Mayarrow and Coodonia. The Bonny River lies between the New and Old Calabar Rivers, and is the most western mouth of the Niger; the Benin mouth gives its name to the extensive bight into which the river flows.

The rivers which have their rise in the southern watershed of the Niger have but comparatively short courses, though most, like the Old Calabar, enter the sea by considerable estuaries.

3 *The Senegal and Gambia.*—Not different in character are these rivers from those already noticed: their courses have been estimated at 1000 miles, but may not improbably be more; they have their sources in the reverse slopes of the watershed of the Niger; their upper courses are through fertile and comparatively healthful regions; they form cataracts in the defiles through which they leave the plateaux, and in their lower course flow through alluvial plains covered with most abundant vegetation, but moist and pestilential. Vessels of some 150 tons may ascend to the rapids of the Gambia; and the Cazamanza—which enters the sea more than fifty miles from the known point of connexion—is considered one of its mouths. The Senegal has its rise in two principal sources, of which the Black Water (Ba-fing) rises at an elevation probably not inferior to that of the Niger; its upper waters flow through a more broken country, but its lower course is so nearly level that the tidal wave extends its influence for sixty leagues up its stream. The delta of this river lies between its two principal channels of communication with the sea, from which the apex is thirty-five miles; these are, however, obstructed by sand-banks; in the rainy season small vessels ascend to the rapids: the principal affluents are the Kokoro on the right, and the Faleme on the left, both being in the upper basin.

4 *The Watersheds and Rivers of the North.*—The culmination of these watersheds on the western coast of the continent has already been noticed. The principal of the ranges, known to Europeans by the collective name Atlas, commences at Cape Geer on the Atlantic coast, and trends in a north-easterly direction through Morocco: this is known to the natives as Djibbel Telge, and from it a lower range, but culminating in a lofty peak, said to exceed the snow limit, extends in a south-westerly direction to Cape Non, forming the northern watershed of the river Drah, which falls into the sea some thirty miles to the southward: it was formerly supposed to lose itself in the Desert, after a course of about 250 miles. Of the southern slopes of the Atlas Mountains we know but little: the spurs on the west are probably continued in the watersheds of the Niger and Senegal; they must enclose fertile valleys towards the Sahara; the descent is by gentle declivities.

The chain of the Greater Atlas with its spurs extends to the north on Capes Spartel and Bon, while the Lesser Atlas stretches to the coast on the north and west as far as Ceuta: the former is known to the natives as Djebel Tedla, the latter as Errif; this does not exceed 2000 feet in height; both, however, have their origin in the central knot, where the rivers Morbeya Omerbergh, and Mulwia, or Mahala, have their sources: further to the east are the mountains of Algeria, which culminate above 6000 feet, and are broken by the deep valleys of several rivers which flow into the Mediterranean. To the south of these another range is found, at considerable distance, which, from the course of the river, should be the principal of these ranges: it is thought, however, not to attain so great an elevation, though having greater breadth and solidity, features analogous to those already observed in other mountain ranges: the valleys between are of great fertility, and are not probably exceeded in this respect: portions of this range are known to the natives as Djebel Amer. The southern slopes of these mountains are continued in parallel ranges of undulating elevations, enclosing valleys, the fertility of which decreases as the Desert is approached and the absence of water is felt. On the north the spurs are extended to the coast, in one place only, to the east of Algiers, presenting a level surface; on the plain of Metidyah the Nefusa hills stretch eastward towards the Gulf of Cabes.

In its geology this district seems to have analogy with those of Spain and Asia Minor; over a large proportion of the surface calcareous deposits predominate, as also do sandstones; saliferous deposits are also abundant; its mineral wealth must be very considerable: copper abounds, to the west iron and lead are also worked, while antimony is plentiful in the Tedla range. Forests of oak and cork clothe the sides of the mountains, the white poplar abounds in the valleys, the olive flourishes, and the dates of the southern slopes are famous. Of the rivers of the Atlas ranges little is known, the Morbeyah Omerbegh, or Umm-er-shieh, has a north-westerly course of probably 250 miles, as may the Mulwiah and Shelliff, or Chinalath, which flows through the marshy Lake Titteri: the other rivers, Isser Sumeim, Wad-el-Keber, Seibous, and Mejerdal are less considerable; the Seibous may have a course of 100 miles, and was formerly navigable: that of the Mejerdal, or Medjerdal, approaches 200 miles: these all lie westward of Cape Bon, to the east of which there are no rivers except the Nile. The Seibous, or Sebus, and Morbeyah flow into the Atlantic. All these rivers are rapid in their upper courses; and those which flow to the west have numerous affluent streams.

Characteristic of the change in the face of the country towards the east are the lakes of Benzerta in Tunis, the one at the foot of the limestone mountain Gebel Ischkel, of fresh but turbid water, three and a half miles long; the other nearer the sea, of salt water, five and a half miles long: they have been always noted for abundance of fish. The lakes are of an average depth of five fathoms, and separated by a neck of land two miles wide, through which a meandering channel, called Tinja, connects their waters: mineral springs are found at the base of Gebel Ischkel, and the surrounding country having a surface of sandstone and marl is highly fertile; similar lagunes to that of Benzerta, and also connected with the sea, exist at Risifa and Tunis, the latter of which is twelve miles long; on the east also, inland, intermittent streams form marshes and occasionally lakes, and here Lake Melgig, which may be above twenty-five miles long by fifteen broad, receives the waters of the Adje, a considerable river having a course of above 200 miles from the north and west.

5 *The Central Basin.*—The famous Lake Chad occupies the lowest part of the central basin of North Africa. The area of the lake is very considerable, and has been stated as 200 miles in length by 150 in breadth; but of this, notwithstanding its recent navigation, we are yet in doubt. The elevation of its surface above the level of the sea has been computed at 1200 feet, but the depth of its waters is inconsiderable; its form is irregular, its shores formed by verdant pastures, interspersed with marshes and thickets, the haunts of wild animals; it receives, from the south and west, the waters of the Shary and Jeou, and probably others from the east, and has been thought to discharge its surplus waters by the Tsadda or Chadda into the Niger, this opinion, however, has no evidence to support it; it contains several islands. The Shary is a considerable stream, entering the lake by several mouths, and being in some places a mile in breadth: the same name has been applied to the Châdda.

CHAPTER XXVII.

OF NORTH AMERICA.

§ 1. Historical sources of our knowledge of the interior.—2. More recent information.—3. Of the boundaries and limits.—4. Of the coast line.—5. Of the watersheds.—6. Of orographical classification.—7. Classification of rivers.—8. Geological formation.

Historical Sources of our Knowledge of the Interior.—The interposition of the French province of Acadia between the British settlements in Newfoundland and New England produced jealousy and antagonism between their inhabitants, while its connexion with Canada, maintained by means of the natives on the St. John's River, gave unity of action to the one which was altogether wanting to the other. The habits of the French settlers also led them into closer connexions with the natives, so that several of them, as the Baron de Custine, became heads of tribes, and possessed of large tracts of country in right of their wives. The fur trade, the great source of wealth in the early days of those colonies, and by no means an unimportant one in some places at present, in the excitement and variety which its pursuit afforded, offered greater inducements to the French than to the Anglo-Saxon races, who, true to their nature, became for the most part agricultural; and thus it happened that the early exploration of the interior of North America is due to them rather than to us; and the routes across what are now New Brunswick, and the States of Maine, Vermont, and New York, by the St. John's, Penobscot, and Hudson rivers to the St. Lawrence, became familiar to them; indeed it may be assumed that much of the interior of that part of the country was better known to the early French colonists than until very lately to those now residing there.

To them also belongs the honour due to the exploration of the basin of the great lakes, and from thence of the Mississippi valley, which was effected by La Salle and De Tonty in the year 1678. The actual discovery of that river, however, is due to Marquette and Joliette, some five years before.

La Salle was commandant of Fort Cataraqui on Lake Ontario, at the mouth of the river of the same name, known also as Frontenac, and now as Kingston; he built a vessel on Lake Erie, which he traversed, and reaching Lake Huron landed at the Miamis, since called St. Joseph's River, crossed from thence to the Illinois, and descended the main stream to the Gulf of Mexico; here he was murdered by his own men; but subsequently the French established themselves at the mouth of the river under Lemoigne d'Iberville, and De Tonty made several voyages up and down its stream, so that its course and the mouths of its affluents became familiar to them.

It should be observed that the Jesuits, and more especially the Recollets, were active in stimulating and assisting in all attempts at discovery in the interior from Canada.

After the conquest of Mexico the Spaniards, as already noted, had established forts on the northern shores of the gulf, and pushed their discoveries to the north-west and east until California on the one hand, and even Florida on the other, became known to them.

In 1540 Fernando de Alarcon ascended a great river at the head of the Gulf of California for eighty leagues, and Francisco de Coronado explored a large breadth of country to the east, probably that lying about the sources of the Gila, and from thence extended his researches into level plains, covered with herds of buffaloes, probably the prairies about the Arkansas and Platte rivers. These expeditions had originated in the fallacious accounts given by Friar Marcos de Niza respecting countries he said he had visited in an endeavour to reach others to the north-west of Mexico, of which accounts had been given to the Viceroy by Alvaro de Cabez Vaca. In 1539, however, Fernando de Soto had sailed from Cuba, landed in Florida, travelled northward to the Chickasaw country, in latitude 35° or 36°, and thence turning westward reached the Mississippi, there died and was buried, his remaining companions returning by that river to the sea, and thence to Mexico.

In California the Jesuits atoned for the falsehood of the Franciscan, for an expedition undertaken for the settlement of that country by Isidro de Atondi having failed, they procured, in 1696, warrants authorizing them to enter it for that purpose; and Father Salvatierra and his brethren founded an establishment at Loreto, on the eastern side of the peninsula, in 1697, and within sixty years had added sixteen others, stretching from Cape St. Lucas to the head of the Gulf. But notwithstanding the success of their efforts towards the education of the natives, the Order was suppressed and its members exiled from the scene of their labours in 1767, and their places supplied by Dominicans. California became a province of Mexico, and the western coast was immediately occupied.

On the east coast, settlements were made in North Florida by John Ribalt under the French flag in 1562; and at May's River, to which the name Carolina was given, by René Landonier, in 1564; but the settlers were dislodged by the Spaniards, as these were again by the French under Dominique de Gourges in 1567, and from them no knowledge of the interior resulted. Nor were the first settlements made in Virginia, at Roanoke and its neighbourhood by Armidas and Barlow, by Sir R. Greenville, Lane, and White, under the direction of Sir W. Raleigh, more fortunate; nor was any permanent settlement effected until the division of Virginia between the London and Plymouth Companies, by James I., in 1606, when one was formed at Powhatan or James River by the former, under Mr. Piercy, brother of the Earl of Northumberland; and in 1607, the latter Company established settlers below the Sagadahook under Captain G. Popham; and in 1614 the Dutch established their first settlement on the Hudson; in 1620 the occupation of New England commenced at Plymouth; while in 1627 a colony of Swedes settled on the Delaware; the following year Endicott settled at Naumkeag in Massachusetts Bay, since called Salem; and in 1633, Lord Baltimore placed a colony in Maryland, and two years after, Fenwick established a settlement on the Connecticut; in 1669, Sayle commenced a settlement in Carolina, as did Penn in the district subsequently called after him, in 1682; Georgia was not occupied until 1732.

The operations and knowledge of these settlers, they being agricultural in their habits, were for the most part confined to the sea-board, but yet the excitement of the hunter's life, and the profits attending the trade in peltries, carried some of them into the interior, and probably across the Alleghanies, yet of the countries to the west of these mountains nothing was known but from the accounts of La Salle, de Soto, &c., until the relations of the Indian traders induced James Maclure and others to explore the country now called Kentucky in 1754; it was settled by Daniel Boone in 1773. Vermont had been settled in 1764: and thus imperceptibly the knowledge of the eastern slope of the American continent had been extended, and its interior basin explored. Of the unexampled rapidity with which this was afterwards accomplished, no greater proof can be adduced than that Kentucky became one of the States of the Union in 1792. But the exploration of the eastern part of the basin of the Mississippi was too independent and unconnected, too much the accidental result of individual interest, labour, and enterprise, to admit of description. It was otherwise to the west and north.

The cession of Canada by France to Great Britain in 1763 giving peace to North America, the energetic spirits who had found congenial employment in it, and habituated themselves to Indian life, became for the most part fur traders, and in consequence a great extension of that trade took place. The followers of De Salle, De Tonty, and Hennepin had ascended Red River and the Missouri, and no doubt most of the affluents of the Mississippi, as well as the mountains from which they descend, had by this time become known to the trappers and voyageurs; and about the middle of the eighteenth century the existence of a great river to the west, flowing into the Pacific, had also become known; though the origin of that knowledge is buried in obscurity. It may be concluded, however, that the fur traders obtained it from the Indians, as Lepage Dupratz is said to have done; it is usually, but without reason, attributed to Jonathan Carver, who published *Travels through the Interior Parts of North America*, in 1778, and who first calls this river the Oregon, as he does the mountains from their perpetual snows the Shining Mountains. Notwithstanding, however, the want of originality in his work, there can be no doubt that, like Mandeville, he contributed very powerfully to the inducements to future exploration. But a further inducement was not long wanting. In 1771 John Hearne, in the service of the Hudson's Bay Company, set out to discover a river, spoken of by the natives as "the far-off Metal River," since known as the Copper-mine River, and pursued its course to the sea. This discovery of the sea, so far as 20° westward, as Hearne computed, of Hudson's Bay, revived the hopes of discovering the Strait of Anian, of Maldonado, and Juan de Fuca; and accordingly the English Parliament altered the terms of a reward of £20,000 offered in 1745, for the discovery of a north-west passage through Hudson's Bay, to the discovery of a passage in any direction from the Atlantic to the Pacific, northward of the 52nd degree of latitude. This produced, as has been shown (History of Maritime Discovery), the voyage of Cook: the consequences of which have been also noted: but it did more, it led Alexander Mackenzie first to the Arctic, and then to the Pacific Oceans, and the path once opened has never since been closed.

Hearne in his three journeys to the Copper-mine River had discovered Great Slave Lake, and must have been acquainted with the existence of the other great lakes with which it is connected, and of rivers flowing into them from the west.

The traders of Canada had organized an extensive association, under the name of the North-West Company, in which all the French elements were included, their right of trade being, as they not unreasonably supposed, altogether irrespective of the charter of the Hudson's Bay Company, since they existed before the cession of Canada to the English, and the King of England could not of course grant what did not thus belong to him. They acted on this belief, and extended their forts and trading stations up the Saskatchewan and other rivers, and approached the base of the Rocky Mountains on the west; while to the north and east they infringed upon the frontier of their chartered rival. The journey of Hearne was an isolated effort, but those of Mackenzie were indeed most important in their results, but not otherwise distinguishable from many made by the servants of the North-West Company, who were remarkable for their energy and enterprise. In his first journey in 1789 he traced the waters of the Slave and Peace rivers, and passing through Slave Lake, entered the river since known by his name, following its course to the Arctic Sea: in his second, in 1792, he ascended the Peace River for about 200 miles, and wintering there, the next year crossed the mountains to the sources of the Tatouche Tesse, afterwards named, from another servant of the North-West Company, Frazer's River, the course of which he followed for some distance; but finding it trend southward, and the accounts of its character by the natives not being satisfactory, and indeed, supposing it to be the Columbia, he returned on his steps, and striking westward across the country, reached the small river known as Mackenzie's Salmon River, and was borne on its waters to the Pacific, recording the fact on the rock at Point Menzies, which had been so named by Vancouver only six weeks previously.

The cession of Louisiana by the French to the United States, in 1803, directed the attention of that government westward, and in 1804 Captains Lewis and Clarke were sent to explore the Missouri. Having traced the course of that river to latitude 47°, they wintered among the mountains, from whence, starting in April, 1805, they reached the falls of the Missouri in the same month, and subsequently the pass called the Grand Gates of the Rocky Mountains; in July traced the river to one of its sources, crossed the Rocky Mountains, and struck the Kooskooskee branch of the Oregon, afterwards called the Columbia, the great river of the west, and after a journey of 400 miles along its course reached the Snake, or great southern branch of the river, to which they gave Captain Lewis's name, and building canoes, floated down its waters, passed the falls and narrows, and arrived without accident at the head of the tide water, from whence it took a fortnight to the mouth of the river; here they built a fort and wintered, explored the coast for about 30 miles to the south, and in the spring set out on their return: on reaching the Kooskooskee, however, they did not retrace their old route, but directing their course eastward, struck the Flathead River near the 47th parallel, and Captain Clarke proceeding up it crossed to the sources of the Yellowstone, while Captain Lewis crossed the mountains in latitude $47\frac{1}{2}°$ to the sources of Maria's River, a tributary of the Missouri, and joined his comrades at the mouth of the Yellowstone. The trials and sufferings attendant on this expedition are well known, as are the constancy and courage with which they were surmounted; the geographical results, beyond the knowledge of the sources of the Missouri and the Oregon, as well as the course of the south branch of that river to the sea, were the knowledge of three practical passes across the great mountain barrier which separates the valley of the Mississippi from the Pacific coast.

The following year Mr. Simon Frazer crossed the mountains further north, indeed to the north of Mackenzie's track nearly 100 miles, in order to extend the operations of that company, which had been limited by the cession of Forts Detroit and Michilimakinak to the United States. He established a trading post on a lake at the head of the Tatouche Tesse river, and gave it his own name, which it still retains. From 1808 to 1810 the American fur traders repeatedly crossed the mountains, and attempted to establish themselves on their western slopes; and Mr. Astor, of New York, having founded a company on a large scale for the promotion of the fur trade, a fort was established, called Astoria, at the mouth of the Columbia; this was however done by sea, the party sent by land not reaching it till the next summer, *i.e.* in March, 1811; and in July Mr. Thompson, the astronomer of the North-West Company, reached the same spot, having descended the northern branch of the Columbia from the fifty-second parallel, but being delayed in his journey by the severity of the winter. The party sent overland to Astoria having kept as far south as latitude 40°, in consequence of the hostility of the Indians, crossed to the head waters of the Snake River, which they traced to its confluence with the northern branch, and then to Astoria; and in 1812 Mr. Ross Cox, leaving that fort, proceeded up the Snake River, then turning northward struck the Spokane, proceeded thence to the Okanagan, explored a large tract of country about these affluents of the Oregon, and subsequently made the journey to Canada by the northern pass about the head waters of the northern branch of that river.

In consequence of the war, and the dominion of the English in the Pacific, Astoria passed into the hands of the North-West Company, who expelled their rivals from the western slope of the Rocky Mountains, to which they did not return for fifteen years; but many independent traders established themselves on the lakes and streams about the head waters of the Great River, as Pilcher on Flathead Lakes in 1827, and Bonneville and others in 1832, so that the country became tolerably well known, as it was not inaccurately represented on the private maps of the North-West Company. Further information was obtained from missionaries from 1834 to 1840, as from Messrs. Townsend, Spalding, and Farnham, until the expedition of Fremont and the other surveyors of the United States government.

On the eastern side of the Rocky Mountains, Major Pike had been sent in 1805 to trace the Mississippi to its source, which was found in some small lakes on the height of land, and of these Lake Ithasca has since been selected by General Cass as the principal source; subsequently the same officer was sent to explore the Arkansas and southern Red River, but striking the course of the Rio del Norte by mistake, he fell into the hands of the Spaniards. In 1819 research was resumed; Major Long and Dr. James having examined the mountains south of the Missouri, descended by mistake the Canadian River to the Arkansas, and the former officer subsequently ascended St. Peter's River, the sources of which he found in close proximity to those of the northern Red River, since when the larger portion of the country has been surveyed for the purposes of allotments for roads, canals, and railroads, of which latter five at least have been projected across the continent from the Mississippi to the Pacific.

The basins of the southern portion of the western coast were opened to our knowledge by Fremont; no doubt they had previously been visited by the mountaineers of the Far West, the daring pioneers of civilization, but of their discoveries he knew little, we perhaps know less. In 1843 he traced the Platte River to its sources in the mountains, ascending the southern pass to an elevation of 7000 feet by insensible degrees, and struck the sources of the Colorado: in the following seasons Lieutenant Fremont visited the Salt Lake in Utah valley, entering by the Bear River, which flows into that water, followed the course of the Columbia to the sea, and crossing the Sierra Nevada to the sources of the Sacramento (as Mr. Ermatinger, in the service of the Hudson's Bay Company, had previously done), reached the Bay of San Francisco, and thence proceeding eastward by the St. Joaquim, made further explorations among the Rocky Mountains to the south and east of the Great Salt basins and about the head waters of the Arkansas and Platte; and since then the courses of the Rio del Norte and Colorado have become better known, as the boundary of the United States to the west has been gradually extended in this portion of the continent. Much however still remains to be done.

On the north an attempt was made by Lieutenant Franklin and Dr. Richardson to connect the discoveries of Hearne and Mackenzie; in 1820, wintering at Athabasca Lake, they reached the Arctic Sea, in July, 1821, traced the coast as far as longitude 109½°, and returned across the country to Copper-mine River. In 1825 the same indefatigable travellers, wintering on Bear Lake, reached the mouth of the Mackenzie in the spring, from whence Franklin proceeded west and Richardson east—the former, as already noted in the History of Maritime Discovery, nearly connected his discoveries with those of Beechey—the latter reached the limit of their former discoveries to the east. Capt. Sir John Ross having spent four winters among the ice, among other means for his discovery, Captain Back followed the course of the Fish River to the sea: and the subsequent journeys of Dr. Rae have completed our knowledge of the northern shores of the continent from Boothia Felix to Cape Barrow. In 1834 and in 1840, Messrs. Bell and Isbister ascended the Peel River, an affluent of the lower course of the Mackenzie; and the journeys of Richardson to the north, and of Sir G. Simpson across the continent, have added somewhat to our knowledge of the north-west part of North America, but what we do know is little indeed. In the centre the government surveys for the boundary line, and the constant traffic of the Hudson's Bay Company, have given us some acquaintance with the lakes and rivers connecting Lake Superior with Lake Winnipeg; and the servants of that company have traced the route by the Nelson River to the same lake year by year. The French Canadians first crossed from the St. Lawrence to James's Bay. The district between that river and the St. John was a *terra incognita* to the learned, although it had been the trading and post road from the Bay of Fundy to Quebec as early as the time of the French company, as indeed it had been the native path before, until the disputes about the boundary between the United States and the British territory necessitated its survey; and it is to be hoped that the continuation of the line to the west will give us reliable information respecting the district which separates the Saskatchewan from the Missouri, sufficiently well known indeed to the native, the trapper, and buffalo hunter, but respecting which accurate geographical details are wanting.

2 *Recent information.*—Of this but little can be added to what has been given. A few miles of the eastern coasts of Vancouver's Island have been traced by Mr. Douglas, its governor, and a survey by Col. Stansbury in the Utah territory of the United States, and reconnoisances about the Rio del Norte and Colorado by Captain Murray and Lieutenants Simpson and Whiting, have been effected; but the course of the Colorado, and the district between it, the Gulf of California, and the table land of Mexico, remains still but little known. The same may be said of the territory nominally under the government of Russia, in the north-west angle of the continent, of which, and the great river Colville, draining, we may presume, the larger portion of it, we know nothing; and indeed our knowledge of the territory occupied on the western coast by the Hudson's Bay Company, and even of Vancouver's Island, its nominal colony, is but little, and what we do know, little as it is, is confined to certain localities. The visit of H.M.S. *Thetis* to protect the gold in Queen Charlotte's Islands, has proved their plurality; and it is to be hoped that the expeditions which have, in consequence of war, been sent to the Russian settlements, will at least bring back some geographical information, and teach men how large and fine a portion of the surface of the world is lying waste and kept as a preserve for wild animals.

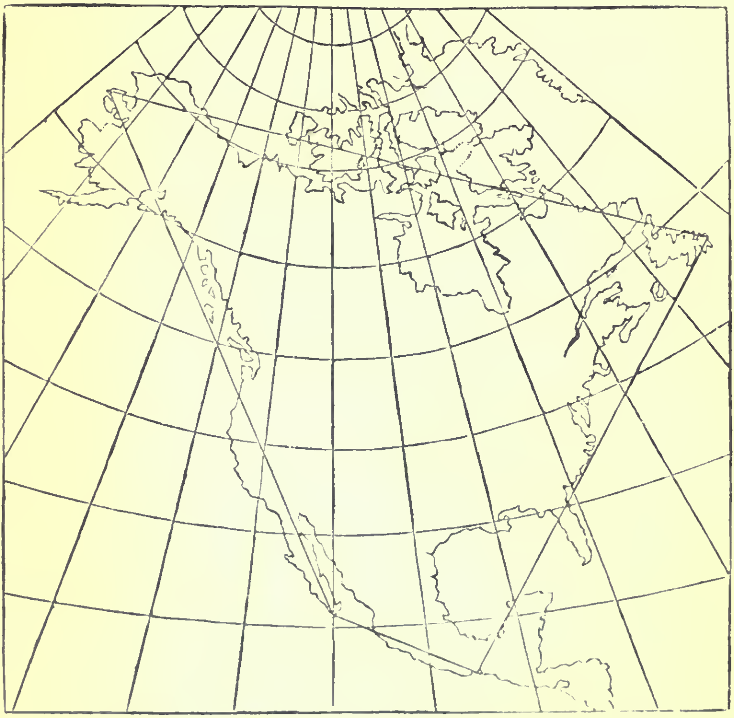
The desire of communicating by railroad between the Atlantic and Pacific has already led to the survey of several different lines by private enterprise, and the government of the United States propose the extension of its surveys to the south of the forty-ninth parallel; it is to be hoped this may stimulate the English government to active exertions in the same direction.

3 *The Boundaries and Limits* of North America may now be more accurately defined than they could previous to the discoveries of Dr. Rae and of Captains Collinson and McClure, whose recent adventures in the Arctic Seas have connected the discoveries of the former with those of Parry, and shown the land to the north to be a congeries of islands of various sizes, and that Boothia Felix is the most northern portion of the American continent, forming an irregular but extensive peninsula, corresponding to Melville peninsula on the east.

The comparatively narrow waters separating the islands to the north from the main land are Sir Thomas Rowe's Welcome, connecting Hudson's Bay by Frozen Strait with Fox's Channel on the east, which is again connected with the Gulf of Boothia by Fury and Hecla Straits; the northern limit of the Boothian peninsula may probably be Bellot's Strait; but the Strait of Sir James Ross to the west of the isthmus, which unites it to the main land, has two channels of communication with Simpson's Strait to the south; that to the east being Victoria Strait, the limit of Victoria Land in that direction, and connecting the coast waters with Barrow's Strait by Peel Inlet, as Investigator Strait, separating Victoria and Albert Land from Baring Island, does with McClure's or Banks' Strait to the west, and from thence the water communication is continuous by Dease's Strait and Dolphin and Union Straits to Cape Bathurst, from whence to the westward the limit of the continent is the Polar Sea.

The islands to the north, and possibly Greenland, must however be considered as much belonging to the continent as the Indian Archipelago and Australia to Asia, so that in one sense the Polar Sea may be considered the limit of the continent to the north.

Nor is the southern limit of its northern division easily determined, whether to extend it to the Isthmus of Panama, or to the bays of Honduras or Campeachy; physically, the former is the more natural limit, but the extent of what is called Central America, and its intimate connexion with the northern and southern divisions, make limitation difficult indeed; an isthmus can never be a separation, but since the larger portion is attached to North America, and has its connexion to the north, the Isthmus of Panama may be most usefully considered as the point of division. On reference to the table given (pp. 204-5), the comparison between the normal figure and true outline may be instituted as before, from which the projections of the latter without the lines of the former, will be apparent. A table of the positive positions of the extreme points is subjoined:—



Cape Race	46° 40′ N.	53° 7′ W.
Tehuantepec	16° 11′ N.	94° 44′ W.
Cape St. Lucas	22° 52′ N.	109° 53′ W.
,, Prince of Wales	65° 20′ N.	165° 25′ W.

The mean area of North America has already (p. 205) been stated as 7,666,900 English miles.

4 *The Coast Line.*—The Western Continent differs altogether in its vertical, and consequently in its horizontal, contour from the old; its two parts differ also essentially from each other, and this difference is most observable to the north, where the irregularity of the coast line is the greatest; but here the vertical contour is but slightly developed in comparison to the horizontal extension, in this showing analogy to the north and north-east of Asia, as is also apparent, not only in the promontorial extensions, but also in the extensive indentations at Hudson's Bay and the Gulf of Boothia; in this portion of the continent the coast line must exceed the average proportion to the area very considerably, while on the western coast, as on the north-western coast of Europe, deep, narrow, and very irregular channels, stretching into the land, produce the same result; nevertheless, the general variation will not be found so great as in Europe. On the north-west the great promontorial extension,

and on the south-east the Gulfs of Mexico and Florida, produce a similar but not so considerable effect; but here again the islands, whether the Aleoutian or the West Indian, can scarcely be left out of the consideration. The Gulf of St. Lawrence and the system of lakes, the waters of which it receives, are without parallel on the face of the earth. As already estimated, the proportion between the area and coast line would be 228, the former 5,472,000, square miles, and the latter 24,000 linear miles. The principal indentations and projections may be estimated as follows :—

Indentations.		Projections.	
Hudson's Bay	10°	Nova Scotia	1½°
Gulf of St. Lawrence	4°	Florida	5½°
Bay of Fundy	2½°	Central America, from Tehuantepec	18°
Gulf of Mexico	15°	Aliaska Peninsula	8°
Gulf of California	10°	Boothia	4°
Strait of Juan de Fuca and Puget's Inlet	2½°	Melville	3°
Cooke's Inlet	2½°		
Norton Sound	2½°		
Gulf of Boothia	3°		

5 *The Watersheds.*—The line of water-parting in North America is comparatively regular, and its principal watersheds well-defined; these are two, on the west the Rocky Mountains extend from the great table land of Mexico in a north-westerly direction at varying distance from the coast line, to which they approach closely in its more northern portion; Mount St. Elias, near the intersection of the sixtieth parallel of north latitude with the meridian of 140° west from Greenwich, extending its spurs into the sea, and being the culminating point in that direction; spurs radiating to the north and east form the limits of the basins of the Mackenzie and Colville, while the extension of the main chain must be looked for in the peninsula of Aliaska and the Aleoutian islands, which connect it with the mountain systems of Asia by the peninsula of Kamtschatka: the long slope throughout being the reverse, *i.e.* to the north and east, the short that to the sea on the south and west.

The central portion of this great chain may be considered to be the primary watershed of North America. In it, between 40° and 55° north latitude, are found the sources of all the great rivers of the continent, the St. Lawrence excepted, and from it spurs of very considerable elevation on the west, but not exceeding 1800 feet on the east, separate the basins of those rivers. Of the elevation of this portion we have not as yet positive information ; rising far above the region of perpetual congelation, its peaks cannot be less than 15,000 feet above the level of the sea, and some may possibly reach 20,000. To the west of this main chain another, uniting with it to the south, and in the north passing out through Vancouver's Island, and the Archipelago beyond it, forms the secondary limit of the basins of that coast; this is known as the coast chain, and is attached to the main chain by the Sierra Nevada, which separates the basin of the Columbia from those of Utah and California, and is apparent on the coast at Cape Mendocino ; and in like manner on the east the Alleghanies, and their extensions to the north and south, form the secondary watershed of the Mississippi; the watersheds of the coast to the north and east pass out into Labrador.

6 *Orographical Classification.*—This, from what has been said, must appear extremely simple, and will be as follows :—

Primary Watershed	Secondary Watershed
The Rocky Mountains	The Alleghanies
	The western coast range.

Of tertiary ranges there are none, the ranges of Nova Scotia and the Kotzebue mountains being extensions of the secondary and primary systems respectively.

7 *Classification of Rivers.*—This is of necessity equally simple, and will be thus arranged :—

Primary rivers.	Secondary rivers.
The Colville Mackenzie Saskatchewan Mississippi Rio del Norte Colorado Sacramento St. Joaquim Columbia Frazer's River, and others to the north.	With the exceptions already made, all the rivers falling into the Arctic Sea, Hudson's Bay, the Atlantic, and Gulf of Mexico, unless the St. Croix and some few of the smaller be considered tertiary.

The St. Lawrence must be also considered as exceptional, unless the secondary chains of the east be considered as extending round the basin of the Great Lakes, for the sources of the rivers which flow into Lake Superior, and which must therefore be considered as its head waters, are found in the eastern slopes of the waterparting between the rivers of the north and south, which is an extension, as already noticed, of an eastern spur from the primary range. The extreme development of the primary rivers, especially in the centre, is the characteristic feature of the northern part of the New World, as it will be found to be of the southern also, and in this will also be observable the characteristic differences between the climate and productions of the eastern and western continents, as well as of their causes ; possibly half the northern portion may be drained by the rivers Mackenzie, Saskatchewan, and Mississippi. The Great Lakes, as already observed, form an exceptional and unique feature in the western hemisphere, as the Caspian and Lake Aral do in the eastern.

The extraordinary facilities thus presented for water communication across the continent in every direction, not only from the proximity of the head waters of the rivers and their connexion by lakes, but from their size and incomparably navigable qualities, have fitted this continent for the rapid settlement which has already taken place in its northern division, and must soon be effected in its southern ; at the same time it will give the superiority to the coast districts on either side over the centre, and to the lake district probably over all other portions of its surface. We must not expect to find in the centre or the south of the valley of the Mississippi, much less in those of the Saskatchewan or Mackenzie, the same development of intellect or industry which is already presented on the eastern coast and in the lake district, and cannot long be wanting to the western coast, which has this advantage over the eastern, that from the narrowness of the Atlantic, and consequent facility of communication, the latter must always remain more or less under the direct influence of Europe, while the former, peopled by a race whose maritime tendencies will acquire their largest development on the shores of the wide extended Pacific, will have to direct the destinies of the people to whom in future ages its islands may be appointed as a home.

8 *Of Geological Formation.*—This is, as might be expected, speaking generally, as simple as the orographical classification, though, in this as in the other, an exception is observable, and in the same locality.

The larger portion by far of this continent has for its surface the primary schistose formations ; these extend from north to south on the western side, and through the north-east from New England to the Arctic Sea. The valleys of the Mackenzie, Saskatchewan, and Mississippi present extensive formations of the transition series, with vast carboniferous deposits, which extend into the valley of the Great Lakes and St. Lawrence, and to the western slope of the Alleghanies ; these are apparent also on the shores of the Gulf of St. Lawrence and Hudson's Bay, as well as those to the north of the continent, and in the islands to the west of Baffin's Bay : in Greenland, the islands of the north-west coast, the valleys of the Columbia, Utah, St. Joaquim, and rivers of California: not improbably, also, in the basin of the Colville.

The secondary deposits extend over a large, but comparatively inconsiderable area, are most observable in the cretaceous formations about the Missouri and its affluents, and on the eastern slope of the Alleghanies; while the tertiary extend round the northern shores of the Gulf of Mexico, and along the base of the Rocky Mountains in the valley of the Mackenzie.

Volcanic action is present in Mount St. Elias and other mountains of the north-west coast, as well as in the valley of the Columbia, in the peninsula of California, and the plateau of Mexico, in all which it has been of recent appearance. Much also of the coast of Greenland bears evidence of this, as do spots now isolated on the north coast, and among the islands of the Polar Sea. Ancient volcanic action has left its evidences throughout the continent.

In no part of the world is it probable that more recent and more considerable changes have taken place than in America. This is well known of Mexico, and the central and southern portions of the continent; and evidences of it are not wanting in other parts, especially in the lake basin and the western coasts: in the former, at present the waters are said to be rising, and no place exhibits more sufficient proofs of successive elevations of surface. It is probable that much if not all of the eastern and northern coast is rising, but data for correct induction are wanting throughout the greater extent of surface.

CHAPTER XXVIII.

WATERSHEDS AND RIVERS OF THE WEST.

§ 1. The primary watershed.—2. The mountains of the coast.—3. The central basin.—4. The rivers of the west.

THE *Primary Watershed.*—Of this vast range of mountains little is known beyond those portions adjoining the passes, by which, at the head waters of the great rivers, access has been obtained from the valley of the Mississippi to the western slopes. It has been customary to speak of three distinct ranges as observable throughout the length of the continent, of this however we have no sufficient evidence; but on the contrary, the course of the rivers shows, that if these ranges are to be distinguished in the principal river basins, their continuity is broken between the Columbia and rivers of California, as well as to the north of Frazer's River. It appears more reasonable to conclude that, as in the Himalayas, so here also, the spurs extend at but slight angles from the main chain, and leave the upper valleys of the rivers nearly parallel to its axis. The radiation of the various streams forming the head waters of the primary rivers from the central portion of this range, as already noticed, renders it the most important, and that where description should commence; and here, as elsewhere, we find the outlying peaks higher than those of the main axis of elevation. These are found to the east in the Wind River and White Mountains; about the sources of the Yellowstone, Platte, and Arkansas rivers: here Long's Peak, James' Peak, and others exceed 11,000 feet in elevation, and the Bighorn may attain to 15,000 between the valleys of the Arkansas and Bravo rivers: Spanish Peak and the Cirro Obscuro are estimated at 10,000; these are the outlying and probably the culminating peaks to the south and east; but higher are said to exist to the west of the Salt basin. The mean height of the principal range, from which these peaks may be detached some sixty miles, is probably not less than 10,000 feet, and this is the elevation given to the transverse spur which extends to the coast at Cape Mendocino, and is known as the Sierra Nevada. On the north the elevation may be somewhat greater, Mounts Brown and Hooker, at the sources of the northern branch of the Saskatchewan, having been estimated at about 16,000 feet, while other peaks about the southern sources of the same river attain a considerable elevation, but none have been accurately measured.

From the central range the transverse spurs do not extend far to the east, but beyond the outlying peaks already noted the descent into the valley of the Mississippi is very gradual. There are however three which may be noted, the Black Hills in the centre, which are opposed to the range of the Sierra Nevada, and extend to the junction of the Missouri and Yellowstone rivers, forming the southern watershed of the latter. These however do not attain any considerable elevation, and towards the east their elevation does not probably exceed 1700 feet. On the north a range of hills, of which we know nothing but their existence, extends between the Missouri and the Saskatchewan, and these are extended to the south in the Côteau des Prairies, between the Missouri and Mississippi, the lowest elevation between the rivers of the north and south being about 1250 feet. From hence, again, irregular and broken ranges stretch eastward towards Lake Superior, and unite with the watersheds of the basin of the Great Lakes: these, more mountainous in appearance, do not attain greater elevation. On the south, the Sierra de Saba, forming the eastern limit of the basin of the Rio Bravo, is extended in the Ozark Mountains—not much more worthy the name than those to the north, which form the limit of the upper basins of the Colorado, Red, and Arkansas rivers, and extend towards the spurs of the Alleghanies, which embrace the valley of the Tennessee.

The central range of the Rocky Mountains is known to the south, where it joins the plateau of Anahuac, as the Sierra Madre, further north as the Sierra de los Mimbres; but of this portion we know little beyond these general appellations: further north the Sierra Verde forms the south-eastern cincture of the Great Salt basin.

The eastern side of the main range presents a series of granite precipices, through the deep chasms in which the rivers rush with fearful rapidity, but from the base of these the slope is very gradual; this is broken again by ranges of conglomerate, sandstone, and limestone, culminating at about 6000 feet, and from thence the prairie slopes even more gradually to the Mississippi; in longitude 95° the mean elevation may be 700 feet, in longitude 105° 4500; the axis of the sandstone and limestone ranges may be about the 106th meridian, and that of the superposition of conglomerate on the granitic rocks, about the 109th meridian; from it to the summit of the south pass, the elevation may be about 2500 feet in 200 miles.

The southern pass at the head waters of the Platte is 7000 feet above the sea, and near it Mr. Fremont measured the elevation of the highest peak of the Wind River range, and found it 13,570 feet; the superior limit of trees was about 10,000 feet, which was also the inferior limit of perpetual congelation; ice fields, possibly glaciers properly so called, occupy here considerable areas.

This, as the pass most used by travellers from the east, is better known than any other in the Rocky Mountain chain, and it is only from analogy with this that we can arrive at any results with respect to the others. Those by which Lewis and Clarke crossed and re-crossed the mountains at the sources of the Yellowstone and Missouri are not nearly so accessible, and have probably a greater elevation. The best known pass to the north, viz. that between Mounts Brown and Hooker—in which is situated the small lake called the Committee's Punch Bowl, which discharges its surplus waters into the Mackenzie on the east, and the Columbia on the west—may have about the same elevation as the south pass, but is far more rugged and barren, the rocky precipices being overhung by as rugged glaciers: one still further north has been similarly described by Ross Cox: one to the south by Sir G. Simpson; the former was estimated at 11,000 feet in elevation—most probably much in excess of its actual height—the latter at between 7000 and 8000 feet:

in both, small lakes, about twenty feet apart, formed the sources of the waters, flowing in opposite directions, and the surrounding peaks were supposed to rise above 12,000 feet; the latter was practicable for horses, and Sir G. Simpson also records the passage of emigrants with wagons, though over one still further south. It may therefore be concluded that the difference between these passes is due rather to latitude than the character of the mountains.

2 *The Mountains of the Coast.*—As has been already noted, the main chain of the Rocky Mountains trends to the westward beyond the fiftieth parallel; here Mackenzie crossed them on compact snow in July, in longitude 125°, latitude 53°; Mount St. Elias, under the sixtieth parallel, in longitude 140°, is estimated as attaining 18,000 feet in altitude, and Mount Fairweather, a little to the south, somewhat less.

The sandstone and limestone ranges at the base of the main chain to the south reappear again to the north, but at greater distance, and no longer parallel to the main axis, and form the western limit of the valley of the Mackenzie River, and the watershed of the Peel and Rat affluents of its lower course: of the intermediate region we know nothing.

The western spurs from the main chain appear on the north to be extremely irregular, dividing the country into numerous small valleys, filled by lakes and rivers. Near the centre they are better defined, the valleys larger, lakes and rivers of greater area and length: both to the north and south basaltic rocks abound; other evidences of volcanic action are common. To the south they enclose the basin of the Great Salt Lake, and stretch in deep, long, and nearly parallel chasms and ravines towards the south-east and south-west, through which the Rio Grande and Colorado rush to the Gulfs of Mexico and California. As the Ozark chain has its root in the eastern watershed of the former, so the coast chain has in the western watershed of the latter, being an extension of the Cordillera de Sonora, which, with the Sierra Madre, becomes distinct from the plateau of Anahuac under the northern tropic. From the Colorado the coast chain appears to form the eastern limit of the basin of the Sacramento and San Joaquim, and then unites with the Sierra Nevada, beyond which it again becomes distinct, limiting the basin of the Wathlamath, or Willamette, a tributary of the Columbia, to the north passing round Puget's Inlet, and forming that remarkable congeries of mountains noticed by Vancouver about the fiftieth parallel. In this range peaks of very considerable elevation are found; Mount Shaste, supposed to be the culminating point; Mount Hood, estimated as rising 11,500 feet above the sea; Mount St. Helens, Mount Rainer, and Mount Baker, all exceeding the limit of perpetual snow. Another range here also appears, forming the coast-line, by some considered the principal extension of the Sierra de San Marcos, or Alps of California, the coast chain to the south; this is not so lofty, but nevertheless Mount Olympus, to the south of the Strait of Juan de Fuca, approaches closely to the limit of perpetual snow, and the elevations in Vancouver's Island though less are still considerable.

3 *The Central Basin.*—The inland basin of the Salt Lake is one of the most remarkable natural features of the western slope of the Rocky Mountains, and it promises to be politically not less so. It must be considered as including the basins of all those smaller lakes and their tributary streams which have no outlet, and do not discharge their waters into the ocean.

The characteristics of this basin differ little, if at all, from those of similar districts already noticed in Asia Minor and elsewhere, the immediate cincture being for the most part of sandstone and limestone mountains, from which hot and saline springs gush, and in the bosom of which vast deposits of rock salt lie stored up for the future use of man; those to the east are known as Bear Mountains, and are accessible from the Wind River range by a pass exceeding 8000 feet in altitude; from these a considerable river of the same name descends into the Great Salt Lake, while another stream, called the Jordan, unites with it the waters of Utah Lake to the south. Bear River is deep and sluggish, varying near its mouth from 100 to 600 feet in width; it has a considerable affluent, the Roseaux, of the same character. The size of the Great Salt Lake probably varies with the character of the seasons; it may be estimated, however, as above seventy-five miles in length from north to south, and somewhat less in breadth; it is deeper than most salt lakes, has rocky islands in it, one of which rises 800 feet above its waters; its shores are low, swampy, and fertile; it is about 4000 feet above the sea. To the south of Utah Lake is Nicollet river and lake, and other smaller streams on the eastern side of the great basin. These seem to be separated from those on the western side by a range of elevated peaks, some of which rise 3000 feet above the lake, on the western side of which, among smaller lakes and streams, Humboldt River and Lake, Mud Lake, Pyramid Lake, and Walker's Lake, deserve mention. This western portion of the basin appears to be more elevated and more rugged than the eastern, some of the intersecting valleys being 6000 feet above the sea; and Pyramid Lake, so named from a pyramidal rock which rises 600 feet above the waters in the centre of the lake, being 4890 feet, or nearly 700 feet higher than the Great Salt Lake; it is about thirty-five miles long, and receives a considerable stream from the south.

The range of mountains separating the basin of the Great Salt Lake from the valley of the Sacramento is, in Mr. Fremont's opinion, higher than the corresponding portion of the Rocky Mountains, the pass by which he crossed it, 11° west and 4° south of the south pass, being at an elevation of above 9300 feet. The descent from these mountains to the west is very precipitous. The south-western limit of this basin appears to be formed of rugged and very irregular mountains, called by the natives 'Waphsatch,' in which the Virgen, tributary to the Colorado, has its rise, and flows through chasms 2000 feet deep, while the Sevier and other streams flow from their northern slopes into the lake of the same name. Here, at an elevation of about 5000 feet, the valley is of great beauty and fertility; but further north and east about the waters of the Trinpanago, the rugged and barren features again predominate.

4 *The Rivers of the West.*—On the western slope of the northern division of the American continent we find four large rivers, beside several others worthy of mention; of these the Columbia is the most important, not only as draining by far the larger area, but as deriving its principal sources from the mountains about those passes already named, by which they are most readily crossed, the southern source being under the forty-second parallel, and the northern under the fifty-third; separated thus by more than 600 miles, and having their courses in opposite directions, the two main streams of this river must always be the great arterial means of communication between the centre of the continent and the coast of the Pacific. The general character of the districts through which these rivers flow is very different; the southern rushes through deep chasms among the mountains, where bare rocks are only occasionally varied by small plains covered with Artemisia, or secluded but well-wooded valleys; in its lower courses this also passes through country bearing evidence of severe volcanic action; the northern has its upper course for the most part through a similar country, but interspersed with swamps, small lakes, and morasses; in its middle course, however, this river and its affluents flow through woods and fertile valleys, and spread into extensive and very beautiful lakes, but as it approaches the point of confluence, it passes through an arid volcanic desert. The valley of the estuary is extensive, well-wooded, and abundantly fertile. The intermediate space, however, along the base of the Rocky Mountains, is far more attractive in its features; here the lakes are surrounded by fertile meadows, and the rivers flow through valleys the sides of which are clothed with magnificent timber; here also, especially to the south, about the head waters of Salmon River, are plains on which the buffalo still lingers.

The main stream of the Columbia or Oregon is formed by the confluence of two rivers, the northern or Okanagan, the southern or Sahaptin, Snake, or Lewis River; the name Columbia is now perhaps more commonly applied to the northern source, although the southern is no doubt the principal. The most important affluent of the Snake River is Salmon River, which rises in the Wind River range, near the sources of the Missouri; it was by this valley that Captain Clarke returned from the Columbia. The others are, on the right, Malade, Reid's, Boissée, and Kooskoos-kee; and on the left, Ouwhyee and Malheur, which latter rises in the Blue Mountains, and flows through a lake of considerable size; none of these, except Salmon River, can be considered navigable. The main stream of the Snake River originates in the mountains about the southern pass.

The northern stream has its principal sources far apart, the more northern, called the Columbia, rising from three streams, the centre of which has its source between Mounts Brown and Hooker, as already noted; while the southern, rising near the southern sources of the Saskatchewan, under the fiftieth parallel, flows northward 150 miles to the point of confluence along the base of the Rocky Mountains, and 300 miles further south the sources of Clarke's River interlace with those of the Missouri; the Columbia is joined on the right by the Okanagan, which flows through the lakes of the same name, and on the left by the MacGillivray, or Kootonaie, flowing through Flatbow Lake, Clarke's River, which flows through Kullespelm Lake, and the Spokane, which has its rise in Pointed Heart Lake.

The Cascade range limits the valley of the Columbia to the west, as the Blue Mountains do that of the Snake; to the south of the latter, however, the small stream of the Cowlitz opens communication from the right with Puget's Sound, while from the left the Willamette or Wathlamath drains the large and very fertile valley between the Blue Mountains and the coast range. At the confluence of its two main streams, the Columbia is nearly 1000 yards across, deep, and rapid, but lower down it is narrowed and rendered unnavigable by the famous Dalles, or narrows, below which the mountains still contract its channel, and break its waters into a series of cascades; these are about forty-five miles from the Dalles, and below them the river widens and deepens, becoming navigable for vessels of 450 tons burden from thence 150 miles to the sea. To this point, also, to which Vancouver's survey extended, and which has been named from him, the influence of the tidal wave is felt. All the affluents of this river, even the Wathlamath, deep and navigable as it is at the mouth, are broken by falls, the others are also extremely rapid, and therefore do not facilitate ascending traffic.

The estuary of the Columbia is very extensive, diversified by numerous low wooded islands, and expanding near the sea into a gulf nine miles in width, the entrance to which, however, is not more than one mile, and presents dangers to navigation both without and within. Nothing can exceed the beauty and fertility of the country about the lower course of the Columbia and its tributaries, the Wathlamath and Cowlitz; the park-like prairies, the giant trees, the pines often rising 150 feet without a branch, and having a diameter at the base of fifteen feet, the lofty mountains rearing over all their snowy summits, have been the theme of universal praise. The entire course of this river is usually estimated at 1000 miles, but it can scarcely be less than 1500.

To the north of the Columbia is Frazer's River, not differing much in character from the northern branch of the Columbia, but flowing through a country of rock and cedar, swampy, and more cold and barren: it is the Tatouche Tesse which Mackenzie mistook for the Columbia; its course is about 500 miles, and it debouches into the Gulf of Georgia just to the north of the forty-ninth parallel; it is not navigable for more than twenty miles: its sources interlock with those of the Peace, Simpson's, and Mackenzie's Salmon rivers, being distant from the source of the latter only 817 paces; it forms numerous lakes throughout its course. Of the latter of these rivers we know something from Mackenzie's description; it may have a course of 150 miles, through a mountainous but well wooded and fertile region, and derives a milky tint from the calcareous rocks which form its channel; it unites with the ocean at Bentinck's Corner: of the second we know little, but that it rises, like Frazer's

River, in a chain of irregular swampy lakes on the western slope of the primary watershed; while Salmon River has its sources in the mountains which form the western limit of the basin of Frazer's River; hence the difference of climate, productions, and physical character generally.

To the south of the Columbia, two rivers, Umqua and Klamath, have their sources in the Blue Mountains; the latter is a considerable stream, may have a course of 500 miles, and flows through a lake of the same name; one of its affluents from the right, the Shaste, has its rise in the most elevated peak of that range, which is so called. The country through which these rivers flow is of the same character as that about the lower course of the Columbia.

Separated from the Klamath by the Sierra Nevada, the Sacramento flows southward through the narrow valley formed by the mountains of the central basin and the coast range; this is of equal beauty and fertility to the valley of the Columbia, and somewhat more southern in climate and productions, its course may be nearly 500 miles, of which 150 are navigable, it has numerous small affluents; its valley has become remarkable for the gold found in it; it unites with the San Joaquim, which flows through the more level country to the south, and expands into the marshy lakes called Tule, having a course of less, probably, than 200 miles; after their confluence they fall into the Bay or Gulf of San Francisco, which extends fifty miles from east to west, and nearly three times that distance from north to south, forming one of the finest and most extensive harbours in the world.

Of the Colorado, which flows from the Rocky Mountains southward into the Gulf of California, we know little, except that its length probably exceeds 750 miles, and that its rapid torrent entirely precludes navigation; with this river near its mouth, the Gila is confluent; its has a westerly course of about 400 miles.

CHAPTER XXIX.

THE RIVERS OF THE CENTRE.

§ 1. The Mackenzie.—2. The Saskatchewan.—3. The Mississippi and Missouri.—4. The rivers of the Gulf.

THE *Mackenzie.*—In contradistinction from the great rivers of Northern Asia, Northern America presents an intricate network of streams, connecting extensive sheets of water, some of which rank among the largest lakes in the world; these may be divided into two systems, that of the Mackenzie on the north, having also an outlet by the Churchill River to Hudson's Bay, and of the Saskatchewan on the south, the outlet of which is by Nelson and Severn Rivers into the same bay.

Of the streams which unite to form Mackenzie River, Athabasca Lake is the first receptacle; this is about 250 miles long by forty broad, and receives from the west the waters discharged by the Peace and Athabasca Rivers from Lesser Slave Lake; from the south, the surplus waters of Methye Lake, and from the east, those of Woollaston and Deer Lakes, Deer and Methye Lakes both communicating with the Churchill River by the Missinippi. Peace and Athabasca Rivers have both their superior sources in the Rocky Mountains, as already noted; the former may have a course of 500 miles to Lake Athabasca, and receives several affluents; the latter is not so long, and its affluents are inconsiderable: Lesser Slave Lake may be forty-five miles in length by ten in breadth: Methye Lake has about the same extent, and is connected with many other smaller lakes: Woollaston and Deer Lakes are larger. Great Slave Lake, the second basin of the system of the Mackenzie, is 300 miles long by fifty broad, of very irregular shape, receiving numerous streams, of which Hay River, from the south-west, is the most important, connected with numerous smaller lakes, of which the most important are Aylmer, Clinton—Golden Lake, and Artillery Lake, forming a chain on the north-east: it has also several islands. The channel connecting Athabasca and Slave Lakes is called Slave River; it is broken by falls and rapids, but well wooded in its upper course: Great Slave Lake discharges its surplus waters from its western angle, and the stream is shortly after met by the Turnagain River, which has its rise from several sources in the eastern spurs of the Rocky Mountains; of these Dease River, rising from Dease Lake, may be the most important. The Turnagain may have a course of 500 miles, and at its confluence the Mackenzie becomes a considerable river, and after flowing about 200 miles, receives the surplus waters of Great Bear Lake from the east by the river of the same name. This lake, of very irregular form, stretches its arms from north-east to south-west about 250 miles, and from east to west nearly to as great an extent: it is only 230 feet above the sea.

From the junction of Bear River the Mackenzie pursues a tortuous course of more than 200 miles to the sea, which it enters by several mouths, through a very extensive delta, with islands formed and in process of formation, stretching far out to sea: and here it is joined by the Peel and Rat Rivers from the south and west; these are not considerable in size, but are navigable, and have their sources in the limestone and sandstone ranges which form the western limit of the lower basin of the Mackenzie.

To the east of the Mackenzie and its tributary waters, the Coppermine River falls from Point Lake into Coronation Gulf; the range of rocky heights which separate the basins is known by the same name: it may have a course of 250 miles; and further eastward Back's River, the Thleweechdesh, or Great Fish River, rushes through rugged channels, dashes over rocky barriers, and expands in still lakes until it reaches the sea at Franklin Inlet; while to the south numerous lakes, for the most part connected, the principal of which is Doobaunt, discharge their surplus waters into Chesterfield Inlet and Hudson's Bay.

2 *The Saskatchewan* has its rise from two principal sources, as already noted, in close proximity to the northern sources of the Columbia. Its name, implying swiftness, is applicable to its upper courses, but in its lower course, after the confluence of its two streams, and from thence to Lake Winnipeg, it is scarcely so, except during the freshets in the spring. The course of this river is very tortuous, especially as it approaches the lake, and may be estimated as not less than 2000 miles, for more than 1000 of which it is navigable on the northern, and it is said for 1500 on the southern branch; of this, however, but little is known, the usual path of the fur traders to the valley of the Columbia being to the north: this much, however, we do know, that navigable throughout nearly its whole length, it flows through a very fertile and, in its upper course, well wooded country; and in this it is to be distinguished from its lower course, where, as it approaches the lake, it assimilates to the character of the lake district.* It may here be remarked, that if a line be drawn between the lakes on the east and the rivers on the west, it will separate two very distinct districts, the former cold and marshy, frozen up for from five to seven months of the year, with stunted vegetation, if not altogether barren; the latter increasing in beauty, fertility, as well as in temperature, as the Rocky Mountains are approached and the ascent of their outlying spurs is made, the line of woods and active vegetable life extending to the mouth of the Mackenzie.

Of the valley of the Saskatchewan, the descriptions given, especially those of Sir George Simpson, raise to a very high pitch the estimation of its natural capabilities; it is said also to possess extensive deposits of coal; lignite, we know, extends along the whole of the western slope of the valley of the Mackenzie. Lake Winnipeg extends from north to south nearly 300 miles, but does not, probably, average more than fifty in breadth: besides the Saskatchewan, it receives the waters of Red River and Winnipeg River from the

* See Palliser's Expedition, *Proc. R.G.S.*, vol. ii.

south, as well as the surplus waters of Lakes Winnipegoos and Manitoba from the west; the former of these may be 125 miles long, the latter 100. Red River rises near the sources of the Mississippi, and its western affluents approach so closely to the basin of the Missouri, and are separated from it by so slight an elevation, that, during the spring freshets, the waters of the southern are said to have found their way into the more northern basin. The Red River may have a course of 250 miles; its principal affluent is the Assiniboine, from the west: its valley is in character, as in position, intermediate between that of the Saskatchewan and the affluents of the Mississippi.

Winnipeg River is as yet little known; it is broad and rapid, broken by numerous, it is said twenty-five, falls, dividing into many channels, receiving several important affluents; its course is for the most part through ravines of lofty primitive rocks, which change to limestone at its mouth; it flows from the lake, or, perhaps, rather three lakes, known as the Lake of the Woods, an irregular and extensive sheet of water, rocky and well wooded to the north, but low and sandy to the south, and very shallow: this lake is connected with lake La Pluie, also of irregular form and uncertain size, by the beautiful valley of the river of the same name: and this lake is again connected, by Namaycan Lake and the river St. Croix, with two chains of lakes, from which Pigeon River on the south, and the Kaministoquoia on the north, fall into Lake Superior: it is not certain, but highly probable, that these lakes are all connected with each other: the southern lakes and rivers are cold and barren; the Kaministoquoia and northern lakes are of the same character as La Pluie. Winnipeg River receives the surplus waters of Red, Sal, and other lakes by English River.

Nelson River is a broad, deep and rapid, but broken stream, with a course of 250 miles; it receives considerable accession of waters from lakes to the south. Severn River is longer, but has not so large a volume of water; it also receives an accession to its waters from the south, Cat Lake overflowing to the north into the basin of the Severn, and to the east into that of the Albany, which falls into James's Bay at the bottom of Hudson's Bay. Several rivers of similar character fall into the bay from the south and east, one of which, the Abbitibbee, has its source in a lake of the same name, in close proximity to Lake Temiscaming, one of the principal sources of the Ottawa.

3 *The Mississippi and Missouri.*—The estimate in the recent census of the United States gives the area of this vast basin as 1,217,562 square miles, or nearly 250,000 more than the usual estimate: 1,500,000 may be a near approximation to that of the basins of the rivers discharging themselves into the northern part of the Gulf of Mexico. The mouth of the Kansas River is nearly in the centre of this basin, which will average 1200 miles in length by 1500 in breadth: this central point is however nearer to the eastern coast of the continent by 250 miles than it is to the western. The primary sources of this great river are, of course, in the primary watershed of the country, the Rocky Mountains; but, as in the case of the Danube, Ganges, and other primary rivers, the secondary source, earlier and better known, has given its name to the united stream.

The Missouri is usually said to rise from three sources, to which their discoverers, Lewis and Clarke, gave the name of Jefferson, Madison, and Gallatin; not impossibly others may hereafter be found with better claims to the honour; of these, however, the former, which lies to the south-west, has its origin in a comparatively small elevation, in a pass of easy access in the Rocky Mountains, close to the sources of the Salmon River, already named as an affluent of the Columbia. The upper waters of the Missouri flow through fertile and well wooded valleys, separated by the northern spurs of the Wind River range, but after being contracted in their lower courses by limestone cliffs, open out into "extensive and beautiful meadows and plains" surrounded by distant but lofty mountains: below these the channel is again contracted, does not exceed 200 yards in width, and the river has a tortuous and rapid course, interrupted by numerous rocks and islands; still lower, its waters, now shallow, expand to more than a mile in width, and flow through a beautiful valley hemmed in by rocky precipices; these again contract the channel below, forming the gates of the Rocky Mountains, as named by the same travellers; here cliffs of black granite rise perpendicularly 1200 feet from the water's edge; the river, narrowed to 350 yards in width, rushes in one deep, heavy mass through the chasm, which extends for above four miles in length; and here the mountains are comparatively barren, yielding only small copses of cedar, pine, and willow; below this the river has an irregular and varied course, is rapid and narrow for about 100 miles to the great falls, where there are indeed a series of falls and rapids: a fall of five feet is followed by one of twenty-six feet, and again another of forty-seven feet, extending in an unbroken line across the river, which is here 470 yards wide; again there is an irregular fall of nineteen feet, and subsequent falls of five and two feet, with rapids between them, all resulting in a total descent of 352 feet in two miles and three-quarters, according to Clarke's estimate, but both above and below this limit there are rapids. It is below the Great Gates that the river justifies its name of Missouri, or Muddy River, which it maintains from thence to its outlet in the Gulf of Mexico: below the falls it also maintains the same character, flowing in a deep and tortuous channel through a boldly undulating country. It receives the waters of numerous tributaries; of those from the right, the Yellowstone and Platte are the principal; these rising, like the parent stream, in the Rocky Mountains, have the same character above the canons or defiles, through which they also find their way into the great plains or prairies which extend from the base of the Rocky Mountains to the united streams of the Missouri and Mississippi, they are mountain torrents, below these slow streams wind in deep channels. The other affluents of the right partake of the character of the lower course of the Yellowstone and Platte, while the affluents of the left assimilate to that of the Red River and southern affluents of the Saskatchewan, rising for the most part in lakes and swamps, amidst cedar, willow, and alder thickets, trees which appear only at scattered intervals on the southern waters.

The Yellowstone and Platte have their sources in close proximity, near the southern pass described by Fremont, rising from numerous streams, which for the most part originate in lakes hidden in verdant amphitheatres in the mountains; their upper waters present scenes of beauty peculiar perhaps to those localities; the line marked by the canons is a rocky sterile desert, with scarcely any vegetation but the cactus, and eastward extend the rolling grassy prairies for 500 miles. Long's Peak marks the southern sources of the Platte, and here to the west, south, and north, the Colorado, Arkansas, and Platte, have their principal sources in valleys of the same character, but more extensive: the dividing ridge to the westward was ascertained by Fremont to be 11,200 feet above the sea. The Yellowstone is however less broken in its course than the Platte or Missouri; its length may be 1500 miles; its principal affluent is the Big Horn; from the right it has numerous others of less importance. The Platte, or Nebraska, has a course of 1600 miles; its principal affluent is also from the right, rising near Long's Peak; it has other affluents, the most important of which is the Iowa from the left. The Little Missouri, Chayenne, White, Qui-court, and other streams, fall into the Missouri from the right, between the Yellowstone and Platte. The Kansas, rising from three sources, drains the country between the latter river and the Arkansas; its course is estimated at 1200 miles, and it is navigable for 900: below the Kansas the Osage also joins the Missouri from the right. The affluents from the left are small; of these the most important are the Maria, leading to the pass by which Captain Clarke returned from the valley of the Columbia, North Mountain Creek, Milk, Porcupine, and White Earth; these do not probably exceed 200 miles in length; and after the main stream takes a southerly direction, the Jacques, Sioux and Grand Rivers, which are larger, and may extend to 500.

To the falls of the Missouri the general course of the river is to the north, from thence to the confluence of White Earth River, in direct distance about

500 miles, it has an irregular westerly course, and from thence takes a south-west direction to the junction of the Mississippi; at the junction of the Yellowstone it is 2600 feet wide, and is navigable for 2500 miles above the confluence of the Missouri, the length from the source to that point being estimated as more than 3000 miles; there is but little timber on the banks of the Missouri above the mouth of the Platte.

The principal source of the Mississippi is now considered to be Lake Ithasca, the elevation of which is only 1500 feet above the sea, and which, like the other lakes in its vicinity, is remarkable for its placid sylvan features; it is about eight miles in length, situated between Red River and the lakes which connect themselves with Winnipeg River and the rivers falling into the head of Lake Superior, from which it is distant about 170 miles. It is one of many similar, from which numerous streams flow into the Mississippi and its tributaries, as well as into the more northern waters. These streams uniting, the main body of water is broken by the falls of St. Anthony, which form the limit of the navigation of 1200 miles from the Gulf of Mexico, the network of streams and lakes above affording canoe and boat navigation between the Mississippi and rivers to the north. The falls of St. Anthony are only sixteen feet in height, the river being here divided into two channels; below the falls, the St. Peter's or Minesota River joins the main stream from the right, from which side the upper Iowa and Lemoine are also affluent. St. Peter's River has its source in a small lake called Polecat Lake, about three miles in circumference; after a course of fifteen miles it flows through Bigstone Lake, which is about twenty-five miles in length by one in breadth, being an expansion of the stream, as are Lac Qui Parle and others. This river has a course of 500 miles, and is navigable for barges to the head of Bigstone Lake, above which it is obstructed by falls and rapids. The valley, of an average breadth of one mile and a-half, though full of small lakes and swamps, is covered with a heavy growth of hard-wood, oak, elm, maple, ash, lime, walnut, and luxuriant undergrowth of vines, shrubs, and grasses; it may be esteemed typical of the affluents of the Mississippi above its junction with the Missouri. The principal affluents of the Mississippi from the left are the Wisconsin, Rock, and Illinois; the former affording communication with Green Bay and Lake Michigan, and the latter being the natural route from that lake to the Mississippi. The upper valley of the Wisconsin is hilly, on the north rugged and broken, yet not rising more than 2000 feet above the sea. The Illinois has a course of 300 miles through heavily timbered valleys, rising in rounded slopes and bluffs covered with herbage.

The valley of the Mississippi below the falls varies from ten to twelve miles in width, is bounded by high bluffs, generally abrupt, often precipitous; at De Moyen and Rock Rapids it is contracted to the breadth of the river, or about 1000 yards; below this the valley widens, and is remarkable for the insulated hills with which it is studded, rising from 100 to 500 feet; the stream is wide, spreading to five or six miles, and forming channels among numerous islands. Lake Pepin is a beautiful enlargement of the river twenty-two miles long, three miles wide, unbroken by islands, and of great depth. The surface of the valley of the Mississippi is varied with wood and prairie.

Below its confluence with the Missouri, the Mississippi flows for about 200 miles without receiving any considerable affluent. The Ohio, which may almost be considered one of three confluent rivers, uniting to form the vast flood which from thence rolls its heavy waters to the ocean, now joins the main stream from the east, draining the entire basin between the southern watershed of the Great Lakes and the Gulf of Mexico, which, uniting with the Alleghanies, afford an amphitheatre of 200,000 square miles in area, and affording by its tributary, water communication with the lakes and St. Lawrence as well as the Atlantic; this may be well considered the most important of the affluents of the Great River; it is no less so from the beauty, fertility, and varied productions, whether mineral or vegetable, which it offers to the use of man.

The Ohio is formed by the junction of the Alleghany and Monongahela mountain streams at Pittsburg, at an elevation of 830 feet above the sea; its course from thence for 300 miles is through hilly country, from which it breaks in rapids, and thence forms a navigable river, increasing from 500 yards to half a mile in width; the extent of navigation afforded by this river and its tributaries is estimated at 5000 miles. The principal of these are the Big Beaver, Muskingum, Scioto, Miami, and Wabash, from the right; and Kenawha, Sandy, Licking, Kentucky, Green, and Cumberland rivers, from the left. These are navigable, the former from 100 to 300 miles, and the latter from 250 to 400 miles. The Tennessee, also from the left, is the most considerable affluent of the Ohio, which it joins ten miles below the Cumberland; it is at the mouth 600 yards in width; its total course is estimated at 1200 miles; it is navigable for large vessels for 260 miles, for vessels of fifty tons for 200 more to the bottom of the falls, by which it is precipitated from the mountains in which it has its rise, and for boats altogether for 1000 miles; its affluents are numerous but unimportant, as, falling from the short slope of the watershed of the Gulf of Mexico, they have neither length nor volume of water.

From the mouth of the Ohio the Mississippi averages 900 yards in breadth and 100 feet in depth; on the left it bifurcates and receives no affluent of importance; on the right the Arkansas and Red Rivers drain the eastern slopes of the Ozark Mountains and the plateaux between them and the Rocky Mountains, in whose defiles they have their rise; of these rivers little is known beyond the facts that, while they do not differ in general character from the Platte, their course is more irregular, and the valleys more broken, varied, and better wooded. The basin of the former is estimated at 175,000 square miles in area, and its length as exceeding 2000: it has several large affluents, of which Red and Saline Forks and the Canadian River, formed by two confluent streams, are the most important; these cannot be less than from 700 to 1500 miles in length. Red River, known also as the Nachitoches, and in its upper course as Escararedra, has its rise among the south-eastern spurs of the Rocky Mountains, close to those of the Rio Bravo del Norte; its total course probably exceeds 1500 miles, much of which would be navigable, but is obstructed by timber brought down by the freshets from the mountains; steamers can ascend it for 400 miles; it has several affluents, of which the Washita is the most important, and expands into more than one considerable lake.

The delta of the Mississippi, as it is one of the most extensive, so it is one of the most remarkable in the world, and that not only from its natural characteristics, but from the scientific research and labour which have been bestowed upon it. It extends about 200 miles in length and breadth, being larger than that of the Nile, and of about the same extent as that of the Ganges; its characteristics are the preservation of its importance by the main stream, notwithstanding its bifurcations and the branches by which its waters also find their way to the sea; and the consequent extension of its mouths in the form of an irregular triangle to a considerable distance beyond the main body of the delta. The principal of the branches and bifurcations are the Atchafalaya, which commences 200 miles from the sea, the Placquemine and Fourche on the right, and the Iberville, Gentilly, and Bienvenu on the left; the former receive several streams, as the Rouge and Teché, and spread into numerous lakes and lagoons varying from five to twenty feet in depth, and the latter communicate with Lakes Maurepas and Pontchartrain, which separate the lower part of the delta from the main land on the east; Lake Pontchartrain is forty-five miles in length and twenty-three in breadth, communicating with Lake Maurepas on the west, and by Lake Borgne with the sea on the east, as well as with the main stream by St. John's Channel, or Bayou, which is the local name for these branches, whether bifurcating or otherwise. The rise of water in the inundation is twenty feet at the head of the delta, and forty near the sea, and its power is restrained here, as elsewhere, by vast dykes, or levées; it is said to cover an area of 400,000 square miles. The peninsular prolongation at the mouth of the river has been probably over-estimated as extending at the rate of 1150 feet annually; at present there are five principal mouths, of which the most important is that of Balize, having only from thirteen to sixteen feet of water. The sands of this delta are more shifting and variable than of most others.

The rivers falling into the Gulf of Mexico from the reverse slope of the basin of the Mississippi are numerous, but comparatively neither large nor important; the most worthy of notice are to the east, the Cactahochee, Alabama, and Pearl. Of these the Alabama is the largest, rising from two principal sources, the Coosa and Talapoosa among the southern spurs of the Alleghanies; it has a course of about 600 miles, receiving, as it approaches the sea, the waters of the Tombidgee, having a course of 300 miles, from the right; the estuary formed by these rivers is known as Mobile River: they are navigable through a great part of their courses. The larger rivers to the west are the Trinidad and Brazos; these have their rise in the reverse slopes of the easterly extension of the Rocky Mountains, which are continued in the Ozark chain. They are rapid in their upper courses, but flow through level lands as they approach the sea, and thus even the smaller streams, as the Sabine, the course of which is not 200 miles, are navigable. The Trinidad has a course of 450 miles, and falls into Galveston Bay. The Brazos in length approaches 1000 miles, and has considerable affluents; it is navigable, but deficient in water, and has a bar at the mouth; the country through which it flows is saline, but very favourable to the growth of cotton. Besides these the Saint Antonio and Neuces may be mentioned. The Colorado or Red River of Texas has throughout its course the rapid and irregular current, which the others have only in their upper courses, and though a large river, is not navigable. It rises among the spurs of the eastern extension of the Rocky Mountains. It is probably 750 miles in length: it has several affluents of similar character, which are still more developed in the Rio Grande del Norte, or Bravo del Norte, which, rising among the defiles to the east of the Great Salt Desert, flows through a narrow and rugged valley, separating the plateaux of Anahuac and Mexico from the great basin of the Mississippi. The sources of this river are, as already noticed, in close proximity to those of the Platte, Arkansas, and Colorado, and separated by the latter from those of the Columbia. For one-half of its course of nearly 2000 miles it is, notwithstanding its size, a mountain torrent; it has numerous affluent streams from the ravines transverse to that through which it flows, but the only affluents of importance are in its middle course, viz., the Puercos from the left, and the Chonchas or Florida, which rises among the defiles of the Sierra Madre, from the right. The Sabine from the right is the principal affluent of its lower course; its mouth is impeded by a bar.

CHAPTER XXX.

THE RIVERS OF THE EAST.

§ 1. The St. Lawrence and the lakes.—2. The watersheds of the east.—3. The rivers of the north-east.—4. The rivers of the south-east.

THE *St. Lawrence and the Lakes.*—The basin containing these inland seas of fresh water is perhaps the most remarkable in the globe, containing by far the largest mass of fresh water, and affording means of communication unrivalled: taking 300,000 square miles as the area of the whole basin, and 100,000 square miles as the area of the lakes, they may be further estimated to have a coast line of perhaps 7500 miles. Assuming the St. Louis, to be the principal source of the St. Lawrence, estimating its length 120 miles, the strait of St. Mary 40, the St. Clair River and Detroit Lake 75, the Niagara 33, the St. Lawrence from Lake Ontario to the sea 650, and the length of the lakes 1355 miles; the total length will be 2273 miles, of which nearly the whole is navigable.* But of the numerous small rivers which fall into Lake Superior, few of which are known, there may be, and probably are, others equal in size to the St. Louis; of more importance certainly are the Kaministoquoia and Pigeon Rivers, which flow into the lake more to the north, as connected with the chain of lakes and streams which, with only a slight interval, unite Lake Superior to Lake Winnipeg, and the waters of the Arctic Sea and Hudson's Bay with those of the Atlantic Ocean. These, and the other rivers of the western side of Lake Superior, either rise in or expand into lakes, and the surface of the country presents more water than land. The rivers run through rocky channels, and are broken into numerous and often lofty cascades; of these the Kakabekka Falls of the Kaministoquoia are perhaps the most remarkable. They are 130 feet in height and 150 yards in breadth. The valley of this river is also remarkable for its beauty and fertility, presenting an undulating surface, covered with verdure. Generally speaking, these rivers partake of the character of the lake, which from its shape alone would appear to occupy deep fissures in the rocks which surround it. Those to the north and west are primitive and igneous, not only granite and gneiss, but basalt, trap, and slate being found in abundance, and the lakes and rivers varying in character and scenery according to the rocks which form their basins. Lake Superior is formed of two principal basins, the larger and western being 230 miles long from south-east to north-west, and 60 miles broad. The northwest shore is for half its length a wall of porphyry and greenstone, broken only by ravines, through which small rivers fall into the lake, and having deep water at the base. To the north, however, there are deep sounds and numerous islands. Thunder, Black, and Neepigon Bays receive respectively the Kaministoquoia, Black, and Neepigon Rivers, the latter being ninety miles long, and flowing from a lake of the same name about twenty miles in diameter. In these bays, although the capes and islands which form them are rocky and precipitous, the former rising from 1000 to 1500 feet, yet the shores and mouths of the rivers are low, fertile, and covered with trees. Isle Royale, the largest island in the lake, lies off the south of Thunder Bay, parallel to the shores of the lake, from which it is distant thirteen miles; it is forty miles long by eight broad, and formed of porphyry, greenstone, and sandstone on the west, north, and north-east, and of sandstone and conglomerate on the south-east, and similarly on the south side of the lake; the shores and islands are of sandstone, from the mouth of the St. Louis to Keewaiwoona promontory, which forms the natural division of the lake on the south, and again extend to the east of that point, mixed with granite as far as the river St. Mary, which connects Lake Superior with Lake Huron. The northern shore consists of greenstone and porphyry on the west, and granite on the east; slate appearing near the centre in a group of islands named from that circumstance.

* Reports to the Congress of the United States give the following statements:—

Lakes.	Length in miles.	Breadth in miles.	Mean depth. feet.	Elevation. feet.	Area. miles.
Superior	355	160	900	627	32,000
Michigan	320	100	900	578	22,000
Huron	260	160	980	574	20,400
Erie	240	80	84	565	9,600
Ontario	180	35	500	232	6,300

The total length, 1355 miles; area, 90,300; total area drained, 335,515.

The eastern division of the lake may be 120 miles in diameter, varied on the south-west by Keewaiwoona Bay, and on the north-east by Nichipicoten harbour, which receives a river of the same name, perhaps the most important of the numerous streams which here add their waters to the lake, and which is navigable for boats fifteen miles to the falls. This harbour is also covered by a rocky island, also named Nichipicoten, fifteen miles long by five broad, producing a luxuriant growth of hard-wood timber. A small sandy island called Caribou lies directly in the centre of the lake towards its eastern extremity; here it forms a deep bay, about twenty-five miles in width, from the bottom of which, between cliffs of porphyry 790 feet high, it discharges its surplus waters into Lake Huron by the river St. Mary. Twelve miles from Lake Superior the river falls over ledges of sandstone, eighteen feet in height, three miles below which it expands into Lake George, ten miles in width, which is divided by Sugar Island for fourteen miles, and subsequently forms three channels between Neebish Island, the south point of Sugar Island, and St. Joseph's Island; the former seven miles long, and the latter seventeen long by thirteen broad. This island occupies a bay at the western extremity of Lake Huron, of triangular shape, and measuring in base and perpendicular about twenty-five miles.

From this point the range of the Manitoulin Islands covers the northern coast to Georgian Bay, while to the south and west the Strait of Michilimackinac opens into Lake Michigan; from north-west to south-east Lake Huron measures 200 miles: Sagana Bay extends to the south forty, and Georgian Bay to the north-east about 100 miles.

The southern and western shores of this lake are for the most part fertile and well wooded; the western shore, as it approaches St. Clare River, is however poor and sandy. This lake differs from Lake Superior, in presenting limestone as its characteristic rock, which, appearing to the south in some islands, constitutes the mass of the islands to the north, as well as much of the coast, though on the main land to the north, and especially the Cloche Mountains to the north and east, granite and quartzose rocks prevail. The northern shore of the lake is extremely rugged and irregular, and covered with innumerable small islands, independently of the Manitoulin chain, which is formed of four principal islands: Drummond's, Cockburn's, the Grand Manitoulin, and Fitzwilliam's, or Horne Islands. These are of extremely irregular form, broken by sounds and inlets, having deep water on the north, where the cliff rises 200 feet, but shoal on the south sides, and extending in a curved line from east to west. They are picturesque, fertile, well wooded, and well watered. The largest, Grand Manitoulin, is eighty miles long, with an average breadth of twenty miles; in it are several lakes, one of which, having an area of fifty-five miles, has no outlet for its waters, and receives only one small stream. Drummond Island may be eighteen miles long by ten broad, and the others smaller.

The most considerable river falling into Lake Huron is French River, which flows from Lake Nipissing. It is however rather a chain of small lakes than a river, and has four principal outlets to the lake. Lake Nipissing is sixty miles distant from Lake Huron, and only about seventy feet above its level. This river and lake are situated in a cold and barren country, but those to the westward, Thessalon, Mississaqui, Serpent, and Spanish Rivers, flow through fertile, well wooded, and beautiful valleys. Between French and Spanish Rivers the Cloche Mountains, a spur from the northern watershed of the basin of the lakes, approach the shore, and form the limit between the fertile and unfertile portions of the country.

Eastward of the Manitoulin Islands, Georgian Bay stretches deep into the land towards Lake Ontario, and receives the Severn River from Lake Simcoe; this river has many falls and rapids, but flows through a beautiful and fertile country. Lake Simcoe approaches within thirty-five miles of Lake Ontario; it is 170 feet above Lake Huron, is thirty miles long by eighteen wide, but of irregular shape, forming deep bays to the west and south—viz., Kempenfelt and Cooke's Bays; the latter receives the waters of Holland River, which rises in the hills to the south, and is navigable for ten miles, and its sources are close to those of the Humber, which falls into Lake Ontario. The banks of this lake are low, but fertile; it has numerous islands, and is separated by a narrow strait from Lake Gougitchin. It is usually frozen over in winter. Lake Gougitchin is twelve miles long by five broad, of very irregular shape, and presents extremely romantic scenery.

The southern extremity of Georgian Bay, Nottawasaga Bay, receives the river of the same name, which flows through a highly picturesque and fertile country, has numerous affluents, but is not navigable.

The river St. Clair connects Lake Huron with Lake St. Clair, which is again connected with Lake Erie by the Detroit, or, as it is called, Detriot River. St. Clair River is twenty-five miles long, and about one mile wide; its course is nearly north and south; its navigation is impeded by sandbanks, and it enters Lake St. Clair by five mouths, and forms a delta which has filled up nearly one-half the lake; of the islands thus formed, Walpole and Harson's, separated by the principal channel of the river, may be noticed. Formerly three channels connected the two lakes, but the two northern became dry, and have given to the northern shore a good harbour.

Lake St. Clair is twenty-five miles broad, and from the entrance of the Detroit to the mouth of the St. Clair is the same distance; it does not exceed thirty feet in depth; it receives several rivers, of which Sydenham and the Thames, from the east, are of most importance. The former, known as Bear Creek, has a course of about seventy-five miles; the latter has a slow and serpentine course of 160 miles through a very fertile valley, receives numerous small affluents, and is navigable for boats throughout nearly its entire length. The Detroit is twenty-three miles long, and from one to two broad; it issues from the south-west angle of Lake St. Clair, and flows south-east and south into the north-west angle of Lake Erie, which here forms a deep bay, about thirty miles across, separated by projecting points and islands from the main basin; there are also several islands, some of considerable size, in the river. Lake Erie has this peculiarity, that while the Detroit flows into its western extremity from the north, the Niagara flows out of its eastern extremity in the opposite direction. Thus lying to the south of the other lakes, it seems to occupy a shallow basin in a plateau raised above the bottoms of those which have independent channels of communication to the north. The river Thames, flowing nearly parallel to its northern shore for half its length, has no considerable streams from that quarter. The shore to the north is indented by four wide bays, separated by low, marshy, projecting points, of which Point Pelée on the west, and the North Foreland on the east, mark the three principal divisions of the lake's surface. Point Pelée Island is about six miles long by three broad, the others smaller. The Ouse or Grand River falls into Lake Erie about half way between the North Foreland and Niagara River; it rises to the north-east of the sources of the Thames, and has a course equally tortuous, but probably longer, receiving numerous small affluents, and flowing through a fertile valley.

The Miamis River is the most considerable which falls into the lake from the south by the bay of the same name; it is navigable for small craft, but the near approach of the southern watershed of the basin to the south shore of this lake leaves no room for affluents of any size; indeed, the sources of the northern affluents of the Ohio are in close proximity to it, and afford means of communication between it and the Mississippi.

The Niagara River is thirty-four miles in length; on leaving Lake Erie it is less than a mile wide, but spreading into two wider channels, separated by several small islands, it then encircles an island of irregular shape, about seven miles long and six broad, below which the Niagara would have the aspect of a lake but for the rapidity of its current; and here Chippewa Creek, by which communication has been opened with Lake Ontario, falls into it from the west. To this point the river is navigable, and to this from Lake Erie the fall is only fifteen feet, while from this to the Great Falls, a distance of only half a mile, it is fifty-one feet, the falls being on the east 164 feet, and from the base to Lake Ontario 106, in all between the lakes 336 feet. The falls are nearly equidistant between the lakes; they are divided by an island, called Grand or Iris Island: that on the west, called the Horse-shoe Fall, is 1900 feet wide and 158 feet high; that on the east 920 feet wide and 164 feet high, the entire width of the river being about 4000 feet. The recession of these falls is probably more rapid than is usually supposed, very considerable portions of the rock having fallen within the memory of man; this is not to be wondered at when 15,000,000 of cubic feet of water have been estimated to pass over it every minute.

Lake Ontario is of regular shape towards the west, but towards the east is broken by a deeply-indented peninsula, known as Prince Edward's county, enclosing what, under other circumstances, might be called the estuary of the River Trent; still further east the mouth of the Cataraqui forms another inlet, as do Blackwater Bay, and Chalmont Bay on the south side; and the eastern portion of the lake is studded with islands, the principal of which, Amherst and Wolf Islands, are respectively ten and fifteen miles in length, the latter of very irregular form, and lying in the embouchure of the lake. This lake is remarkable for its natural facilities of communication with Lake Huron on the west and the River Ottawa on the east, the former by the River Trent and the latter by the Cataraqui.

The River Trent may be said to have its rise from Balsam Lake, and to pass through Sturgeon, Pigeon, Shemong, Shebantekon, and Trent Lakes; between the latter and Rice Lake it is known as the Otonabee, and below that as the Trent. Within about two miles of Balsam Lake, Talbot River rises, which flows into Lake Simcoe, from which the Severn falls into St. George's Bay of Lake Huron. These lakes are of very irregular shape, and vary from five to fifteen miles in length; they receive many small streams, and are all navigable. The Trent in its tortuous course forms numerous islands, some of considerable size; its valley is fertile, and rich in mineral wealth. Like the Trent, the Cataraqui is connected with an extensive though smaller chain of lakes; but the country through which it flows is colder, and less fertile, being formed principally of primitive rock.

Lake Erie also receives considerable affluents from the south; of these the Gennessee and Oswego are the principal. The former has a course of 150 miles, broken by a beautiful fall of 226 feet, the latter is formed by the confluence of the Seneca and Oneida Rivers; these flow through two lakes of the same names, which are connected with many others. Oneida Lake is twenty-three miles long by six broad.

From the eastern extremity of Lake Erie, the St. Lawrence issues at Frontinac or Cataraqui, and extends in the Lake of the Thousand Islands, for thirty-nine miles; here the beauty and variety of the scenery cannot be surpassed: the islands number 1692; and below this, until within fifty miles from the confluence of the Ottawa, the river is broad, deep, and easily navigable: rapids here break its course for nine miles, below which again the river forms two wide expansions known as Lakes St. Francis and St. Louis, which are separated by rapids called the Cascades, and are also studded with islands; they are respectively twenty-five miles long by five broad, and twelve miles long by six broad; the latter unites with the Lake of the Two Mountains, formed by a similar expansion of the mouth of the Ottawa River.

This, the largest affluent of the St. Lawrence, may be estimated as having a course of 500 miles, but from Lake Temiscaming to its mouth is 350, below which, like the main stream, it is alternately broken into rapids and cascades, or swells into lake-like reaches; of these latter, Lake Chaudière is eighteen miles in length; from which it issues in the falls of the same name, sixty feet in height and 500 yards in width, from which point the river is navigable for sixty miles to the Long Sault, below which it expands in the Lake of the Two Mountains.

Below the confluences of the Ottawa, two larger islands lie close to the northern bank, Isle Jesus and Montreal, the one twenty-two miles long and six broad, and the other thirty-two miles long and ten broad; the former is low, the latter rises to the south in the hill from which it takes its name; both are fertile, the latter so much so as to attract the particular attention of the first discoverers; its position is politically and commercially of the first importance: forty-five miles lower down the river again expands in Lake St. Peter, and it is here more shallow, yet vessels of large burden can ascend to the Island of Montreal: a group of islands extends for nine miles in this lake.

The St. Maurice River, rising in Lake Oskelanaio, leaps from the high table land to the north of the St. Lawrence over a precipice 150 feet high, and flows for much of its course between lofty and rugged cliffs; its lower course is, however, fertile; its mouth is divided into three channels by two islands, and hence it is known as 'The Three Rivers;' to this point the tidal wave ascends the St. Lawrence: its total course is 150 miles. Smaller, but similar in character, are the Jaques Cartier, Portneuf, St. Anne's, and Batiscan Rivers, St. Charles, Gouffré, Mal Bay, Petite Rivière, and numerous affluent streams which join the main river from the north; one, however, the Saguenay, must be excepted, which has rather the character of a deep inlet than an affluent stream, and is navigable for more than sixty miles for the largest vessels, being indeed deeper than the St. Lawrence itself; its extremity forms two deep bays, one of which, Ha Ha Bay, is capable of containing a large fleet, and here cliffs of sienite rise 500 feet above the river; into the other the surplus waters of Lake St. John flow by two channels. This lake is about fifteen miles in diameter, and receives the waters of several affluents which rise in proximity to the head waters of the St. Maurice, the Batiscan, and the rivers falling into Hudson's Bay.

The affluents of the St. Lawrence from the south are more important as flowing through a more fertile country, and opening communication with the rivers to the south and the shores of the Atlantic. Of these, the Richelieu flows for seventy miles; from Lake Champlain it is navigable for fourteen miles to the basin of Chambly, and above that again to the lake; its valley is the most fertile of those formed by the affluents of the St. Lawrence. Lake Champlain occupies a long, narrow, irregular chasm among the hills, and stretches from north to south for 140 miles, is in its greatest breadth twelve miles and in its least half a mile; its surface is only 140 feet above the Atlantic, and it is usually frozen in winter. Lake George, at its southern extremity, is about thirty miles long and seven in extreme breadth, and lying among well wooded hills is remarkable for its beauty, even in America, the land of lakes. As Lake Champlain opens communication between the St. Lawrence and the Hudson River, so does Lake Oneida between Lake Ontario and the Susquehanna, the intermediate country being occupied by some of the most lofty mountains in the east of the continent. The St. Francis rises in a lake of the same name and Lake Meudon, near the sources of the St. John, and is increased by the confluence of the Magog River; from Lakes Memphremagog and Massawhippi it has a rapid course of 150 miles, and falls into Lake St. Peter: similar in character is the smaller river Besancour, but the Yamaska has a winding course of ninety miles through a fertile valley. The Chaudière is even more remarkable than the St. Francis for its rapidity and broken course; its great falls, about four miles from its mouth, are well known, and are more than 100 feet in height: the total length of this river must exceed 120 miles; in its upper course it expands in Lake Megantic, its principal tributary is the Du Loup. The Etchemin, a smaller river rising in a lake of the same name, affords that communication which the broken waters of the Chaudière deny; below this the Rivière du Sud flows through a fertile plain, beyond which isolated granite hills indicate the proximity of the mountain district of Gáspe, from which the Mitis and Matane, and other smaller streams, fall into the estuary of the St. Lawrence.

The shores of the St. Lawrence are for the most part bold, excepting about the mouths of the affluent rivers; its estuary is closed in to the south by rocky mountains rising nearly 4000 feet; on the north, a rocky ridge, but of less elevation, separates it from the table land in which the rivers falling into it from that side have their rise, and from which the mountains of the centre of Labrador rise to probably as great an elevation as those to the south: both districts are cold and barren, covered with lakes and streams, and but little known. The island of Bic, below Green's Island, which is on the south side opposite the mouth of the Saguenay, is the first island in the river; these gradually increase in number and size until, in Isle Aux Coudres and Isle Orleans, they extend to twelve and twenty miles in length; above the latter the river is 1314 yards across, and in the basin of Quebec, two miles below, at the Rivière du Sud, the channel expands to ten miles, at Mount Pelee to seventy-three, and at the mouth to 100; it enters the gulf of the same name by two channels separated by the rocky island of Anticosti, in length 125 and in breadth thirty miles.

2 *Watersheds of the East.*—The watershed of the rivers falling into the Atlantic Ocean, as well as those from the opposite slope into Lake Ontario and the St. Lawrence, is formed by the Alleghany or Appalachian chain and its northern extensions. The general character of this has already been indicated. It may be said to connect the mountains of Labrador on the north with the Ozark Mountains on the south, while in the centre the watersheds of the great lakes uniting, extend to the Rocky Mountains; and on the extreme north the coast chains are continued to the Romanzow Mountains, the north extension of the lower ranges of the Rocky Mountains, which stretch to Cape Barrow, thus completing the cincture of the three great basins of the northern lakes and rivers; of the great lakes in the centre, and the Mississippi on the south; while the principal extension of these mountains must be looked for from the north of Labrador through the Archipelago of the Arctic Sea. On the south coast of the estuary of the St. Lawrence, as already noted, these mountains rise to nearly 4000 feet, and on the south-east Bald Mountain may have the same elevation, while Kataadan, near the Kennebec, presents an isolated peak 5385 feet in height. Between Lake Champlain and Lake Oneida, and the other small lakes which find the same outlet by the Oswego to Lake Ontario, the mountains have an equal or greater elevation, the mean of which may be 3000 feet; but the peaks of Essex and McIntyre attain respectively to 5467 and 5183 feet, and many others are about the same height. Here, on the east, are the sources of the Hudson, and the Juniata on the west may be considered the principal source of the Susquehanna. These ranges unite below Lake Champlain, and extend in three principal and parallel chains, trending nearly due north and south. Here, between the sources of the Connecticut and Merrimac Rivers, the most elevated summits of the whole are to be found; many exceed 5000 feet, and Mount Washington rises in rugged pinnacles of granite and gneiss 6234 feet above the sea: here also is a narrow defile, called The Notch, two miles in length, and bounded on either side by precipitous cliffs. This is a country of lakes and rivers; the valleys narrow, and only fertile where alluvial deposits cover the rocky basin; but it is of the highest picturesque beauty, and much of it remains in its pristine state.

In the south, the Green Mountains divide the waters of the Connecticut from those of the Hudson; they are of less elevation, not exceeding 3500 feet; they are also of more rounded form, and covered with forests and mossy verdure. These mountains are extended towards the sea coast in two ranges, the Hoosac and the Taghannac, the latter being the western and more elevated, culminating in Saddle Mountain, 4000 feet above the sea. More eastward still, irregular spurs form the principal ranges, diversify the country towards the coast, and give great variety and beauty to the scenery. The most marked elevations are Mounts Tom, Holyoake, and Wachuset, rising between 2000 and 3000 feet in elevation. The prolongations of these ranges to the sea coast, which to the south of Cape Cod trends nearly east and west, have no great elevation; they may be separated into five, dividing the rivers which fall into Long Island Sound. The most important are Green Mountain, and Saghanic or Housatonic ranges.

It has been already noticed, that the mountains to the west of Lake Champlain attain an elevation of above 5000 feet; here the sources of the Hudson are 4747 feet above the sea; and Avalanche Lake, the most elevated of the lakes of eastern North America, is 3000 feet above the sea, while the River Au Sable descends 4600 feet in a course of forty miles to Lake Champlain. These mountains extend southwards, and are known as the Catskill as they approach the coast; their average elevation may then be 3000 feet, and they culminate on Mount Round Top at 3804 feet above the sea.

This district is noted for its magnificent waterfalls, of which those of the Au Sable River, the Trenton and Cohoes Falls of the Mohawk, and Glen Falls on the Hudson, are the best known, and probably the most remarkable; extending southward, these mountains form the Kattatinny range and Schooley's mountains, as well as the better known palisades of the Hudson, where the trap and greenstone rocks present their nearly perpendicular escarpments to the river, above which they rise from 200 to 500 feet; but unlike the more northern ranges, their summits form a table land sloping gradually to the west. The Kattatinny range extends southward in the North Mountains; this is the more eastern of the southern ranges, but rises irregularly, culminating 4000 feet above the sea, the more solid portion, which forms the watershed of the country, and known as the Appalachian chain, lying further west. In their greatest width these mountains are 150 miles; the western spur, which limits the basin of the Ohio, is known as the Chestnut ridge; the more remarkable are Sewell, Gauley and Flat Top Mountains; further south they become less defined and less elevated, Pilot Mountain, the highest summit, not exceeding 1765 feet, of which 214 are formed by a perpendicular pinnacle of rock. Still further south, detached mountains only are found, but some of these exceed 3000 feet in height, the main ranges trending to the south and west, and the peninsula of Florida not exceeding 150 feet in elevation at its highest point. The western ranges as they approach the Mississippi decrease in elevation, until the average does not exceed 1000 feet.

3 *Rivers of the North-East.*—Among these irregular and narrow ranges, numerous rivers have their rise, and flow eastward into the Atlantic. The more northern spurs form the valleys of the Ristigouch, Nipisiquit, and Miramichi Rivers, having respectively courses of 1000, 80, and 150 miles; the latter is navigable for one-third of its length for large vessels. The rocky peninsula of Nova Scotia here forms the Bay of Fundy, into which the St. John, the most important river of the north-east seaboard, discharges its waters, draining an area of more than 20,000 square miles. The main source of this river is found near those of the Chaudière and Penobscot; in its upper course it receives the Allaguash from the right, and the St. Francis from the left, the former flowing through Windy Lake, which is 870 feet above the sea, the river having to its confluence a fall of 350 feet; and beyond these the Madawaska, which may be considered the secondary source of the river, flows through Lake Temiscouata, by which access is gained to the St. Lawrence, from which its sources are only distant twenty miles.

From the junction of the Madawaska the St. John has a southerly course, and forty miles below it is precipitated over the Grand Falls, which have a perpendicular height of forty feet, and with the rapids below give to the river a total declivity in this portion of its course of 120 feet. These falls are the limit of navigation, 200 miles from the sea, but ninety miles lower down, where the river has a still more southerly trending, there are rapids which impede navigation; between these the river receives two important affluents, the Tobique, from the left, which, rising among the highest elevations of the country, Blue, Ox, and Bald Mountains, which attain an elevation of about 4000 feet, flows through a most fertile and beautiful valley, between rocks of gypsum, limestone, and sandstone; and the Aroostook from the right, a still more considerable stream, flowing nearly parallel to the main stream in its upper course. Below the rapids already noticed, a chain of lakes, occupying a fertile valley, send their surplus waters by a short canal to the main stream; and below this the river receives the Washedemoke, Belle Isle, and Kennebacasis, all of which expand into shallow lakes before joining the main stream. Besides these, it has a feature peculiar to itself, for near its mouth, after expanding to nearly a mile in width, it suddenly narrows, and rushes impetuously through deep channels, among rocks and islands of limestone covered with verdure; thus forming a shute or fall when the tide in the harbour is low, but the tidal wave generated in the Atlantic, and forced into the narrow channel of the Bay of Fundy, rises to from forty to eighty feet, and then at high water there is a similar fall up the river. The upper valley of the St. John may have an average elevation of 500 feet above the sea; it is a cold, damp, and dreary region, yet not altogether wanting in beauty or even sublimity. The middle course, comprising the valleys of the Tobique and Aroostook, is fertile and well wooded; the lower course, in the intervales, extremely fertile; pine and spruce, with the hackmatack, alone flourish in the upper, the others abound with maple, beech, elm, oak, and walnut. The entire course of the St. John may be 450 miles; it is navigable for vessels of some burden ninety miles to the rapid already alluded to, and for steamers and barges to the Grand Falls.

The St. Croix rises on the reverse slopes of the watershed of the Aroostook; its sources are found in the waters of two chains of lakes, lying in basins of primitive rock; these are of irregular shape, and from thirty to fifty miles long. The streams which they discharge uniting, trend to the east, and after being broken by two considerable falls, form a broad estuary, which again opens into an extensive bay, known as Pasamaquoddy Bay, which also receives other small rivers.

Between the St. Croix and Cape Cod, the south-west extremity of the Bay of Fundy, some important rivers fall into the sea: the Penobscot, rising from several sources near those of the St. John, and Chaudière, which expand into numerous lakes, some of which are of considerable extent. Mount Kataadan is situated in the fork formed by the confluence of the eastern branch of this river; and below this, its principal affluent, the Matawamkeag, drains the country between the Aroostook and the Chiputneticook Lakes, the sources of the St. Croix River; its only other affluent of importance is the Piscataqua from the right; from this point the course of the Penobscot is nearly due south; its entire length exceeds 250 miles: it is navigable for large vessels for fifty miles, and falls into the extensive bay of the same name. The Kennebec has its principal source in Moosehead Lake, an irregular sheet of water, fifty miles in extreme length, and fifteen in breadth. The course of this river is more tortuous than that of the Penobscot, the country through which it flows is interspersed with lakes, but fertile: it is navigable for large vessels for twelve miles, and for small for thirty-five; its length exceeds 200 miles; it falls into Merrimeeting Bay, as does the Androscogging, which, rising near Lake Megantic and the source of the Connecticut, collects the surplus waters of several lakes, and flowing south, is turned to the east by Mount Washington and the spurs of the White Mountains, and reaches the sea after a tortuous course of 150 miles. From the western spurs of the White Mountains, the Saco has a rapid fall into the bay of the same name, and is navigable for six miles from the sea; its entire length may be 160 miles. Below this is the Piscataqua, which has but a short course of fifty miles, but is noticeable as falling into Portland Harbour.

To the south of Cape Cod some small rivers are found to the east of the Connecticut, the Pawcatuc, and Providence, of which the Pawtucket is an affluent; these streams are rapid, and broken by falls, but the mouths are accessible to vessels of moderate size; the Merrimac, a more considerable river, rising from two principal sources, of which the Pennigewasset, the northern, is the larger, and has its rise in the White Mountains: the Winnipiseogee flows through the lake of the same name, which is twenty-three miles long, by ten broad, and remarkable for the beauty of its scenery: it contains several islands, and is 470 feet above the sea; it is the largest of the lakes with which this district abounds; the united streams obtain the name of Merrimac 125 miles from the sea; the entire course of this river may exceed 200 miles, and it is navigable for about one-third of its length. The Connecticut has its sources, as already noted, near those of the Chaudière and Kennebec; its general course is south, and it has no affluents of importance, but its length is estimated at 450 miles, and it is navigable for fifty.

West of the Connecticut are the Housatonic and the Thames, both of which are navigable, the one for twelve, the other for sixteen miles; but the next important river is the Hudson, the most westerly of those which have a southerly trending: it rises, as already noted, in the mountain district to the west of Lake Champlain, has a course of above 250 miles, is navigable for large vessels 118, and for small 145 miles; its only affluents of note are the Sacondega and the Mohawk, already mentioned as having its source near Lake Ontario in Oneida Lake. A branch of this river is noted for its beautiful falls at Trenton, as the main stream is for Glen Falls, unrivalled for picturesque beauty. The Hudson is remarkable for the beauty of the scenery on its banks, and for the breadth and extent of its estuary. These rivers fall into Long Island Sound, and to the south and west are the Hackensac, the Passaic, the Rariton, and Little and Great Egg Harbour Rivers of inconsiderable length, but navigable for from ten to twenty miles from the sea. The Passaic is remarkable for its beautiful falls, seventy feet in height.

4 *Rivers of the South-East.*—To the south, Delaware River falls into the extensive bay of the same name. This river rises in the Catskill Mountains, is navigable for vessels for 125 miles from the ocean, and for small craft thirty miles further; its principal affluent is the Skuylkil, which, rising in the Blue Mountains, has a course of 130 miles, and falls into the main stream about 120 miles from the mouth of the bay; it also receives the Lehigh or Leigh, which has a course of seventy-five miles, from the right, ninety miles above the limit of the ship navigation, and the Popacton from the left.

The Susquehanna rises in two principal sources, the one in Otsego or Oswego Lake, and the other in the westerly range between it and those of the Alleghany; its principal affluent, the Juniata, has a course of 180 miles from the west and south. In its course of 350 miles this river receives many small affluents, but is broken by short falls and rapids, and is only navigable at the mouth for small vessels; it falls into the head of the Bay of Chesapeake, and between this and the Potomac several smaller streams fall into the same bay, the chief of which is the Patuxent, which has a course of 110 miles, and is navigable for forty-six: the others are generally navigable for some considerable portion of their lower course. The Potomac rises from two sources near those of the Monangahela, and flowing first to the north, trends to the east and south-east, and after a very tortuous course of 400 miles, falls into the lower part of Chesapeake Bay: it is navigable for the largest vessels for more than 100 miles, but above that point is rapid and broken; the Great Falls are seventy-five feet in height; it issues from the Blue Mountains, 168 miles from its mouth; its principal affluent is the Shenandoah from the south, which has a course of 200 miles, and is navigable for half that distance. The Rappanahok, York, and James Rivers also fall into Chesapeake Bay; the former, rising in the Blue Mountains, has a south-easterly course of 160 miles, and its mouth is twenty miles south of the Potomac; it is navigable for small vessels for 105 miles. York River, formed by the confluence of two small rivers, is navigable for the largest ships for twelve miles, and forms an excellent harbour. James River is formed by the junction of the Jackson and Cowpasture Rivers; it has a course of 300 miles, and is navigable for 140; its principal affluent is the Appomatox, which flows into it about 100 miles from the sea; it has a course of 120 miles from the south, and is navigable for twelve miles. To the south of Chesapeake Bay, Chowan and Roanoke Rivers fall into Albemarle Sound, which opens into Pamplico Sound, which again receives the river of the same name, and Neuse's River, forming an irregular and intricate navigation, indented with numerous creeks, some of which are connected by small streams with Lakes, as Lake Phelps, and Alligator Lake. To the north of Albemarle Sound is the Dismal Swamp, extending thirty miles, and covering 235 square miles; Lake Drummond occupies the centre, and the rest of the surface is thickly wooded.

The Chowan is formed by the confluence of the Nottoway and Moherrin, which have a course of more than 100 miles; the Blackwater is an affluent of the latter. The Roanoke also has two principal sources, the southern falling from the watershed of the Great Pedee, the northern from that of the Kenawha; the latter is known as the Staunton, and has a course of 180 miles to the point of confluence: the length of this river must exceed 300 miles, and it is navigable for large vessels to the Falls, seventy-five miles from its mouth. The Pamplico River, also called the Tar, has a course of 200 miles, and is navigable for thirty. The Neuse is about the same size.

Cape Fear River has a course of 300 miles, is navigable for ninety; in its upper course it is known as the How: its affluents are Deep River from the south, in its middle course, and south and north-east rivers from the north in its lower course. The Pedee, known in its upper course as the Yadkin, is a rapid and tortuous river, receiving many small affluents, of which none are important but Lynch's Creek and the Little Pedee, which join it from the south and north respectively, as it approaches the sea: it is navigable for more than 100 miles, and exceeds 400 miles in length. The Santee is formed by the confluence of the Wattaree and the Congaree, the former is also known as the Catawba; both have their sources in Blue Ridge: this river is navigable for small vessels for 100 miles to the confluence of its two sources, and forty miles further up both of them; its length may exceed 300 miles. The Savannah is formed by the confluence of two streams, the Keowee and the Tugaloo; its affluents are all from the right; of these, Broad and Ogeehee Rivers are the principal: it is navigable for ships for seventeen miles, and for small vessels for 400 miles to the mouth of Broad River; its entire course may be 500 miles. Eighteen miles south of the Savannah is the Ojeechee, which has a course of 200 miles. The Alatamaha has two sources, and is navigable for small vessels for 300 miles: its total course may exceed 500 miles, and it enters the sea sixty miles south of the Savannah. The St. Illa and St. Mary's are about 100 miles long, and are navigable. Here are also extensive swamps, of which that of Okefenoko is the most remarkable; it is 180 miles in circumference, and in wet seasons becomes a lake. The St. John River rises in an extensive cypress swamp, and flowing northward, expands into numerous lakes, of which Lake George is the most extensive, being twenty miles long and twelve broad: its principal affluent is the Oklawaha from the left, and it receives the waters of Lake Orange, those of Dunn's Lake also join the main stream from the right. Lake George is 107 miles from the sea, and to this point the river is navigable.

The Peninsula of Florida abounds with lakes and lagunes, the former remarkable for their depth; the largest of these is Lake Okeechobee or Macaco; this is nearly circular, and may have a diameter of more than thirty miles. It receives the surplus waters of Tobopkalega, Cypress, and Istopoga Lakes from the north by Kissinee River.

5 *The Vegetation of North America.*—The natural divisions of North America have already appeared, but with respect to their vegetable productions they require further subdivision, consequent on latitude, position, and exposure, or it may perhaps be more convenient to make a fresh division for this purpose, which may be thus stated—

The districts of the Northern Lakes, the Great Lakes, and St. Lawrence, the North-east Littoral, the South Littoral, the Mountains of the East, the Mississippi proper, the Ohio and its affluents, the Missouri and its affluents, the Great Salt Basin, the rivers of the South-west, the rivers of the West, the Southern extension of primary watershed, the Northern extension of primary watershed.

The district of the Northern Lakes is that least important in this particular. To the south, the watercourses are in most parts bordered by swamps and well-wooded alluvial tracts; the principal trees being the spruce, white cedar, white beech, and willows; these become less frequent as the latitude increases, stunted willows, and birches, and the luxuriant grasses, give place to mosses and lichens; along the course of the Mackenzie, however, vegetation extends to the sea, the white spruce covering a large portion of its delta, and attaining to nearly 70° of north latitude. To the east the barren grounds afford a more sparse vegetation of the same character, but on the islands to the north, especially on Melville Island, both the character and the development of the vegetation improve greatly, and fit it for the support of animal life. The temperature of this region does not differ very materially, the greater portion being within the limit of perpetual ground frost, yet enjoying a warm, though short, summer, in which the heat approaches 100°.

The district of the Great Lakes and St. Lawrence is intermediate between this, the basins of the Mississippi and Ohio, and the North-east Littoral; its vegetation depends on soil and climate, the latter on exposure and longitude. The cincture of rocky hills to the north, so close to the lakes, gives a favourable exposure to a large portion of the country; the vicinity of waters to the whole, especially to the great Peninsula of Western Canada, between Lakes Huron and Erie, modifies the temperature, which is further improved by the quality of the soil; limestone and sandstone predominating from the shores of Lake Superior to the Ottawa River. Here, in addition to the trees above-mentioned, the vast forests of pine have been a source of national wealth, while on the richer soils hardwoods of all descriptions,—walnut, beech, oak, birch, and maple of all kinds, are found in great abundance, and of magnificent growth; the sugar-maple produces an article not only of domestic use, but foreign export; rice grows on the margin of the smaller lakes; and wild fruits,—grapes, raspberries, strawberries, cranberries, &c., abound, the latter covering extensive swampy grounds in cold situations on poor soil, and the former springing up among rocks, while the strawberry, as in England, delights in the grassy sward of the fertile upland. So constant is the vegetable product to the quality of the soil, that the one known, the other may be predicated with much certainty; on the shores of Lake Erie, the successive terraces or raised beaches which have been formerly borders of the lake, are apparent at a distance from the difference of their vegetation. Varying in latitude from 41½ to 50° north, and extending to 93° west longitude, the temperature increasing with the westerly as well as the southerly increase of distance, although throughout experiencing extremes both of heat and cold, this district differs considerably in temperature in different parts, the most temperate portions being, of course, those in most immediate proximity to water; the varieties of its vegetation are best seen in those of the surrounding districts.

The North-east Littoral consists first of the valleys of the rivers north of Cape Cod, and second of those between that Cape and Cape Hatteras; of the first the prevailing trees are coniferæ, which grow in the greatest luxuriance over the higher ground as well as on the sandy soil near the coast. Nevertheless, in the wide intervales along the course of the rivers, and on the margin of the lakes, hardwood is not wanting, but generally confined to the middle and lower courses, the upper as well as the high lands being occupied, wherever the axe of the lumberer has spared them, by pine, spruce, hemlock, larch, cedar, the dark foliage and irregular outline of which form a regular and constant background to the picture, both in winter and summer. The change between the divisions of this district is marked by the valley of the Hudson, yet here the pines still occupy every elevated position, while to the south the magnolia and similar evergreens take the place of the deciduous trees, which again displace the evergreen coniferæ on the hills, the tops of which are frequently covered with greensward.

The Southern Littoral has these characteristics, but exposes great tracts of pine barrens and cypress swamps, and is suitable for the cultivation of cotton, tobacco, and even sugar; maize is the local cereal. It is on the islands of the southern Littoral that the finest cotton is cultivated, but in the lower portion, within the line of coast, a district of barren sand is found from twenty to forty miles wide; from it a terrace of remarkable fertility rises to the west, abounding with the finest hardwood timber, especially hickory, walnut, and mulberry. In the marshy districts of the south rice is extensively cultivated, and has become the most important article of export next to cotton.

The peninsula of Florida, as its name implies, is very rich in vegetable productions; its swamps abound in cypress and aquatic plants, some of which are peculiar to the locality. The rising grounds are covered with oak and other deciduous trees; the magnolia grows luxuriantly, and the southern portion, having a rocky soil, presents mastic, lignum vitæ, wild fig, palmetto, and mangroves. The eastern portion of Florida is less favourable for vegetation than the western, where the soil is calcareous, and the exposure more genial; there the orange, sugar-cane, cochineal, cactus, and coffee tree are naturalized; and cotton, sugar, rice, indigo, and maize, are the staple products of cultivation. Pine barrens and cypress swamps cover a large proportion of the surface between Florida and the Mississippi, to the west of which river a saline tract extends, destitute of other vegetation than coarse grass and reeds, beyond which are again found cypress swamps, adapted for the cultivation of rice, and comparatively poor tracts covered with pine trees.

The mountain district of the east requires little description, being indeed but the division between the districts of the coast and the interior, and partaking of the character of both. As already noticed, the rugged mountain peaks of the north are clothed with a magnificent growth of pine and spruce, while in the valleys alone the deciduous trees are found; to the south these last prevail and are accompanied by vegetation of a semi-tropical character, as indicated by such names as chesnut ridge, laurel ridge, &c. Here sarsaparilla, ginsing, and other useful plants abound.

The district of the Mississippi Proper has already been described as intermediate between the prairies, the wooded region, and the region of primitive rocks, and the vegetation is correspondent to each. The balsam poplar, aspen, and ash, are here characteristic trees, and these, with pine, spruce, hazel, arbor vitæ, and occasionally sugar maple, and elm, extend to the Saskatchewan, which is their northern limit; on the other hand forests of pine, larch, and birch, extend to the eastward, while the valleys of the rivers and shores of the lakes between Lake Winnipeg and Lake Superior assimilate in character to those of the north-eastern affluents of the Mississippi. The district of the Ohio and its affluents is essentially one of deciduous forests, neither so wet nor so cold as the more northern, with a soil of great fertility; its forest vegetation is of the most luxuriant as well as the choicest kind, the upper waters of the river, flowing in rocky channels, present little if any alluvial soil, and yet are overhung by verdant forests. Even the barrens, so called, are so indeed only by comparison, and few portions of the earth's surface are more generally fertile and available for industrial occupation. To the west open glades begin to expand, dotted park-like with clumps of trees, to spread still wider into prairies; these again are bordered, near the rivers, by wide tracts of the richest alluvial soil; the vine here also grows in great luxuriance. The climate of this district is, however, colder on the whole than that of the Littoral.

The district of the Missouri is one of prairies which extend on both sides of that river and the country drained by its affluents, as well as on the lower course of the so-called Mississippi; these prairies are limited as already noticed, on the west by the 105th meridian, and on the south by the Ozark

Mountains; on the north they extend, with more or less integrity, to the lower course of the Mackenzie, varied only by occasional patches of willow or cotton wood on the banks of the rivers, which, however, usually flowing in deep channels, have but little effect on the neighbouring vegetation. The accumulation of water in the lower course of the Mississippi, with the mass brought down by its great affluent rivers, causes extensive inundations, covering an area of 25,000 square miles, the greater part of which is never sufficiently drained for cultivation: here extensive cypress swamps are found.

The south extension of the primary watershed presents a greater proportion of barren surface than any portion of the continent save the north-east; yet even here, the climate, favourable to vegetation, produces, wherever sufficient earth is to be found, a heavy and semi-tropical growth of plants, and assimilates closely to that of Mexico, with which it will be naturally described. The eastern spurs from the main chain have much similarity to the more favoured portions of the Appalachian chain, presenting in elevation at a low latitude the same features here which a more northern latitude affords there. To the east the pine tree grows to a great altitude, not unfrequently exceeding 10,000 feet, while the mountain valleys are rich with vegetation similar to that of the lower course of the Atlantic rivers. The difference between the ranges of primitive rock and limestone in this respect has been already noticed, as has the sterile strip at the base of the mountains, with its vegetation of cacti and artemisia. The northern extension of the primary watershed gradually loses the presence of the deciduous trees, until the pine stands out in bold relief from the background of the eternal glacier, or rises in giant grandeur from snow still compact in July. The western slope of these mountains is more abundantly wooded than the eastern; the deciduous trees forming the characteristic feature round the grassy lakes of the Columbia, while the spruce and cedar border those of Frazer's River and the Okanagan, and extend to the rocky margin of the northern sea coast, being abundant even as far north as Cook's Inlet. Deciduous hardwoods are, however, found not only on the Columbia, but on the lower course of Frazer's River, Simpson's, and Salmon Rivers.

The most marked feature of this mountain range is the great salt basin, approached as it is on the east by the plains of the southern branch of the Columbia, covered with artemisia. Here the bottoms of the rivers and margins of the lakes alone are fertile; but few trees are found, and those small, principally willow and cotton-wood, while saliferous plants prevail. The mountains which surround it, however, have forests of pine and spruce, and on the western slope of its cincture, the Sierra Nevada, the luxuriant woods of California rival those of Ohio in beauty, and exceed them in variety and development of the species which they contain; while to the north, in the lower valley of the Columbia, the increased humidity of the atmosphere favours a vegetation of extraordinary and almost fabulous magnitude, especially of the coniferæ; these are, however, in consequence of their more rapid growth, less valuable for useful purposes, and the best timber is found above the 50th parallel in Vancouver's Island and still further north.

CHAPTER XXXI.

MEXICO AND CENTRAL AMERICA.

§ 1. Sources of our knowledge of the interior.—2. More recent information.—3. Boundaries and limits.—4. The watersheds.—5. The rivers and lakes.—6. Natural productions.

SOURCES of our knowledge of the Interior.—We owe our knowledge, such as it is, of the interior, both of Mexico and of the Isthmus, to the Spaniards. Cortez not only crossed to, but penetrated along the western coast as far as the Huascahualco, and returned to the Caribbean Sea. Vasco Nunez de Balboa had, however, been the first to cross the narrow portion. This was in 1513, and in 1572 Drake saw both oceans at one view; after him the Buccaneers crossed frequently. The Spanish conquerors had three regular tracks besides those discovered in the search for gold; but of the information obtained by the Spaniards we know little, from the jealous policy of the Spanish court. The pearl fisheries in the Pacific were the means of maintaining a path across the eastern portion; transit was also kept up by the San Juan and Lake Nicaragua; and the civilization and riches of Mexico stimulated to exploration and conquest on the north-west. Alvarez had penetrated to the south and east, along the coast, for 400 miles, and Nunez de Guzman far to the north; but the promontorial extension of Honduras and Yucatan remained unexplored. In more recent times we are indebted to Humboldt for our knowledge of Mexico; and in the endeavour to secure easy transit from sea to sea, the emissaries and surveyors of Spain, England, France, and the United States have explored the isthmus in almost every direction. Of these, Garay surveyed the course of the Huascahualco to connect the Gulf of Honduras with the Pacific; Oersted, Squier, and Baily have been employed on the district of Nicaragua; Lloyd, Falmarc, Morel, Garilla, and Hughes, between Chagres and Panama; Wood on the Cupica, Greiff on the Atrato; and the reports of Cullen and Gisborne on the Savannah and Chuquanaqui have led to the surveys of the officers of the French, United States, and English navies, which have resulted in our more satisfactory knowledge of the valleys of the rivers falling into the Gulf of San Miguel.

2 *More Recent Information.* — The surveys conducted under Captain Prevost, conjointly with officers of the United States navy, have removed all doubt, if reasonable doubt existed, of the considerable elevation of the watershed of the Isthmus of Darien, and its proximity to the northern coast. The activity of the citizens of the United States, who are now apparently taking possession of these regions, will soon add to our at present but small stock of information concerning them.

3 *Boundaries and Limits.*—The northern limit of Mexico is indefinable, either politically or geographically; in the latter view it should at the least extend to the apex of the triangle formed by the Colorado and Rio del Norte; this, however, can scarcely now be expected. If Central America be considered —as is most usual—to extend from the narrow neck which joins the plateau of Mexico to the mountains of Honduras, to the still narrower isthmus by which the southern portion of the western continent is attached to it, it may be represented as formed of two triangles; its greatest length may be 950 miles, and its greatest breadth 400; and its area may be estimated at 50,000 square miles; its eastern extremity may be 120 miles wide; its western has the greatest extent, already given; the breadth of the smaller triangle may be 384 miles, while across the triangles, 150 and 120 miles may be estimated respectively.

4 *The Watersheds.*—The watersheds of the southern extension of the Rocky Mountain range form an elevated plateau, more remarkable in many respects than any other of which we have knowledge. The Sierra Madre, already noted as the continuation of the main range from the north, now approaches the western coast, trending south-east as far as the Isthmus of

Tehuantepec, where a depression is found, beyond which the mountain ranges become less connected and less regular; as to the north the Sierra de los Mimbres and the lower chains to the east enclose the upper valleys of the Rio Grande del Norte, so to the south the Sierra Madre and the Cordillera Colahuela, or Potosi, enclose mountain valleys divided from that of the Rio Grande and from each of them by transverse chains, by which all outlet for their waters is prevented, and by which the Laguna del Cayman and other lakes are formed. These valleys extend about 450 miles from north to south, with a breadth of 150; their average elevation may approach 6000 feet: to the south a mountain knot, indicated by the Cerro de Potosi, rising more than 16,000 feet above the sea, separates these valleys from those of the River Panuco and Rio Grande del Lerma, to the south of which plateaux or mountain valleys of smaller dimensions but as great elevation are again found; of these that of Tenochtitlan or Mexico is the most remarkable; it is 7470 feet above the sea, about fifty-five miles long by thirty-seven broad, and surrounded by porphyritic ridges; above and around these valleys tower some of the most elevated peaks of these ranges: Popocatepetl, Orizaba, and Iztacihuatl are volcanoes in recent action, and respectively 17,716, 17,380, and 15,700 feet above the sea. Here the mountains approach nearer to the eastern coast, and a table land extends on their western slope for 400 miles, supported by lower ranges near the western coast, from which rise the volcanoes of Colima and Jorullo, the former 12,000, and the latter not much more than 4000 feet above the sea. There are many other extinct cones. To the south and west of the Plain of Mexico the descent to the coast is by parallel valleys, rising respectively 500, 1700, and 3300 feet above the sea, and here the mountain ranges become irregular and confused; on the east the table land approaches closely to the coast, sinking rapidly down from an elevation of 3000 feet to the level of the plain which skirts the shore; here the Sierra de St. Martin stretches toward the Isthmus of Tehuantepec, terminating towards the east in the volcano of Tuxtla. The northern of these ranges, especially the Sierra Madre and Cordillera of Potosi, are remarkable for the abundance of the mineral deposits, and contain some of the richest silver mines in the world; the porphyritic and amygdaloid rocks, with greenstone and basalt, occupying a large portion of the surface of the country. The line of perpetual congelation is here about 15,000 feet, and consequently only four of the most elevated summits are covered with perennial snows.

The watersheds of Central America may be briefly described as consisting of one principal, running throughout the entire length, connecting the Mexican plateau with the mountain ranges of South America, and having its short slope to the Pacific, while to the north, transverse ranges stretch towards the Gulf of Mexico, enclosing valleys, narrow, but fertile, seldom extending into plains, except near the centre, where the mountains rise in isolated cones, and at the extreme north, where the mountains disappear as the coast is approached. The whole surface is however very irregular and varied. If the mean altitude be taken at 7000 feet, it will probably be in excess, yet the loftiest summits attain to 14,000 feet above the sea. The entire range gives evidence of volcanic action, both ancient and recent, and many of the mountains have been raised by volcanic energy, if not within the memory of man, within the traditionary recollection of two generations; it is indeed one of the remarkable centres of such forces, and second only perhaps to that of the Indian Archipelago. The active volcanoes are all situated near the main axis of elevation.

To the west, the more remarkable elevations are those of De Agua, Del Fuego, and Atitlan; the former rises in regular conical form 13,578 feet above the sea; its crater, the fires long since extinct, measures 300 feet in diameter; the second, as its name implies, is still active, but does not attain to so great an elevation, nor indeed do those to the eastward. The most remarkable volcano is that of Yzalco, which has been in continuous action since its elevation, probably about the year 1750; it does not exceed 1600 feet in height. San Salvador mountain does not attain to a greater elevation than 8000 feet, but is very rugged, and separated from the main chain by a precipitous ravine; San Vincente rises to about the same height, but San Miguel does not much exceed 5000.

Farther eastward, within the second triangle, the main range divides, forming the basin of Lake Nicaragua; the coast range is here of but little elevation: to the south, volcanic cones stand isolated from the principal mass; of these, Momotomba, at the northern extremity of Lake Nicaragua, may have the greatest elevation, attaining probably to 5500 feet; the more important of the others are El Viejo, Telica, Nindiri, Mombaco, and Omotepe on an island in Lake Nicaragua. To the east of these, the elevations become greater; the mountain of Cartajo, rising 11,500 feet above the sea, that of Votos 9840, and Orosi 5200: the former has a crater, the fires of which are now extinct, extending for more than a mile in circumference.

At the eastern extremity of Central America, the order of the slopes of the main watershed is reversed, the shorter being to the north, and the longer to the south; the mean height does not probably exceed 5000 feet, and there are not many elevated summits, although the height increases as the southern division of the continent is approached.

5 *The Rivers and Lakes.*—These are numerous, but not important. Of the rivers of the north the most considerable is the Rio Grande del Lerma, or Santiago, which has its rise from two sources: one, which is the larger, in the western slopes of the plateau of Mexico; the other in the little Lake Lerma, at the base of the volcano of Toluca: its upper course is through the mountain valley of Toluca, 8570 feet above the sea, its middle through the fertile valley of Baxio, in the plain of Queritario, extending from the south of the Sierra Madre, 6500 feet above the sea; here its direction is north-west, and its waters deep and still, but from thence turning westward it descends into the plain of Xalisco, which extends almost to the shores of the Pacific, and has not a greater elevation than 4000 feet; the river has a rapid course to Lake Chapala, where its two sources unite; it is of irregular form, and may have a greater length of seventy-five miles by fifteen in breadth, with an area of 1300 square miles. From this lake the course of the river is broken by, it is said, sixty falls in about three miles, below which it is still rapid and irregular: it has a broad estuary, containing several islands; it has two considerable affluents from the right,—one in its upper and one in its lower course; its entire length may be nearly 500 miles, but few portions of which are navigable. Not dissimilar in character, though more navigable, is the Panuco, which descends from the opposite side of the table land of Mexico to the Gulf, the source of the two rivers being not far distant from each other. Its upper course is rapid and broken, and receives the surplus waters of Lake Zumpango: here it is known as the Moctezuma; it becomes navigable for boats 170 miles from its mouth, and in its lower course receives the Tamoin from the west, below the conflux of which it obtains the name Panuco; eighty miles from its mouth it is navigable for vessels of considerable size; its mouth is obstructed by a bar; its entire course exceeds 400 miles. The plain through which the lower course of the Panuco reaches the sea is, for a breadth of ten miles, nearly level, and skirted by dunes and shifting sands, arid and barren, and interspersed with swamps; the interior is, however, undulating and fertile: to the north the coast is covered by low islands forming lagunes, some of which have been shut off from the sea; of these the most considerable is that of Tamiagua. The Santander and Alvarado, considerable rivers, and some others of less note, also fall from the eastern slope into the Gulf of Mexico. Those to the south are for the most part scarce worthy the name; to the west, the principal is the Motagua; its course south-east, east, and north-east, for about 200 miles; to this the River Tinto is confluent at the mouth; its affluents are the Piscaya, Sacatepiques, Platanos, and Chiquimila, on the right; those of the left are unimportant: it has the character of a mountain torrent in the upper course, bringing down in the rainy season a considerable body of water. The eastern coast has several large rivers — of these the Belize has a course of about 200 miles, the Sibun of probably 150, the

Nuskioi and Hondo of about 100: the two latter, with the San Josef, flow into an extensive estuary, sixty miles long by ten broad, and communicating with the navigation in thick reefs, which cover the eastern shore of Yucatan for 130 miles, at a distance of from four to eight miles. The rivers of this country are subject to violent floods, not only from the rain, which frequently falls in excessive quantities, but also, it may be believed, from the elevation of their sources. The interior of the country must be lofty, since there are mountains within sight of the shore, which exceed 5000 feet in height. The coast is, however, low, and intersected with lakes and lagunes. The Polachic has a very irregular tortuous course of about 150 miles to the Gulf of Dulce. The Lacantun has a course of 400 miles, receives La Passion, and Usumasinta, both considerable streams, and falls into Lake Terminos. The former rises among the mountains of Chamma, in Lake Lacandon; it has two important affluents, the Santa Isabel and Mataquece. This river brings down with its waters an immense quantity of mud and *débris*, and has with its confluent streams formed an extensive delta at their mouth, extending westward from Lake Terminos.

The Gulf of Dulce is a remarkable feature in this part of the country; it is thirty miles long by ten broad, and communicates with the seas by the smaller lake, called Golfete, and the River Dulce, which, together, may be twenty-five miles in length; a bar at the mouth of the river impedes its navigation. Several lakes are also found here; Lake Peten may be thirty miles long by ten broad; Lake Atitlan fifteen by eight,—this lake receives several streams, but has no visible outlet; Lake Amatitan is small, but communicates with the Pacific by the River Michatoyat.

Eastward, the Lempa flows for above 100 miles, bearing the surplus waters of Lake Guija, which may be fifteen miles long by five broad, to the sea; it receives several affluent streams. The Paza, falling into the Pacific, may also be noticed. The Camulicon, Ulua, and Aguan fall into the Caribbean Sea: of these, the Ulua is the most important; it is formed by the conflux of the Venta and Sulaco, as the former of these is by the Santa Jago and Santa Barbara, receives several affluent streams, of which the more considerable are the Blanco, from the left, flowing through Lake Yojoa, which may be twenty miles long, and the Cullampa from the right, watering the great plain of Sula on the coast, and has a course of above 300 miles. The Aguan, also called the Roman, may have a course of 100 miles; it has two principal mouths. The Tinto and Wanks are also considerable streams. These rivers flow through thickly wooded districts, and are but little known.

The most important river of Central America is, however, the San Juan, by which the surplus waters of Lake Nicaragua are carried to the Caribbean Sea. The lake, which is ninety miles long by thirty broad, is ninety feet deep, and 125 feet only above the sea, and receives the surplus waters of Lake Managua from the west by the River Tipitapa or Panaloya, the course of which is broken by a fall of thirteen feet; it is 100 yards wide, and in its lower course flows slowly through a nearly level channel; this lake is thirty-eight miles long, and twenty-eight feet above that of Nicaragua. The River Tipitapa is sixteen miles, and the St. Juan 110 in length; the latter is rapid, and in many places shallow, but has been made practicable for small steamers; it enters the sea by several mouths. On Lake Nicaragua are several islands, the most important of which is Ometepe, consisting of two granite cones, the eastern of which, Las Maderas, is an active volcano. This island exceeds 5000 feet in elevation, is twenty-seven miles long and nine broad, but in the centre is only an isthmus six miles long and one mile broad. The plain of Leon extends to the south and west of the lakes, but a chain of mountains, not indeed of considerable elevation, but presenting elevated peaks, separates it from the Pacific. A more massy and important range passes along the north shore of the lake, and stretches its spurs into the territory of Mosquitia to the north. Eastward of the St. Juan no river of importance is found, until the Savannah and the Chuquanaqui unite to form Savannah Harbour at the head of the Gulf of Darien or San Miguel. These are considerable streams, especially the former, which, rising to the north of the Tichique range, bends round its eastern extremity, and becomes confluent with the Tuyra, which rises from the western slope of the watershed of the Atrato, the Cordillera Chacargun forming the Rio Grande or Santa Maria. The Atrato, or great river of Darien, flows from the south into the Gulf of Darien, has a course of 200 miles, and is navigable for about 150. The recent survey of this portion of the isthmus shows the country to be rock of considerable elevation, in the interior deeply intersected by the watercourses, and covered with the most luxuriant vegetation. The lower course of the rivers is through the richest alluvion; they are navigable for some distance, but choked with mangroves; indeed, the vegetation of this country is rich both in number of species and development.

6 *The Natural Productions.*—The geological formation of the mountains of Mexico has been already noticed, and is familiar to most from the descriptions of Humboldt; its mineral wealth has obscured the botanical productiveness of the country, the great variety of its climate and soil making it suitable to the vegetable life of both temperate and tropical climates, varying from the cold arid plateau of the Cordilleras to the low moist valleys of the Isthmus of Tehuantepec, and from the bare walls of irruptive rock to its dense forests; but 3000 mines offer temptations too potent for human reason to resist. The country is comparatively uncultivated, its natural productions neglected, and to the north cattle form the staple produce, and from the upper valleys of the Rio Grande no doubt the horses have descended which are now the principal wealth of the natives of the prairies of the Missouri and the upper valleys of the Columbia. The geological formation of Central America may be briefly stated as consisting of immense parallel bands of auriferous granites, gneiss, porphyries, chlorites, slates, hornblendes, and quartz rocks, intersected transversely by deep ravines. Sandstones are present in Nicaragua; coal is said to be found in Veraguay and Chiriqui, especially in the island of Muerto; auriferous deposits abound, as suggested by the local appellation Costa Rica, and there can be no doubt that the mineral wealth of the country is very considerable. At present, however, this yields to the more apparent luxuriance of the vegetable productions, especially of the eastern extremity, which are scarcely to be exceeded anywhere, the general fertility of the soil and the variety of climate making it suitable for the production, not of tropical plants only, but those of temperate climes; indeed, the extended plains and oak forests of Darien have great similarity to those of Northern America. Indigo, tobacco, cocoa, vanilla, sarsaparilla, cotton, sugar, gums, spices, balsams, and dye-woods abound; nor is mahogany the only valuable wood, for besides teak, mora, rosewood, ebony, satin-wood, lignum vitæ, and lance-wood, the hills produce oak, ash, beech, cedar, fir, larch, and other well-known European trees; and the bamboo and mangroves form numerous thickets in the low lands. Central America then not only unites the northern to the southern division of the western continent, but is in production as in situation intermediate between them.

CHAPTER XXXII.

OF SOUTH AMERICA.

§ 1. Historical sources of our knowledge of the interior.—2. More recent information.—3. Of the boundaries and limits.—4. Of the coast line.—5. Of the watersheds.—6. Of orographical classification.—7. Classification of rivers.—8. Geological formation.

HISTORICAL *Sources of our knowledge of the Interior.*—The Conquest of Peru and the western coast of South America are topics which belong to History. It may here be sufficient to say that, as in Mexico, the state of civilization in which these countries were found made discovery for the most part unnecessary or undesirable; so that the knowledge of the interior acquired by their conquerors has, even to this day, amounted to little more than what was transferred to them from those whom they conquered.

In the endeavour to extend their conquests south from their settlements at Panama, the unhealthy climate and luxuriant vegetation of 'Terra Firma' constantly baffled them; and it was from the sea that Peru was invaded, in 1531. The next year Almagro invaded Chili, and at his death in 1537, Pedro de Valdivia penetrated to the fortieth degree of south latitude: in 1533, Sebastian Belnacazar subdued the province of Quito; and Alvarado, who had been trained in the wars of Cortez, ascended by the river of Guayaquil to the plateaux of the mountains. In 1540, Gonzalez Pizarro marched from Quito eastward in quest of the country where the natives stated that cinnamon was to be found in abundance, and which was in consequence named Los Canelos, a name which it has retained to the present day; after crossing the mountains, with much suffering, from earthquakes, storms, and cold, Pizarro reached the Province of Zumaco, and found the plant for which it was so famous (which however proved not to be the cinnamon of commerce); from thence he pushed eastward into the valley of the Napo, and constructing a boat, sent Francisco de Orellana with forty men forward to collect provisions, who, on reaching the confluence of that river with the main stream, finding it scarcely possible to support life in his own party, or to return to Pizarro; tempted also, no doubt, by the hope of making the discovery of the course of what promised, what it has since proved, to be the largest river on the surface of the earth, commenced his downward voyage on the 31st December, 1540, and after great hardships reached the sea in August, 1541. In Spain, the account of his discoveries easily procured for Orellana a grant of extensive territory, which in 1549 he returned to colonize, but perished from the diseases incidental to the climate, and the attempt to colonize in that country was abandoned. The river which he descended has by some been called by his name; the name Amazon was conferred on it, in consequence of one of the fables he related; that of Maranon was however earlier applied to its lower course by the followers of Columbus, and, as in the case of the La Plata, and indeed of the entire continent, the name which was least applicable has been most commonly retained.

Pizarro returned with difficulty to Peru, when, on reaching the mouth of the Napo, he found no traces of Orellana, but subsequently, in 1560, Pedro de Orsua explored the Juati and Jurua, affluents from the right; in 1615 the governor of Maranham, Alexandro de Moura, sent Francisco Caldeira up the Tocantins, who formed a settlement where the tower of Para now stands; and in 1648 some Portuguese discovered the Rio Negro, and crossed the Andes t Quito.

It has been already related that Sebastian Cabot discovered the river La Plata, and even ascended the Parana to beyond the twenty-seventh degree of south latitude; but Pedro de Mendoza having obtained a grant of the country, founded the city of Buenos Ayres, in 1535, from whence he despatched Juan de Ayolas to select a favourable site for another city higher up the river. Having ascended the stream for more than 1000 miles, and passed the twentieth degree of south latitude, he struck off to the west, and penetrated to the borders of Peru, from whence returning he was massacred by the natives. Domingo Martinez de Yrala, who had been left by Ayolas to wait for him, having given him up for lost at the end of the time fixed for his return, now followed in the steps of his late commander, and in 1549 ascended the Paraguay to the seventeenth degree of south latitude, and crossed the mountains to the head waters of the Guapay. Falkner, a naval surgeon, who had become a Jesuit missionary, visited and resided in the southern extremity of the continent.

But little further information respecting the interior of South America is obtainable, until the disputes between Spain and Portugal as to the southern limits of Brazil induced the former to send Felix de Azara to survey the country about the boundary in the year 1781; and in 1778 the same enterprising officer examined the coast south of the La Plata; and subsequently, in 1799, Alexander von Humboldt, and his friend de Bompland, landed at Cumana, and crossed the Cordilleras, to the llanos, embarked on the Apure, and descended this river of crocodiles to the Orinoco; having reached the mouth of the Temi, they ascended that stream, and having dragged their canoes across a short portage to an affluent of the Rio Negro, and surveyed the remarkable canal, called the Cassiquaire, which unites that river and by it the Maranon to the Orinoco, they returned by that channel, having performed a canal voyage of more than 1500 miles, on the waters which flow among the primeval forests of the south, and reaching Cumana safely, passed thence to Cuba.

In 1801, Humboldt, having agreed to meet Capt. Baudin, then on a voyage of exploration to the Pacific, landing at Carthagena, passed to Santa Fé de Bogota: and having crossed the Andes by the pass of Quindiu at an elevation of 12,000 feet, and traversed the Cordilleras of Almaguer and tableland of Los Pastos, reached Quito, after a journey of four months' duration: and in 1802, in conjunction with Bompland and the Marquis de Selvalegre, he visited the most remarkable of the volcanic cones of the Andes of Peru; afterwards crossing the Andes, he descended the Chamaya to its junction with the Maranon, and returning across the Andes visited Caxamarca and Truxillo, and from thence crossed the desert country to the coast at Lima; from Guayaquil he sailed to Acapulco; arrived in New Spain, he devoted himself to inquiries into its history, geography, and natural productions, visited the volcanoes of Jorullo, Popocatepetl, and Itzacuhuatl, and the peak of Orizana, and then sailing from Vera Cruz, returned to Europe by the United States.

When the rapacity of the Spaniards had exhausted the supply of labourers in the mines, and the morbid avidity with which the treasures of South America had been sought by them had subsided into the indolence and sensuality natural to a dominant race in such a fertile country and salubrious climate, English capital and energy were soon engaged in reopening and working the mines which had been deserted by them, or which they found themselves incapable of working: and much of our knowledge of the interior of South America is derived from the journeys of those employed in this work. Of these, the first and most remarkable was Captain, now Sir Edmund Head; he crossed the Pampas, or great plains which extend eastward of the La Plata for 900 miles, and visited the gold mines of St. Louis, and the silver mines of Uspallata.

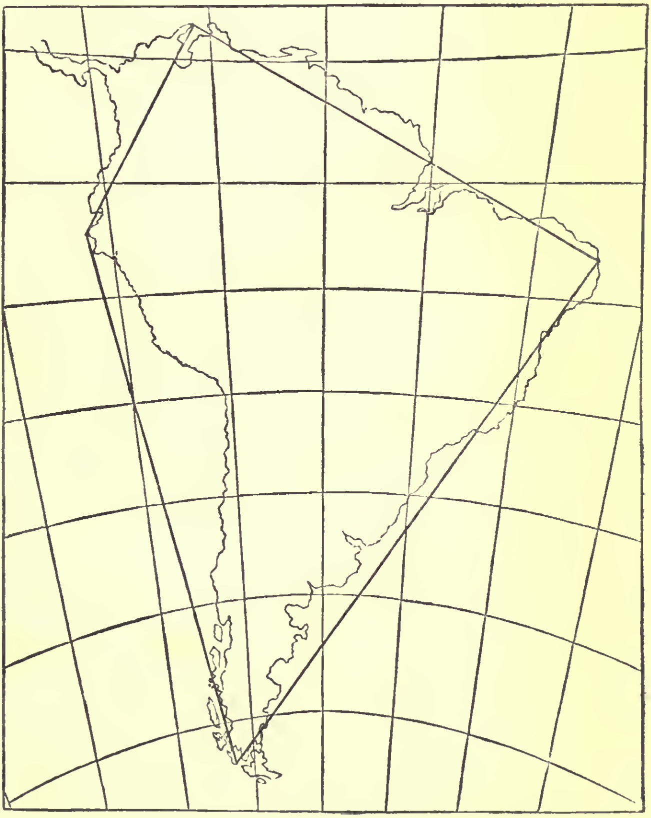
In 1826, French visited the provinces of La Rioja and Cordova, 172 leagues from Buenos Ayres; and in the same year Soria explored the Vermeyo, an affluent of the Paraguay; in 1821, Lieutenant Hibbert had crossed the Pampas from Cordova to San Juan at the foot of the Andes; and from these and other sources, a general knowledge of this country was obtained, but doubtless much might yet be communicated, especially by those who have traversed it for botanical purposes.

In 1836, Gosselman, a Swede, journeyed from Cordova to Mendoza, and the same year explored the gold and diamond districts in the interior of Brazil, through the northern provinces of which Koster had also travelled; while at the same time Schomburgk was exploring the Essequibo and its affluents, the Cuyunuy and Rupunoony; and subsequently McCann galloped, like Head, through the Argentine provinces.

2 *More recent Information.*—The rapidity with which our knowledge of the interior of South America is increasing is not a little remarkable, and the last half of the present century will probably see it fully developed.

But in no part of South America has this increase of knowledge been so remarkable as in its most important part, the great valley of the Maranon. Condamine had descended that river in 1745, Lieutenant Smyth in 1835, and Castelnau in 1843: and these voyages and that of Edwards up the river, had attracted attention to it, which was increased by the exertions of Lieutenant

Maury, of the United States Navy: the indefatigable Lloyd had also his attention directed the same way, indeed it may be said that generally the eyes of Europe were attracted to it. Lloyd himself having visited the mining district of Copiapo in 1852, crossed the Andes to the valley of the Chimose, an affluent of the Maranon, but was turned back by the impenetrable character of the forests, and the unhealthiness of the climate. Lieutenants Herndon and Gibbon, in the employ of the United States Government, were sent to explore the Huallaga and Madera; and Mr. Markham visited the sources of the Purus; and the characters of the rivers of the south became better known; while on the north, Wallace explored the Rio Negro during the years 1850, 51, and 52, and the Napo and Coca were examined by Yturburu: and thus opened, the navigation of the Queen of Rivers has commenced, and a steam voyage up the Maranon will soon be as readily effected as one up the Mississippi. Further information may also be expected; the State of Ecuador, as well as the Empire of Brazil, is fully awake to the value of her portion of the Great Valley; Deville has been sent from Paraguay to trace the course of the Madera to the main stream, and the labours of Bompland and Weddell, released from the ignorant tyranny of Francia, give promise of an abundant harvest.



3 *Of the Boundaries and Limits.*—These are more easily stated with reference to South America than any other continental portion of the earth's

surface. The Caribbean on the north, and the Atlantic and Pacific on the east and west, almost encircle it, while it has only a slender attachment to Central America by the Isthmus of Darien. The simplicity of the form of this portion of the western continent will appear from the accompanying normal figure, as will its position on the globe and its extent from the corresponding table of the positive position of its extreme points. Reference to the tables (pp. 204, 5) will afford the same means of comparison as given in other cases.

Cape St. Roque	5° 28′ S. Lat.,	35° 16′ W. Long.
,, Horn	55° 59′ ,,	67° 16′ ,,
,, Blanco	4° 17′ ,,	81° 16′ ,,
Point Gallinas	12° 25′ N. Lat.,	77° 44′ ,,

The mean area of South America has already been stated (p. 205) as 6,355,813 miles.

4 *The Coast Line.*—This is less indented and broken by gulfs or promontories than any other continental portion of the earth's surface. Promontories or peninsulas it has none commensurate to its extent, in this resembling Africa; those of St. Joseph on the south, and of Paria on the north, being scarcely worthy of mention, nor are indeed the Gulfs of Venezuela, Guayaquil or St. Patras, more so when compared with those gulfs and seas which give such importance to North America, Europe, and Asia; but the pride of South America is in her rivers, and their extensive estuaries give that entrance into the interior of the country which her more regular outline denies. The most indented portion of the coast line is to the south-west, where Chiloe and the neighbouring isles present, with the shores of the continent, an extensive coast line in proportion to the area, which is continued through the islands of the south. As already estimated, the proportion between the area and coast line is 576, the former being 5,136,000 square miles, and the latter 13.600 linear miles.

5 *The Watersheds.*—Equally regular is the distribution and position of the watersheds of the southern portion of the continent of America. The great Cordilleras of the Andes extend south-west, south-east, and south, throughout its entire length, in close proximity to the western coast; on the north sending off several spurs to the coast of the Caribbean Sea, and limiting the basin of the Magdalena and Orinoco: in the centre, at the head of the great valley of Maranon the chain is single, and solid, but to the south divides, enclosing the basin of Lake Titicaca; more southerly still it becomes again single, while decreasing in height and importance, and loses itself in the southern Archipelago.

On the north, parallel ranges, little known but of considerable elevation, separate the valley of the Maranon in its middle and lower course from the rivers of the northern coast. These are not, however, apparently connected with the Andes, but a level tract marked by the course of the Cassiquaire connects the valleys of the Maranon and Orinoco.

To the south of the Maranon the watershed is more continuous, and of considerable elevation, apparently connecting the Andes with the coast ranges, which form the limits of the basins of the Tocantins, St. Francisco, and La Plata, southward of which there are no mountains but the Andes, and some isolated ridges extending towards the coast.

6 *Orographical Classification.*—This is therefore extremely simple; the Andes forming the primary watershed, and the systems of Parime and Brazil the secondary; the course of the Maranon at right angles to the general trending of the primary watershed is a feature peculiar to this part of the world.

7 *Classification of Rivers.*—South America has four principal primary rivers, besides those of the western coast, which, by comparison, hardly deserve the name; the Maranon in the centre, the Magdalena and Orinoco on the north, and the La Plata on the south: these are of very various size and importance, yet even the smallest worthy from its size to take rank among the primary rivers of the world: there are also on the south, the Colorado, Rio

Negro, Desire, and other smaller streams; those falling into Lake Titicaca, and those which lose themselves in the lakes of the plains on the eastern side of the Andes, must be placed in this class: the others will all be secondary. Of these the Essequibo, Berbice, Paranahyba, and St. Francisco are the most important and best known. The rivers of South America are remarkable, not for their number as in North America, nor for the variety of their classification as in Europe, but for their extent, the importance of their affluents, and the slight fall of their middle and lower courses.

8 *Of Geological Formation.*—This is also of much simplicity, and remarkable for the comparatively small development of the primary, transition, and secondary strata, of which so large an area is apparent on the northern portion of the American continent. The crystalline schistose formations extend throughout the length of the Andes, and the mountainous districts of the north and of the east coast; throughout the former also the later igneous rocks are extremely abundant. In the centre of the chain of the Andes, in Peru, about the Gulf of Venezuela, and in the valley of the Orinoco, secondary deposits appear; while the primary and transition series are limited to the districts of the head waters of the upper affluents of Maranon, and the eastern slopes of the Cordilleras of the Andes, with portions of the mountain districts of Parime, Brazil, and Uruguay. The tertiary formation has however a very extensive development, appearing throughout the entire length of the continent, at the eastern base of the Andes, forming in the centre the tablelands surrounding the middle basin of the Maranon; on the llanos of the Orinoco and on the south, the pampas of La Plata and plains of Patagonia, and in the valley of the La Plata exceeding 2000 miles in breadth and stretching along the basin of the Maranon to that of the Paranahyba; while on the north it appears surrounding the mountains of Parime at their bases: the alluvial deposits rest upon this in the valley of the Maranon from the mouth of the Napo, and throughout the valley of the La Plata from the confluence of the streams forming its head waters. The northern coast from Cape St. Roque to the mouth of the Maranon is also covered with it.

Of South America, especially the western side, it may be said, as already observed of North America, that it has undergone many and considerable changes within the historic period. Of these, enough have been recorded not only to justify this conclusion but to indicate that others, to probably an extent little contemplated, have taken place already, and that many more equally considerable may be expected.

CHAPTER XXXIII.

WATERSHEDS AND RIVERS OF THE WEST.

§ 1. The primary watershed.—2. The southern extension.—3. The northern extension.—4. The central basin.—5. The rivers of the west.

THE Primary Watershed.—The unbroken regular chain of the Andes, extending for more than 4000 miles from north to south, presents this peculiarity, that although in the centre, parallel ranges and detached peaks are found, yet throughout the greater part of its length the highest summits are in the line of greatest elevation, and that on the western side there are no transverse ranges of importance. The central portion of this range, extending from the Knot of Pasco to the southern limit of the Cordillera Reale, and the Alturas de Lipez, from the sources of the Maranon to those of the Pilcomago and Saldado, for nearly 1000 miles, may be divided into two portions, the northern forming the upper valleys of the sources of the Yucayali, and the southern embracing the plateau of Bolivia, or rather the valley of Lakes Titicaca and Uros or Pansa, and the River Desaguadero. Within these limits are several of the highest summits of the Andes, but not the highest, Aconcagua, 700 miles to the south, being of greater elevation. At either extremity parallel ranges are found; those on the north extend from the Knot of Pasco in three well-defined ridges, known as the Western, Central, and Eastern Cordilleras, of which the Western is the watershed of the country, the valley between it and the Central being the upper basin of the Maranon, as that between the Central and the Eastern is of the Huallaga, while the larger stream of the Yucayali flows along the eastern base.

The sources of the Yucayali may be considered as lying under the sixteenth degree of south latitude, rising to the west of the flank of the Cordillera Reale, while those of the Purus and Madera fall from the eastern slopes of the same range. It should seem therefore that here we have the characteristic feature observable in the central ranges of the great primary watersheds of the Rocky Mountains and Himalayah, and that the Cordillera Reale, its name and appearance notwithstanding, must be considered as subordinate to the range of the Andes of the coast, if of it the Central and Eastern Cordilleras are the northern prolongations; nowhere is the main chain of the Andes more regular or less broken than it is here, and it culminates towards the south in the peak of Sahama, 22,350 feet above the sea; while its neighbour Gualatieri rises 21,960 feet. The Cordillera Reale has also elevations nearly as great, the peak of Sorato being 21,290 feet. The Cordillera de Yuracaraes extends eastward from the centre of the Cordillera Reale between the sources of the Madera; and the elevated plateaux on the northern and eastern sides of these ranges no doubt extend far into the unexplored country between the Purus and Yucayali; the smaller affluents of the Maranon, the Yarani, Jutay, Jurua, and Teffe, having their sources in the slopes which would correspond with the axis of the Cordillera Geral on the eastern side of the Madera, and not improbably it may be found that they are buttressed up by similar ranges, completing the cincture of the middle basin of the Great River, which would thus exhibit remarkable regularity: the upper waters surrounded by the giant ranges of the Cordilleras, its middle basin by the inferior ranges forming the limit of the lower basins of its affluents and of its vast silvas; while to the north and south of the plateaux in which these affluents have their upper courses, the llanos of the Orinoco and the Parana extend to the estuaries of those rivers, and from the point of their commencement, or of the divergence of the transverse ranges which enclose the valley of the Maranon, the prolongations of the chain of the Andes extend north and south round the basins of those rivers. As in North, so in South America, three principal basins are thus formed; the northern and central being even more intimately connected in the southern than in the northern portion of the continent, it remains to be proved whether this be so on the south as well; but it may be assumed, without much fear of error, that the upper valleys of the Rio Grande and Guapore do not afford great facility of communication between the valleys of the Maranon and La Plata, and that transverse ranges of some elevation and much irregularity present themselves in the valleys of the Beni and Purus.

To the south of the central mass of the primary watershed of South America, near the mountains already mentioned, the Pass of Atacama crosses the Western Cordillera at an elevation of 16,000 feet; near the centre, the Gualilas Pass is 14,750 feet above the sea; and here the Nevado, or Snowy Peak of Chipicani, rises 19,700 feet; farther north, the ridge of Aripigna and the cone of Chacain have as great elevation, that of the latter exceeding 20,000 feet; and still farther, those of Ambato and Corpuna, with the dome-like Nevado of Choquibamba, rise to about the same height. The breadth of the Western Cordillera may be seventy-five miles, and its mean elevation 16,000 feet; the mean breadth of the plateau of Bolivia may be 100 miles, and its mean elevation 12,000 feet; while the Eastern Cordillera cannot be more than fifty miles in breadth, its mean height probably much less than 15,000 feet, and its culminating points, Illimani and the Nevado de Sorato 21,150 and 21,290 feet respectively; the appearance of these Cordilleras is very different, the Western consisting for the most part of trachytic dome-like masses, the Eastern of irregular serrated ridges and rugged peaks; on this therefore the glacier region is more extensive, descending to about 16,000 feet, the limits of perpetual snow being about 16,500 feet. The breadth of the entire mass of the Bolivian Andes may be 250 miles. It is from the northern flanks of the Nevados of Sorato and Illimani that the deep gorges extend through which the head waters of the Maranon, descending from these eternal snows and glaciers, rush to swell the volume of this mighty river; but to the south, the greater portion of the Cordillera Reale is below the level of perpetual snow, and the passes by which it is crossed do not much exceed 13,000 feet in elevation. The Sierra Nevada of Cochabamba, or Cordillera de Yuracaraes, may have an elevation of 17,000 feet, the greater portion, as its name implies, being above the level of perpetual snow. The northern limit of the plateau of Bolivia is the Knot of Vilcanota, 17,525 feet above the sea; beyond this the western chain is continuous, but less elevated than to the south, while to the east three irregular valleys are formed, in which the principal sources of the Yucayali are found; the central, approaching within seventy-five miles of the coast of the Pacific, flows at right angles to the axis of the Cordillera; but those on the north and south, being distant from each other more than 350 miles, flow parallel to that axis, their basin being limited by the irregular and broken extensions of the Cordillera Reale, which again unite in the Knot of Pasco, culminating in the Nevado de la Vinda, 16,000 feet above the sea: the upper valleys of the Yucayali may have an elevation of 11,500 feet.

2 *The Southern Extension.*—To the south of the central watershed, the Andes of Chili extend from the twenty-first degree of latitude, in a direction diverging slightly to the west and east of south, forming one regular chain of about thirty miles in breadth, with a mean elevation not exceeding 12,000 feet, but culminating in the centre in the Peak of Aconcagua, 23,910 feet above the sea; this is, as already noted, the highest point of the entire chain of the Andes; to the south the elevations rapidly decrease, its nearest neighbour the Nevado of Tupungato is only 15,000 feet in height, while those of Osorno, Minchimadeva, and Yantiles, to the south of the fortieth parallel, do not exceed 8000.

From this portion of the Cordillera, transverse ranges extend eastward between the valleys of the rivers which fall into the Atlantic; the principal of these is the Sierra de Cordova, forming the southern limit of the valley of the Parana. On the west a granitic range forms the coast line, and encloses a valley corresponding to the greater depressions to the south, between the islands of Chiloe and the main, while the irregular mountains of Southern Patagonia, consisting of a series of ranges—prolongations of the Cordilleras of the Andes—culminate probably in Mount Stokes, 6400 feet above the sea. The snow line varies considerably in the Andes of Chili and Patagonia; under the fortieth parallel it is nearly 14,000 feet above the sea, under that of the thirty-third it sinks to 12,780, and under that of the twenty-seventh to 8300. In the Andes of Southern Patagonia, the glaciers, like those of Norway, descend almost into the fiords by which the coast is indented.

3 *The Northern Extension.*—This prolongation of the central watershed commences under the fifteenth parallel of south latitude from the Knot of Pasco; here, as already noted, three distinct chains appear; of these, the eastern extends to the north-east as far as latitude 5° 30′; the central having a more northerly direction, extends further, and terminates in two spurs, round which the Maranon bends its course from the north to the east; the western, which is the highest, runs parallel to the coast, but this in only one point exceeds the limit of perpetual snow, in the peak of Huaylillas, until near the Equator, where Chimborazo, the third in grandeur among the giants of the Andes, attains to 21,424 feet above the sea.

The Knot of Pasco forms a plateau elevated 14,000 feet above the sea, the mountains round it not rising more than 1000 feet above its surface; it is about twenty-five miles long by twelve broad, and is covered with moss and peat, interspersed with barren rock and numerous small lakes and pools, three of which are important as the sources of rivers.

The Western Cordillera is continued unbroken to about the fourth degree of south latitude, but from that point to the Equator it is much less clearly defined, although the summits of this portion of the Andes are little inferior in general elevation to those of the central range. From the Knot of Loxa to that of Assuay, two parallel chains are however apparent, enclosing the valley of Cuenca, and culminating about 15,500 feet above the sea: further north two ranges are again seen, uniting again near Chimborazo, where the narrow wall of Chisinchi forms the watershed of the country, and again diverging to be again united in the Knot of Los Pastos, from which the plateau of Pasto extends to the north and east, 10,000 feet above the sea. The width of the Andes here may average 100 miles.

In these ranges, besides Chimborazo, there are the remarkable volcanic cones of Cazambe, Antisana, and Cotopaxi on the east, and of Pichincha on the west, the latter attaining an altitude of only 15,924 feet, the eastern being now the watershed of the country, and the peaks above-named rising to an elevation of 18,535, 19,137, and 18,075 feet respectively; to the north are the volcanoes of Cumbal, Chiles, and Pasto. From the Knot of Los Pastos two chains again diverge, enclosing the valley of Almaguer these again unite in the Knot of Las Papas, from whence three chains, or rather the three northern spurs, diverge to the north and north-east; of these the middle is the more important —this is known as the Cordillera of New Granada, or Quindiu, and presents the volcano of Puracе, 17,934 feet in height, and the peak of Tolima, the culminating point to the north, 18,000 feet above the sea, and terminates between the two branches of the Magdalena, the eastern of which, known as the Cordillera of Suma Paz, extends to the north and east in the mountains of Merida and the coast chains of Venezuela, while the western, known as that of Choco, passing into the Isthmus of Darien, though of much less considerable elevation, is remarkable for its rugged and impassable character.

4 *The Central Basin.*—The existence of such a basin as that of Lake Titicaca, at an elevation exceeding 12,000 feet, surrounded by the highest summits of the Central Andes, has been considered singular, and it is so if only its elevation and isolation are considered; but the basins of the Salt Lake in North America, and even of Lake Lob, and the river of Kashgar, are not dissimilar in character or position, while the more elevated valleys of the sources of the Indus, and the less elevated valleys of the Columbia, resemble those of the Maranon, their elevation notwithstanding, as does the valley of the Sanpo. In all these cases, indeed, the difference is rather in the details than in the general characteristics of the situation. This valley, or plateau, as it is usually called, is estimated to be 12,850 feet above the sea, and to contain about 16,000 square geographical miles; its length may be 500, and its extreme breadth 130 miles. Lake Titicaca exceeds 100 miles in length, and covers an area of more than 2000 square miles; it forms a deep bay to the south, in the entrance to which lies the island from which the lake takes its name; its surface is 12,846 feet above the sea, and it is more than 700 feet in depth; it receives the waters of several small rivers, but the slope from the Western Cordillera being only 4000 feet, and from the eastern still less, the volume of its affluents is inconsiderable; it discharges its surplus waters by the Desaguadero into Lake Pansa or Uros, which, although not much less in length than Lake Titicaca, is disproportionately narrow, resembling a chasm in the rocks: the Desaguadero has a course of 190 miles. This basin, like that of the northern salt lake, is crossed by transverse ranges, but these do not exceed 16,000 feet in height, and therefore do not attain to the region of perpetual congelation. The most remarkable feature of the basin, next to its proximity to active volcanoes, is its mineral wealth. The temperature is exceedingly regular, the climate dry, no rain falls, and but little snow, except in

summer, and then, though frequent, not in considerable quantities. The soil is fertile, but cereals do not ripen; there are no trees, but the surface is covered with beautiful herbage.

5. *The Rivers of the West.*—From the rapidity of the slope of the Andes to the Pacific, these, though numerous, are inconsiderable; the more important are the rivers of Guayaquil, the De Loa, the Biobio, and the Osorno; these are generally rapid in their upper courses, of small volume, but expanding towards the mouth; that of Guayaquil being two miles wide, where it meets with the bay of the same name. The Biobio has a course of 200 miles, is also two miles wide at the mouth, and is navigable for boats throughout its whole length. The Callaculla and Maule are also considerable streams; the latter has a course of more than 100 miles, and is navigable for twenty for small vessels. The Maypo and Aconcagua are most valuable for irrigation. A chain of lakes communicating with the sea, occupies the extreme southern part of the valley between the coast range and the Andes.

CHAPTER XXXIV.

THE WATERSHEDS AND RIVERS OF THE NORTH.

§ 1. The secondary ranges of the north.—2. The primary rivers of the north.—3. The secondary rivers of the north.—4. Lake Maracaybo.

THE Secondary Ranges of the North.—The eastern ranges of the Cordilleras have already been noted as extending round Lake Maracaybo to the mountains of Merida and the coast chain of Venezuela; these culminate in the Silla de Caraccas, 8600 feet above the sea, and terminate in a plain or plateau, having an elevation of 2000 feet. These must be considered as extensions of the primary watershed. The secondary watershed will therefore appear on the other bank of the Orinoco in the system of Parime or Parima, of which scarcely sufficient is known to justify description. The regular descent of the Orinoco and the rivers of Guyana by a series of cataracts, seems to confirm the opinion that it consists of several nearly parallel ranges, of which that of Imataca near the coast is the first, which does not exceed 3000 feet in height; to the south the chain of Baragnan corresponds with the narrows of the Orinoco, from which indeed it has been named; and south of this Quittima, or Maypures, forming the second cataract to the south; again the highest range, rugged and almost unbroken, culminates in Duida, 7150 feet above the sea. As these ranges gradually assume a southerly trending, they may not improbably be connected by some central knot, from which also the Sierra of Paicarama may diverge to the east and north, throwing out spurs, to the north of which Roraima is the culminating point, at an elevation of 7450 feet above the sea; and still further east, though more southerly, the Sierra Acaray and its extensions form the watershed of the country, and buttress up the tableland of Guyana, while forming the northern limit of the lower basin of the Maranon. Between all the ranges, elevated valleys of great fertility and verdant tablelands are found, which serve to fit this district for the habitation of a numerous and industrious population; the lower valleys are however subject to inundations, and the density of the vegetation, which consists principally of palm trees, renders them unhealthy. This system may extend 500 miles from north to south, and nearly twice as much from east to west; on the west, however, it becomes irregular and broken, permitting the junction of the waters of the Orinoco and Maranon, though beyond this point it is again developed between the Rio Negro and Japura, and its connexion, thus indicated, with the lower ranges of the Andes, which support the tablelands of their eastern slopes. These mountains, nowhere approaching the limit of perpetual snow, are almost everywhere covered with forests, which prevent their outline from being easily traced.

2 *The Primary Rivers of the North.*—These are the Magdalena and the Orinoco. The former, as already noted, consists of two principal streams, which are confluent at the extremity of the Central Cordillera, nearly 200 miles from the sea. The principal stream is the Eastern, rising in the Knot of Los Papas, in a small lake of the same name, and flowing through a narrow valley, which gradually increases to fifty miles in width, at an elevation not exceeding 1500 feet; its total length may be 1000 miles, for nearly one-half of which it is navigable as far as the Cataracts; these lie under the fifth parallel of north latitude, where the valley is not more than ten miles in its greatest width in an extent of nearly 200 miles; its upper course is very rapid, but its principal affluents are the Soarez, Soganozo, and the Bogota, the latter remarkable for the Fall of Tequendama, 600 feet in height, by which it descends to the plain: in its middle course it bifurcates and forms the Island of Morales, forty miles in length. The average descent of the Magdalena has been estimated at twenty inches to a mile; this cannot be throughout its course, but should probably be confined to its middle waters. The Cauca or Eastern branch, is considered of inferior length to the Magdalena or Western, and is estimated at 500 miles from the confluence; its principal affluent is the Nechi: its upper course is through a narrow glen for fifty miles, and then through a mountain valley 3000 feet above the sea, 180 miles long, and about twenty-five miles wide: below this it forces its way with great rapidity through a narrow gorge for more than 100 miles, forming a succession of rapids and falls, below which the valley gradually widens, tending to the east to meet that of the Magdalena.

Below the confluence of the Cauca, the Magdalena flows northward through a wide and fertile plain; it has two principal mouths, which separate about sixty miles from the sea, enclosing an extensive delta: the northern, that of Savanilla, is the most considerable. The Eastern, the better known, then expands into several lakes, and terminates in the lagoon of Santa Martha, which unites with the sea by a narrow channel, having a bar at the mouth. There is also another channel communicating with the sea to the westward, which has been rendered navigable for vessels of shallow draught by art, and is called the Canal of Mahates.

The valleys of the Magdalena and Cauca differ in that the latter is subject to inundations, and is the more fertile, though the lower part of it is best adapted for pasturage; both produce all the ordinary tropical fruits and vegetables. The Plain of Bogota, 8000 feet above the valley of the Magdalena, extends above forty miles in length and breadth, is fertile, and has a remarkably temperate climate, with two rainy seasons; whereas the valleys below have but one: the grains and fruits of temperate climates are here cultivated, but in the mountain valleys above, rye and barley are the only cereals. The lower valleys of the Magdalena and Cauca are for the most part undulating, and covered with grass, interspersed with bushes; trees are rare, and comparatively so throughout the entire course of these rivers.

The sources of the Orinoco have not been ascertained; below the Cataract of Guahariboes it is joined by the Cassiquare, which unites its waters to those of the Maranon. This remarkable natural canal has a south-westerly course of 170 miles; it is 100 yards wide at its junction with the Orinoco, and above 500 where it joins the Rio Negro. There are in all probability many similar bifurcations connecting the waters of these great rivers. The upper course of the Orinoco is westerly, but in its middle course it trends north, and subsequently east; it must, however, be noted, that the Guaviare is probably the principal source of this river, and if so esteemed, the entire stream will have an easterly and northerly course: this river is said to be navigable for 200 miles, and its entire course must exceed 750 miles to its confluence with the Orinoco; it has its rise in the eastern slopes of the watershed of the Magdalena, and in close proximity to the sources of the Japura.

At the junction of the Guaviare, the Orinoco is a broad, deep, and rapid river, flowing over a rocky bed, and forming the cataracts of Maypures and Atures, connected by numerous islands, separated only by very narrow channels, but extending 8000 feet in breadth. Here Mount Uniana raises its isolated summit 3000 feet above the sea. From hence the rocky character of the country continues for above 170 miles to the confluence of the Apure; but the river is navigable from the confluence of the Meta, fifty miles below the falls. From the mouth of the Apure its course is eastward; the delta commences 150 miles from the sea, and above this point there is a remarkable whirlpool; below this the river does not exceed 100 yards in breadth, and flows with great rapidity, estimated at eight miles an hour. The delta is intersected by numerous branches; the southern and most considerable, known as the Boca de Navios, forms the island of Cangrejos, and is twenty miles in breadth where it unites with the sea; it has an extensive bar at the mouth. The other channels are known as Boca Chicas, *i.e.* Small Mouths, and are mostly navigable for vessels of light draught: ten of these are known, the most westerly being the Boca de Manamo Grande; the entire delta is covered with trees, of which the Mauritia palm is most numerous; the extent of the base of the delta may be 150 miles.

Of the affluents of the Orinoco, the Meta is the most considerable; this river rises in the Eastern Andes, near to the sources of the Guaviare, and is navigable to their base; its course exceeds 500 miles, and it joins the main stream fifty miles below the Cataracts; it has numerous affluents, for the most part navigable. The most northern of its tributaries, the Cassanare, falls from the Pass of Toxilla, leading to the Bogota. The other affluents of the Orinoco belong to its lower course. The upper course of what has been considered the secondary source, viz., that from the east, giving its name, as usual, to the main stream, has many affluents; and those from the west rise in close proximity to the affluents of the right in the lower course of the river, having northerly courses, of which the principal are the Caura and Caroni. On the left the Apure is the most considerable, having several sources which are surrounded by the mountains of Ocana; its course cannot be estimated at less than 500 miles; it is for the most part navigable; as are its tributaries, especially the San Domingo; in its lower course before joining the main stream it frequently anastomoses.

The upper course of the Orinoco is, as might be expected from its bifurcation in the Cassiquaire, through a nearly level alluvial plain, covered with dense forests, and subject to inundations: this indicates a considerable fall from the mountains in which it has its source, as does the rapidity of the current, which is considerable. The middle and lower valleys of the Orinoco may be divided into the llanos and wooded plains; the former extend over the upper course of the Meta, and terminate in that of the Guaviare; the latter part extend over the valley of the Guaviare, the lower course of the Meta, and from thence to the Arauca.

The llanos or treeless plains have a surface of grass on a sandstone base, but are fertile, and when cultivated, productive, like the prairies of North America; here also the river channels are marked by a growth of brushwood, and the plains are subject to inundation in the rainy season, though for a longer duration, lasting for a month or more. These are most extensive about the lower course of the Apure, where a temporary lake, more than fifty miles in length and breadth, is formed by them; the waters rise from twenty-five to thirty-six feet. The subsidence of the waters leaves luxuriant pasturage for cattle, which is again dried up by the heats of summer, when the plains are covered with fine dust. The most elevated portion of these llanos does not much exceed 300 feet above the sea, towards which they slope gradually: they are shut in towards the north by low spurs extending from the mountains of Venezuela, which stop the outfall of the waters; beyond these the wooded delta stretches to the sea.

The wooded plains of the Orinoco unite with those of the Maranon, and into them the wooded heights of the lower declivities of the Eastern Andes and mountains of Parime gradually subside. The mean elevation of these plains may be 750 feet, and they are covered with an impenetrable growth of magnificent trees, through which the only paths are those afforded by the rivers. The intense heat and constant moisture render them extremely unhealthy, but equally favourable to the development of vegetable life; the waters abound with amphibious animals.

3 *The Secondary Rivers of the North.*—A few small rivers fall into the sea from the northern slopes of the mountains of Venezuela, between the rivers Orinoco and Magdalena; there are also several which fall into the estuary of the Maranon; those examined by Shomburgk, on the south side of the estuary, the Guaini, Barima, and Amacura, were found considerable streams in their lower courses, and connected with each other by branches or bifurcations similar in character to the Cassiquaire; they are separated from the affluents of the Cuyuny by elevations not exceeding 500 feet, and are remarkable for the magnificent growth of the trees on their banks. The more important, however, of the secondary rivers of this part of South America are those of Guyana, of which the basin of Essequibo and its confluent streams may have an area equal to that of all the others.

The principal source of the Essequibo is probably that to the south, which may have its rise in the Sierra de Acaray, the southern limit of the mountain system of Parime, which, though 4000 feet in elevation, is covered with dense forests, interlocking with those of the Branca, the principal affluent of the Rio Negro, from which it is separated by the Sierra Canucu and spurs of the Sierra Pacaraima, from which and the Sierra de Rinocote to the north, it draws a considerable portion of its waters; its principal affluent, the Cuyuny, draining the valleys between the latter and Sierra Imataca on the east, as the Caroni does on the west. These are separated by a transverse range, having an elevation of about 2000 feet. The southern sources of this river are in close proximity to those of the Corentyn on the east, and probably the position of the Demerara and even the Berbice between these rivers, might lead to their being, especially the former, classed among tertiary rivers.

The valley of the Essequibo is crossed by several granitic ranges, which cause rapids and falls, some of which, as that named after King William the Fourth, in the upper course, are of considerable size and great beauty. Those of Ourpocari are also worthy of notice: and the Yucorit Fall, formed by the Sevasinkie Mountains, is marked by a pillar fifty feet in height, of three granite rocks balanced upon each other. The lower falls are distant from the sea only fifty miles, to which point the river is navigable for small vessels; and here the granitic ranges begin with slight elevations of 200 feet; the stream being only 100 yards wide, but in its middle course it is frequently 1500, and often studded with islands, some of which are of considerable size; its lower course extends in a broad estuary, full of islands, which at its junction with the sea is more than fifteen miles wide. The valley of this river is well wooded, and fertile. In its upper course it receives only one considerable affluent, Smyth's River. The most interesting portions of its basin are those occupied by the Rupunoony and Cuyuny, the principal affluents of its middle and lower course.

The former of these rivers is by some considered the principal source of the Essequibo, but as it has less volume of water it must be considered the secondary source, which conclusion is justified by its intimate connexion with the source of the Branca, tributary, as already noted, of the Rio Negro. The Walcooroo and the Tocoto, sources respectively of the Rupunoony and Branca, both unite in the waters of Lake Amucu, which in the rainy season covers the whole intermediate country, but which in the dry season, reduced to a small extent, forms the natural source of the Tocoto; like the Essequibo, the Rupunoony is broken by numerous falls and rapids, those in its upper course being over granite dykes. The valley of this river is less well wooded than that of the Essequibo, passing the Sierras of Saeraeru and Pacaraima, both remarkable for their barrenness, yet of no great elevation, not exceeding 2000 feet; while in its lower course the Sierra Conocon has its base covered with luxuriant forests; in the upper course of the river the savannahs are extensive, and remarkable for the richness of their herbage.

This river may have a course of 200 miles, and enters the Essequibo 240 miles from its mouth, and 200 from that of the Cuyuny, which has a course of 300 miles, and, as already noted, has its sources in close proximity with those of the Carouy and the small rivers falling into the estuary of the Orinoco.

The upper course of the Cuyuny is remarkable for the numerous anastomosing branches, which are formed in the rainy season through the rich alluvial soil of the valley. This may be 500 feet above the sea, and from it the surrounding mountains rise 2000 feet in elevation. From its upper valley the Cuyuny, now 500 yards in width, issues by the Fall of Kanaima, below which it is divided into numerous channels by well-wooded islands, and from this point rapids and falls succeed each other almost uninterruptedly for sixty miles; and this first series of rapids is succeeded by two others, which do not terminate till the confluence of the Cuyuny with the Magarony and Essequibo. The Magarony is indeed the principal source of the river known as the Cuyuny, and for the greater part of its course flows nearly parallel to the main stream on the west, as the Demerara does on the east, and at about the same distance.

The Demerara has a course of probably 250 miles in its middle course; at the Great Falls it approaches probably within six miles of the Essequibo: to this point it is navigable. It is a mile wide in its lower course, and where it unites with the sea, double that width; it has a bar at the mouth, with eighteen feet at high water spring tides.

The Berbice River is navigable to the Cataracts, 165 miles from its mouth, and to this point the tidal wave is perceptible: its upper course is like the other rivers, broken by many falls and rapids; its sources are not known.

The Corentyn is also broken by cataracts at about 150 miles from the sea, above this point it has two very considerable falls of thirty and forty feet respectively; its sources are, as already noted, in the Sierra de Acaray. In this river the tide rises thirty inches seventy miles from the sea, and thirty miles lower down it enters the plain which is continuous to its mouth; here it is one mile wide, and where it unites with the sea, ten miles, but it has only nine feet of water on the bar at its mouth.

The River of Surinam is only known in its lower course, which is navigable for barges; its estuary admits vessels of considerable size: but the Marony is a more important river, having its source probably in the Sierra de Acaray, and therefore not less than 500 miles in length: like the rivers already named, it is navigable for about fifty miles, admitting vessels of considerable size, and being at this point one mile and a half wide; its navigation for boats, interrupted indeed by falls, extends for 150 miles. The Surinam, Marony, and other rivers to the east, as well as the affluents of the Maranon, which correspond with them, appear to have their sources in the slopes of an elevated tableland formed by the eastern extension of the Parime system, which is stated to be remarkable for its fertility and the salubrity of its climate; in this differing so much from the valleys of the rivers, which in their middle and even in their upper courses are unhealthy from the density of the vegetation, and in their lower from the extensive deposits of mud which cover the whole coast line to the east of the Orinoco.

4 *The Lake of Maracaybo.*—This is a remarkable basin belonging to the system of secondary basins of the northern coast of South America: it is surrounded on all sides but the north by elevated ranges, but the lands forming its shore are low; on the west of its mouth is the isolated range of Sta. Martha already noticed, rising 18,000 feet above the sea: from the ranges which

form the cincture of its basin, Lake Maracaybo is said to receive the waters of above 100 streams, of which the most important is the Zulia, which is navigable for some considerable distance, and has a course of 170 miles. The lake itself is 120 miles in length, and eighty in breadth, with depth sufficient for the largest vessels; it is connected with the Gulf of Venezuela by a channel nearly twenty miles in length, and from five to ten miles in breadth: vessels of great burden cannot, however, enter the lake, in consequence of a shifting bar, having only fourteen feet of water on it, at the mouth of this channel. The water of the lake is fresh, excepting when strong northerly winds drive the salt water into the upper part of it. It abounds with fish, but not with turtle; its shores are only cultivated on the west, and are generally unhealthy: bitumen abounds on the north-east, where the surface of the ground is constantly inflamed; the waters of the lake are remarkable for their petrifying qualities.

CHAPTER XXXV.

THE RIVERS OF THE CENTRE.

§ 1. The Maranon.—2. The affluents of the north.—3. The affluents of the south.—4. The central table land.—5. The lower valley, and confluent streams.

THE Maranon.—The sources of this river are, in direct distance, from each other, seventeen degrees of latitude, i.e. above 1000 miles. The northern sources of the Napo being north of the Equator, and those of the Apurimac more than sixteen degrees to the south; the principal sources are in the Knot of Pasco and the Sierra de Vilcanota, nearly 500 miles apart; while the sources of the Yucayali, of which the Apurimac is the most important, are distant 750 miles in direct distance from the confluence of that river with the New Maranon, or Tunguragua, the other principal source; and this point, more than 1750 miles from that where the main stream joins the ocean: for this distance the Maranon is navigable for large vessels, and flows through a marshy level plain covered with one dense and continuous mass of forest, receiving the waters of numerous affluents: of these, some are rivers inferior in magnitude to few elsewhere, and of many the names are scarcely known. The great plain is towards the east, and about 400 miles in breadth, but measures in the centre to 800, and is not probably less towards the west; having an area which may be approximately estimated at 1,250,000 square miles. The principal sources of the Yucayali are in the Sierra de Vilcanota and the mountain Knot of Pasco; the southern source, the Apurimac, has probably an elevation of 14,000 feet above the sea, and collects the waters of a valley extending 250 miles in length from the northern watershed of Lake Titicaca to the Knot of Cusco, in which its principal tributary, the Pampas, has its rise. This portion of the upper valley of the Apurimac is noted for its beauty and fertility: the spurs from the mountains which extend across it are not elevated, are covered with verdure to their summits, and plentifully clothed with luxuriant forests, which descend into and fill the valleys, through which the rivers flow with great rapidity, forming numerous falls and cataracts. It unites with the northern source, the Janja or Montaro, after a course of 300 miles. The Janja has its rise in Lake Chinchaycocha, 14,000 feet above the sea, among mountains rich in deposits of silver, and descends for about 120 miles through a narrow gorge, into a valley, 8000 feet in elevation, remarkable for its fertility: its course is estimated as exceeding that of the Apurimac, and the united streams after their confluence are known as the Tambu, which, after a northerly course of 200 miles, is joined by its most important affluent, the Yucay or Vilcamayo, from the right. This river, formed of two confluent streams, the Qullebamba and the Pancastambo, which descend from the eastern slopes of the Sierra de Carabaya; each of these has a course, probably exceeding 200 miles, and their united waters flow 100 miles further to the north before they join the Tambu: the waters of the Vilcamayo flow through long narrow valleys, nearly parallel, diverging north-east from the axis of the main chain of the Andes; not much below the mouth of the river, a considerable affluent, the Uruni, rising from two sources in the Andes, joins the main stream. From the confluence of this river the Tambu flows north-west for 100 miles, where it receives a considerable accession to its waters from the left in the Pachitra or Pachite, which has its rise in the slopes of the Knot of Pasco; from this point the river assumes the name by which its entire course is commonly distinguished: and as the Yucayali, flows 500 miles before joining the Maranon. The Yucayali is navigable for large vessels for 100 miles; above this, its waters are rapid, but used for the purposes of transit by the native inhabitants.

Between the Yucayali and the Maranon, the Huallaga, rising in Lake Chiquiacoba, flows northward through the valley between the central and eastern Cordilleras. The course of this river is extremely rapid, and it receives no considerable affluent; sixty miles from its source its valley is only 6300 feet above the sea; below this the valley is narrow, and frequent falls break the course of the stream, which issues from the Cordilleras about 250 miles in direct distance from its source; the lower portion of this valley is about 2000 feet above the sea, well wooded, and very fertile. The lower course of the river is through the plain of the Maranon.

The New Maranon, or Tunguragua, issues from Lake Llauricocha, 14,000 feet above the sea, through a deep gorge, in which, like the Huallaga, it descends 8000 feet; below this the valley opens; yet for the first 300 miles of its course it is not navigable; below this the valley again narrows, and the river is precipitated over the rocks in the Cataract of Rentema, below which the river is only 1230 feet above the level of the sea: from hence the river has a tortuous course, but is increased in breadth to nearly a mile: it issues from the mountains by a narrow chasm, 150 feet in width and nearly seven miles in length, like the canons of the north, through which its waters rush with great rapidity into the plain below. The course of the river among the mountains is about 700 miles; its upper valleys are cold and sterile, though rich in mineral wealth, and the lower not remarkably fertile. At the Pango de Manseriche, the river is about 2500 feet wide, and to this point it is navigable for vessels drawing five feet of water; and flowing through a nearly level plain, its fall is regular and its current equal—the former not exceeding two feet in a mile, and the latter three and a half miles an hour. The course of the Maranon through this plain is divided into two parts by the narrows of Pauxis, or Strait of Obydos, situated 400 miles from the mouth of the river, and above the confluence of the Tapajos; where it is less than a mile in breadth; but above that point it exceeds three miles, and immediately below, four: to this point the tidal wave is felt, often rushing in with a bore dangerous even so far from the sea; below this the river rapidly increases in breadth, and at the mouth of the Xingu assumes a northerly course—its direction hitherto having been easterly; and lower still its width soon exceeds that of any other river in the world, being at the mouth 200 miles, or 50 more than that of the St. Lawrence. The mouth of the Maranon is occupied by numerous islands of considerable size; of these, that of Marajo, or Joannes, is the largest, being about 125 miles in length and breadth, the surface principally consisting of alluvial soil, rising gradually to the south; it has two navigable rivers, the Auajay and the Mapua, but the channel surrounding it is known successively as the Tagypura Rio das Bocas, and Rio de Para. The island next in size is that of Caviana, which is however only thirty-five miles long by twenty broad. The entire course of the river is studded by islands; those formed by anastomosing branches being of great extent. The principal mouth of the river is the Canal de Braganza di Norte: it is about fifty miles wide, and is intersected by the Equator just to the south of the island of Caviana; so great is the volume of water poured out by this river, that the water about this island is seldom even brackish, and the sea is freshened by it many miles from the mouth.

The upper portion of this river, to the mouth of the Yarani, is known as the Maranon, between which and that of the Rio Negro it is called Solimas, or Solimoes; and from thence to the sea, Amazonas, or the Amazons. It is probable that the first and most proper appellation belonged originally to the lower course of the river. The entire plain of the Maranon is covered with forests, through which the rivers afford the only passage; and during the inundation, which is at its height in the upper course in January, in the middle in February, and the lower in March, rising fifty feet above the ordinary level, a large portion of the country on both sides of the river, and extending far up the course of its tributaries, is laid under water. the navigation of this river is remarkably facilitated by the wind, which, excepting during the period of the inundation, blows up the stream, the depth of which forms one of its most remarkable features, being throughout its navigable course nearly twenty fathoms.

2 *The Affluents of the North.*—The Maranon has some considerable affluents before its confluence with the Yucayali; they are all from the north: of these the Santiago joins the main stream near the Pongo de Maseriche; but the most important is the Paztaza, which has its source in the Patali, to the north of the Peak of Zunguragua; this stream is continued in that of Banos, which, by its junction with the Canelos, issuing from Lake Bobonaza, on the north forms the River Paztaza. The Banos may have a course of 150, and the Canelos of 100 miles to their confluences, below which the united stream has a sinuous course, in direct distance thirty miles, to the Maranon. The Banos receives numerous affluent streams. The mouth of this river is more than 200 miles in direct distance from that of the Napo, the most considerable affluent from the left in the upper course of the Maranon. The principal sources of this river are in two large crevasses in the eastern slopes of the volcano of Cotopaxi, which uniting, flow through deep narrow ravines; above which the Cerro Blanco, named "Bella Vesta," runs in romantic beauty: this river has two principal affluents from the right, the Anzupy and Arajuno, which join it respectively 170 and 200 miles in direct distance from its source, beyond which it receives numerous affluent streams from the left, falling from the south-western slopes of the Cordillera de Guacuamayo and the Volcano Sumaco, which terminates with its snowy cone that range to the north-east, the principal of these is the Pajanino, which may have a course of 200 miles, and is also remarkable for its mineral wealth, and the auriferous sands in its bed; it unites with the Napo fifty miles in direct distance below the Arajuno. The Coca, having its principal source in a lake to the north-west of the volcano of Antisana, but formed by the junction of numerous affluent streams, flows eastward to its junction with the Cozanga, in direct distance 150 miles; its principal affluent is the Quijos from the right, which, like the Cozanga, has its rise in the eastern slopes of Antisana. The Cozanga flows northward with a rapid current, through ravines at the base of the Cordillera de Guacuamayo, and unites with the Coca at a point 150 miles north-west of the confluence of the Coca with the Napo; from whence, bending in a circular arc round the spurs of the Cordillera, its course is from north-east to south-west, almost parallel with that of the Pajanino, uniting with the Napo at more than a right angle to its course; from that point to the confluence with the Maranon, 150 miles in direct distance, the Napo is navigable, as is the Coca, to the cascades of St. Raphael, near the centre of its great bend; it here receives the waters of some affluent streams from the right, the principal of which, the Curaray, rises in the Cordilleras, between

the sources of the Arajuno and Banos, and has a course of more then 400 miles, joining the Napo near its confluence with the main stream. The affluents of the Coca and lower course of the Napo from the left are not important, with the exception of the Aquarico, or Ora, which has its sources to the north of those of the Coca, and unites with the Napo after a course of nearly double its length. The Napo forms the limit between the mountain streams which are affluent to the upper course of the Maranon, and the rivers of its middle and lower course; the larger portion of its valley is formed of extensive plains of great elevation, but below the Cordillera de Guacuamayo it assimilates to the wooded character of the great plain of the Maranon; here also the river bifurcates, and forms numerous islands like the Negro, and indeed the main stream. The middle valley of the Napo is the Cinnamon country of the early Spanish writers; and the Bobonaza is, from this circumstance, and the town similarly named on its banks, known as the Canelos; the other principal products of this valley are the pita or agave; sarsaparilla is also abundant.

Two considerable affluents unite with the Maranon between the Napo and Negro, the Putumayo or Ica, and the Japura or Coqueta; the former, like the Huallaga, flows through a contracted valley, and receives no affluents of importance, though it has several sources in the southern slopes of the Knot de los Papas, one of which rises in the small Lake Sebondoi; the latter, also rising from many sources in the eastern slopes of the same mountains, has two considerable affluents from the left; it is broken by cataracts about the middle of its course, before entering the plain of the Maranon, and is the last affluent from the left which has the character of a mountain stream: in its lower course it anastomoses with the Negro, and probably with the Japura, as well as the main stream; its sources are in close proximity, as well with those of the Orinoco and Magdalena as of the Japura. The character of the next affluent from the left is altogether different; while hitherto the sources have been many thousand feet in elevation, those of the Negro rising in the chain which buttresses up the tablelands of the Eastern Cordilleras on the south, cannot have an elevation exceeding 5000 feet, probably not that; the highest level attained towards its principal source, the Naupes, under the seventieth meridian, being but little more than 1000 feet above the sea; and its secondary source, as usual giving name to the river, the Negro, rising in the northern spurs of the same range at probably no greater elevation, and communicating, as already noted, by the Cassiquaire with the Orinoco. This river is the most important tributary to the north of the Maranon; the upper waters of its principal source, the Naupes, flow through comparatively level uplands, from which it descends by the Great Fall of Jurapaxi Caxoeira, and 100 miles below this a series of falls and rapids, some of ten or fifteen feet perpendicular height, and exceeding fifty in number, break its course for 180 miles. Fifty miles lower down another group of cataracts of great violence bring it to the level plain, from whence it flows 130 miles with uninterrupted navigation to the Negro; in this part of its course the Naupes is more than a mile wide; at its junction with the Cassiquaire, the Negro is not more than three-quarters of a mile wide; above that it has the name Guainia, as already noted, and does not exceed half a mile in breadth below the rapids, where the river flows in contracted channels with great rapidity among granite rocks, extend for twenty miles; this formation commencing about 64° 25′ west longitude, and extending to the sources of the river, the Sierra de Jacamie presenting isolated peaks of a few hundred feet in elevation, while those of Curicuriari and Caboburi may exceed 3000 feet above this point. The islands are rocky, of sandstone, with alluvial deposits, yet a ridge of granite appears again opposite the mouth of the Rio Branco. This is the principal affluent of the Negro, and from the left, rising in the Sierra de Pacairama from two principal sources, which collect the waters from the extremities of its base, meeting near the centre, is a considerable stream, and remarkable for waters forming so strong a contrast with those of the Negro in colour, as to have procured for it a contrary appellation: rising among rocky mountains its upper waters are pure and crystalline, but in its middle course they become charged with deposits which give to them a milky whiteness, and the other affluents flowing parallel to it are also white, though less strikingly so; while the sources of the Negro and its affluents of the south, flowing through granitic districts, heavily timbered, are of dark-brown or black; the Negro in its lower course assumes a jet black hue, but the upper course of the Naupes is white, as are the waters of the Japura.

Below the line of granitic formations, the Negro is more than four miles wide, and gradually increases until, for nearly 500 miles, it presents rather the appearance of an extensive lake studded with islands, than a river, being often twenty miles wide; its numerous channels unite in two principal, which form one broad stream about ten miles from its confluence with the Maranon, which it enters 800 miles from, and not much more than 150 feet in elevation above, the Atlantic; it has numerous affluents from both banks, though none very considerable but the Branco; its length may exceed 1000 miles.

The line of cataracts on these rivers indicates the limits of a plain extending to the lower slopes of the Cordilleras, having an average elevation of about 700 feet above the sea; it is covered with dense vegetation, but differs geologically from the lower plain, as already noted.

Below the Negro no considerable affluents flow into the Maranon from the left, though numerous comparatively small streams, falling from the southern and eastern slopes of the mountains of Guiana, fall into its lower course, and into its estuary. Of this portion of its valley little is known.

3 *The Affluents of the South.*—The character of these will appear from what has been already stated. Although in some respects dissimilar, the Madera on the south, will, like the Negro on the north, mark the change between the upper and lower affluents: those to the west of that river will be mountain streams, having great fall in their upper courses, while those to the east, though not affording the same extraordinary connexion which the Negro possesses by the Cassiquaire with the Orinoco, and having considerable altitude for their sources among the mountains of Brazil, yet bear no comparison with the torrent courses of the Huallaga or Purus; nevertheless, on the south there is, as on the north, a terraced table land, through which the upper courses of the rivers, especially the Madera, flow; the limits of which are marked by the falls and rapids which separate their upper from their lower navigation: in the Madera these are 450 miles from its confluence with the main stream, yet above them that river is navigable for small craft nearly to the sources of the secondary affluents, by which communication is obtained with those of the La Plata. It has already been noted that the smaller affluents of the south, Yarari, Jutay, Jurua, Tiffe, and Coary, between the Yucayali and Purus, have their sources in the slopes of this table land, which increases in elevation towards the west; the latter river having a rapid and tortuous course through a narrrow valley, and receiving no affluents of importance, but having its rise in the north-eastern slope of the principal watershed of the country in the Knot of Vilcanota. Next to the Purus, and parallel with its lower course, the Madera joins the Maranon, of which it is the most important affluent; it has its rise from many sources, which form two confluent streams, the Guapore and the Beni; the former has three principal sources,—the Marmore or Rio Grande, the Ubai or Magdalena, and the Guapore or Itenez; of these the central, the Rio Grande, is the most important, having its rise in the Sierras of Potosi and Cochabamba, and receiving numerous affluents, principally from the left: the Beni has its numerous sources in the eastern ravines of the Sierra Reale, while the Guapore has its sources in the table lands of Matto Grosso, and flows with a north-westerly course at the base of the Sierra Geral. In its middle and lower course the Madera receives many affluents; its entire length must exceed 2000 miles; the broken water extends for 150 miles from the confluence of its three sources; the descent of all the falls, thirteen in number

does not however exceed 160 feet, and the highest is only thirty; above them, the river is only 500 yards wide, but even within the limit of the district of rapids and cataracts it extends to 2000. Notwithstanding the obstacle presented by the rapids of this river, it is the natural means of communication between the valleys of the Maranon and of the La Plata, the Guapore flowing through the plain of Moxos, which is separated from that of Chiquitos only by very moderate elevations: the level character of this plain, and slight fall of the river, lay the country about the upper courses of the Guapore and Maranon under water two months before the lower courses of those rivers indicate a great accession to their waters: the plain of Moxos is, for the most part, bare of trees, excepting by the watercourses, but presents verdant pasturage. The next affluent of the left, the Tapajos, is an important stream; it is formed by the confluence of the Juruena and Dos Arinos rivers, the former rising in the eastern slopes of the Cordillera Geral, and the latter in the northern declivities of the Sierra Arapares; by the Dos Preto, an affluent of the latter, communication is opened with the valleys of the Guapore and La Plata. This river is broken by falls and cataracts in the middle course, being similar to those of the Madera: in its lower course it widens, and at its mouth is four miles broad; of the Xingu, the next affluent of the left, little is known, but it must exceed the Tapajos in length and volume of water.

4 *The Watersheds of the Centre.*—These are formed by the eastern spurs of the Central Andes, and by the mountains of Brazil. Of the former but little is known; but it is apparent that on the south the same characteristics will be found as on the north, though more highly developed. The limits of the great plain of the Maranon, as well as the position of the cataracts of the Madera, point to the existence of table lands ascending to the base of the Cordilleras; and these, as already noted, extend round the entire base of the Maranon and its tributaries, varying in elevation from 600 to 8000 feet above the sea, and in character from the densest forests to verdant upland pastures. The mountain system of Brazil is very extensive and varied in outline, forming the secondary watershed of the centre, and containing the sources of the great secondary rivers. As in North so in South America, the secondary ranges are not apparently connected with the primary; the sources of the Madera and Pilcomayo, affluents respectively of the Maranon and La Plata, flowing north and south, like those of the Mississippi and Red River, being separated by an inconsiderable elevation. To the east, the Cordillera Geral forms the limit of the valley of the Madera, having a north-westerly and south-easterly direction; presenting a lovely country, fertile, well wooded, and rich in precious stones. This is probably a transverse spur from the principal range, which has the line of its axis from west to east, and which throws off on both sides several similar, the most important of which is the Sierra Grande, dividing the basins of the Tocantins from that of the Araguay. These mountains culminate to the east, near the sources of the Rio St. Francisco, where the peaks of Itambe, da Piedade, Itacolumi, and Itabira, rise respectively 5960, 5830, 5750, and 5250 feet above the sea, the latter presenting a mass of the richest iron ore; indeed, these mountains not only abound in mineral wealth, but in vegetable productions, being the choice field for botanical researches, even in South America. From the culminating point the coast chain extends north-east and south-west, forming the eastern cincture of the basins of the St. Francisco and La Plata, being continued north to Cape St. Roque, and southward to the estuary of the La Plata.

The country enclosed by these ranges has a mean elevation not probably much exceeding 3000 feet; it for the most part consists of plains, interspersed with shrubs, below which the rivers flow through densely-wooded swamps.

5 *The Tocantins.*—This river can now scarcely be termed confluent with the Maranon, their united deposits having nearly obliterated the original connexion; it is large and important, having its rise in the sources of two confluent streams, the Araguay and the Tocantins, of which the

former may be the most important, the one being formed by the junction of the Maranao and Paranatinga, which have their sources in the Sierras Pyreneos and Tabatinga, the other rising from several sources in the Sierras Seida and Santa Martha, one of which, the Vermelho, affords communication with the valley of Para. Of these rivers, the Tocantins is the more rapid and broken, but the Araguay has nevertheless its falls and rapids; in its middle course it anastomoses, and forms the Island of Santa Anna or Banana, which is above a hundred miles long and about twenty broad; the eastern branch is known as the Furo; after this confluence, the united streams, broken by rapids and falls, flow through a narrow channel between rocks, for 150 miles. The estuary of this river is of considerable extent, and already noted as the Rio de Para, and as being in reality one mouth of the Maranon. The Tocantins has two mouths, separated by a long low island; these are called respectively the Bahias de Maritana, to the east, and Limoeiro to the west, and the river here has a width of about fifteen miles.

CHAPTER XXXVI.

THE RIVERS OF THE EAST.

§ Rio La Plata.—2. The rivers of the east.—3. Natural productions.

RIO La Plata.—The name Plata, given to the estuary of the confluent rivers Parana and Uruguay, is not so unsuitable as has been thought, its highest and probably most important sources being in the eastern slope of the Sierra of Potosi, the Altures des Lipes, and the spurs of the Cordillera Reale. The mineral wealth of the basin is, however, both in gold and silver; its most precious productions, diamonds; but its present greatest commercial wealth resulting from the vast herds of cattle which feed on the Pampas.

The watersheds of this basin have been already described; they indicate the character of the streams which flow from them; on the west there are those flowing from the lofty Cordillera of the Andes; in the centre that which is considered the main stream, and which is so, as a means of communication, separated only by a slight elevation from the affluents of the Maranon, as already noted; and on the east, those which, rising among the mountains of Brazil and the coast ranges, drain the upland plains or Pampas of Brazil.

Of the two streams which form the Rio la Plata, the Parana is the more important, not only from its size and number of affluents, but from those of the right having their sources in the primary watersheds of the country; these, however, belong to that branch of it which is known as the Paraguay, and it is the singular characteristic of this river, that it draws its waters from extensive sources on the east and west, which are respectively within 150 miles of the Atlantic and Pacific Oceans.

The Paraguay may be said to be formed of two principal streams, the Pilcomayo and Paraguay. The former has its rise in the eastern slopes of the Andes, as already noted, from numerous sources, which unite after flowing some 350 miles; below their confluence, the river has a tortuous course, without receiving any considerable affluent: it is rapid, shallow, and not navigable; in its lower course it divides, forming two mouths, by which it joins the main stream; these are about 100 miles in length; its total length may be nearly 1000 miles. The Vermejo is the only other affluent from the right worthy of notice; it has two principal sources in the Cordillera Des Poblado, which forms the eastern watershed of the upper valley of the Pilcomayo; these are known as the Tarija and Lavayen, and from their junction this river is navigable; it has a tortuous course, exceeding 500 miles in length.

These rivers, in their lower course, flow through Gran Chaco, the northern part of which, or the llanos of Manso, is dry, and destitute of wood, but affords good food for cattle; the southern part is saline and sterile, yet in both narrow strips of woodland are found along the banks of the rivers.

The Paraguay rises in the table land of Parecis, in close proximity to the sources of the Tapajos, and overlapped more than 300 miles by the upper waters of the Madera and Xingu: in its upper course it receives two considerable affluents from the left, the San Laurenço and Tacoary, both navigable for the greater part of their length; the importance of the latter, as affording communication with the Araguay, has already been noted: the former has an affluent, the Cuyaba, also navigable. The upper basin of the Paraguay is limited, under the twenty-first parallel of south latitude, by the rocky ridge of Otaquis on the west, an extension of the spurs of the Andes, and by the Sierra Calbano, which extends from the Sierra Scida on the east; here its channel becomes contracted, and the accumulation of the waters of its upper basin wanting sufficient outlet after the rainy season, are dammed up, and cover the level plain above, through which at other times they flow with a gentle current. These narrows are known as the Fecho dos Morros, and here the river flows with great rapidity through two channels, forming an extensive island; from this point it is navigable to the sea, and indeed, for boats, nearly to its extreme sources. The general course of this river is from north to south, with a slight westerly trending in its lower course; its length must considerably exceed 1500 miles.

The Parana has its sources in the reverse slopes of the watersheds of the Tocantins and San Francisco; its upper waters are collected from a table land bounded on the north by the Sierra Seida, on the east by the coast ranges and the Sierra Tiririca, and on the west by the extension of the Sierra Amambahy, which separates its valley from that of the Paraguay, which it resembles in the contracted character of the channels by which its waters leave their upper basin. The elevation of this basin varies from 1500 to 3000 feet above the sea; on the east, where it has the greatest elevation, its surface is broken and irregular; on the west it is more level, and varied only by isolated elevations; on the south it forms the plain of Guarapuaba: this extensive basin has forests at the base of the mountain, but the greater portion of its surface is destitute of trees and covered with coarse herbage.

The principal source of the Parana is the Rio Grande, which rises in the Sierra Mantiqueira, and after a course of 500 miles is joined by the Paranahyba, and from this point the united stream is known as the Parana: its course is broken by falls and rapids, as is that of its important affluent the Tiete or Anhemly, which nevertheless, in its westerly course of 400 miles, is much navigated: there are also several affluents from the right, of which the Pardo is the most important; under the twenty-fourth parallel this river is four miles wide, but gradually contracting, is reduced to 100 yards in width, and forms a fall of about sixty feet in height, named Salto de Sette Quedas, from the seven channels which are formed by the rocky islands which impede its course, and from this cataract rapids extend to the mouth of the Curitiba or Yguasu, its most important affluent from the east: this has a course of 300 miles, is rapid, and broken by numerous falls, one of which, the Salto de Victoria, ten miles from its mouth, is said to be 120 feet in height; below this the Parana is partially navigable to the Cataract of Apipe, 100 miles from the mouth of the Paraguay, and from this point it is navigable to the sea for vessels of 300 tons' burden.

In its lower course, the only affluent of the Parana is the Salado; this river rises in the southern spurs of the Cordilleras Des Poblado and Des los Valles; its name, Salt River, expresses the character of its waters and of the country from which they are derived. The upper course of this river is extremely rapid, and in it, its waters are fresh: its entire length may be 1000 miles, for two-thirds of which it is navigable. There is another river of the same name, which, rising in the Pampas to the south, has a course of about

400 miles to the sea, at the extremity of the southern shore of the estuary of La Plata: the country through which it flows is not saline, but the sources of the river are, and its waters are impregnated with salt throughout its entire length. The River Dulce may perhaps be considered as an affluent of the lower course of the Salado; it rises from two principal sources in the plain of Tucuman, and flows into a salt lake of considerable but varying dimensions, called Los Porongos, from whence smaller streams appear to be connected with anastomosing branches of the Parana. The entire course of this river may be 500 miles, and as its name implies, its waters are sweet; it offers few facilities for communication. The Tercero, a smaller river, is confluent with the Salado at its mouth; it is navigable for a considerable part of its course; this river is the northern boundary of the Pampas or plains of La Plata, which extend westward to the Andes of Chili, and southward to the Rio Negro or Cusu Lebu. The upper courses of this river and the Salado, drain an undulating fertile country, productive of corn, rice, maize, &c., well wooded, and of salubrious climate: to the east and south of this is the Salt Desert, many portions of which are not more than 200 feet above the sea: here many streams, generated in the western and higher portion of the country, lose themselves in the sand: the climate is intensely hot in summer, and the district altogether unproductive; it is bounded on the south by the Sierra de Cordova, which rising from a terrace 1000 feet above the sea, may culminate at 6000 feet: like similar mountainous districts in Asia Minor and elsewhere, as well as in other parts of America, these mountains present at the top extensive plains covered with grass; the valleys on the sides, and at the base of the range, are fertile and well wooded.

The Uruguay has a very considerable estuary, which gives it, in passing, the appearance of being a larger river than the Parana. This river rises in the Sierra Sta. Catharina; its principal affluents are the Ibicuy and Mirinai, both from the left, the latter of which drains Lake Ybera; but its most important affluent is the Negro, also from the left, which joins it in its lower course, and being partly navigable, affords communication with Lake Mirim to the east: its length may be 300 miles. The Uruguay does not afford much facility for internal communication; its stream is rapid, and broken by several rapids and falls: its entire course may exceed 800 miles. The llanos of Entre Rios, *i.e.*, between the Parana and Uruguay, are verdant level plains; similar are those on the eastern bank of the latter, but more undulating, and occasionally presenting a rocky surface. To the south of the estuary of La Plata the Pampas extend, as already noted, affording no very great diversity of feature, excepting in the western portion, which is saline, and presents numerous streams issuing in lakes connected with each other, but having no outlet to the sea; the surface is sandy, mixed with volcanic *débris*, but not altogether unfertile nor unsuitable to the production even of trees, where water is found; of these rivers and lakes the more northern are known as Guanacache, receiving the waters of the Mendoza and San Juan Rivers, which rise in the ravines of Aconcagua, and flow through the valleys formed by its projecting spurs. The Desaguadero connects these lakes with Lake Bevedero, which is again connected with numerous other small lakes, and receives the waters of the River Tunuyan; this river rises in the declivities of the peak of Supungato, and after flowing through a fertile valley in its upper course, passes by a ravine in the eastern chain of the Andes to the plain, from whence an anastomosing branch, recently formed, connects it with the Rio Diamante, which in its lower course is also termed Salado and Desaguadero; it terminates in Lake Urre or Urre Lauquen, *i.e.*, Bitter Lake, being more salt than those already mentioned: it is, like the former, connected with others immediately surrounding it. The Cerro Nevado and Cerro Payen limit this basin to the south, and from them rises the Colorado, which flows for more than 700 miles through the Pampas to the sea; it may be navigable for one quarter of its course; it is also known as the Cobu Leubu, as its neighbour to the south is known as the Cusu Leubu or Rio Negro. This river rises from two principal sources in the Andes: one flowing from the north, the other from the south. The latter, called Rio de Encarnacion or Limay Leubu, carries the surplus waters of Nahuelhuapi, an extensive lake, to the main stream; the former is known as the Catapuliche; these unite under the fortieth parallel, and retaining the name Limay Leubu, are joined by the Rio Neuquen, which has its sources far to the north, near those of the Colorado; from the confluence, the river assumes the name Cusu Leubu, and to this point, *i.e.*, the base of the eastern chain of the Andes, through the valleys, between which and the western or principal chain its head waters flow, while the Rio Neuquen, having its course at the foot of the eastern chain, is also considered to be navigable for some distance, though its current is rapid; its length may be nearly 1000 miles, and although two miles wide at the mouth, narrows to one-fifth of that breadth some sixteen miles inland; its lower course is through a fertile country, its upper valleys are well wooded.

To the south of the Negro the sterile plains of Patagonia extend, an undulating surface, varied only by irregular rocky ranges, on the east and south; these present nearly a level surface on the top, but deep ravines separate them, and volcanic products abound. The only portion of this country, of which anything is well ascertained, is the basin of the Santa Cruz River, which flows with rapid current through a sterile valley, but is notwithstanding said to be navigable for 400 miles to the foot of the Andes: one of its sources is said to be in a large lake, Capar or Viedma; other streams of considerable size also flow through the plain of Patagonia, but of these little is known.

2 *The Rivers of the East.*—These may be classed into three systems: those of the north, partially connected with the system of the Maranon, of which the Paranahyba is the principal; those of the centre, subsidiary to the San Francisco; and those of the south, which have their outlet in the Lake los Patos; of the former, the Gurupy, Turijapu, Maranham, and Itaquiera, flow into the sea to the west of the Paranahiba, the Croayhu, and other similar streams to the east; these all have their sources in the extreme spurs of the mountains of Brazil, and of these the Gurupy may have a course of 250 miles, the Turijapu somewhat more; the Maranham or Maranhao is confluent at the mouth with the Itaquiera or Itapicuru, which flows into the Mosquito Channel, separating the island of Maranham or Maranhao from the main; it is twenty miles long. The Itapicuru is navigable for 200 miles. The Paranahyba has a course of 600 miles through a level plain, and is navigable to the confluence of the Balsas, one of its two principal sources, about 400 miles from the sea; it has several considerable affluents from the left, draining the lower valleys of the spurs of the mountains to the south. The plain of this river is undulating and varied, with frequent elevations of several hundred feet, spreading out into verdant table lands; these with the greater portion of the plain produce plentiful pasture; trees are only found scattered here and there, though often of lofty growth: the southern, which is the highest portion of the plain, rises 700 feet above the sea, and has extensive swampy meadows; the lower portions near the sea are dry and sandy. The Paranahyba enters the sea by five principal mouths, enclosing a delta extending thirty miles along the coast; these are not navigable for vessels of great burden. The streams to the east of the Paranahyba are of little importance.

The San Francisco rises from several sources in the southern and most elevated mountains of the system of Brazil, and may have its principal source in the north-west slopes of the culminating peak of Itambe; this source is known as the Rio das Velhas, its secondary source to the west is estimated as rising 3000 feet, and their confluence under the seventeenth parallel is estimated as 1700 above the sea; to this point its current is very rapid, but a little lower down it becomes navigable, flowing through an elevated valley, and being 1000 feet above the sea 500 miles from the confluence of its sources; in this portion of its course it receives numerous affluents from the left; lower down, it is broken by rapids and falls, the most considerable of which, those of Alfonzo, are fifty feet in height; from the lowest of these the river is navigable 200 miles to the sea, which it enters by two mouths, of which the northern is two miles wide, but only deep enough to admit small vessels: the southern is narrower but deeper. The entire course of this river may be 1500 miles: its upper valleys are fertile, but salt plains are found on its left bank, and the country about its lower course is comparatively arid and barren, producing little but grass; the tidal wave is felt in it fifty miles from the sea.

Of the rivers to the south of the Francisco, the principal are the Belmonte, the Doce, and Parahyba: the former, more properly the Rio Jequitinhonha rises from two principal sources in the Sierra Freo, and may have a course of 500 miles, as may the Doce and the Parahyba; the latter has several considerable affluents, of which the Murinhe is the chief; its course is parallel to the coast between the ranges of the Sierras Espinhaco and Des Orgaos. Lake Patos is an inlet of the sea at the mouth of the Rio Grande de Sul, extending 140 miles in length and forty in breadth, it is connected with several other lakes by channels like itself, navigable for small craft; of these, Lake Mirim, to the south, is the most important, being 100 miles long by twenty broad, and receiving the waters of several rivers; this appears to have two divisions, the southern of which is known as Lake Mangueira, is narrow, and discharges its surplus waters into the sea by a small channel, the Tajim, while, by the Mirim, the lake of that name is connected with that of Los Patos: the River Jacuhy, which has a course of more than 300 miles, falls into Lake Los Patos, and the Yaguaron into Lake Mirim; both flow through fertile and beautiful valleys, and are navigable for the greater part of their courses. These lakes are separated from the sea by sand dunes, with occasional swamps and meadows; but to the west, in the interior, rich pastures extend through the valley, interspersed with copses and groves of fine timber trees. The temperate climate of this valley makes it productive in the grains and fruits of Europe.

3 *The Natural Productions.*—No division of the surface of the earth can be esteemed so rich in natural productions as South America, when considered with reference to quantity. Hitherto her mineral wealth has made her the treasury of the world for the precious metals; and even since in the production of gold California and Australia have proved more than rivals, in that of silver she stands alone; while her other minerals, until now obscured by those esteemed more precious, are beginning to find their true value, and the coal-fields of Chile and Patagonia will before long not only speed the returning steamer from Australia, the Eastern Islands, and China to Europe, but assist in opening up the interior by means of the ramifications of the great river systems by which the surface of the Continent is drained.

Although the geological formation of South America appears simple and regular, yet variety of substance is not wanting on its surface, and the wide extent of volcanic action gives a prominence to recent igneous formations not elsewhere to be found. The precious stones obtained in the central districts have already been noted. But the vegetable productions of South America are the most remarkable, not only on account of what we already know of them, but as affording with Africa and the Eastern Islands the most tempting fields for botanical researches; the vast silvas of the Maranon and Orinoco, the upper valleys of the Uruguay and Parana, the mountains of Brazil and Parime, and even the valleys and slopes of the Andes, have much that yet remains to be explored.

It has been remarked that the vegetation of South America is partial, that the local floras are distinct, that "particular families of plants prevail in different localities, and predominate so exclusively where they occur as to change the appearance of the forest," indeed, that "almost each tributary of the great rivers has a flora of its own;" but still the main divisions may be noted without difficulty by their general characteristics. The coasts of the north are covered with numerous species of deleterious euphorbiæ, especially the manchineel, with the mangrove and avicenna; here the poisonous strychnia and the creeping ourari abound; but here also medicinal plants, so plentiful to the south, are not altogether wanting, and "groves, whose rich trees weep odorous gums and balm," are characteristic of the upper waters of the rivers; here also are found forests of gigantic plantains; trees also of singular properties are found here; one laurel produces essential oil which will dissolve caoutchouc. The palo de vaca or cow-tree, described by Humboldt as confined to the Cordilleras of Venezuela, yields its milky juice, scarce inferior to that from which it is named, in great abundance; and the soap-tree, sapindus japonaria, justifies its name by its usefulness; and if less singular, the cassada, chocolate-palm, and cacao are not less valuable.

Like the plains of Asia Minor, the east of Europe and Asia, the llanos of the Orinoco and of Guiana are after the rains carpeted with brilliant flowers; and these must yield the palm to the varied colours which contrast with the white summits and dark sides of the Cordilleras of the Andes; while even the richness of the tints of the gentian, which peeps forth from their perennial snows, will scarcely compare with the hues which in so wonderful variety deck the gigantic forests of the Maranon. These have, however, been so fully described by Humboldt and others, that the beauty of the flowering forests of tropical America can be well appreciated: nor is their utility less remarkable than their beauty; the pita or agave alone would be well worthy mention, as affording every fibre necessary for those manufactures to which hemp is applied in Europe: but this is more particularly the district of medicinal trees, although the true bark, the cinchona, is confined to the Cordilleras of the Andes; here also the mora and numerous other trees best fitted for the builder's use, are in the greatest abundance. Contrasting with the richer vegetation of the valley of the Maranon, the less fertile districts of the mountains afford forests of stunted deciduous trees, while the grassy plains of the east present myrtles instead of the mimosas of the north: the cactus is abundant on all sandy soils, and its different species extend from Patagonia to the Lake of the Woods. Some of the larger afford wood for industrial uses, and on them the cochineal insect feeds.

The forests of the Parana and Uruguay are but little inferior to those of the Maranon, and have also their peculiar characteristics: here are found the algaroba, an acacia, producing flour from which a kind of bread is made and liquor distilled; and the jerba mati, the leaves of which have been constantly used as those of the tea plant.

The flora of the Andes differs, not only in latitude, but on the opposite sides; in the centre the western slopes are bare, but on the eastern the vegetation is of the most luxuriant character; arborescent plants do not however exceed 14,000 feet in elevation; the Alpine plants extend to above 16,000; grasses and mosses succeed, and at 21,878 feet of elevation the snow lichen alone is found.

The Andes of Chili and Patagonia are remarkable for their vast forests of araucaria, supplying food for the natives. These, when burnt, afford a remarkable phenomenon, being succeeded by a thick growth of dwarf oak; it has been remarked, that "the ancient and undisturbed forests of Pennsylvania have no undergrowth, and when burnt down they are succeeded by a thick growth of rhododendrons:" it might be added, that further north the burning a forest of spruce fir produces a copse of white birch bushes, so true is it that the vegetation which follows the burning of primeval forests is quite unaccountable.

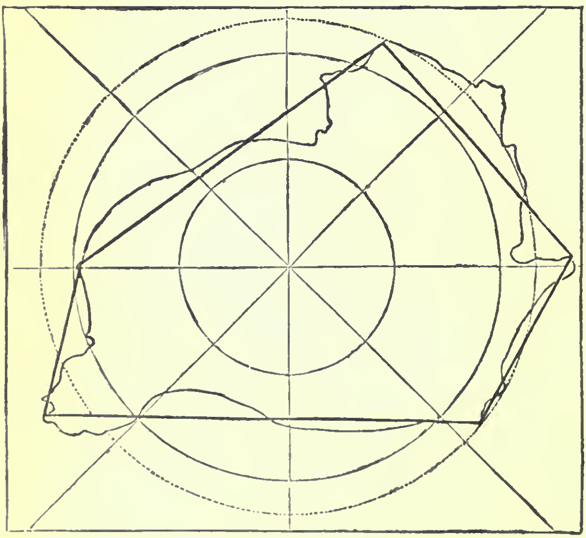
While the vegetation of the more elevated portions of the southern Andes is similar to that of the southern coast, all the vegetable productions being dry and stunted, the valleys present a flora comparable with, and closely allied to, those of southern Africa and Australia, which, extending upwards, mingles with the plants of the Alpine region. There, as in Europe, the southern flora is connected on the west, south, and east with that of America, Africa, and Asia, so the vegetation of South America presents close analogies with that of the southern extremity of the Eastern Continent, uniting the extremities of the Atlantic and Pacific Oceans.

CHAPTER XXXVII.

THE OCEAN, ITS COASTS AND ISLANDS.

§ 1. The Antarctic continent and its islands.—2. The islands of the Southern Pacific.—3. New Zealand.—4. The neighbouring islands.

THE *Antarctic Continent.*—This extensive but inaccessible and uninhabitable mass of land, occupies an area corresponding very nearly to that of the Arctic Sea; projecting towards South America and Tasmania beyond the Antarctic Circle, it is contracted on the other sides, forming an irregular hexagonal figure, 2880 miles in length and 2040 in breadth, and having an area probably exceeding 4,000,000 square miles, as indicated by the subjoined normal figure.



The positive positions of extreme points are thus indicated:—

Sir James Ross farthest . . .	78° 4′ S. Lat.,	161° 0′ E. Long.
Mount Erebus	77° 33′ „	166° 58′ „
Mount Sabine	71° 42′ „	169° 55′ „
Adélie Land, Geology Point . .	66° 35′ „	140° 10′ „
Mount William	64° 45′ „	63° 51′ W. Long.

Of this continent, Graham's Land, Louis Philippe Land, Joinville Land, Alexander the First Land, Adélie Land, Sabrina Land, and Victoria Land, named respectively by Briscoe, D'Urville, Bellinghausen, Balleney, and Sir James Ross, form portions. It may suffice to say, that the eternal snows which cover it are only varied by projecting black rocks and lofty volcanic cones; of these, Mount Sabine and Mount Terror may exceed 10,000, and Mount Erebus 12,000 feet in elevation above the sea—the latter was in action when first discovered. The coast appears to be formed for the most part of dark volcanic rocks, behind which the land rises 3000 feet, but on the coast of Adélie Land, perpendicular walls of ice were seen 200 feet in height. The outline of the coast appears to be irregular and deeply indented, affording resort for the black whale, seals, &c.

In close proximity to this, several islands and groups of islands have been discovered; of these the most important are the South Shetlands and South Orkneys, to the north of Graham Land and opposite to Terra del Fuego. These are mountainous, rocky, and barren, presenting indeed few, if any, traces of vegetation, the coast high, bold, and steep; they abound in amphibious animals and waterfowl.

At the other extremity, under the 160th meridian, are the Balleney islands. This group consists of five islands, of which Young Island is the principal, culminating, according to Balleney's estimate, at 12,000 feet above the sea. They are volcanic, presenting evidences of recent action. Between Balleney Islands and New Zealand, several scattered islands are found; between them and the South Shetlands and Orkneys, there are none south of the sixtieth parallel, while 10° further north there are only the uncertain group, named after the *Nimrod*, under the 168th meridian, and the outlying group of Sandwich Land and South Georgia. No portion of the ocean presents so unbroken a surface as this; it may be said to be without land for 170° between Cape Horn and New Zealand to the east, and if the Nimrod group be rejected, above 100° to the west.

2 *The Islands of the Pacific.*—The groups of islands alluded to, may therefore be considered as connecting links between the extremity of South America and the Antarctic Land; and, like Terra del Fuego and New Zealand, they are volcanic in their origin.

Emerald Island, like Nimrod Islands, must be considered as doubtful. Macquarie Island is about twenty miles long and twelve broad, it lies under the 159th meridian, and in 54½° south latitude; it is represented as the others are, as barren and inaccessible, and rising 1500 feet above the sea.

Campbell Island, under the 169th meridian, and in latitude 52½°, is about twenty miles in circumference, and presents some good harbours; the shores are in many places 800 feet high, but the extreme height of the land is not probably more than 1500 feet. Trees grow here in sheltered places, but are most frequently inclined towards the east by the prevailing winds.

The most important of these islands are, however, the Auckland Group, so named by Bristow in 1806. These present remarkable basaltic formations, and rise in rounded hills not exceeding 1500 feet in height, covered with grass; at the foot of which a forest of gnarled and stunted trees of fir and maple extends; it consists of one large and several smaller islands, the former may be thirty miles long by fifteen broad. There are several good harbours. Cattle thrive well, and the climate is mild, but subject to violent gales.

The distances between these islands and the main lands, are from Terra del Fuego to the South Shetlands 450 miles, from the Antarctic Land to Emerald Isle 540, and from the same point to South Cape, New Zealand, 1150 miles.

3 *New Zealand.*—As forming the natural limit between the Pacific and Indian Oceans, Australia and Van Dieman's Land must be considered apart from them, and, in the former, as New Zealand presents the most considerable surface, so it affords the greatest interest. This is a group of three islands. Of the straits which separate them, the northern is from twelve to seventy-five miles wide, and the southern from thirteen to twenty. The southern island is inconsiderable, the central the largest, and the northern remarkable for the extremely irregular outline of its coast; this outline is of an irregular boot-like shape; the long narrow promontorial extension of the northern island being to the north-west, with deep bays opening to the west and north-east. From the extreme north to the south point of the northern island, may be in length 450 miles, and from the east to the west 250, forming a curved cross; while the middle island, of more regular form, is 400 miles long by 150 in its greatest, and seventy-five in its least breadth. The southern is of triangular

shape, and in length and breadth about forty-five miles. A group of rocky islets extending over an area of about eight miles square, named by Tasman Three King Islands, lies off Cape Maria Van Diemen, in latitude 34° 27′ south, and longitude 172° 36′ east, which is the north-west point of a peninsula, connected with the land to the south by a narrow rock formed of sand-hills and swamps; to the east of which Mount Camel rises 500 feet above the sea. Here deep inlets formed for the most part by basaltic rocks commence, and form the characteristic feature of the eastern coast, interspersed with sand-hills and occasional mangrove swamps; of these inlets, the principal are Wangaroa Harbour, where the cliffs are lofty and the entrance only 450 feet broad, yet forming an extensive sheet of water within: the Bay of Islands containing numerous anchorages; and Wangaruru Harbour, below which Hauraki Gulf stretches more than fifty miles to the south, with an average breadth of ten miles, abounding with harbourages; of these, the most important is the harbour of Waitemata, receiving the river of the same name, and navigable for large ships for eight miles; while from the extremity of the boat navigation to the harbour of Manukao on the west side of the island, is only one mile and a half in one direction, and only a quarter of a mile in another. These inlets are surrounded by volcanic cones of small elevation, indeed not exceeding 300 feet. The southern extremity of Hauraki Gulf receives two considerable streams, the Thames and the Piako, which flow through fertile and well wooded valleys. Wai Hekeh Island lies off the entrance of Waitemata Harbour, Olea or Great Barrier Island, forming with others a considerable group at the northern extremity of the gulf. To the east the Bay of Plenty extends for above 100 miles, presenting a coast elevated by recent and continued volcanic action, covered by islands, one of which, White Island, though low, is in constant ignition, and valuable as producing sulphur; lignite is also found in many places in large quantities. The centre of the bay is marked by Mount Edgecumbe, rising from an extensive plain to the east, the coast is again high and rocky, terminating in East Cape in latitude 37° 42′ south, and longitude 178° 39′ east, a truncated cone 350 feet high, joined to the land by a narrow sandy neck.

The western coast to the mouth of the Hokianga river is comparatively regular, rising gradually towards the south, and beyond that point being high and rugged, unbroken for about the same distance to Kaipara harbour. The former of these is described as a magnificent estuary, receiving more than one navigable river having their rise in the hills from the opposite slopes, of which the water pours into Wangaroa harbour and the Bay of Islands. In the south the watershed extends from sea to sea, and on its southern slopes the Wairoa river is generated, which may have a course of seventy-five miles, and receiving several affluents, flows into a broad estuary forming the northern arm of Kaipara harbour, as the Kaipara does the southern. This is more properly an inlet fifteen miles long by two broad, and approaches closely to the harbour of Waitemata.

Manukao is another extensive inlet, differing in character from those to the west, but corresponding to those on the east coast, the country round it being low, of volcanic formation, and destitute of trees, while that to the north is lofty and well wooded; it extends fifteen miles in length and ten in breadth.

To the south of Manukao the coast bends to the west, forming an extensive bay, terminating in Cape Egmont, in latitude 39° 20′, marked by Mount Egmont, an extinct volcanic cone rising nearly 9000 feet above the sea from a level plain, and covered for more than 1500 feet from the summit with perpetual snow. This seems to be the most westerly of several volcanic summits of considerable elevation which stretch across the island, of which Ruapehu may be the central as well as the culminating point, and from which the Ruahine mountains extend to the south; and from this point the waters of the Waikato river flow to the north, and the Wanganui to the south.

The head waters of the former are collected in Lake Taupo, which may be twenty miles long by twelve broad: and about seventy-five miles to the north the river Waipa, rising in the northern slopes of the Rangototo range, is confluent, and the united streams fall into the sea about thirty miles to the south of Manukan harbour. This river may be navigable for vessels of fifty tons for nearly 100 miles. The coast here consists of sandstone cliffs, and farther south of sandy downs, broken by the harbour of Wangaroa, remarkable for its limestone cliffs and lofty well-wooded hills of Astea and Kawia, besides numerous small streams.

To the south of Point Egmont another wide bay forms the north side of Cook's Straits, into which the Patra, Wanganui, Wangaito, Rangitiki, Manawaku, and other streams flow: vessels of 200 tons may enter the Wanganui, which is, as is also the Manawaku, 900 feet wide at the mouth. These streams rise far in the interior. Kapiti or Entry Island, about twenty-five miles in circumference, lies off this coast; it is lofty and well wooded.

The southern extremity of the northern island is formed into deep inlets by the Tararua and Remulaka ranges; on the west, Port Nicholson, an extensive landlocked harbour, is formed by the bold projecting peninsula, terminating in Cape Sinclair, it receives the waters of the Hutt river; on the east Palliser Bay extends for twenty-five miles, its open roadstead receiving the waters of Ruamahanga river; this river flows through an extensive valley about ten miles wide, and forms at its southern extremity two lakes covering an area of 50,000 acres, these are only open to the sea when the accumulated waters break through the sandy barriers thrown up by the southerly winds.

The south-east coast of this island is unbroken from Cape Palliser, in latitude 41° 37′, to Cape Matana Maui, in latitude 39° 41′, the line of mountains parallel with the coast form the watershed of the country; farther north Hawke's Bay, about forty miles in breadth, surrounded by comparatively low lands, and receiving the waters of the Wairoa, a considerable stream; and from hence to Cape East the coast is irregular, rocky, and broken.

The middle island is far more regular in shape than the northern, and in proportion embracing a much more considerable area. The central watershed appears to be situated at about one-third of its length from the north, and from thence passing along the west coast leaves open an extensive plain on its longer slope to the east; on the north the mountains divide, trending north and north-east, and rising above the level of perpetual snow. These ranges are separated by the deep ravines through which the waters of the Kawatiri or Buller river, the Wairau or Providence river, and the Motueka river flow to the south-west, north-east, and north respectively, to the sea; the mountains culminate in Mount Arthur on the west and Mount Kaikora on the east, the latter exceeding 9000 feet in height.

The northern coast of this island is extremely indented and irregular in its outline; in the centre it opens from the mountains, projecting into the sea, and forming islands and promontories, separated by deep, narrow, and tortuous sounds or fiords; while Blind Bay stretches far to the west, and the smaller expanse of Cloudy Bay forms the eastern limit.

Blind Bay has in its western extremity a deep indentation called Coal or Massacre Bay, which is protected from the north by a long spit of sand stretching from Cape Farewell, the most northern point of the island, for fifteen miles to the east. This bay receives the waters of two rivers, the Hairiri or Aoere, and the Takaka, the valleys of which are fertile; coal is found in abundance and of good quality on the eastern side of the bay, which forms a good roadstead; and is about ten miles in breadth. The more southern and principal indentation ought perhaps to be known as Tasman Bay; it may extend thirty-five miles between Separation Point and D'Urville Island. On the west the coast is rocky, with deep ravines heavily timbered, through which torrents rush to the sea; here is the Adele Island and Astrolabe road of D'Urville; to the south is the Motueka river, which rises far to the south, near the sources of the Warrau and Matuki, in the table land known as

Ingestrie Plains; it may have a course of seventy-five miles. The Waimea, a small river, falls into the bottom of the bay, having an island of the same name opposite the pool formed by its waters, and at the base of the rocky eminences which form the eastern side of the bay, the still smaller Matai forms an extensive lagune; beyond which a bank of boulders, stretching for six miles parallel to the coast, at only a quarter of a mile distant, forms the Harbour of Nelson.

D'Urville Island, the Rangitoto of the natives, is about twenty miles in length by five in breadth; it is lofty, rocky, and covered with timber; on the north of this island is Port Hardy, an excellent harbour. To the east is Admiralty Bay, which extends for about seven miles from the east to west, and communicates by an opening about a mile in width with Pelorus Sound, an arm of the sea, extending among lofty cliffs and rocky islands covered with dense forests for nearly thirty miles into the land; it is from two to three miles in breadth, and the cliffs are from 2000 to 3000 feet in height. It has numerous bays and harbours, and receives the waters of the Pelorus and Kaituna rivers at its southern extremity; the former has its rise in the same table land as the Wairoa, and the latter affords communication with Queen Charlotte's Sound; to the east this is of the same character, but less narrow and intricate than Pelorus Sound, and on the west side has the Ship Cove of Cook, the Totarranue of the natives, a most excellent harbour. East Cove and West Cove, deep inlets, terminate the bay to the south. The rocky peninsula which separates these sounds is well wooded, extremely picturesque, culminating to the west of Ship Cove at 2000 feet above the sea. The east side of Queen Charlotte's Bay is formed by Arapawa, or Wellington Island, of irregular form and about fifteen miles long. Cloudy Bay extends to the south-east about twenty miles; on the north, Port Underwood approaches closely to Queen Charlotte's Sound; here the shore is rocky, and the centre of the bay is the mouth of the Wairau, which may have a course of 100 miles, and receives several affluent streams, but is only navigable in its lower course for small craft, and separated from the sea by a bar; the valley through which it flows is fertile, as is the Wakefield or Kaiparatehau on the south.

The coast to the south of Cloudy Bay is rocky and almost unbroken for eighty miles; here the river Hurunui, having its source in a fertile table land, falls into the sea; and below, the coast forms a deep bay, terminating to the south-east in Banks Peninsula. Pegasus Bay receives the waters of some small streams and of Courtenay river, the Waimakariri of the natives, which rising among the snowy mountains to the west may have a course exceeding seventy-five miles; it has several affluents, draining the Wilberforce Plains, is navigable for small craft in its lower course, but has a bar at its mouth.

Banks Peninsula is about thirty miles from west to east, and twenty from north to south; at its junction with the main land are Ports Victoria and Albert, formerly called Ports Cooper and Levy, both excellent harbours, but the latter is the less exposed; the former is also known as Port Lyttelton, from the town of that name recently established there. To the south is Akaroa harbour, of similar character, but having a narrow entrance. This peninsula, though rugged and mountainous, is in many parts fertile and covered with timber: to the south-west extends the ninety-mile beach; here a narrow bank of shingle, 17 miles long and about half a mile broad, forms Lake Ellesmere, the Waihora of the natives, an extensive lagune, having an area of above 70,000 acres, and receiving the waters of the Selwyn and other small streams; it communicates during half the year with the sea by a narrow opening: the country consists of extensive plains rising gradually towards the base of the mountains about thirty miles from the coast, drained by numerous rivers, the principal of which is the Cholmondeley or Rakaia, which rises in Mount Kaimatau, distant only about twenty-five miles from the western coast; in its upper course it forms Lake Coleridge, a considerable sheet of water, and enters the plain at the foot of the snowy range below Mount Hutt, from whence the mountains continue unbroken for about forty miles to Rowley Peak, from whence a lower range trends to the south and east, and sends out spurs towards the coast which are known as the Cheviot Hills; behind which is an extensive valley, with several lakes drained by the Waitangi River: this has a rapid stream, and reaches the sea "through a labyrinth of gravel banks and small islands;" its lower course is through an extensive plain; and among the hills to the north there is coal. To the south the hills form the coast, which is well wooded, and broken only by the channels of small streams as far as Port Otago, which is formed by a rocky peninsula terminating in Cape Saunders; it is of similar character to those on the north, and is divided into two portions by two islands, the outer harbour being about six and the inner seven miles in length. The isthmus connecting the peninsula with the main land is very low, and probably of recent formation. To the south the valley of the Taieri opens, and grassy downs extend to the Molyneux or Clutha River, also known as the Matou, having a deep but not rapid stream 400 yards in breadth, and accessible for small steamers; in its lower course it has numerous creeks connected with lagunes, and is navigable for large boats probably for more than fifty miles: its upper waters flow through several extensive lakes, of which the most northern, Haiwea, is in the centre of the island, and separated by a mountain range from the lakes of the upper valley of the Waitangi. The largest of these lakes, from which the Clutha flows, is Wanaka, which may be twenty-five miles long, and lies at the base of the main watershed, only twenty-five miles distant from the western coast, and in close proximity to the sources of the Awarua river; the valley of this river is very extensive, fertile, and ten miles north of the mouth, a seam of coal from twelve to twenty feet in thickness, forms part of the cliff. Several considerable rivers flow into the sea to the south of the middle island; of these Jacob's River and New River are important, as forming harbours. Bluff Harbour, on the south-east, is a landlocked basin about five miles in diameter. The south coast is low, but at the south-east indented by numerous irregular and extensive inlets forming excellent harbours; these are known as Port Preservation, Chalky Bay, Dusky Bay, and Breakfast Cove, the two latter being separated by Resolution Island, in which is Facile Bay, perhaps the most important harbour on this coast. The country here is, as might be supposed, mountainous and rugged; for here the southern spurs of the main watershed reach the sea.

Paterson Island is formed by a narrow channel connecting Breakfast Cove with Gaol Harbour to the west, and may be twenty-five miles long; beyond this the coast is rocky and unbroken except by the mouths of small streams and a few small harbours formed by projecting points, of which Milford Haven, False Bay, near the mouth of the Awarua, already noticed, Jackson's Bay, formed by Cascade Point, and Torata Bay, may be mentioned.

Bold Head, in latitude 43°, is formed by a spur from the main watershed; and beyond this the mountains recede from the coast, and the rivers become larger; the only important one is, however, Grey River, which, rising in the north near the southern sources of Buller River, receives from the south the confluent stream of the Kotuurakaoka, which flows from Lake Brunner, and other smaller lakes which occupy a depression between the mountains, affording access to the valley of the Courtenay. This river is only navigable for small craft near its mouth. Buller River, which flows into the sea about ten miles to the east of Cape Foulwind, is formed by two confluent streams flowing from the north-east and south-east, draining narrow valleys among the mountains, each having a course of about fifty miles; the northern draining Lakes Arthur and Howick, lying in narrow mountain valleys; from their confluence to the sea, about twenty miles, the river is only navigable for boats. To the north, the only feature of importance is Wanganui Harbour, which is excellent for small vessels, and presents, like Massacre Bay on the east, available seams of coal.

The Southern Island, called also Stewart's Island and New Leinster, is of triangular shape, its sides respectively forty miles in length; it is undulating, and covered with wood, and culminates in the centre towards the north in a lofty peak; it has one small river, the Patterson, falling into Port Somes, which, as well as Ports Adventure, Pegasus, Facile, and Mason, afford good harbourage for shipping. South Cape, the southern extremity of the island, is in latitude 47° 17′, longitude 167° 32′. The extreme east point of Banks' Peninsula is in latitude 43° 46′, longitude 173° 14′, and Cape Farewell in latitude 40° 31′, longitude 172° 47′.

The existence of active volcanoes in these islands has been already noticed; there are many also of recent but not present action, and much of the surface is of recent volcanic formation. Trap and basaltic rocks are found in abundance, and greenstone and porphyritic formations, one of the lakes in the upper basin of the Clutha being surrounded by rocks of the former; sandstones are prevalent in the plains. The mineral wealth of the islands is considerable; coal has been already mentioned as being found in large beds close to the surface, copper and manganese also abound, but the larger portion of the surface is as yet unexplored; and the forests, remarkable for the varieties and useful qualities of the woods they contain, still cover a large portion. Of the vegetable productions, the phormium tenax, a plant having the same qualities as flax, is, perhaps, the most remarkable. The most characteristic are the ferns, one of which is edible, and the pines, some of which are peculiar. The quadrupeds are all domestic, and introduced by the British settlers; the native birds are, however, numerous, and some remarkable remains of extinct species have been found; fish abound in all the waters.

4 *The neighbouring Islands.*—Three small groups are found in closer proximity to New Zealand than any other considerable mass of land, and claim therefore description with it. Of these the Chatham Islands are the most important. This group consists of two islands and several rocks and reefs. Warokauri or Chatham Island, the largest, is square in form, with a deep bight or bay, called Waitangi or Petre Bay, on the western side; on this side the shore is flat, stretching out in wooded tongues of land; on the northern, also, it is deeply indented; the eastern is rocky, and the southern "abrupt and precipitous." The surface of the island is undulating, but not high, the low hills near the shore being covered with wood, the interior chiefly with New Zealand flax and fern; the island is volcanic, and there are beds of coal or lignite which have been ignited, and remained in a state of combustion. In the interior are several lakes, some of which are connected with a river which enters the sea at Waitangi Bay; the largest is twenty-five miles long by six broad, it is rather a lagune than a lake, the water being brackish and influenced by the tide; there is also much marsh land. This island may be fifty miles in length by fifteen in extreme breadth; the area has been estimated at 477 square miles. Rangihaute or Pitt Island is fourteen miles distant from Chatham Island; it is only seven miles long by three broad, it is high, and covered with wood. These islands lie between 44° 20′ and 43° 30′ south latitude, and 176° 49′ and 177° 5′ west longitude. They are 300 miles east of New Zealand.

The Norfolk Island group is smaller, Norfolk Island being about five miles long by two and a half broad; it culminates in Mount Pitt, at the northwest angle, 1050, or, as some say, 2000 feet above the sea; the coast is often precipitous, and there is no good harbour, but the island has been described as a "terrestrial paradise;" its vegetable productions are similar to those of New Zealand, though it has some peculiar to itself. Philip Island, though only one mile and a quarter long, is scarcely less elevated than Norfolk Island; it is densely covered with timber. Nepean Island is smaller, and has suffered much from earthquakes; these lie under the twenty-ninth parallel, and the meridian of 167° 47′ east, and are about 800 miles east of Australia, and 375 north-west of New Zealand.

The Kermandec Islands are also small, the largest, Raoul or Sunday Island, not being more than seven miles long; it is of triangular shape, lofty, rugged, covered with wood, and of volcanic formation. Matthew Island is also volcanic, and has been in recent action. There are several other small islands in this group, they lie between 29° 12′ and 30° 36′ south latitude, and 179° 15′ and 176° 47′ west longitude, and are distant from New Zealand 400 miles to the north and east.

Bounty and Antipodes Islands, insignificant in size, rocky, and sterile, may be named as the only islands known to the south-east of Australia.

CHAPTER XXXVIII.

THE ISLANDS OF THE CENTRAL PACIFIC.

§ 1. The southern groups.—2. The western groups.—3. The outlying islands to the north.—4. The Sandwich Islands.

THE *Southern Groups.*—The principal islands of the South Pacific lie between the 10th and 23rd parallels, and extend from the 135th meridian west to the 165th of east longitude. On the west they are connected by the Solomon Islands with the Eastern Archipelago, while the Gilbert and Marshall Archipelagos connect the scattered islands to the north of the equator with the Carolines, from whence the Ladrone, Bonin, and other smaller islands stretch due north to Japan. Of the southern groups, the more important are ten in number, including the Marquesas or Mendana, which lie to the north of the 10th parallel. These islands form the extreme north-east limit of the southern groups. They were originally named from the Marquis of Mendoza, viceroy of Peru, but have also obtained the second name from Alvarez de Mendana, who discovered them in 1566: they form two groups, lying between 7° 50′ and 10° 31′ south latitude, and 138° 39′ and 140° 46′ west longitude. The north-west consists of six, and the south-east of four. These are all similar in character: culminating near the centre the mountains send off spurs towards the coast, forming beautiful valleys, which are usually luxuriantly wooded and remarkable for their fertility. The principal island of the northern group is O-hiva-oa or La Dominica, which is about twenty-two miles long and seven miles broad, and culminates towards the south 4000 feet above the sea. In the northern group, Uapoa or Roapoa is noted for its beauty; but Nuka-hiva is the largest; it is also the most important in the archipelago, affording good harbours, which are wanting elsewhere. Of these Comptroller Bay, and Ports Anna Maria and Tschitschagoff on the south side are the best, the latter being entirely land-locked. This island is seventeen miles long and ten broad, its shores are steep and rugged, but diversified by numerous and beautiful cascades.

To the south of the Marquesas, the low or dangerous archipelago stretches over sixteen degrees of longitude and ten of latitude. The native name, Paamuto, a cloud of islands, well expresses its character; it may, however, be divided into distinct groups, of which eighty or ninety have been enumerated. The principal are Anhar or Chain Island, and the Gambier Islands. They are all of coral formation, many of them lagune islands or atols, others of dead coral apparently elevated by volcanic action; most are covered with vegetation, but this is rather sparse than luxuriant. Ducie Island is the south-easternmost, it is a lagune island, and rises only twenty-six feet above the sea, and is not perceptible at seven miles distant. It is less than two miles long and about one wide.

Elizabeth and Oeno Islands connect Ducie Island with the Gambier group, which differs from the former in being of volcanic origin; it consists of five large and some smaller islands, encircled by a triangular coral reef. These culminate near the centre in Mount Duff, at the south extremity of Peard Island, the largest in the group; this is about six miles long. The lagune is accessible by more than one entrance, the depth of water within being about 150 feet, while without the sea has not been fathomed. Mount Duff is in latitude 23° 7′, longitude 134° 55′ west. The well known island of Pitcairn, to the south of Oeno, is also volcanic.

Although uninhabited, the Amphitrite or Actæon Islands may be named. They are three in number, extending about thirteen miles in length, in latitude 21° 23′, and longitude 136° 33′. Clermont Tonnerre Island is ten miles long and one and a half wide; it is a lagune island, producing cocoa-nut palms, and is inhabited. Scale Island is of similar character. Harpe or Bow Island, so named from its shape, is also a lagune island, and thirty miles long by five broad. There is an entrance to the lagune on the north side. The native name is Heyou or Eaoo. To enumerate others of similar character would be useless, but Anaa or Chain Island, in latitude 17° 23′, longitude 144° 36′, must not be omitted, on account of its political importance, its inhabitants having had rule over the other islands to the West of Bow Island; it is not large, but very populous. The neighbouring island, Raraka, is remarkable for its pearl fishery, as is Tairo or King's Island, twenty miles further to the north-east. The Palliser Islands consist of three groups of many islands, connected by reefs enclosing an area of considerable extent. Romanzov Island is remarkable as not having any lagune. Vliegen Island, so named from the swarms of flies which greeted the arrival of its discoverers, Schouten and Maire, and named also by Byron, Prince of Wales Island, is sixty miles in length; and an extensive labyrinth of islands and reefs is supposed to exist to the westward, its west point is in latitude 15°5′, longitude 147° 58′. Aurora or Metia Island is formed of coral upheaved, presenting a line of cliff 250 feet high, worn into caverns at the base, it has consequently a more varied vegetation than the other islands.

The Society Islands, discovered by Quiros in 1606, and made familiar to all, by Cook's account of his residence there for observation of the transit of Venus in 1769, are eleven in number, the name being now extended to the islands south of Tahiti, which was at first confined to those to the north-west, not indeed including what is now the principal island. This, called by Cook Otaheite, since more usually written Tahiti, is about thirty-two miles long, and formed of two elevated peninsulas, united by a low isthmus only three miles in breadth, the one Tahiti nui, the other Tahiti iti, the greater and the less; these are also named Opoureonu, after the great navigator, and Tiarrabu. The northern peninsula culminates in Orohena more than 8000 feet above the sea; from this and other peaks spurs are thrown off to the coast, forming transverse valleys, now so famed for their beauty and fertility. The island is surrounded by a coral reef at a distance of two or three miles, which affords many excellent harbours, of these Matavaî Bay, and Papawa, and Toanoa harbours may be mentioned; but Papiete is the largest and most frequented, this lies at the foot of Orohena, these are in the northern peninsula; the southern is, though mountainous and rocky, even more fertile than the northern, but the most fertile portion is the isthmus. The southern side has several harbourages, but no good harbours. The northern point of this island, where Cook established his observatory, was named Point Venus, and may be estimated to be in latitude 17° 37′, and longitude 149° 30′.

The easternmost island of the Archipelago, Maitea or Osnaburgh Island, is only seven miles long, but rises 1500 feet out of the sea, it is in latitude 17° 53′, longitude 148° 5′. Teturoa is a group of coral islets about forty miles north of Tahiti, extending six miles in length. Eimeo is only ten miles from Tahiti, and remarkable for the wild beauty of its scenery, it is volcanic, and, like Tahiti, surrounded by a reef. There are four harbours in this island, the best of which, and one of the best in the South Pacific, is that of Talu on the north side, between two and three miles in length, and surrounded by precipitous rocks, often rising 2000 feet from the water. The mountains on this island exceed 4000 feet in height. Huahine or Vahine, though much smaller, being little more than eight miles long, is, like Tahiti, formed by two peninsulas, but here the isthmus is overflowed at high water. It has one harbour, named Owharre, in latitude 16° 43′, longitude 151° 7′. Twenty-one miles to the westward is Raiatea or Uliatea, 130 miles north-west of Tahiti; this, like the others, is mountainous and covered with vegetation, but having more abundant supplies of water; it is also surrounded by its reef, and has several harbourages, and two good harbours, one on the east and the other on the north-west side. Tahaa or Otaha is only two miles distant from Raiatea, and encircled by the same reef; it is about one half the size, and is surrounded by numerous islands forming good harbours. Bola-bola is rather more than twelve miles north-west of Tahaa, it is more rugged than the other islands, and the reef which encircles it more irregular in form; it has one good harbour on the west side, which is the most fertile. Tuboi or Motu iti is the most northern group of these islands, and consists of low islets. The northern point is in latitude 16° 11′, longitude 151° 48′. The most western island is Marua or Maupiti, remarkable for its rugged cliffs of basalt; it is, however, fertile, rising in the centre in well wooded hills, and lies forty miles to the north-west of Raiatea, and is in latitude 16° 26′, longitude 152° 12′.

The Austral are to the south of the Society Islands, and may be considered a continuation of the chain of Cook's Islands. The volcanic island of Oparo lies off to the south in latitude 27° 37′, longitude 144° 15′, and is the extremity of a volcanic chain, trending north-west through Cook's Islands and Navigators' Islands; as Pitcairn's Island, is of a similar but not so extensive range, passing through the low archipelago to the Society Islands. Indeed, Easter Island, Sala y Gomez, and even Masafuero and Juan Fernandez, may be considered as connecting the lines of volcanic action in the Pacific with the volcanoes of Chile. Oparo, or Rapa, is only about six miles long, it is mountainous and rugged, and to the south of it other islands have been reported, viz., Bass's Islands, in latitude 28°, and Dougherty Island in latitude 59° 20′, 120° 20′ longitude, which is further separated from other land than any spot on the surface of the globe. Easter Island, known to the natives as Teapy or Waihu, and remarkable for the remains of an extinct race of inhabitants, is of triangular shape, with sides from nine to thirteen miles in length; it is high, and contains the crater of extinct volcanoes, it is fertile, but has no good harbour; it lies in latitude 27° 28′, longitude 109° 24′. Sala y Gomez lies to the east of Easter Island, under the 105th meridian; it is a rugged and barren rock frequented only by sea fowl.

The Austral or Toubouai Islands are low and comparatively barren; the only one of interest is Vavitao, the largest and also the highest in the group; it has a good harbour on the north-west side; it lies to the south-east of the others, under the tropic of Capricorn, in longitude 147° 11′ east.

Manjaia, the southernmost of Cook's Islands, is about 350 miles distant from Rimitara, the most northern of the Austral Islands, it is of volcanic origin, has no encircling reef, nor any harbourage; is high, but fertile, and is about thirty miles in circumference; it is in latitude 21° 57′, longitude 158° 7′. Rarotonga, an island of about the same size, but more lofty and picturesque, is surrounded by a reef, but has no harbour, and forms with Waiteo and Manjaia, a triangle, the sides of which may be roughly estimated at 100 miles in length. Waiteo is a mere bank of coral, as are Parry's Island and the Hervey Islands to the north-west.

2 *The Western Groups.*—The Samoan or Navigator's Islands are eight in number, the south-easternmost of which is Rose Island, a small low coral reef, in latitude 14° 32′, longitude 168° 9′. Manua, the Oponu of La Perouse, rises in domelike form, covered with vegetation, to an elevation of 2500 feet; it is well watered, but has no harbour, and may be sixteen miles in circumference. Orosenga and Ofu are small rocky islands; but Lutuila is seventeen miles long and five broad, culminating in the peak of Matafoa, 2300 feet above the sea; it is traversed by ridges of basaltic rock often 300 feet high, above which the luxuriant vegetation reaches to the top of the mountains; it

is remarkable for the excellent harbour of Pago-pago, a circular basin with narrow entrance, surrounded by precipitous rocks. Opolu is the centre island of this group, and thirty-six miles from Lutuila; it is also volcanic, fertile, beautiful, but has only one small harbour. Manono is a small wooded island, only one mile from which is the volcanic basin of Apolima, forming a natural fortress and harbour for boats, Apolima is seven miles from Savai, the most western and largest of the group, being about forty miles in length and twenty in breadth; it is also the most fertile and beautiful, but has only one tolerably safe harbourage, the Bay of Mataatu, off the north point of the island; it culminates near the centre, 4000 feet above the sea.

To the north-west of Navigators' Islands lie numerous small islands and groups stretching to the Gilbert Islands, which lie under the equator.

The Fidjee Fedjee, or more properly Viti Archipelago, is perhaps the most important in the South Pacific, on account of its size and position, as well as from the possession of numerous large and excellent harbours; it was discovered by Tasman in 1643, and has been recently surveyed with care by the Expeditions under Captains Wilkes and Denham. This Archipelago is situated between the fifteenth and twentieth parallels of south latitude and the meridians of 177° east and 178° west, extending about 300 miles in each direction, and consists of 154 islands, sixty-five of which are inhabited, besides numerous reefs and shoals. The island of Viti-levu, or Great Viti, gives name to the group, which is of volcanie formation, fertile, and generally well wooded.

The most important islands are Kambara, which, though only about three miles long, is to be noted for the goodness of its timber, of which the canoes of the natives are made; Vanua-levu, or Sir Charles Middleton's Island, which is about fourteen miles in length and two in breadth, but irregular in form and presenting several harbours; it is the largest of a subordinate group which has been named Wilson's, from its discoverer, and which is surrounded by a reef of triangular shape extending twenty-four miles on each side. Susui, another of the same group, has a beautiful harbour on the north-west side. Batu-bara is also remarkable for its table rock, which, rising from the centre, forms a well-known landmark; Tabe Ouni, or Vuna, for its excellent harbour of Tabou; Vanua Levu, is the second in size of the whole, and has been also known as Sandalwood Island, but that name is no longer applicable; its magnitude is implied in its name "Greatland;" it is ninety-six miles long and twenty-five broad; it has several excellent harbours; Savu Savu is an extensive bay, protected by a reef on the southern side; here are springs having a temperature of 200°, Sandalwood Bay, on the south-west, is, however, esteemed the best, as it is the largest; it is in shape a segment of a circle; six miles across there are others of less importance. This island is fertile and beautiful, rising in many parts 2000 feet above the sea, which appears to be about the average elevation of these islands. Viti-levu is the largest, being eighty miles in length by fifty-five in breadth; it was formerly known as Ambou, a name more properly belonging to a small island at the eastern extremity of Viti-levu. This island is remarkable among those of the Central Pacific for its rivers, the mouths of which are among low marshy land covered with mangrove bushes; the interior, however, rises in mountain peaks 5000 feet above the sea, and thus this island approximates in character to those of the Indian Archipelago; its principal harbour is that of Savu on the south, where also is the good anchorage of Rewa roads. To the west of Viti-levu are numerous groups of mountainous islands surrounded by coral reefs and affording numerous anchorages, among which the harbour of Levuka in the island of Oralau has been preferred to any in this archipelago; this island is seven miles long, and more lofty and picturesque than those around it; it is almost united to that of Matoriki, in which is the extensive Bay of Ambou. Kandabou, the south-westernmost of this archipelago, is remarkable for the truncated conical peak, which rises 2000 feet above the sea at its western extremity, and for its excellent pine timber. The most western of these islands are the Asaua group, famous for their turtle: they are less fertile than the others, and afford no anchorages of importance.

The Friendly or Tonga Islands lie to the south east of the Viti Islands: the discovery of these islands we owe to Tasman, but our knowledge of them to Cook and his successors. They are more than 100 in number, and lie between 18° and 22° south latitude, and 174° and 176° west longitude; the majority are mere banks of coral and sand, some of which have trees on them, and a few rise to some considerable elevation; seven are from five to seven miles in length, but three only are of any size, viz., Tongatabu, Vavao. and Eoa, which are from 15 to 20 miles in length. Pylstaart, the southernmost, lies detached from the others, is 700 feet high, and covered with timber. Tongatabu, best known as a station for the astronomical observations of many voyagers, is the principal southern island; it is very flat, not rising more than sixty feet above the sea; is surrounded by reefs, and remarkable for its fertility and productiveness in roots and fruits; it has one good roadstead on the north, formed by two islands, and called Paughai-motu; it has a lagune in the centre five miles long and three broad. To the north, in the Namuka or Annamooka group, is the active volcano of Tofoua, rising 2800 feet; to the north-east of which is the conical rock Kao, which rears its head 5000 feet above the sea. Eoa is rocky and comparatively barren. Vavao or Vavau is the principal northern island, it is of small elevation, surrounded by reefs and islets, some of which form Ports Refuge and Valdez, near the west point of the island, the scenery of these is described as beautiful, and much of the island as fertile.

The New Hebrides are what remains of the Australia del Spiritu Sancto of Quiros; they form an extensive and important archipelago lying between 20° and 15° south latitude and under the 170th meridian east longitude. Annatom, the southernmost, is about ten miles long by six broad, lofty but not fertile, and has a small harbour on the south-west side. Tanna, the largest to the south, is low, but well wooded and fertile; it has a good harbour, Port Resolution, to the south-east, marked by an active volcano on its west side. Erromanga is high and rocky, but not fertile, producing little but palms and sandalwood; it has no harbour, but Sandwich Island has several, the principal of which is on the west side, which is spacious, easy of access, and well sheltered; the island is fertile and produces fine timber, and may be considered the finest in the archipelago; it is about thirty miles in length. To the northward is Amboyna Island, twenty-one miles in length, lofty, and having active volcanoes, but covered with verdure. Mallicolo is forty-five miles long, remarkable for its fertility and picturesque beauty; it has a harbour at the south-east end three miles long by one broad, easy of access, completely land-locked, and having good anchorage. Leper's Island is also large and fertile; but the largest of the whole group is Espiritu Sancto, which is above sixty miles in length and encircled by numerous islands and reefs; it is mountainous, and the valleys extremely fertile, possesses several good harbours, and is rich in turtle and pearl oyster: it is also remarkable, like Easter Island, for its antiquities.

Banks' Islands lie to the north of the New Hebrides; of these four are of considerable size, the largest may be twenty miles in length: they are lofty and covered with wood, and lie between 13° 16′ and 14° 10′ south latitude, and 167° and 168° 30′ east longitude. Farther north still is the Santa Cruz group, of which the southernmost, Vanikoro, or Vanikolo, is noted as the scene of the loss of the ships of La Perouse; this is also known as Recherché Island, and is about ten miles long; it culminates in Mount Kapogo, 3000 feet above the sea, is fertile, and covered with wood; it has harbourages to the north in Tevai Bay; close to which is the island of the same name, and two smaller ones at no great distance. Santa Cruz island to the north is, however, the largest, being twenty miles long, but it is uncertain whether it has any good harbour; it is also known as Uitendi. Tinakoro is a volcanic cone more than 2000 feet in height, and has been in recent action. These islands are remarkable for their humidity both of soil and climate. Duff's group, or Mendana Islands, lie still farther north, in latitude 9° 27′, longitude 167°, it consists of eleven islands, the largest of which is not more than three miles long.

New Caledonia connects the islands of the Central Pacific with Australia, as the Solomon Islands do with the Indian Archipelago. This island is remarkable for its triple ranges of mountains, rising more than 3000 feet above the sea, and its extensive reefs, which extend 200 miles beyond its extreme points; it is 200 miles long and about forty miles broad; for the most part barren, but fertile and well wooded in the valleys; in productions it resembles Van Dieman's Land. In the Island of Pines, at the southern extremity of New Caledonia, Victoria Harbour affords security for shipping, as do several bays in Woodin Channel, within the reefs to the south of the island; between it and the Island of Pines the principal is Port St. Vincent, which is accessible to the largest vessels. The coasts of this island to the north-east and south-west are supposed to afford few advantages for shipping, and are very dangerous on account of the reefs and islands which cover them; but on the north-west a good harbour is said to be found near Cape Queen Charlotte.

The Loyalty group, consisting of five principal and several smaller islands, lie to the east of New Caledonia, between latitude 20° and 21°; they are of coral formation, well wooded and fertile. The main island is twenty miles long by ten broad, rising 250 feet above the sea, but level, and presenting no harbours. Britannia Island is a lagune island, thirty miles long. The lagune is very deep, and accessible to large vessels. This island, known also as Uea or Nungavi, resembles the preceding in character and productions, as does the Island of Lifu or Chabrol, thirty-seven miles long, which lies to the north. The most northern is Halgan or Onea, also known as Hive Island, which forms part of a group enclosing a basin fifteen miles in diameter.

3. *The Outlying Islands to the North.*—Numerous small islands lie to the south of the equator, between the Marquesas Islands and the New Hebrides, none of which are sufficiently important to require description. They are mostly lagune islands, and none exceed ten miles in length; they form two chains stretching from the Society Islands on the east and Navigators' Islands on the west, crossing the equator in longitude 155° east and 175° west, the eastern chain trending north-west, stretches as far as latitude 5° 50′ north, where Palmyra Island, a lagune island fourteen miles long, is found in longitude 162° 23′ west. Washington and Fanning's Islands lie to the south-east, and Walker's Island to the east of these, in latitude 3° 31′, longitude 149° 15′, more than 500 miles distant.

The western range is more important, connecting the Navigators' and Fidjee Islands with Gilbert's Archipelago; the islands of which it consists are all small, of coral formation, and mostly containing lagunes. The only known harbours are in Ellice's group, in latitude 8° 30′ south, longitude 179° 13′ east, and at Peyster's group, in latitude 7° 56′, longitude 178° 27′ east. Paanopa, or Ocean Island, differs from the others, being high in the centre.

The Gilbert Archipelago is an extensive range, which may be divided into three separate groups: these have been named Kingsmill, Simpson, and Scarborough, but by some the first of these names is applied to the whole range.

The Kingsmill group lies to the south-east: Arurai, or Hurd's Island, is the most southern, being in latitude 2° 50′ south, longitude 177° 19′ east; the largest of the group is Drummond Island, which may be above twenty-five miles in length, there is harbourage, and all the islands are fertile. The Simpson group lies under the equator, it consists of three principal islands, Nanouki or Henderville's, Kuria or Woodle's, and Apamama or Hopper's Island, the latter about ten miles long, the two former each about five. Apamama lagune forms an excellent harbour. The Scarborough group consists of Taraua or Knox's Island, Marana or Hall's Island, Apia or

Charlotte's, and some smaller islands and reefs; the former is twenty miles in length, it appears to form an extensive bay, the reef to the west being under water. The most northern island is Makin, which is in latitude 3° 20′ north, longitude 172° 57′ east.

The Marshall Archipelago is distant from the above-mentioned islands about 150 miles. This is formed by two distinct ranges, the Radack on the east, and the Ralick on the west; the former extends from latitude 6° north, longitude 172° west, to latitude 11° 48′ north, longitude 170° west; the Ralick, from latitude 4° 39′ north, 168° 50′ west, to latitude 11° north, longitude 167° 25′. The eastern chain consists of several distinct groups, these are named the Melville, on the south, extending for forty miles, the Arrowsmith or Medero for eighteen, Daniel and Pedder Island, Au, Ibbetson or Traversey Islands thirteen miles long, Raven or Calvert Islands thirty, Ezerup twenty-four, Otdia or Romanzov twenty-eight, Legiep nineteen, Ailu fifteen, Tagai twenty-five, besides some detached islands; Bigar or Dawson Island being the most northern. The groups are all Atol Islands disposed in oval rings, mostly affording harbourage, but often inaccessible from the surf. The western chain is of the same character, but not so well known. Bigini or Pescadore Islands are the most northern; the Radolaka or Rimski Korsakof, the largest, being above fifty miles in extent, and the Namou Odea or Muskillo group about thirty, the Helut twenty, and the Kyli or Bonham Islands thirty, as are the Boston or Covel, the most southern of the group. These islands are often fertile, but their most remarkable characteristic is the small surface exposed in proportion to the area over which they extend: like the Gilbert range, they are probably fast wearing away; both abound in turtle and fish.

The Caroline Archipelago is of the same character, and is said to consist of forty-eight groups, containing from 400 to 500 islands; it has been calculated that their average area is only one German square mile, and their entire length twenty-five German miles; they extend from ten degrees north of the equator. Our knowledge of them is due to Duperrey and Lutké, although probably first discovered by Diego de Roche in 1525. The name by which the Archipelago is known was given to a large island by Franceso Lanzano in 1686. The most eastern of these islands is Ualan, or Strong's Island; this, unlike most of the others, is of volcanic formation, and indeed may perhaps properly be considered as detached from the rest; it is in latitude 5° 21′, longitude 163° 6′ east; like so many in the Pacific, it is surrounded with a coral reef, within which on the east and west sides are two good ports, and on the south a small one; it is very fertile and covered with thick forest, and abounds with rivulets fringed with mangroves; the climate, though humid, is healthy; it rises in numerous peaks, of which Mounts Buache and Crozer rise 2000 feet above the sea. A low isthmus, only two miles and a half broad, separates the eastern and western ports. The McAskill islands form a group of about seven miles in diameter, and Duperrey's group are of about the same extent. The lagunes of both are accessible to large vessels. The Seniavine Islands consist of three separate groups, and lie between latitudes 6° 43′ and 7° 6′ north, and longitudes 158° and 158° 30′ east. Among these the largest, most remarkable, and, as has been remarked, the latest discovered of all the Carolines, is named by the natives Painipete, the Pouloupa and Fanope of Duperrey and Kotzebue; it may be nearly twenty miles long, is estimated as fifty miles in circumference, culminating in Monte Santo, 2858 feet above the sea, and remarkable for the basaltic cliff, 1000 feet in perpendicular elevation, which forms its north-west point; it is surrounded by a reef of coral islands, and affords good harbours at the south and north-east ends. This island is remarkable for its fertility and the variety of its productions, in which it resembles but exceeds Ualan. The Andema group lies to the south-west of Painipete, seven miles distant; it is said to be composed of about "a dozen coral islands covered with verdure." The south point is in latitude 6° 43′ north, longitude 158° 5′ east. The

Paguenena group, more westerly still, consists of five small islands surrounded by a reef about five miles long by three broad. The Ugaryk group consists of eight small islands, the Nuguore of thirty, of which the largest does not exceed ten miles in circumference. The lagune is twenty miles long and fifteen broad, and remarkable for the abundance of the pearl oyster. It is in latitude 3° 27′, and longitude 155° 48′. The Mortlock Islands consist of three groups containing ninety islands, one of which, Longounor, at the eastern angle, may be noted for its excellent harbours. The Sotoane group, containing sixty islands, is only seventeen miles in length by twelve in breadth. One of the most extreme groups is that of Hogoleu, which is circular, with a diameter of fifty miles; it may consist of seventy islands, which are very fertile, and afford good harbours. The other groups are of similar character, but smaller; and extending to the north-west, terminate in Yap or Eap, in latitude 9° 30′, longitude 138° 30′, it has an excellent harbour on the north-east.

The Pellew Islands may be considered the extreme western group of the Central Northern Pacific, they extend for 120 miles from north to south, and fifteen from east to west, under meridian 134° 30′ east. The largest island is Babelthouap, which is about twenty-seven miles long; it has a high mountain at the northern extremity, and is in latitude 7° 40′. These are best known as the birthplace of Prince le Boo.

The Mariana or Ladrone Islands extend from north to south for 420 miles. Of these the most important is Guahan or Guam, the most southern; it is about twenty-nine miles long and three broad; the shore is steep on the east, but shelving on the west; it is fertile in roots, fruits, and the cocoa palm, it affords good harbourage in several places; the south-east point is in latitude 13° 14′, longitude 144° 86′. Most of these islands are of volcanic formation; Saypan is distinguished by its peak rising 2000 feet above the sea; Tinian, which nearly joins it for its fertility; the islands form together a sheltered roadstead; Guguan also culminates at 2000 feet, and has an extensive crater in recent action on the north side; Grigan Island rises to even greater elevation; Ascunciao is a volcanic cone, but less elevated; Guy Rock, in latitude 20° 30′, longitude 145° 32′, is the most northern of this archipelago.

The Bonin or Arzobispo Islands were discovered by an English vessel in 1825. We owe our knowledge of these to Beechey, Lutké, Perry, and Qvin; they are well wooded and fertile, and consist of three clusters, lying between 26° 30′ and 27° 44′ north latitude. The principal is Peel Island, in which is a good harbour called Port Lloyd, of which formal possession was taken by Capt. Beechey, in 1827.

Some islands are reported between the Bonin Islands and Japan, and there are detached rocks and shoals to the east, extending across the Pacific.

4 *The Sandwich Islands.*—Of the outlying groups this is by far the most important, if it be not more important than any in the Central Pacific. They were probably known to the Spaniards, but that knowledge was lost, and we are indebted to our own great navigator Cook for their discovery. The archipelago consists of thirteen islands, extending from latitude 18° 54′, longitude 155° 30′, to latitude 23° 34′, longitude 164° 47′; the largest, the south-eastern Hawai, the Owhyhee of Cook, is triangular in shape, the west side being 100, the north-east eighty-four, and the south-east sixty-four miles in length: it is one mass of comparatively recent volcanic formation, rising in three principal mountains, Kea on the north-east, Huakali on the north-west, and Loa on the south.

Mauna Kea is not so apparently an active volcano as the others, but it is the most lofty, being 13,953 feet above the level of the sea, rising in one great mound covered with forests to within 1000 feet of the top, which divides into nine cones. Mauna Huahali or Huarari, written Wororay by Vancouver, is only 7822 feet in height, its sides are covered by numerous cones and craters, and its summit forms one of great extent. Mauna Loa rises like a flattened dome to the height of 13,760 feet above the sea; there is an extensive crater in active operation at the summit; on its side, 3970 feet above the sea, is the volcano of Kilanea, a crater three miles and a half long and two and a half wide, in which lava is in a constant state of ebullition; from it an eruption took place in 1840, and recent accounts (1856) speak of another fearfully destructive. The northern and especially the eastern portions of the island are very fertile, the southern rugged and barren, formed by the volcanic débris; a portion of the north-west coast is also rocky. Hilo Waiakia or Byron Bay is the only harbourage on the east side of the island; it is extensive, and considered by Wilkes to be safe throughout the year, it receives the waters of Wailuku River, and the country is covered with luxuriant vegetation. At the north-west extremity is Towaihai or King's Bay, this is the principal harbour in the island, and the district surrounding it was famous for its sandalwood. Kailau and Karakakooa Bays, the latter familiar as the scene of the death of Captain Cook, are also on the west side, which being the leeward side, and therefore deficient in moisture, is not so fertile as the eastern.

Maui, the Mowee of Cook, is formed of two peninsulas, connected by a low isthmus only nine miles wide. Two volcanoes rise one at each extremity, that on East Maui, the largest peninsula, rising in one continuous slope 10,000 feet above the level of the sea, covered with extinct craters and volcanic débris. West Maui is broken into several peaks, the highest of which is 6130 feet, forming deep valleys extending in fertile plains; the limit of the woods is 6500 feet above the sea. The isthmus is about fifteen miles in extent, sandy, but affording food for cattle during nine months of the year; this island has no harbour. The island, Kahoolawe, fourteen miles long, lies to the south-west of Maui, and appears to have been once connected with it; Lanai, about the same size, is twenty miles further north-west, and beyond is Molokai, which, though forty miles long by nine broad, is for the most part mountainous and barren. Oahu, the next island, is somewhat larger, being of the same length as Molokai, and twenty miles broad, this is the most important in a commercial point of view, on account of its harbour of Honolulu, the best in the whole archipelago. To the south this island is like Hawai, rocky, barren, and unpromising, but the greater part is eminently fertile and productive; the eastern side is remarkable for the beauty of its scenery, rising in bold precipices 3000 feet in height, broken by waterfalls and covered with verdure; the western is steep and often craggy, except towards the south, where a fertile district stretches for twenty miles about. Opooroah or Pearl Lagune, so named from the pearl oyster being found there. This extensive basin is landlocked save at one entrance, where there is only fifteen feet of water, but within the depth is sufficient for ships of any size, and the space for any number. The harbour of Honolulu is good, but the surrounding country wanting in the appearance of fertility; its most characteristic feature is the extinct volcanic cone, Lialu or Diamond Hill, so named from the crystals which are found in the crater. About ten miles to the east of Honolulu is Waikiki, remarkable for its salt-pits. The northern side of the island is the most fertile.

Kauai, or Atooi, is 100 miles from Oahu; it is twenty-eight miles long and twenty broad; the north and west sides are rugged, but from the south the island rises regularly to its culminating point, Wailioli, 6000 feet above the sea. This island is very fertile, and Warinea Bay on the south side affords good anchorage, as does Halalai Bay on the north side.

Uihau, or Ouceow, is sixteen miles to the south-west of Kauai; it is eighteen miles long and eight broad; it is only remarkable for its yams and fruits. Kaula, fifteen miles south-east of Uihau, a small rocky island; Bird Island, above 100 miles to the north-west, and Nicker Island, nearly 200 miles to the westward, complete the number. The importance of this archipelago is not consequent on the fertility of its soil, the salubrity of its climate, or the number and variety of its productions, but on its position. Situated within the trade winds, the distance from it being to San Francisco, California, 2083, Juan de Fuca Strait 2292, Tahiti 2379, Acapulco 3285, Petropaulowski 2745, Japan 3853, Shanghae 4301, Auckland, New Zealand 3817, and to Lima 5160 miles respectively, thus being naturally the centre of the trade of the North Pacific.

CHAPTER XXXIX.

THE EASTERN COAST OF THE SOUTH PACIFIC.

§ 1. The coast of Patagonia.—2. Terra del Fuego.—3. Western Patagonia.—4. Chiloe.—5. The northern coast.—6. The islands.

THE Coast of Patagonia.—The Strait of Magelhaens, separating Terra del Fuego from Patagonia, forms an irregular triangle, having its apex towards the south, and extending north-east and north-west for about 150 miles. Its southern point, Cape Froward, a bold headland with a round hill above it, is in lat. 53° 53′ S., long. 71° 18′ N., and marked by several rocky peaks of considerable elevation; Mount Tarn, on the east, rising 2600, and Nodalis Peak about 2500 feet above the sea.

From the eastern extremity, Cape Virgin, in lat. 52° 20′ S., long. 68° 21′ W., two wide reaches extend, separated by a narrow strait; here the shores are low, and the outlines of the coast regular; a second strait, but not so narrow, leads to another expansion, varied by islands and shoals, and deep indentations of the coast. Lu Bay and Gente Grande Bay are on the south, and Packet Harbour and Oazy Bay—the former good, the latter inferior—on the north, while on the same coast Elizabeth Island covers a roadstead about seven miles long; and here, at Shoal Haven, the coast is low, and the country covered with lagunes, and the great sheet of Otway Water approaches closely to the sea. Below this point, the strait spreads to the width of fifteen miles, trending nearly south for fifty miles, Useless Bay spreading wide into the land on the east, and Admiralty Sound stretching deeply towards the south-east; from these the main channel is separated by Dawson's Island. Here, under Mount St. Philip, 1300 feet high, is Port Famine, well-known in the history of this region; it is well sheltered, and by no means destitute of resources, yet altogether unfitted for a colony of Europeans, such as Sarmiento endeavoured to place there, whose miserable end caused it to be so named.

Port Famine is about thirty miles distant from Cape Froward on the east, as Port Gallant is to the west; this has been described as a perfect wet dock: the strait is here about five miles wide, and broken by islands; the north coast, low, regular; the southern, lofty, broken, and indented. From hence, the strait narrows to less than two miles, and having for fifty miles an average breadth of about three; and here the Gulf of Xualtega stretches eastward for twenty-five miles, with an extreme breadth of ten, and approaching closely Jerome Channel, which trending north-west for ten miles, and north-east for ten more, its shores deeply indented with bays and fiords, opens on Otway Water, which extends forty-five miles to the north-east, and gradually expands to fifteen miles in breadth; its southern shores are broken by numerous bays, the northern are more regular; Inglefield and Vivian, with two smaller islands, form a group about ten miles from Point Stokes at the south-west entrance.

Fitzroy Passage, irregular and narrow, not exceeding one mile in width, and trending north and north-west, leads from Otway Water to Skyring Water, of more irregular form, exceeding sixty miles in length from east to west, but with only an average breadth of ten miles; to the east, the shores are comparatively low and unbroken, but proceeding westwards, high ranges of hills on the north, and on the south, mountains 3000 feet high, with glaciers descending to the water's edge, vary its outline; here also are many islands, of which Dynevor Castle, the largest and most easterly but one, occupies the centre of the water. There is no outlet known to these waters to the east, west, or north, although they approach within about two miles of arms of the sea in each direction. From the Gulf of Xualtegua to Cape Tamar, the western extremity of the south coast of Patagonia, in lat. 53° 55′ S., long. 73° 48 N., the coast is high and bold; Tamar Island lies to the west of the Cape, and there is a secure cove on the east side. The two peninsulas formed by Otway and Skyring Water, and the fiords to the north-west, are named respectively Brunswick and King William Lands.

2 *Terra del Fuego.*—This Archipelago, so named from its numerous and active volcanoes, consists of several large and a multitude of small islands, extending between the 66th and 75th meridian of west longitude, and having its southern extremity, Cape Horn, in lat. 55° 59′ S., long. 67° 16′ W.

The largest mass of land in Terra del Fuego appears to be the King Charles Southland of Narborough, known as Eastern Terra del Fuego, and which is supposed to extend from the Strait of Magelhaens to Beagle Channel,—*i. e.*, about 150 miles from north to south,—and from Cockburn Channel on the west, to the Strait of Le Maire on the east, which is more than 200. The northern and eastern portions are low, and the centre low and marshy, and there may be divisions at present unknown to us. The southern and western portions, or Terra del Fuego Proper, consist of a rugged range of mountains, from 3000 to 4000 feet in general elevation, and culminating in Mount Sarmiento, a snowy peak, 6800 feet above the sea, and which can be seen from Elizabeth Island, already mentioned, thirty-two leagues to the north; there are other peaks of nearly as great elevation, Mount Darwin, to the east, attaining to 6600 feet. All these mountains are snow-covered, and vast glaciers descend from their sides, but many of the valleys and coves are well-wooded and fertile, and the country about them of much picturesqueness of character, the eastern slopes of the hills being generally covered with wood. Navarin and Hoste Islands are separated from Terra del Fuego Proper by Beagle Channel.

To the east of false Cape Horn, in lat. 55° 43′ S., long. 68° 6′ W., the southern extremity of Hoste Island, is a group of islands, of which Wollaston Island is the larger, and Horn Island the most noted, its southern extremity being Cape Horn. Staten Island, presenting a singularly irregular outline, and several secure harbours, is separated by the Strait of Le Maire from Terra del Fuego, which was so named from the Dutch navigator who discovered it in 1616, and is about twelve miles wide. The island is about thirty-five miles long by five in extreme width. Cape St. Diego is the western limit of the strait on the north.

Gordon Island and Londonderry Island form Darwin Sound, and from the latter numerous small islands stretch to the north-west, on the north of the western extension of Terra del Fuego Proper, separate the Strait of Magelhaens from Admiralty Sound, St. Gabriel, Magdalen, and Cockburn Channels; while Barbara Channel separates Clarence Island from the great western mass of Terra del Fuego, the Land of Desolation of Narborough: this extending for above 120 miles in a north-west direction, is no doubt an extensive archipelago, of which the better known groups to the south and west are outliers, and form Stokes Bay, Breaker Bay, and Otway Bay, which, indeed, are rather sounds than bays. The Land of Desolation terminates in Cape Pillar, in lat. 52° 43′ S., long. 74° 43′ W., the western limit of the Strait of Magelhaens.

3 *Western Patagonia* extends from Beaufort Bay, to the north of Cape Tamar, to the Gulf of Penas—*i.e.*, over five degrees of latitude; its entire coast is covered by an archipelago, and deeply indented by fiords. The most remarkable of the latter is the most southern, the Ancon-sin-salida, which, extending thirty miles inland, ramifies deeply to the north and south; on the latter, one arm, Destruction Sound, approaches closely to Skyring Water. Among the islands the largest appears to be the most northern, called Wellington Island, which yet may prove to be divided, and is separated from the main by Mesier Channel, the distinguishing character of which is that the shores

are hilly but not high, the low land being generally thickly-wooded with trees of small size; it is about 150 miles long by three miles wide. The western termination of the channel is in the Guaianeco Islands, which are rocky, and partially wooded. Two of these, Byron and Wager Islands, are larger than the others; and in the passage between them is Speedwell Bay, a spacious and secure harbour.

The outer coast of Wellington Island, or archipelago, is much broken, and covered by smaller islands. The Gulf of Trinidad, in latitude 50°, separates it from that of Madre de Dios, which again is separated from Hanover Island, or archipelago, by Conception Strait, and this again from Queen Adelaide Archipelago by Lord Nelson Strait. These are all rocky and barren to the west, which, as a lee shore, is dangerous, though there are numerous excellent harbourages. Through the channels which separate the islands, vessels of any size may for the most part pass safely. The most marked feature of the coast is the Cape Tres Puntas of Sarmiento, which rises 2000 feet above the sea; and here, at Port Henry, is an admirable land-locked harbour, called Aid Basin, capable of containing a large fleet: a spacious harbour is also found to the north of Cape Corso, on the opposite side of the Gulf of Trinidad; and Port St. Barbara, at the northern extremity of Campana Island, is to be noted for its safety and for the picturesque beauty of the hills which surround it, covered with flowering shrubs.

The mountains along this coast rise 2000 feet above the sea; "rocky islets, rocks, and breakers" lie off shore for two or three miles, over which the surf beats heavily.

The Gulf of Penas extends for about forty-five miles from the Guaianeco Islands to the peninsula Tres Montes, a bold promontory rising 2000 feet above the sea, but not appearing in threefold division. The outline here is less rugged, and the country better wooded than to the south. Port Otway, about fifteen miles from the Cape, within the Gulf, is perhaps one of the best harbours on this coast, being safe, and affording timber for spars, as well as water. The Gulf of St. Estevan is also to be noted, extending to St. Quentin's Sound, which is ten miles deep, the shores low, and covered well with grown timber. Kelly Harbour, remarkable for its glacier, Jesuits' Sound, and Channel's Mouth, are fiords stretching from the Gulf of Penas to the east and south. The coast northward of Cape Tres Montes is remarkable for its bold outline and thick covering of forest, and varies from 2000 to 4000 feet in height; it extends for about seventy-five miles to Cape Taytao, or Taytao-haohuon, from which rises a peak 3000 feet in height, surrounded by "a wilderness of rocky, granitic mountains;" numerous islands lie off to the north and east, and connect it with the Chonos Archipelago, which is formed by numerous small islands, lying very close together. They are lofty, and some of the islands around them rise 3000 feet above the sea; but Huafo, near the northern coast, is comparatively low and thickly wooded, and does not exceed 800 feet in height. There are numerous safe harbours among these islands. From them the Cordillera of the Andes is visible.

4 *Chiloe.*—The island of Chiloe is about 100 miles in length and forty in breadth; is hilly, but not mountainous, and well wooded. Sixty-three smaller islands to the east complete the archipelago, which is separated by the Gulf of Ancud from the main land, a narrow slip at the base of the Cordillera. The gulf side of the Island of Chiloe, as well as the archipelago, has a drier climate than the seaward, and is also better provided with harbours. Cucao Bay may, however, be noted here. The wooded tableland has an elevation of from 2000 to 3000 feet. The port of San Carlos to the north of the island, is now the most important, and is much frequented by whale ships; its harbour is excellent, as is also that of Chacao, the first settlement of the Spaniards at the north-east extremity of the island; here the narrow channel which separates Chiloe from the main does not much exceed one mile at its narrowest part.

The western coast of Chiloe is comparatively unbroken; the eastern deeply indented, and covered with islands. Cancahue Island covers an extensive roadstead, in which the land-locked basin, Oscuro, or Huyter Cove, offers great facilities for the repair of ships. Quinched, Quehuy, and Lemuy Islands, cover the bay and inlet of Castro. The eastern side of the inlet is about 150 feet in height, and covered with wood; the west rises in terraces to about 500 feet, behind which the wooded hills buttress up a tableland 1000 feet in elevation. Tranque Island covers Campu Inlet, and Houldad Inlet may be mentioned to the south; as well as a deep bay, covered by the islands Caylen and Laytee, about the same size, but one semicircular in form, the other about twelve miles long, and divided by a strait two miles wide. Colita Island, near the shore of Chiloe, is low and thickly wooded. Huamblin Island, at the south-east extremity of Chiloe, from which it is separated by a very narrow channel, rises in two peaks, covered with wood, the westernmost of which culminates 3200 feet above the sea. Huape, or Quilan, a small island, lies to the south of the Cape of the same name, which forms the south-west extremity of Chiloe. It is 300 feet high, rounded, woody, and remarkable for the yellow cliffs near to it.

Chiloe is covered, with the exception of the cultivated portions on its eastern coast, with continuous forest; of its interior nothing is known; the only remarkable feature beyond the coast line, with which we are acquainted, being Cucao Lake, on the west side, of irregular form, and about ten miles long.

The Chaugues Islands form an irregular group between Chiloe and the main, nearer to which lie those of Chulin, Talean, and others.

The western coast of Patagonia lies at the base of the Cordillera, which rise, covered with wood, to a height of 4000 feet, and with snow above. From Melemoyu, the Trident Mount of Fitzroy, which he estimated at 7500 feet, and which lies nearly under the 44th parallel, Yantiles Mountain, which is above 8000, the Volcano of Corcovado, 7500, Minchinmadeva, 8000, and other lofty peaks, point northwards to the Volcano of Osorno, or Purraraque, which, with its remarkable cone, 6000 feet in height, is the landmark of the country, and attains an elevation of 17,550 feet above the sea. About the base of this volcano are several lakes—those of Llanquihere and Nahuelhuapi, are large; but of them little is known. The river Puella issues from the latter, and falls into Reloncavi Inlet, which again unites with the sound of the same name, extending inland for twenty miles, and ten miles in width. Around it are several lakes, and it has two islands within it, and two at its mouth, which narrow the entrance to about two miles. Of the coast from this point to the Peninsula Tres Montes, but little is known.

5 *The Northern Coast.*—From the volcano of Osorno the Chilian Andes rapidly increase in elevation; Villarica, under parallel 39, being 16,000, and Aconcagua, under the 32nd, 23,200 feet above the sea; they also recede from the coast, from which, in latitude 37°, their peaks are 150 miles distant.

Chocoy Head, the southern extremity of the Chilian coast, is opposite San Carlos; at the entrance of the Narrows of Chacao some rocks and islets mark it to seaward, and to the north, Maullin Inlet stretches deep into the land; from hence, however, the coast is unbroken, and formed of hills rising 2000 and 2500 feet from the sea, affording no harbourage for ships till Valdivia Harbour, the entrance of which is to the north of the 40th parallel. Several small rivers empty themselves into this harbour; the Calla Calla, on which is the present town of the same name, the Tolten, Cauten, and others. The headlands and islands rise 300 feet, and the country, everywhere well wooded, is for the most part 1000 feet above the sea, forming a barrier between it and the llanos which stretch to the base of the Andes.

Mocha Island, about seven miles long and three broad, in lat. 38° 23′ S., long. 73° 59′ W., is remarkable as the only island off this coast, from which it is distant twenty-five miles; it is abrupt towards the south, and culminates

1250 feet above the sea, sloping gradually to the north; it lies about half-way between Valdivia and Conception. None of the rivers on this beautiful and fertile coast are navigable now, though some were formerly, and especially the Tubul. The coast, excepting near the mouths of the rivers, is high, steep, and well wooded, the water deep; towards Tucapel Head it is wild and rugged.

Arauco Bay is formed by a deep bend of the coast, marked by the small rocky island Santa Maria, about thirty miles to the south-west of the entrance of the Bay of Conception, which is the finest on this coast, being six miles deep and four miles wide, with good anchorage and well sheltered. Tumbes Point and Loberia Head mark the entrance, and five miles from the latter to the east, Mount Neuke, though the highest land in the neighbourhood, rises only 1790 feet above the sea. The coast here rises above 500 feet, excepting near the mouth of the River Maule, which, though the outlet of a most fertile country, has a bar at the mouth, preventing the entrance of shipping. In this latitude is the easiest passage across the Cordillera. The projection of Point Angeles or Branca, forms the Bay of Valparaiso, nearly under the 33rd parallel; the land here is rugged and rocky, rising abruptly behind the bay from 800 to 2000 feet, and the Nevada of Aconcagua towers in the distance above the Cordillera. This bay is open to the destructive effect of the "Northers" which prevail in the winter, and is moreover said to be rapidly filling up.

To the north of Valparaiso the coast becomes more rugged and barren, presenting regular lofty blue cliffs 150 feet high, above which the land rises for 300 feet, backed by a range of mountains from 3000 to 4000 feet in height, about three miles further inland.

Coquimba, or La Serena, is the next marked indentation of the coast, though to the south of the southern point which forms its entrance, the small but secure harbour of the Herradura de Coquimba is found: here the coast range attains in Cobre Hill an altitude of 6100 feet; beyond this Chanaral Bay opens on a valley, which, though the most fertile on the coast, did not afford pasturage for the horses of Mr. Darwin's party: yet the abundance of copper in this district, otherwise so unproductive, should give it an important export trade. The whole of this country has been subject to many elevations, as may be seen in the parallel raised beaches of Coquimba and Guasco.

The Herradura of Carisal to the north of Lobos Point, may be noticed as offering security to vessels which Copiapo to the northward does not, though covered by Isla Grande; here at one time a large river must have debouched, but probably few countries have had their natural features so altered by earthquakes as this; yet here there are no volcanoes, and the range of the Cordillera does not often exceed the limit of perpetual snow, the rivers maintaining nearly an equal quantity of water throughout the year.

It has been already observed (pp. 436-8), that transverse and parallel ranges are only found on the east side of the line of watershed of South America, which for the most part lies near the coast, the only navigable river in the central part being the Piura, which has only a length of about 120 miles. North of Coquimba, Constitution Road may be mentioned under Mount Moreno, so named from its brown colour, which rises, barren and rugged, 4160 feet from the sea; the anchorage is covered by Forsyth Island. The headlands on this coast are bluff and lofty, rising 1000 feet, and sometimes covered with guano, giving them a chalky appearance.

Cobija Bay may be mentioned as occasionally resorted to for copper ore, but on this desert coast harbours are rare because they are not required; to Cobija and Iquique, a small port to the north, among barren sand-hills, all necessaries are brought by sea; to the latter, even water from the Pisagua, 40 miles distant. The sand-hills of Iquique are surrounded by a wall of rocks 2000 feet high, which are continued along the coast; from hence abundance of saltpetre is exported, and here silver was abundant. About the River

Pisagua the cliffs are lower, but to the north rise again in regular line, broken only by two deep gullies. At Arica the coast is again low, and continues so along the plain of Arica, which rises gently from the sea to a plateau, with scattered trees. Between Cobija and Arica the marked features of the country are the Nevadas of Sehama or Gualatieri, Chungara and Parmiacota, known as the Twins (Nuelizzos), and the ragged ridge of Anacalache; to the river Juan de Dîoz or Juan Diaz, the coast is low and sandy, but rises again forty-five miles from Arica in the Morro de Sama, 3890 feet above the sea, thirty-one miles from which is Coles Point, a low sandy spit, having the anchorage of Ylo within it. From Arica the coast trends north-west to this point, and continues in that direction more or less to Cape Blanco; under the fifth parallel from Ylo the coast is rocky, the cliffs from 300 to 400 feet high. The old port of Mollendo is now silted up, but the Bay of Ilay affords good anchorage; and here the most remarkable feature of the coast is the white ashes which cover the basis of the hills: here also, fifty miles inland, rise the nevadas of Picupicu, Arepiqua, and Chacani, the second, giving name to the second city in Peru, is a truncated cone 18,300 feet high, the others form serrated ridges.

The country on this coast opens in fertile valleys; of these, Tamba and Camana are remarkable; these have trees, but the mountains and coast are rocky and barren. Two deep bays, covered by islands, are found here, Yndependencia Bay and Pisco, the former offering little but secure harbourage, the latter, known from the abundance of guano afforded by the Chilca Islands. These, though they present only seven square miles of surface, are said to have a supply exceeding 50,000 tons for 1000 years. They are granite rocks, and the guano in the centre of the most northern 100 feet deep. Here no rain ever falls, and hence the deposit remains. Beyond the Chilca Islands the country opens in the valley of Lurin, off which are the Pachacamac Islands, so called from a Peruvian temple, the remains of which still exist on the summit of St. Francisco, the largest of them, which was formerly connected with the mainland by an isthmus; sandy beaches here characterize the coast.

The Bay of Callao, covered by the island San Lorenzo, which rises in three points, the northern culminating 1284 feet above the sea, is four miles and a half long and one broad; the island is composed of limestone, clay, and slate, and has afforded remarkable evidence both of the rising and depression of this part of the coast. Here the Cordillera is, from sixty to seventy miles from the coast, unbroken, and the passes over it above 15,000 feet in elevation. Callao is the principal port on this coast, which here is comparatively low, with bluffs and shingly beaches. Off Salinas Point are the rocky islets called Huaras. The Bay of Salinas is large, and affords good anchorage. The Bay of Huacho is marked by the three double peaks of the Beaver Mountains, and beyond it the coast is moderately high with a sandy outline, afterwards rising in clay and rocky cliffs. Guarmey is a tolerable harbour. The coast is here marked by the Cerro Mongon, which is said to enclose a fertile, well watered valley: but the best harbour on the coast is the Bay of Samanco; it is six miles long and three wide, and two across at the mouth, and very superior to that of Ferrol to the north, which is better known. The small islands, Lobos de Tierra and Lobos Afuera, are frequented by the natives of the coast for fishing.

The port of Payta, marked by the hill or saddle of Payta, with its three peaks, is excellent, and much frequented; the coast is here low and sandy, but rises again at Parnia Point, twenty-four miles to the north; the line of coast hills culminates here in Amatape, which rises nearly 4000 feet above the sea. Cape Blanco, in latitude 4° 17′ S., longitude 81° 16′ W., is high and bold, and from hence the coast has a north-easterly trending to the head of the Bay of Guayaquil, and about seventy-five miles from it is the mouth of the River Tumbes, where Pizarro landed for the conquest of Peru, but which offers no facilities now for such a purpose.

The estuary of Guayaquil is very extensive, but much embarrassed by shoals; it receives the Guayaquil and Daule rivers; the former is the most important to commerce on the west coast of South America; it is, however, narrow (not exceeding one mile and a half wide), and muddy, though rapid; its banks lined with mangroves and swarming with alligators. The islands of Puna and St. Clara lie within the estuary, and the entrance of the river at Point St. Elena is sixty-eight miles from the latter. Selange and La Plata Islands lie on this part of the coast, the latter noted as the resort of the Buccaneers, and so named by Drake; it is bounded by high cliffs, flat, and wooded at the top. The sugar-loaf cone above Manta marks this part of the coast, beyond which Caraccas Bay, noted for the beauty of its scenery and the richness of the soil about its river, opens.

From Cape Passado, a bluff projection from a well-wooded mountainous country to Cape St. Francisco, a distance of about fifty miles, the coast line is varied by many projecting low points, and beyond this several rivers fall into the sea; the Esmeralda, Tumaco, and St. Jago, all of which are said to be navigable; here the coast is low and full of creeks. The islands of Gallo and Gorgona lie off this coast, the latter is five miles long, covered with trees, well watered and fertile, and rising 1296 feet above the sea; rain is said to fall here daily, but without doubt, the contrast between the humidity of this portion and the dryness of the central portion of the west coast of South America is very great.

Buenaventura Bay affords every facility for becoming one of the most important commercial ports on the Pacific; its harbour is of considerable extent and sufficient depth; the rivers Dayna and Chiuquiquîra, navigable for boats, fall into it. To the north is the Bay of Tupica or Cupica; this is said to be a good harbour, and the country round it is hilly and well wooded.

6 *The Islands.*—The islands off the west coast of South America are few and far between: on the south, Juan Fernandez and Massafuero, St. Felix and St. Ambrose; on the north the more important group of the Galapagos, and the little detached island of Malpelo off the Gulf of Buenaventura.

Juan Fernandez, also called Massa Tierra, has been often described, and is well known as the scene of Defoe's romance. At a distance the mountain Yunque, or the Anvil, rises 3000 feet above the sea from a precipitous range, the shore being formed by a wall of rock 800 or 900 feet high, broken by wild ravines, through which rush mountain torrents; within are verdant glades surrounded by luxuriant woods; in the upper parts are extensive grassy plains, fringed with dark myrtle bushes. The Yunque is wooded nearly to the summit; from its base an extensive valley opens to the shore, through which flow two streams. French, Cumberland, and English Bays—the second of which is the best, but even that is open to northerly winds—offer some shelter and supplies to shipping; sandal wood is said still to be found there, and the hills abound with goats, from which the neighbouring rocky island, St. Clara, is sometimes also named: Juan Fernandez is about twelve miles long by six broad.

Massafuero, or Massa e fuera, is smaller, and lies in lat. 33° 49′ S., long. 80° 56′ W. This island is rocky, but well wooded and fertile, and culminates 2300 feet above the sea; it is about five miles distant from Juan Fernandez. The Spanish fort, Juan Baptista, on Juan Fernandez, is in lat. 33 37′ S., long. 78° 63′ W. St. Ambrose and St. Felix are small rocky islands lying near the intersection of the southern parallel 26, with the meridian 80th west, about 450 miles from Copiapo; they offer no shelter, but are resorted to for fishing and for water; the former about five miles in circumference, and rising 1600 feet above the sea; the latter, a group of five rocky islets, presenting the appearance of hummocks covered with sand, but having steep and rugged shores; these are about ten miles distant from St. Ambrose.

Of the islands off the coast of South America, the Galapagos are by far the most important, not only from their size and productions, but from their position, lying under the intersection of the Equator and the 90th meridian W. from Greenwich, they are in the direct track not only of vessels from Panama to the islands of the Pacific, New Zealand, and Australia, but have, notwithstanding their position, from the influence of the great ocean, and their distance from land (about 550 miles), a climate sufficiently mild for the production of many of the vegetables and fruits of temperate regions; and although the northern slopes are comparatively barren, the southern slopes, from the constant precipitation resulting from the regular southern breezes which bring to them the water of the Pacific, are verdant and productive throughout the year. Cattle thrive on their natural produce throughout the year, fish abound in the seas, and they afford one of the best whaling stations in the Pacific. They are named from the large terrapin or land tortoise, with which they still abound; are of volcanic formation, and bear tokens of recent action: Captain Morrell gives accounts of terrible irruptions in Narborough Island in 1825; among them are excellent roadsteads; indeed, from the constancy of the southerly winds, the northern or lee sides are almost always safe, as the southern would be during a " norther," if such should by chance blow home. Coal is reported by Dr. Coulter on Chatham Island, but the geological structure of the islands renders its existence improbable.

This group consists of six principal and nine smaller islands, with numerous islets and rocks; the largest is Albemarle Island, the two portions of which form an extensive bay, in which lies the smaller island of Narborough; this is called Elizabeth Bay; and both are formed by the elevation of volcanic cones, of which, on Albemarle Island, there are six, rising from 2000 to 4600 feet above the sea, and broken by huge craters; off the south-east point, which is low, lie four small islands, the remains of volcanoes. The south-west cape, Point Essex, is high, and Narborough Island is supposed to be the highest land in the group. Tagus Cove, the remains of an extinct crater, and affording good anchorage, lies in the strait between the two islands.

Albemarle Island is, like so many other islands of the Pacific, formed of two parts, united by a narrow isthmus, called Perry Isthmus, about five miles and a half broad; the extreme length of the island is about seventy miles, and its greatest breadth at the south forty-five; the two portions lie at right angles, the northern measuring fifty miles by ten, the southern forty-five by twenty. Narborough Island is quadrangular, and fifteen miles in diameter. The northern points of Albemarle Island are Capes Berkeley and Albemarle, distant seventeen miles; from both of which, at the distance of fifteen miles, a high barren rock, called Redondo, rises out of the deep water.

The most northerly of the group is Culpepper's Island, in latitude 1° 23′ north; this, like Wenman's Island to the south-east, is merely the barren top of an extinct crater. Abingdon Island is remarkable for the bold face presented by its western side, which rises 1000 feet above the sea, showing very distinctly the stratification characteristic of volcanic formation. This island is about seven miles long, and rises in one bold peak 2000 feet. Bindlar's Island has its surface formed by mud thrown up from the crater; Tower's Island, unlike the others, is flat; James Island, remarkable for its dome-like mountain, called the Sugar Loaf, 1200 feet high, and its salt lake, occupying a crater in its centre, and producing beautifully crystallized white salt, as also for the abundance of water in its higher grounds, and the richness of its vegetation, is twenty miles long by ten broad. Indefatigable Island has good anchorage to the north-west in Conway Bay, and is twenty-one miles long by fifteen broad. Chatham Island, the most easterly, is twenty-one miles long by six broad; here on the north are numerous fumeroles and truncated hillocks, giving vent to subterranean gases, yet the hills are covered with prickly pears, quince trees, and cotton wood. On the south-east side is a cove with a waterfall thirty feet high; the south side is, like that of the others, verdant and well wooded. Charles Island, though only ten miles long by six broad, is that best known as the resort of whalers, and once the site of a colony, and as having a good harbour, and water easily accessible.

The group covers nearly three degrees of latitude and two of longitude. The importance of its position may be best seen from the following table:— Distance of Galapagos from

		G. M.			G. M.
Panama . . .	14°	840	Sandwich Islands .	66°	3960
Conception . .	38½	2310	Tahiti	59½	3570
Cape Horn . .	58	3480	Easter Island . .	41	2460
St. Francisco .	48	2880	Port Nicholson, N.Z.	92	5520
Vancouver's Island	70	4200	Sydney, Australia	111½	6690

CHAPTER XL.

THE EASTERN COAST OF THE NORTH PACIFIC.

§ 1. The southern coast of Central America.—2. Of Mexico and California.—3. Of Oregon and Vancouver's Island.—4. The north-western Archipelago.—5. The Aliaska and the Aleoutian Archipelago.

THE south coast of Central America.—The high bluff of Point Francisco may be considered the south-eastern limit of the Bay of Panama; from hence to Point Mala the north-western limit is about 200 miles. From this line to Panama the bay may be 120 miles deep; more commonly, however, the Bay of Panama is considered as lying between Point de Chame and Point Brava, the western limit of the Gulf of San Miguel, between which points the distance is about ninety miles, but even within these limits the bay is thirty miles deep.

The Gulf of San Miguel consists of two parts: the Bay of Guarachiné to the south, between Points Guarachiné and Patnia, and the Gulf of San Miguel Proper, between the latter and Point Brava; these are distant respectively about eleven and nine miles. The former bay offers nothing worthy of notice, the latter is important as receiving the waters of two large rivers, the Tuyra and Savanna. The Gulf is about sixteen miles deep, narrowing to the north-west, where it is divided into two channels by an island, round which the northern channel, Boca Grande, bends to the north-east and south, having a breadth of nearly two miles with deep water, and the channels, after their junction to the east, have about the same width; here the Savanna from the north and west meets the Tuyra from the south and east, and their united estuaries form Darien Harbour. The Tuyra is about three miles wide at the mouth, the Savanna only one, but both are navigable, the latter for about twenty-five miles; of the former little is known. Within the Gulf and estuary there is everywhere good anchorage, but the shores are low, and covered with mangrove bushes, and the country consequently unhealthy. Several rivers fall into the east of the Bay of Panama, of which the Cheapo is the most important, but it is not navigable; and numerous creeks intersect the coast. In the centre of the Gulf lie the Islas del Rey, or Pearl Islands, the principal of which, Isla del Rey, is seventeen miles long by ten broad. To the west are San Jose and Pedro Gonzales, and to the north a small group, of which the most northern, Pacheque, is thirty-three miles south-east from Panama. These islands, now known as the Islands of Columbia, but formerly from the pearl fishery still carried on there, cover an area of about 400 square miles, are well-wooded and fertile, but comprise numerous islets: the passages between them are only fit for boats.

Off the river Cheapo, and forming a good roadstead, is the island of Chipillo, about twenty-four miles from Panama and three miles from the shore; it is one mile long, and rising with a gentle ascent to the south, it is noted for its salubrity and fertility.

Panama, now so important as the centre of steam communication between the Atlantic and Pacific, offers nothing better for shelter than an open roadstead: shoal water extends on the south-west one mile and a half from the shore, and at the edge of these banks are several small islands; those nearest to the city, at about two miles and a half, are Perico, Ilenao, and Culebra, these are connected; Isle San Jose lies outside of them, and still further to the south-west, Tortola and Tortolita; a large shoal is also on the south-east of the city at one mile and a half distant. The land at the bottom of the bay is broken by irregular bluffs, and the interior rises in rugged mountains, which, however, are covered with luxuriant forests to their summits.

In its more extended acceptation, the Bay of Panama includes the Gulf of Parita on the west, as well as the Gulf of San Miguel on the east, formerly called Escnada de Nata y la Villa, from two towns so named, the latter of which is now called Parita, situated on its shores; from Point de Chame to Point Mala is about seventy-five miles. There are several small islands along the shores of the bay, as well as from Point de Chame towards Panama; of these latter the largest is Taboga, where ships generally take in supplies.

The peninsula of which Point Mala is the extremity, separates the Bay of Panama from Montijo Bay. Here are several small islands, and Quibo Island, nineteen miles long and seven miles broad, in the form of a crescent, opening towards the east; beyond it are Hicaron and Hicarita, small islands, but rising above 800 feet in height, and bearing palm trees, and Rancheria, famous for its Palma Maria trees, used by the Buccaneers for masts and spars; these islands were better known to them than they are to us, Quibo being a principal rendezvous for them. Anson describes this island as one continued wood, swarming with tigers, snakes, monkeys, and iguanas, as the sea around did with alligators, sharks, sea snakes, and gigantic rays; pearl oysters also abounded on the rocks, and a river, forty yards wide, fell in rapids of great beauty over a rocky declivity 150 yards long; the cedar trees are remarkably fine. Quibo is low, the highest of the islands being Hicaron or Quicara, to the south.

From the Cordillera, which extends through the isthmus of Central America, but nearer to the north than the south coast, numerous streams and rivers descend to the Pacific; of these the Santiago is the most important, and may be considered the type; at its mouth numerous islands, rocks, and banks cover a good port, formed by a projecting spit of land. This port lies at the head of the Gulf of Puebla Nueva, which is about ten miles broad and the same deep. Similarly the Contreras Islands cover the mouth of the St. Lucia River to the west, but on the east of the Gulf an almost landlocked basin, five miles across, affording perfect security and every convenience, wants but the hand of man to make it the most desirable resort for shipping on the coast. Montuosa Island, about five miles in circumference, and covered with cocoa-nut trees, lies thirty miles west of Quibo, Cebaco, Governadone, and others, in the entrance of the Bay of Montigo.

From Burica Point to the eastern extremity of the Gulf of Dulce, the coast is high and covered with trees. The Cordillera, which to the east had scarcely exceeded 7000 feet, here in the Chiriqui Mountain attains to 11,265 feet, and increases in height to the west: of this coast comparatively little is known; within the Gulf of Dulce, which is twenty miles across, or, reckoning from Burica Point, forty, the coast becomes low and covered with trees, and sand banks are marked in the old charts as extending on both sides of the entrance of the Gulf of Dulce; the rivers which flow into it, at least the Rio Dulce, are no doubt navigable, and harbourages covered by islands appear on the west side: the western limit of the Gulf was formerly termed Point Gorda; beyond this is the small island of Cano, and still westerly, Port Mantas, or Agujas, receiving the river St. Carlos, the mouth of which is covered by islands; from hence the coast trends to the north as far as Point Hermanduras, at the entrance of the Gulf of Nicoya, which is distant from Cape Blanco, the western extremity, twenty-seven miles.

This gulf is an inlet lying deep among lofty volcanic mountains. From Cape Blanco, so named from two white rocks which lie off it, the coast trends north-east for about twenty miles, and then suddenly turning north-west, extends for twenty-five more, forming a deep narrow gulf, having a large island, characteristically called Shoal Island, at its head, receiving many rivers, and forming numerous excellent harbours. The immediate coast is low and extremely rich, covered with a luxuriant growth of timber, but few parts of the unhealthy coast of Central America are more unhealthy than this. Above the eastern coast rises the Aguacate range of mountains, and below the volcano San Pablo is the modern port, Caldera, separated from the older port, Punta di Arenas. The bottom of the gulf is distant only some forty-five miles from the Lake of Nicaragua, the greater part of that distance being up the valley of the Tempisque. On the eastern side the Rio Grande enters the Gulf, descending from the slopes of the Chiriqui Mountain, and to the south of Herradura Point, and the small island Lojarto, is good anchorage.

The mountainous peninsula of Nicoya extends for seventy-eight miles to Point Gorda, at the entrance of the Gulf of Culebras. The coast is irregular, and probably affords good harbourage; Port Guiono, fifteen miles from Cape Blanco, is the most important of its indentations.

From Point Gorda the coast trends northward, and presents four deep bays; of these the southern, Port Culebra, is esteemed the best on this coast; it is marked by the detached islands known as the Viradores, to the south of which lies Cocos Bay. Point Sta. Catalina, of the old charts, lies about twenty miles to the north of Point Gorda, and is the south limit of the Bay of St. Elena, and this is distant about ten miles from Descarte Point, the south limit of the Bay of Salinas, and the north-west point of Salinas Bay. Point Natan is distant twelve miles due south from Descarte Point. The peninsula separating these bays is about five miles long. About ten miles further on is the port of San Juan del Sur, and the little harbour, Nascolo, from whence the coast trends north-west in nearly unbroken line for 100 miles to Realijo, well marked by the volcanic cone El Viejo; this is a good port, and covered by the islands Castanon, Cardon, and the Asseradores, affording two safe entrances. The island Castanon also separates the Estero of Dona Paula from the Pacific. This creek runs up towards Leon, and is navigable to within ten miles of that city. From Rialijo to Point Cosiguina, at the entrance of the Gulf of Concagua, is forty miles more.

This extensive Gulf corresponds somewhat with that of Nicoya, indicating a similar character of country to the west of the great basin of Nicaragua, as that does to the east. It is formed by the peninsula of Cosiguina, on which stands the remarkable volcano of the same name, distinguished by its ragged crater and for the destructive effects of its eruption in 1835, the force of which was felt 400 miles off, and it is said at Merida, in Yucatan, a distance of 800 miles, and the dust from which was wafted as far to the northward as Jamaica (vol. I. p. 269). The entrance of the Gulf is about twenty miles across, and marked on the north-west by another volcanic cone, known as Mount St. Michel.

This Gulf, formerly known as that of Amapalla, and often called Conchagua, or Fonseca, was well known to our early voyagers, and accurately described by Dampier; is about twenty-five miles in depth, and studded with islands, of which Tigre Island, Sacate, and Mianguera are the principal. These islands do not now appear to answer the description given of them by Dampier, and it is probable that they have undergone alteration since his time; he calls the two principal Mangera and Amapalla, and places the former to the south, but makes the latter the largest, describing them both as lofty, while the others are all low, and says that the two channels for entering the Gulf lie, one between those islands, the other between Mangera and Point Casirina, *i.e.*, Cosiguina; in the channel, are now the Farrallones islets. To the east the Gulf stretches for fifteen miles, having a breadth of eight, and on the west forms a bay eight miles deep and three miles wide, in which is the port of La Micon, which lies to the north of Chicarene Point. The shore here is flat, and on the shoals oysters abound. Two considerable bays are also formed to the north, the easternmost of which is Port St. Lorenzo, into which falls the river Nacaome. In the north, of St. Michel, also called Candadilla, is the estuary of the small river Sirama, and beyond is the cone of Amapalla, 3800 feet in height, beneath this is the port of San Carlos, or Concagua, off which is the small island Concaguita. The eastern arm of the Gulf receives the Choluteca, a considerable stream. The Estero Reale is navigable for small vessels for sixty-five miles towards Lake Managua.

2 *The Coast of Mexico and California.*—From the Gulf to Sonsonate Road, a distance of above 100 miles, the coast is only broken by the Bay of Gequilisco, which affords well-sheltered anchorage, being covered with a long narrow island: beyond this is the River Lempa, which, though the largest on this coast, is not navigable. Sonsonate Road, known also as Port Acajulta, is an open bay formed by Point Remedios; there is an open roadstead also at Port Islapa at the mouth of the Michatoya, which is the outlet for the waters of Lake Amatitlan, and said to be navigable. This roadstead is the one from which Alvarado embarked for Peru, and is marked by the famous Volcano di Agua, placed at right angles between the Volcanoes de Fuego and Pacaya. From Point Remedios the character of the coast changes; the Balsam coast to the east is bold, but to the north the coast is low and covered with low islands, intersected by canals often forming lagunes, which extend beyond the mouth of the Gulf of Tehuantepec, and make the coast inaccessible for ships of burden: indeed, this coast must have undergone much alteration since the time when Cortez selected Tehuantepec for his principal port on the Pacific, the lagunes there being now inaccessible to vessels of burden, and rapidly filling up. On a coast so deficient in harbourage, the bays of Bamba and San Rosario are worthy mention: there is also good anchorage behind the island Tangola. The coast here makes in small steep headlands with sandy beaches between them, rising in irregular hills covered with primeval forests to the Cordillera. Port Guatulco, formerly of importance, is still a most excellent harbour: the Spanish town here was taken by Drake, and burnt by Cavendish; to the north and west the Cerro Zadan rises 6000 feet above the sea, and over it the mountains of the interior are plainly visible. The little green island of Sacrificios also offers shelter from the terrible swell of the Pacific: the coast here is comparatively barren. Acapulco is one of the finest harbours in the world, whether for capacity or safety; from its interior, the sea cannot be seen; it looks like a lake surrounded by mountains, those on the north and east rising from 1500, 2000, to 7000 feet; but on the west the hills do not exceed 500. The coast here is extremely prominent and bold, rising 3000 feet above the sea. To the westward are the Paps of Coyuca, resembling a mountain fortress, and here the coast is formed by long beaches bearing the same name, and 120 miles from Acapulco is another excellent harbour, Sihuantango, the Chiquelan of Dampier.

The port of Manzanilla is very good; it is marked by the volcano of Colima, the most westerly of those of Mexico, which rises 12,000 feet above the sea; and another extinct crater to the north, which exceeds it in elevation. The land about this coast is high and barren, the coast itself irregular, and there are anchorages between Manzanilla and Cape Corrientes. This cape has a remarkably bold outline, is covered with underwood, and is situated in latitude 20° 25′ north, longitude 105° 39′ west. Of the Peninsula and Gulf of California we have until lately known nothing beyond what the exclusive policy of the Spaniard has permitted, nor indeed has further knowledge been required for any practical purposes, for the country surrounding it has hitherto been isolated from other parts of the Continent; now, however, that Northern California is opened to commerce by its accession to the American Union, the unknown Gulf will, no doubt, soon become well known; and Sir E. Belcher has, by his examinations and surveys, afforded a base for further operations. The peninsula may be roughly estimated as 600 miles in length, and about 100 in average breadth, the gulf being of about the same dimensions; a range of mountains passes through the centre of the peninsula throughout its whole length; of the character of its interior we are ignorant, but its appearance is rugged and barren, its mountains are of volcanic origin, and, though lofty towards the north, decrease in height to the southward.

The Gulf has had many names: it was called the Sea of Cortez, after its discoverer; the Red or Vermilion Sea by the Spaniards; by the Jesuits, the Sea of Loreto, after the so-called home of the Virgin Mary: it was also remarkable in the early days of Spanish occupation for the great size and beauty of the pearls, and the productiveness of its pearl fisheries. From Cape St. Lucas, the southern extremity of the peninsula, to Cape Corrientes, which may perhaps properly be considered as the limits of the entrance of the Gulf, is nearly 300 miles; and from Cape Corrientes to the mouth of the Colorado, about 850. Cape St. Lucas is in lat. 22° 52′ N., long. 109° 53′ W.

The coasts of the Gulf are low, sandy, and barren for the most part; but as far on the east as the mouth of the Cinaloa River, about 200 miles from Mazatlan, where the sierra of the same name approaches closely to the sea, it is rocky, neither the river Cinaloa nor the rivers Piastla, Tamazula, or Rio del Fuerte, appear to be navigable, though their mouths are accessible to small vessels. The harbour of Guaymas, however, is well sheltered, has depth of water for large vessels, and is of considerable capacity; the inner basin is protected by two small islands, and the island of Pajaros covers the entrance, the eastern point of which is formed by the islet of Morro, which is connected with the eastern shore of the Gulf by a spit of sand. Guaymas is surrounded by high mountains, one of which, named Las Tetas de Cabra, from its double peak, presents a well-defined landmark. There is another good harbour to the north of Guaymas, Puerto Escondido; here are also some small islands,—San Pedro, Nolasco, La Tortuga, and San Pedro, and in latitude 29° that of Tiburon, ten leagues in length, separated from the land by the narrow and dangerous canal, Peligroso. The Rio de la Conception de Caborca, the small bay Sta. Sabina, the islet Sta. Inez, and the Rio de Sta. Clara may be named, but the entire north-east coast is a barren waste of sand.

The Rio Colorado, although presenting a considerable body of water, is not navigable on account of the rapidity of its current, nor is its entrance accessible to vessels on account of the sandbanks which impede it. Of the western shore of the Gulf little can be said; it is marshy as far as Cape Buenaventura; below this are a few unimportant islands and watering-places, but the first of importance is the island De los Angelos, nearly opposite that of Tiburon, about forty miles long, and separated from the western coast by the Canal de Ballenas, so named from the number of whales found there; indeed, the whale and seal fisheries on this coast would, if followed, be highly productive. The southern extremity of this canal is rendered dangerous by several rocky islands.

To the south is Cape de los Virgenes, marked by an extinct volcano, the last on this coast, which however is reported as in activity in 1745; and below this to the south Moleje Bay, the only considerable inlet, being about thirty miles deep, and receives the river of the same name, which, however, is scarcely accessible to boats. To the south, the small islands and indentations of the coast present safe anchorages, especially under the islet Carmen, and at Loreto, marked by the highest peak in Lower California, Cerro de la Giganta, which culminates 4560 feet above the sea; this was a place of much importance during the rule of the Jesuits, but is now deserted. Carmen Island is one of a chain which stretches southward, covering the coast to the eastern extremity of the Bay of La Paz, originally called Santa Cruz, and subsequently Del

Marques del Valle, the title of Cortez: from this place the pearl fishery is still carried on. The anchorage here is in Pichilingue Bay, covered by the islands San Juan, Nepumoceno, and Espiritu Santo. Towards the south the peninsula has wood, and for this the dangerous bay of San Jose del Cabo is frequented, as well as the not much safer bay of San Lucas. The country here is mountainous, of primitive formation, the coast bold and steep. Cape San Lucas is a moderately elevated rock connected with the interior range of mountains by a serrated ridge: the country here is barren and sterile. From the Cape to the island San Margarita, on the western coast, steep, white, rocky cliffs, apparently detached, are found, the country rising behind in lofty mountains. The most remarkable headland on this coast is that under the forty-fourth parallel, named from its three truncated peaks, Las Mesas de Narvaez.

Sta. Margarita Island, twenty-two miles in length, but only two miles and a half broad, having the usual character of the islands of the Pacific, indicating its origin, is formed of two elevated portions, connected by a low sandy isthmus; the southern of these rises near Cape Tosco, the south-east extremity, 2000 feet above the sea.

This island covers an extensive bay formed by a promontory, of which Point St. Lazarus is the western extremity; here are two deep indentations affording excellent harbourage, Almejas Bay to the south, and Magdalena Bay, the larger, to the north; the former is twelve miles in extent, and covered by Mangrove Island, which is low; the latter is very extensive, and not fully explored, having numerous deep inlets which the French surveyors have named; Sir E. Belcher even thought these might be found connected with those from La Paz Bay, on the opposite coast. The mountains here are distant from the coast, which is for the most part low, the highest land being Mount Isabel, three miles and a half from Entrada Point, the southern extremity of St. Lazarus Promontory, which is only 1270 feet high; it is distant from Cape Redondo, the northern extremity of Magdalena Island, two and a half miles.

This coast appears to have been recently subject to upheaval, and to have been raised from below the sea level at no very distant period.

Cape St. Lazarus rises 1300 feet above the sea; between it and Abreojos Point, distant about 130 miles, the coast makes a deep bend, terminating below the latter in Ballenas Bay, an open and rocky roadstead. To the north is the threefold Bay of San Bartolome, affording good harbourage, and surrounded by mountains; and northward of this, Point San Eugenio forms the southern extremity of the extensive bay named San Sebastian Viscaino, after the well-known Spanish navigator. Off this point lies the small island La Navidad, and beyond, to the north, the larger island Cedros or Cerros, which is about thirty miles long, rugged, and high, with a remarkable peaked mountain at the southern extremity; this island covers the bay. The islets San Benito lie twenty miles to the north-west.

Northward the coast is dreary, being either sandy or volcanic. St. Quentin Bay, formerly known as San Francisco, affords good shelter, and is marked by a headland having five hills, from which it was once named; it is the Bay of Virgins of the early Spanish navigators, and the Cape retains the names, and its north point is Point Zunigas of Vancouver, off which lies the small but remarkable volcanic island, Cenizas or St. Hilario; the rocks are of recent volcanic formation, and the low lands covered with scoriæ; Cape Colnett is remarkable for its distinctly marked stratification, dividing it horizontally into two equal parts. To the north of this the mountains approach closely to the coast, which is lofty and rugged; here are the bays Los Todos Santos and San Diego, the latter an admirable harbour for vessels under 300 tons' burden; and to the north of this point the beautiful and fertile valleys of Upper California open on the coast. Portions of the coast here are low lagunes, and bituminous springs are found. The roadstead of Sta. Barbara affords good anchorage.

Point Conception is a remarkable headland rising perpendicularly out of the sea, and sloping gradually towards the low land with which it is connected; it is nearly 300 miles distant from Cape Colnett, and about 480 from Cape St. Eugenio, the coast forming an extensive bend between them marked as at the south by Cedros Island, so at the north by several, forming two groups, Sta. Catalina, and San Clemente, and Sta. Barbara on the south, and Sta. Cruz, Sta. Rosa, and San Bernardo on the north, these latter, with the mainland, form the channel San Bernardo.

Between Point Conception and Point Pinos, distant about 150 miles, the Sierra Sta. Lucia, which culminates 2700 feet above the sea, runs parallel and close to the coast; this is covered with wood, for the most part pine, but the comparative moisture of the climate keeps the valleys extremely fertile and verdant; Point Pinos forms the southern limit of the Bay of Monterry.

This bay, though so well known and capacious, being eight miles wide and six deep, is difficult of approach, on account of the fogs in which it is almost constantly enveloped, and by no means safe as an anchorage, while landing is difficult, from the heavy surf which rolls in on the sandy beach. It is noted for the numerous whales and pelicans which resort to it. The pine and oak forests here afford timber of excellent quality, only inferior to that in the north; from hence a sandy barren coast extends for thirty miles to the Bay of San Francisco.

This vast bay or harbour is one of the best, as it is one of the largest in the world; indeed, one of its faults is its size, which gives to the larger portions of its surface the character of a roadstead rather than a harbour: much of its southern side is also shallow, the entrance is narrow, and the coast exposed, and consequently the rollers set with great force on the bar. The channel by which this harbour is entered is about two miles wide and six long, having everywhere more than twenty-six feet water; the points at the entrance are, Lobos on the south, and Bonita on the north. Alcatraces Islet faces the inner mouth of the channel, and commands the entrance from within.

The harbour or gulf of San Francisco forms two deep bays to the north and south; that on the north forming the richer harbour of San Pablo, about five miles broad, the entrance to which, between Points San Pablo and San Pedro, is about one mile and a half wide, opposite which are two deep bights: and further south, on the west shore, Sausalito or Whalers' Bay, covered by the island Los Angelos, the largest in the whole harbour. San Pablo Bay is surrounded by high hills, and the cliffs at the entrance are of sandstone; it communicates by the Strait of Karquines with Suisun Bay, into which the river Sacramento falls. This bay winds fifteen miles to the south and east, and then stretches away twenty more to the north: vessels of the largest class can lie close to the shore. Towards the east the Sacramento River is also navigable, but to the north it is more shoal. The banks of the Sacramento are clothed with clumps of fine plane and oak trees, disposed in park-like order; the river frequently overflows its banks, and its floods are very destructive. Yerba Buena Cove lies to the south-east of the inner mouth of the entrance to San Francisco Harbour; it offers a fine roadstead, covered by the island of the same name, distant one mile and a quarter.

The land about this vast sheet of water is generally low, but the hills in the interior are high, and the country rises rapidly to the snow-capped sierra. The Sierra Diavolo, 3770 feet high, is opposite the entrance of the harbour, and marks the position of the mouths of the Sacramento and San Juan Rivers.

The peninsula which forms the outer basin of the harbour is marked by the Sierra San Bruno, which culminates in Blue Mountain, 1087 feet high. The northern peninsula is marked by Table Hill, 2569 feet in height, which is placed at the intersection of the two ranges, forming Whalers' Cove, and is seven miles and a half distant from the entrance of the harbour.

From the entrance of San Francisco, the coast trends north-west to Cape Mendocino, distant about 175 miles, and from thence nearly due north for

500 more to Cape Flattery, at the entrance of the Strait of Juan de Fuca. Few lines of coast of the same length are less broken, or afford less harbourage. To the north of the entrance of San Francisco is Port Sir Francis Drake, formed by the northerly extension of Point los Reyes ; it is surrounded by low white cliffs; here, as Vancouver supposes, Sir Francis Drake anchored and found shelter, but it is exposed to north and north-west winds. The Farrallones, a cluster of rocky islets, but rising 300 feet above the sea, lie off this port; beyond, the coast is high and rocky, but broken by the deep valleys, through which several streams find their way from the mountains to the sea.

3 *The Coast of Oregon and Vancouver's Island.*—Cape Mendocino presents two lofty promontories about ten miles apart, the northern probably being the true cape, though the southern is the highest; this is sometimes marked Point Gorda. Here the south-western spurs of the Great Sierra Nevada, which separates the valleys of the Sacramento and Columbia, stretch into the sea; to the north-east the apparently detached peak, Mount Shaste, which approaches 15,000 feet in elevation, marks not only the mouth of Smith's River, which is available for vessels of some draught of water, but the point where the coast range detaches itself from the Sierra Nevada trending north and west towards the mouth of the Columbia, and contiuued beyond it to Cape Flattery, and through Vancouver's Island, to the archipelago of the north coast.

Mount Shaste, like many other peaks on this coast, is a volcano, which has been in action at no distant period of time; from its sides, Smith and Clamet Rivers flow to the sea, their valleys limited to the north by another transverse spur, which forms Cape Blanco or Orford; to the north of which several small rivers flow from the western slopes of the coast-range to the sea, but none are navigable, nor does the coast present any harbour. To the south it is high, rocky, and comparatively barren, though iu many places covered with pine forests; to the north it is low, and the couutry undulating, and well clothed with timber, but rising inland in lofty and rocky peaks; the littoral being marked by occasional lines of sandy beach; but neither here are there good harbourages, although the mouth of the Umqua admits small vessels. From the north, Cape Orford appears as a long, low, rounded promontory, terminating in a high and precipitous cliff.

Cape Foulweather is a fine bold headland, and beyond it the coast rises, becomes steep and rugged, though in the valleys clothed with verdure, but gradually declining towards the mouth of the Columbia River, the southern point of which, named by Vancouver, Adams, is a long, low tongue of land, covered with lofty timber trees.

This river is navigable for fifty miles to the head of the tide water for vessels drawing fourteen feet at all times, but the surf on its outer bar is extremely heavy, and the entrance dangerous, although Point Adams is four miles and three quarters from Cape Disappointment, the northern limit of the entrance. There appears to be no danger in the river navigation, although, from the tortuousness of the channel, it is tedious. Baker's Bay, behind Cape Disappointment, affords good anchorage, as does Grey's Bay, some eight miles higher up, behind Chinook Point: the mouth of the Willamette River also admits vessels of burden. This is the outlet of so extcusive a valley that it cannot but hereafter become a port of first-rate consequence.

To the north of the mouth of the Columbia is Grey's or Whidbey's Harbour, which, though shoal, affords good anchorage and shelter, and receives the river Chekelis, which is also navigable for vessels of 200 tons for eight miles. From hence the coast gradually rises and becomes rocky but well wooded, the country inland mountainous, aud culminating in Mount Olympus, 10,000 feet above the sea. It is dangerous from the rapid currents which set on it, especially from the north and west: there are also detached rocks, aud one rocky island, named Destruction Island, about a league in circumference. Cape Flattery, remarkable as the point from whence Cook stood off the land at night and so escaped discovering Juan de Fuca Strait; the great navigator describes it as having a round hill over it, and says all the land upon this part of the coast is of moderate and pretty equal height, well covered with wood, and of a fertile and pleasing appearance; Vancouver has represented the greater part of it with much accuracy. It may, however, be added to this, that the interior is a mass of irregular mountains, culminating in Mount Olympus, 10,000 feet above the sea. The country between the Columbia, the Strait of De Fuca, and Puget's Inlet, forms indeed an extensive promontory, not less remarkable for its beauty than fertility, and attached by the low watershed of the valley of the Cowlitz to the continent.

The Strait of Juan de Fuca is universally recognised as the future centre of the trade of the north-west coast of America; few, if any, inlets of the ocean on any part of the globe present equal, none certainly superior, facilities for such a purpose than this; the safe anchorages and good harbours abounding in it are far too numerous even for mention; and throughout the 2000 square miles of area over which they are calculated to extend, there is no danger to the navigation of the largest vessels; its entrance is limited to the south by Cape Classet and Pillar Rock, a remarkable landmark rising from the beach, about 400 feet in height. Half a mile off the Cape lie Tatouche Islands: they are small, flat, rocky, and surrounded by numerous other rocks.

The northern shore of the Strait is formed by Vancouver's Island; of the southern little need be said; Neah Bay, five miles from the entrance, Callan Bay, seven miles further east, and Port Angelos, nearly thirty miles from the entrance, offer harbourage, and behind New Dungeness Point there is secure anchorage; but these are of no account in comparison with the almost unequalled character of Ports Discovery and Townshend, which, separated from each other by a peninsula from two to three miles in width, afford not only safe anchorage for any number of the largest vessels, but facilities for the construction of docks, scarcely to be met with elsewhere; in addition to a safe and extensive roadstead formed by Protection Island, off the mouth of the former.

Port Discovery is about seven miles deep and two miles wide, perfectly sheltered, with deep water and safe anchorage everywhere. Port Townshend is about five miles deep and two miles wide; it is covered to the east by two islands, lying parallel to each other; that to the west is three miles long by one broad, and that to the east five miles long by one broad, the channel between having from three to eight fathoms of water, and the south point of the west island connected with the main by a bank; and here is the entrance to Admiralty Inlet, leading to Puget's Sound, Hood's Canal, and their numerous bays, coves, harbours, and islands.

Points Wilson and Hudson form the extremities of the peninsula already named; these are distant from each other about two miles, and the former from Point Partridge, forming the entrance to the inlet, about five miles. This latter point is the west extremity of Whidbey Island, which is of irregular form, about thirty miles long, and Port Gardner is the entrance to Sinahomis River. Hood's Canal, the mouth of which is about ten miles distant from the south extremity of Port Townshend, extends about fifty miles into the land, with an average breadth of two miles, and deep water everywhere. At its entrance are Ports Ludlow and Gamble; within it, Suquamish Harbour, and Dahap and Colseed Inlets. Possession Sound, eight miles wide, to the south of Whidbey Island, forms the entrance to Puget's Sound, which stretches seventy miles into the land, and terminates to the south in four inlets, each about eight miles deep, trending south, besides two larger ones to the north; in its course to Fort Nisqually, at its south extremity, its breadth, which is very unequal, may average two miles: its extreme breadth across Vashon Island, nine; its least width in the narrows below, one: it carries deep water everywhere; the river Sinawamis debouches on its eastern shore: Ports Madison and Orchard, covered by Bainbrigge Island (eight miles long), afford most secure harbourage on the west; while to the south and east it may be considered one extensive harbour. Case Inlet, the most northern of those at its extremity, approaches within two miles of Hood's Canal, with Kelmso pond between them.

It has been noted that the north shore of Juan de Fuca's Strait is formed by Vancouver's Island; the eastern extremity of this lies north of New Dungeness, and between that and the land a group of islands which has never yet been fully surveyed, and which covers an area of twenty-seven miles from east to west, and twenty from north to south, and is separated from the island by Haro Strait, called by Vancouver—Canal d'Arro. The principal islands are Lopez on the south, San Juan on the west, and Orcas on the north. Rosario Strait affords a navigable channel between these and the smaller islands, Fidalgo, Guemes, and Cypress, which lie to the north of Whidbey's Island, and close to the land: and, with M'Laughlin Island, cover Bellingham Bay, which extends for fifteen miles in breadth, and five in depth; having its entrance between Points Francis and William, eight miles apart.

This group forms the southern portion of the Haro Archipelago, which stretches along the south-east coast of Vancouver's Island for more than sixty miles. The middle group, consisting of Saturna and two other islands, forms with the southern port St. Antonio; while the northern consists of a chain of islands separated by Dod's Passage from the shores of Vancouver's Island. To the north of this Archipelago, stretching from Bellingham Bay to the north-west, is the Gulf of Georgia, which may be estimated as 120 miles long and twenty-five broad, and which is connected with the sea to the north by Seymour's Narrows and Johnstone's Strait, which stretch north and west 150 more to the extremity of Vancouver's Island.

This island, now called after the great discoverer and surveyor of these regions, was originally named by him the Island of Quadra and Vancouver, in compliment to the commander of the Spanish squadron whom he met there, and whose officers surveyed the east coast of the island, which, in consequence, has not been so accurately rendered as the coast line of the continent, to the delineation of which, as given by him, subsequent surveyors have added but little.

Vancouver Island* is in extreme length from south-east to north-west 250 miles, and in extreme breadth seventy-five; the main watershed lies nearer the west than the east coast; the western slope is of primitive rock, and indented by numerous gulfs, bays, fiords, and canals: the eastern is of the carboniferous series, and affords extensive and valuable fields of coal, which, in so far as they are now worked, give importance to this island in the trade of the Pacific, and must make it the most important portion in this respect of the north-west coast, on which, south of this, so far as is known, coal does not exist. From Cape Classet to the opposite point of Vancouver's Island, Bonilla Point, is thirteen miles and a half, and from thence to the extreme southern point of the island, Cape Church, where it narrows to nine miles, the shores of the Strait are nearly parallel. The southern shore of the island is within that distance broken by Port St. Juan, four miles deep and one and a half broad near the entrance, and by Sooke Inlet and Becher's Bay near the eastern extremity, the former of which terminates in Copper Cove, a basin about two miles in diameter; while round the south point of the island, Esquimalt and Victoria Harbours lie open to the north-west of Ports Discovery and Hudson, from which they are distant twenty-seven miles. Esquimalt Harbour extends for one mile and three-quarters in nearly a direct line to the north, forming on the east the triangular harbour called Village Bay, one mile and a half long by three-quarters broad, with another smaller bay to the north. The entrance of the harbour is half a mile wide, but there are islets and rocks which impede it. Victoria Harbour is an irregular canal, four miles deep, terminating in marshes, and forming West Bay and James' Bay on the east; its entrance is about a quarter of a mile wide; it was originally called Camosac. The southern extremity of Vancouver's Island forms a bay twelve miles in extent

* See *Journal R.G.S.*, vol. xxvii., Col. Grant's paper, with map.

from south-west to north-east, called Royal Bay. The shores here are comparatively low, fertile, and well wooded, but opening on grassy prairies; the islands of the Haro Archipelago are also well wooded.

Dod's Passage is navigable: at the south is a deep inlet named Saamitel; at the northern extremity is Nanaimo Harbour, covered by Newcastle Island, and forming three inlets available for shipping; here the coal crops out on the coast in thick seams, and extends northwards along the coast for thirty-five miles to Valdez Inlet, which is ten miles deep. There is nothing further remarkable on the west side of the Gulf of Georgia. The east side is of a very different character; for, although as far as the mouth of Frazer River it is low, well-wooded, and fertile, from thence it becomes rugged, high, and rocky, lofty mountains approaching close to the coast, and deep indentations and fiords extending far up the valleys between them. Birch Bay lies to the north of Bellingham Bay, and is separated by another bay, formed by Point Roberts, from the mouth of Frazer River, which has formed a delta, and enters the sea by three channels, about eight miles apart. This river is navigable for vessels for twenty-five miles, but not even for boats in its upper course, on account of the rapidity of its current and numerous rapids and falls.

The sounds or fiords between Frazer River and the Narrows, are Bernard's Canal, Howe's Sound, and Jarvis' Canal; off the latter is Feveda Island, remarkable for its limestone rocks and the quality of its timber; Sangster Island lies to the south, and it is separated from the main by Malaspina and Rosario Straits; it is about thirty miles long and five in average width. Harwood and Savory Islands lie to the north, and beyond, at the entrance to the Narrows, an archipelago covering the mouths of Desolation Sound and Butes's Canal, the former named from the rugged and barren cliffs which characterize this coast, on which are only found a few pine trees, and down which the cataracts incessantly rush to the sea, and form the sides of the snowy range which rises above them

Seymour's Narrows extend from Point Mudge to Point Chatham, twenty-five miles, with an average width of one mile and a half. At the entrance of Johnstone's Strait, here five miles wide, Thurloe Island covers Loughborough Canal; Hardwick's Island succeeds, then Port Neville, then Call's Canal and Knight's Canal, and the deep inletsabout Port Philip, covered by Broughton's Archipelago, extending for thirty miles along the north coast, above which towers the rugged summit of Mount Stephens. On the southern coast there is Salmon River, but nothing worthy note until, at Neil Harbour and Beaver Harbour, so named from the vessel by which it was frs discovered, coal is again found. Malcolm, Cormorant, and some other islands, cover this part of the coast, and connect the south extremity of Broughton's Archipelago with the islands of Galliano and Valdez to the north, which are separated from the main island by the Golitas Channel, about two miles in width; they extend for about twenty miles in length and five in breadth, and here on the south side of the channel is the harbour of Newettee or Shoshautee. Cape Scott is the north-west extremity of Vancouver's Island, beyond it lie Scott's or Beresford's Islands, the largest of which is about five miles long, high, and rocky; the most westerly is fifteen miles further to sea, and there are numerous rocks between.

The northern part of Vancouver's Island is comparatively low, but the west coast rises and becomes rugged from Woody Point, fifty miles from Cape Scott; between these two points are several beautiful bays—opening into a fertile, well wooded, undulating country, with open prairies, abounding in game and fish—of which the only one known is the Sea Otter Harbour, and St. Patrick Bay of Hanna, which is the Bay of San Josef of the Spaniards. Sea Otter Harbour is an oval basin four miles long by two broad; St. Patrick's Bay is seven miles long by three broad, it receives the waters of several streams. From Woody Point, southwards, the coast approximates in character to that of the mainland. Nootka Sound is now known to be separated from a similar sound to the north, by the triangular island now called

Nootka, the sides of which may be roughly estimated at twenty miles in length, and at the south-east extremity of which is the Friendly Cove of Cook; these sounds terminate in five canals, the centre of which forms a basin, which receives the waters of two small rivers. Clayoquot Sound is covered by Flores Island, forming two entrances twelve miles apart, and Wieananish or Port Cox terminates in Tofino Inlet, twenty miles in length. These all partake of the same character as those on the mainland, but the rocks are not so high, and the trees much finer, and snowy mountains in the interior are wanting, though the mountains near the east coast sometimes retain their snowy covering till July; but Nittinat or Barclay Sound approaches nearer to that of the southern portion of the island. This sound is about fifteen miles wide and the same depth, forming two deep inlets, the Boca de Canavera to the north, of which nothing is known, and the Alberini Canal on the south, which extends from the head of the sound nearly fifteen miles, and approaches within eighteen miles of the east coast of the island; at its mouth is Port Effingham, about three miles deep by one broad, and affording all possible security and good anchorage. There are many islands in the sound, and from Cape Beal its southern limit to Bonilla Point is sixteen miles, from its northern limit to the entrance of Port Cox is twenty-seven miles, and from Point St. Rafael, at the northern entrance of Clayoquot Sound to Point Breakers, at the southern entrance to Nootka Sound, is nearly ten miles; probably no coast has more places of safety for vessels within the same distance.

4 *The North-west Coast.*—To the north of Vancouver's Island the same character is maintained along the coast which has been already observed, but that the mountains recede from the coast, the fiords become longer, and sometimes terminate in fertile valleys, and receive the waters of considerable rivers: the timber also, though still chiefly pine, is of large dimensions and regular growth.

Queen Charlotte's Sound, which leads to Johnstone's Strait, lies between the northern part of the island and Cape Caution. Twenty-three miles distant from each other, to the north of Cape Caution, are Smith's Inlet and Rivers' Canal; and, from hence, Fitzhugh Sound stretches northward, separating Calvert Island and the southern of Princess Royal Islands from the main, and terminating in four deep canals to the east, into the southern of which falls Salmon River, by which Mackenzie reached the sea, to inscribe his name on Point Menzies, which Vancouver had reached only a few days before.

Princess Royal Islands extend about 100 miles, and Pitt's Archipelago for about the same distance along the coast; and off these, at a distance of about forty-five miles, lie Queen Charlotte's Islands, as they are now known to be, divided into three principal parts, or groups, of 150 miles in length, with a base to the north of sixty miles; they are mountainous, but well wooded and fertile, abounding in minerals, and producing gold in some abundance; the southern point, Cape St. James, is distant from the nearest point of Princess Royal Islands about 100 miles; while the north-east point, Ymbisible, is distant only twenty-five. The northern group is divided from the central by Rennell's Sound, which is very extensive, and presents numerous indentations; the cliffs here are high and rugged, Hippa Island lies off the north entrance. Cartwright's Sound and Englefield Bay represent other dividing channels, in which numerous good harbours are afforded on the western side; but of the east little or nothing is known.

Prince of Wales' Archipelago lies about thirty miles to the north of Queen Charlotte's Islands; it extends for 100 miles in length and forty-five in width, being separated from the mainland, the islands of Revilla Gigedo, which lie at the entrance of Behm's Canal, and Duke of York Island, separated from them by Prince Ernest's Sound, by the Duke of Clarence's Strait, which also separates it from another archipelago to the north, unnamed, but which, more properly, may be considered as forming part of it. To the north, again, is Admiralty Island, about seventy-five miles long, separated from the main by Stephens' Passage, which terminates in Lynn Canal, the last on this part of the coast; from which, to seaward, lies King George the Third's Archipelago, extending for 125 miles in length by forty-five in breadth, separated from Admiralty Island by Chatham Strait, the north-west extremity of which is distant about ten miles from Cape Spencer, the south extremity of the mainland to the north; the entrance here is called Cross Sound.

These archipelagoes abound in secure bays and harbours; but, excepting for the fur trade, whale fishing, or for timber, there is nothing at present to bring vessels to the coast; and from trade on this coast British subjects are prohibited, by the licence of trade granted to the Hudson's Bay Company. In King George the Third's Archipelago is Sitka, or New Archangel, the Russian Fur Company's settlement, on the island of the same name. The port is formed by a cluster of small islands, and marked by the dome-like snowy cone of an extinct volcano.

From Cape Spencer, the character of the coast changes; the mountains rise, as it were, out of the sea; glaciers fill the valleys; and the snowy summits of Mounts Fairweather and St. Elias tower above the scene: yet, in the bays, fertile and wooded valleys are not wanting, although the coast is rugged and rocky in the extreme.

Behring's Bay lies between the mountains already named: here the coast trends to the west. Prince William's Sound extends for above 100 miles, covered by several islands, of which Moulagin Island is the largest, and beyond, Cook's Inlet stretches 150 miles into the land; and receives from the west the surplus waters of Ilaean Lake, lying at the foot of the volcano of the same name; which, with others, form the south extremity of the Tshigmit, or Big Beaver Mountains, which form the limit of the Valley of the Yucon in that direction, and from which the rivers flowing into Behring's Straits fall. From hence the coast bends southerly; and here are the Kodiak, or Kekklak, Islands, separated from the main by the Strait Chilikof, or Chilighoff, above 100 miles in length; and from hence the Peninsula of Aliaska and Aleoutian Islands stretch to the south and west towards Kamtschatka.

The Kodiak Archipelago differs little from those already described on the north-west coast. Its eastern shore presents several good harbours; of which the best is that of St. Paul: the western coast is little known.

5 *Aliaska, and the Aleoutian Archipelago.*—The Peninsula of Aliaska is in length above 300 miles, about 100 miles wide at the north, and gradually diminishing towards the south: it is high and rocky; presents active volcanoes; and has numerous lakes in the interior, by which passage is obtained across it. The most remarkable of these is Lake Nauonantoughat, which is connected with the sea by the river Ougagouk, which falls into the Bay of Pasto.

The small groups of islands named Eodokuf, Tchirigov, and Schemagin, may be considered an extension of the Kodiak Archipelago to the south: they are rocky and barren.

The Aleoutian Islands are separated from Aliaska by the Strait Isanotskoy; of these the first is Ounamuc, or Ounimack: they have been divided into several groups; the western, or Blignie, consists of Attou, Agattou, Semitsch, and Bouldyr; there are also the Rat and the Andrianoff Islands: while the eastern group is known as the Fox Islands, and extends from Ounimack to Amoukta.

Ounimack may be fifty miles long by twenty-five broad; it consists of numerous volcanic mountains, and culminates on the Chichaldinskoi Volcano, 8935 feet above the sea, and nearly in the centre of the island, Ruruk or Ommack Strait, is the best passage to Behring's Strait. Akoun is mountainous and precipitous, and has a volcano on its north-west extremity. Akoutan has a diameter of about twelve miles, and a volcano in the centre, rising 3332 feet above the sea. The largest and best known of these islands is, however, that of Ounalashka, or Nagomalashka, which is seventy miles in length; it has several good harbours, principally on the north shore. Illuluk, on the east, is excellent, but has a difficult entrance.

The Bay of Otters, or Bobrosaca, presents numerous safe coves and anchorages; it is formed by a peninsula, at the extremity of which is the Saganooda Bay of Cook. The Bay of Killialack, on the east coast, is also an excellent harbour. Ounalashka is of very irregular shape, the peninsula forming the Bay of Otters and Makouchinskoy Bay being forty miles in circumference; here are lofty mountains, among which the crater of a volcano is conspicuous. Onnimack, the next in size to Ounalashka, from which it is separated by a strait four miles wide, is sixty miles in length; it is the Amoughta of Cook; the mountains on the north of this island are covered with perpetual snow; it has two active volcanoes—Vevidonskoi, in the centre, which is the culminating point, and Tonliskoi, ten miles from the north-east side. The south coast of this island is steep and not very high, nearly straight, but presenting a few coves; here grass flourishes, and potatoes and turnips are cultivated, and a river discharges itself into Glonbokaia Cove; the east coast is steep and rocky, but not high; the north, though sandy, regular; the west coast is mountainous, but not steep. The island is remarkable for its hot springs.

To the north of Onnimack is a long reef, marked by a rock, named by Cook from its appearance Tower Rock; and within this the small volcanic island, Joann Bogasloff, which has appeared since 1796: it culminates 2240 feet above the sea. Yaounashka, to the south-west, is a mass of rocks almost inaccessible.

Amoughta, or Amouktou, the most westerly of the group, is about six miles in diameter, and nearly round. It is mountainous; its coasts low, but steep and unbroken.

Of the Andrianoff islands but little is known; Segonam or Gorelli is easternmost, and is distant from Amoukta fifty-five miles; it is larger than that island, and seems to be divided into three great volcanic masses. Amlia is narrow, and may be forty miles long; it is mountainous, but has no active volcano; on the south shore is Schretinkoff Harbour, one mile and a half deep and one mile and a half broad, sheltered at the mouth by an island and reefs on the east, but leaving an entrance open to the west. This island produces abundance of grass.

Atcha, or Atkha, is the largest of this group, being more than fifty miles long: the north part forms a mountainous peninsula, marked by an active volcano at the extremity, called Kororvinsko, and rising 4852 feet above the sea. Korovinskaia Bay, to the west, is six miles and a half broad, and affords shelter from all but northerly winds; it has two coves and an inner harbour, the entrance to which is however difficult; here is enormous quantity of fossil wood. The small island of Soleny (salt) lies to the west, and on the same coast are two good harbours; on this side is also Kourovskaia and the remarkable volcanic rock Koniouge. Mineral springs abound on this island, which everywhere bears evidence of volcanic action.

A group of small islands and rocks, named Tchastie, *i.e.*, crowded, lie to the west of Atcha, and beyond those East Sitkhin, about twenty-five miles in circumference, culminates in a snowy volcanic peak, 5033 feet above the sea. Kanaga, about twenty miles long by seven broad, has also a remarkable high volcano, as has also Tanaga (which is thirty miles long by ten broad), at the south-west point, near which is a bay receiving the waters of two rivers, and affording good anchorage and shelter. Goreloy, or Burnt Island, has a circumference of about eighteen miles; some small islands also lie to the west of Tanaga.

Of the Kryci or Rat Islands, Semsopochnoi, or the Island of Seven Mountains, lies fifty miles west of Burnt Island, the strait which separates them is the most easily traversed of any of the entire chain of the Aleoutian Islands. Semsopochnoi is circular, thirty miles in circumference; the mountains do not attain to the height of perpetual congelation; it has one active volcano on the north side. Amsthitka is about thirty miles long, comparatively low, and has only one bay, which is on the north side, and does not afford secure harbourage. Kryei, or Rat Island, from which the group takes its name, is seven miles long, and mountainous. Kirka and Bouldyr are also hilly and rocky, and there are rocks and reefs beyond them.

The Blijni group consists of two islands and many rocks, the name implies their nearness to Kamtschatka; of these, Agattou has a circumference of thirty-four miles, and is separated from Attou, which is one of the largest of the whole chain, by a strait fifteen miles wide.

Attou may be above forty miles in length; on the north coast is Tschitschagoff Bay, affording excellent harbourage, in lat. 52° 56′, and nine miles from the east point of the island.

Behring's and Copper Islands connect the Aleoutian chain with the peninsula of Kamtschatka, and within these islands, as far as Behring's Strait, is sometimes called the Sea of Behring, and here we find commencing that which is the peculiar characteristic of the east coast of Asia,—viz., extensive seas covered by chains of islands.

CHAPTER XLI.

THE WESTERN COAST OF THE NORTH PACIFIC.

§ 1. The Sea of Okhotsk.—2. The Sea of Japan.—3. The Yellow Sea.

THE Sea of Okhotsk.—This extensive basin lies between the 45th and 65th parallels of north latitude, and is surrounded by the peninsula of Kamtschatka on the east, the shores of Asiatic Russia, the island of Sagalin on the north and west, and the Kurile islands and Jesso on the south; it measures, from the shores of the island of Sagalin to those of Kamtschatka, 450 miles, and more than 1000 miles from Jesso to the northern coast, besides Shanstarki Bay to the south-west, and the still deeper indentations of the Gulf of Ghijinsk to the north-east: it is noted for the tempestuous character of its climate, and its low northern shores are covered with ice during the winter. The water is sufficiently deep everywhere, and the navigation unimpeded.

The peninsula of Kamtschatka is about 800 miles in length, by 250 in extreme breadth, but in the narrowest part behind Karaginski Island only sixty five. This island lies in the centre of a bay which extends for 180 miles, from Cape Gorenski, in latitude 59° 50′, to Cape Ozerni, in latitude 57° 35′. The southern part is known as Usinsk Bay; the shores appear to be low, but the water sufficiently deep; it receives several small rivers, among which the river Karaga, falling into the Karaginskaia Bay, may be mentioned; this offers harbourage, and the country round is well wooded. The island is fifty-eight miles long, with an average breadth of fifteen, but narrowing towards the south-west; it is mountainous, culminating about 2000 feet above the sea, the mountains rising in three distinct and parallel ranges, with deep ravines between them; the north and east sides are high and steep, the west marked by gently-rising sandy beaches; in the centre of the west side the gravel spit of Seminoff stretches seven miles to the south-west, with an average breadth of 300 yards, forming an excellent roadstead. This island has no harbour. Below Cape Ozerni is the northern mouth of the river of Kamtschatka, which has a course of about 200 miles to the north-east to the pond, from whence its two mouths separate, the one continuing for seventy-five miles its north-east course, and falling into the bay to the south of Cape Ozerni; the other and more important trending due east for sixty-five, and forming the Liman or Lake Nepitchie, about ten miles in diameter, before it enters the Gulf of Kamtschatka to the south; the two mouths are about sixty miles apart, but there appear to be other, or anastomosing branches between them. This river rises in a depression of the mountains near the sources of the Bolskaia, or Great River, which, however, has not so great a length by about fifty miles. The valley of the Kamtschatka is about thirty-five miles wide, and lies between the great central chains of the peninsula and the south-east volcanic range. The south-east slope is gentle, but the north-west steep. The volcanoes of the east coast are the characteristic feature of the peninsula; that of Shivelutch rises in three peaks in the centre of the triangle formed by the two mouths of the Kamtschatka River, and the peninsula surrounding Lake Nepitchie appears to be volcanic, between which and Cape Kronotski to the south the Gulf of Kamtschatka extends for seventy miles, separated from the Gulf of Kronotski by the spurs of the Kronotskaia volcano, and having the great Klocheffskaia volcano rising high above its western shore. The Klocheffskaia or Klutchevskoi volcano, so called from the springs at its base, forms a steep truncated cone about 16,000 feet in height, to the north of which rise two other flattened mountains, while a serrated ridge extends to the south; these are all covered with perpetual snow. The Kronotskaia volcano rises 10,610 feet above the sea, and is also conical; on the west slope is a considerable lake; other lofty peaks are seen in the interior, but not forming a connected range. The coast here is high and rocky, but the country well wooded. The Gulf of Kronotskoi extends for more than 100 miles; Cape Shipanski, the southern extremity, is formed by the spurs of the Journanov or Jupanoff volcano; as the bay to the south is limited by those of the volcano Vilutchin; this latter is conical in form, but does not much exceed 7000 feet in height. Within the bight thus formed lies Avatcha or Awatska Bay, more properly Swaatscha, which is reached by a channel four miles long and one broad, and forms an irregular basin ten miles in diameter; it contains several excellent harbours, that of Petropaulovski on the east is best known, and will receive the largest vessels; that of Rakorya, to the south, is equally excellent, but not quite so accessible; that of Tareinski, to the south-west, is also of great size and excellence. Although the shores are in many places low, the land rises in gentle and well-wooded undulations, backed by the volcanic ridges already referred to. To the south of this bay, the most important in Kamtschatka, the coast is high and rocky, broken only by small indentations, and trending nearly south-west; to the southern extremity, Cape Lopatka, in latitude 51° 2′ N., longitude 156° 50′ E., which is low and flat, and of a form corresponding to its name, *i.e.* the blade-bone of a man.

Off the east coast of Kamtschatka lie the Romandovski or Governor Islands, named after Behring; these, as has already been noted, are not to be considered as a portion of the Aleoutian chain, although they connect the volcanic ranges of America with those of Asia. Behring's Island, the westernmost, distant 100 miles from the coast of Kamtschatka, is about fifty miles long by fifteen broad, narrowing towards the south: a range of mountains extends through the island, rising above 2000 feet. The coasts are rocky and dangerous, and there is only a small and badly sheltered harbour on the north. Cape Manati, the southern point, is in lat 54° 41′ N., long. 123° 17′. Meduy, or Copper Island, is about thirty miles long and five wide, though in many places not more than two: there is a small harbour on the north-east. Like Behring's Island, this is rocky: on neither are trees found; but the former abounds in small rivers, the margins of which are fertile: there are not any active volcanoes on either.

The western coast of Kamtschatka is little known; it is, however, low and sandy, for twenty-five miles inland producing willow, alder, mountain ash, and birch; and broken by numerous streams, which flow from the mountains. Of these only the Bolskaia, or Bolchoireka, already mentioned, deserves the name of a river: it has two affluents about twenty-two miles from its mouth, the Gottsofka and Bistraia, and the estuary is accessible for vessels of considerable size: to the south is the Opulnaia volcano. The coast shoals gradually, and spits of sand form small narrow gulfs parallel to the coast line, which is very regular: the principal of these is the Gulf of Chkanigitch, about 100 miles north of the Bolshaya. The principal projections of the coast line are Capes Ntkolokoki; Omigon, to the north of which the Tigel, the largest river of the north part of the peninsula, flows into the sea; and Pyati Bratski, or the Five Brothers.

The north-east angle of the Sea of Okhotsk is extended in a deep bay called Ghijinsk Igiginskoi, or Jieghinsky, of which little more is known than its general form and size; it is rectangular, and about 150 miles long by 120 wide: at the north-east extremity the Gulf of Penginsk or Pengina, stretches far into the land, and receives the waters of two considerable rivers, the Talofka or Galofka, and Penginsk or Pengina. The former is described as flowing through a well wooded country, and as having its rise in lakes; the latter as broad, but cumbered with ice heaped upon its shores; between them extend large plains covered with broom. The mountains here approach closely to the coast, and two other rivers, the Oklana and the Egatcha, fall into the head of the Gulf.

The Gulf of Penginsk is about fifty miles wide and 150 long; it is separated from another gulf, not nearly so extensive, by a peninsula of about the same width, terminating in Cape Pororatim. This gulf also receives a river at its extremity, which gives the name Ingiga, or Ghijinsk, to the whole bay; and the coast is here more broken, presenting on both sides bays, of which, however, little more than the names are known. At the south-west angle of Ghijinsk Bay is Jamskaia Bay, which also receives a river of some magnitude, and the peninsula separating it from the Sea of Okhotsk terminates in Cape Piaghin, off which lie several small islands.

The northern shore of the Sea of Okhotsk is broken in the centre by Tanok Bay, about fifty miles in width, which receives the river Toya from the west, besides other streams: its shores are low and deeply indented, as are those of the sea for seventy miles to the west, when volcanic cones begin to appear; and from thence the coast is high and rocky. At the north-west angle the River Okhotsk falls into the sea, and many other small rivers break the northern and western coast line. The junction of the Okhotsk and Kaktui forms a shallow harbour, not easily accessible, but, it is said, the best on that coast: the land surrounding it is low, marshy, and barren. On the west coast the Gulf of Aldom and Port Aian may be named; the latter a secure harbour about one mile and a-half long by one and a-quarter broad at the mouth, with sufficient water for large vessels.

At the south-west angle of the Sea of Okhotsk is Shantarski Bay, in which are the islands of the same name, and which forms three deep bays or gulfs of very irregular form. The Shantar Islands are four in number, rocky and barren; the largest, Great Shantar, is about thirty-five miles long and twenty broad, presenting an open bay to the south, and a deep cove to the north-east. Feklistoff Island, the second in importance, is about twenty-five miles long and ten broad, also having an open bay to the south: the others are unimportant. To the west of Feklistoff Island is Uaski Bay, receiving the river Uda from the south; it is about forty-five miles in extent. Tugursk Bay is about fifty miles deep, and forms at the extremity a basin, into which the Tugur discharges its waters; it is separated by an irregular rocky peninsula from the Gulf of Akademia, into which the river Usalghoi flows to the east, forming the gulf of the same name, and separated from Ulbonski Bay, which is about twenty miles deep by fifteen wide, by a low narrow spit: near the entrance of the Gulf of Akademia, on the west side, the Gulf of Konstantia affords safe harbourage. From hence an irregular coast trends east and south to Cape Romberg, in lat. 53° 26′ N., long. 141° 15′ E., the eastern limit of the Asiatic Continent.

The island, or as it was formerly considered the peninsula, of Saghalin, is remarkable not only for its great length in comparison with its breadth, the former being estimated at above 500 miles, while the latter does not exceed sixty, but for its peculiar position at the mouth of the great River Amur, or Saghalin-ula, from which it is separated by the Liman, or Lake Amur* or Amur, which communicates with the Sea of Okhotsk on the north, and the Gulf of Tartary on the south. This lake is about seventy-five miles long by thirty broad, and though in many parts shallow, has a narrow channel, with deep water through it, which neither Broughton nor La Perouse discovered. The Amoor flows into it on the west side, separated from the Sea of Okhotsk by a rocky peninsula about twelve miles wide: the mouth is accessible by two narrow and comparatively shallow channels, between which the great banks deposited by the stream stretch into the Liman: it opens first to the north-west for sixteen miles, flowing between rocky banks, with a breadth of four miles, the water deepening to twenty fathoms; and then bends suddenly to the south-west, forming a lake-like basin thirty-seven miles long by eight broad. The northern entrance to the Liman of the Amur is about twelve miles wide, but the channel is reduced to four; the southern entrance is only about two and a-half miles in width: both coasts are deeply indented, but present no harbourage from the shallowness of the water; but to the north, on the west coast of this island is the circular basin known as Obruan Bay. The northern extremity of Saghalin, Cape Elizabeth, is in lat. 54° 24′ N., long. 142° 7′ E., a naked mass of rock, the extremity of a spur from the mountains which extend through the island. Cape Maria, to the west, is distant about seventeen miles, which is the breadth of the island to the north. North Bay lies between these capes. The northern part of the island, though mountainous and rocky, is covered with luxuriant forests; the north-east coast is, however, dreary in its appearance, consisting entirely of granitic rocks. From Cape Klokatcheff, in lat. 53° 46′, the coast becomes low and sandy, rising in rounded hills; but at Cape Delisle de la Croyere the coast becomes again rocky, and the interior mountainous. There appear to be rivers on the coast, which, however, have not been explored.

Cape Patience, the eastern extremity of the island, is in lat. 48° 52′ N., long. 144° 46′ E.; it is low, and stretching to the south forms Patience Bay, which extends seventy miles to the west; its northern coast is mountainous and rugged, and lofty snow-capped peaks rise in the interior, excepting in one part, probably the valley of the river Neva, which debouches into the head of the Gulf. Cape Somionoff, a high promontory, is the limit of the bay on the west, to the south of which the island forms a long promontorial extension, of about thirty miles in average width for 120 or more, when dividing, it stretches north-east and south-west, surrounding an extensive sheet of water called Aniwa Bay, sixty miles across at the mouth, between Capes Siretoko and Nottoro, the Aniwa and Crillon of Vries and La Perouse. Cape Aniwa is rocky and barren, but the country at the head of the bay is beautiful and fertile, and affords abundance of the finest timber.

The eastern coast of Saghalin south of the Bay of Patience, is irregular and broken. Cape Tonin, in lat. 46° 50′, forms Mordwinoff Bay. Of the western coast of the island little is known; it appears to be broken by numerous indentations, in which, from the proximity of the mountains to the seaboard, there is no doubt deep water. Estaing Bay, under the same parallel as Cape Somionoff, is a basin six miles in diameter; and at Jonquière Bay, under the same parallel as Cape Delisle, there is good shelter from the south-west, and coal is found. Two small islands lie off Saghalin: Robben Island, noted for the dangerous reef which surrounds it, fourteen miles from Cape Patience, and Totomoseri, the Monneron of La Perouse, about 23 miles from the western coast, to the north of Cape Nottoro. Saghalin was called by the Japanese Yezo, or Jesso Uka, *i.e.*, Northern or Great Jesso, to distinguish it from the Yezo or Jesso, with which they were well acquainted, which is separated from it by La Perouse Strait, twenty-five miles in breadth: this, with the Kurile Islands, completes the cincture of the Sea of Okhotsk, which may thus be said to be landlocked. These islands are above twenty in number, and stretch in a scattered chain from Kurile Strait, which separates Shumshu

* See *Journal R.G.S.*, vol. xxviii., for account of the Amur.

Island from Cape Lopatka, the southern point of Kamtschatka, in lat. 50° 50′ north, to Yezo Strait, which separates Kuna-siri from Yezo, in lat. 43° 50′, thus extending through five degrees of latitude and ten of longitude.

We owe our knowledge of these islands to Broughton, La Perouse, Vries, and Golownin, and the straits between the islands commemorate their names or those of their vessels. The islands owe their general appellation to the volcanoes which are found in the more northern, the same term, "smoky," being applied to the lake at the southern extremity of Kamtschatka, between the volcanoes Itterna and Kosheliova. Kurile Strait is only eight miles broad, but has deep water. Shumshu Island is low, of rectangular shape, fifteen miles long by ten broad; it is separated by Little Kurile Strait from Paramushir Island, the most important of the northern division, which is about sixty miles long and fifteen broad; it is lofty and of irregular outline; to the north-west, distant ten miles, is the little outlying island Alaid; and to the south-west, distant five, the still smaller island Shrinsky. Onnekotan is separated from Paramushir by Amphitrite Strait, nineteen miles broad; the island is near thirty miles long. The ten islands between this and Simusir are all inconsiderable, but this last deserves notice; it is twenty-seven miles long, mountainous, and has a port at the north end affording shelter to small vessels, named after Broughton. This island forms the north limit of Boussole Channel, which divides the Kurile Islands into two groups, the Russian and Japanese. Boussole Channel is nearly sixty miles wide between Capes Rollin and Itoientomo (Cape Kastriku of Golownin), the south-east and north-east extremities respectively of Sumisir and Urup. Three small islands lie in the channel; these were in mistake named by La Perouse "The Four Brothers," the northern, which is a high bare rock, is named Broughton Island; Urup, Ouraup, or Company's Island, also called by the Dutch Staaten Island, is above fifty miles in length, but only eight in extreme breadth; some rocky islets lie off the north point; Yturup, or Itouroup, by some considered the Staaten Island of the Dutch, is of very irregular form, above 130 miles in length, and exceeding twenty in extreme breadth, but narrowing in more than one place to three miles; there is a deep bay on the south-east, between Capes Nonesio and Torimoinots, which are distant from each other ten miles, and one still larger on the north-west, between Capes Itobiri, Kawoi, and Moikeri. Cape Ikabanots is the extremity of a rocky peninsula, which stretches ten miles into the sea from the north-west side of the island, on which there are several small lakes and rivers. Peco Channel, between Capes Teriko and Moimoto, eighteen miles wide, separates Yturup from Kuna-siri, which might well be considered one of the Japanese group, lying within the deep bay formed by the north-east part of Yezo. It is of irregular form, and its shores deeply indented; the eastern coast forms a slight curve, the chord of which, from Cape Moimoto to Cape Keramoiu, the south-east point, is fifty-five miles, in the centre of which a peninsula extends for four miles, forming apparently harbours on either side, which are separated from one on the west side by a distance of only one mile. Cape Moimoto is distant from Cape Rewansi, the north-west point, twelve miles, and there is a deep bay between them and a rocky islet off the east point. Cape Keramino is distant from Cape Itorin eight miles; there is a bay also between these. The island may be considered fifty-eight miles in extreme length and ten in extreme breadth, which is at the north part.

These islands are noted for the rapidity of the currents which surround them, and the fogs which envelope them; the climate is strictly maritime, and of their productions little is known.

The Gulf of Tartary, gradually widening towards the south, from the narrow channel which connects it with the Liman of the Amoor, opens in the Sea of Japan, between the Island of Yezo and the main, which are distant about forty-five miles. The east shore, formed by the Island of Saghalin, has been already noticed; of the west little can be said; its general trending is north-east and south-west, and from Cape Crillon, in lat. 45° 14′, to the entrance of the Liman, may be 470 miles; its mean breadth may be seventy miles; the surface is unbroken by islands, excepting in the bight formed by Cape Lesseps, in lat. 49° 30', where there are two, named Blondela and Le Prisi, eighteen and seven miles in length respectively. To the north of Cape Monty, in lat. 50° 38', there is an extensive bay, with deeply indented coast, promising harbourage, which is found in Castries Bay, in lat. 57° 30'. This basin is about two miles in diameter, and contains four small islands: its shores have also several coves.

2 *The Sea of Japan.*—This sea extends from the Strait of the Corea to La Perouse Strait, more than 700 miles from south-west to north-east, and is more than 500 miles broad in the centre. The southern part, between Mantchoo Tartary, the Corea, and Niphon, forms nearly a circle, with a diameter of about 500 miles; the northern might be considered the extension of the Gulf of Tartary, and like that gulf, its surface is unbroken, excepting by some small islands to the south: it has also steep shores and deep water everywhere.

The coast of Mantchouria and the north-east coast of the Corea are little known and less frequented; they are irregular, broken, and rocky; the country mountainous in the interior, and well wooded. The Bay of Motao, under the thirty-ninth parallel, extends for fifty miles, and contains numerous islands.

The Japanese Islands stretch for more than 1000 miles between the south point of Saghalin and the Corea; they consist of two principal, Yezo and Niphon; two smaller, Kiusiu and Sikok; besides many other islands and groups of less importance, they are mountainous, rising in volcanic peaks, some of which exceed 12,000 feet in elevation; are well watered with rivers and lakes, fertile, and well-wooded; abounding in minerals and metals, including gold and coal. These islands present two climates, the western approaching to the continental, permitting the growth of vegetables of the temperate zone, severe in winter, hot in summer; yet with the limit of perpetual congelation as low as 8000 feet in some places: the eastern, maritime, in which many of the vegetables and fruits of the tropics are found, and rice and sugar are cultivated largely; and although of course the temperature and productions vary considerably within so many degrees of latitude, yet the difference in longitude produces effects much more striking in this respect.

The Island of Yezo Jesso, *i.e.*, the Coast, or more properly Einso, from the name of the native inhabitants, is of irregular cruciform shape, extending about 300 miles from north-east to south-west, and about 200 from north to south; or it might be fancifully described as a fish, of which the coast of Yezo Strait would be the head, and the south-west extremity the tail. The north-east side extends about forty miles from Cape Soya to Cape Kaminüroka; within this distance there appears to be one bay or harbour at Sarwia; from Cape Kaminüroka it makes a wide sweep, forming an extensive but not deep bay, to Cape Siretoko, distant about 150 miles. In the bottom of the bay a lagune fifteen miles long by five wide is formed by a spit, and a harbour appears to the east of Cape Nottoro. Several streams fall from this coast, those to the east being the more considerable; Cape Siretoko, or Spangberg, is distant fifty miles from Cape Uossyam or Broughton; the eastern extremity of this island, in lat. 43° 38' N., long. 46° 7' E., off which are five rocky islands and numerous islets, extending for thirty miles in a north-west direction: between these capes, Yezo Strait makes a deep rectangular bend: here also a spit twelve miles long projects; and in Laxman Bay two deep indentations are found. From the east point the coast, off which are several small islands, trends west and south for 100 miles, when the deep Bay of Good Hope presents itself, forming two basins, protected to seaward by the peninsula of which Cape Horason is the extremity. From Cape Seriba, the west extremity of Good Hope Bay, the coast forms a wide bay, extending for about ninety miles to Cape Yerimo (Eroen or Evosn?) under the forty-second parallel; on the eastern side of this bay two rivers, the Kasuru and Aleanbets, bear the surplus waters of two considerable lakes to the sea: these lakes lie among the volcanic peaks of the north-east of the island, of which, in that part, Atosya, Akani, and Matsunesiri are the most prominent. To the west of Cape Yerimo the coast trends north and west, and then bending to the south-west, projects in the irregular promontory of Cape Yetomo, distant from Cape Yerimo seventy-five miles; beyond this is the circular basin called by Broughton Volcano Bay, thirty miles in diameter, the bottom of which is not, probably, more than twenty miles distant from the north-west coast of the island; a glowing description of the beauty and fertility of the country round the bay is given by that navigator. To the south is a triangular extension, terminating east and west in Capes Yesan and Sirakami, or Nadjiedja, the southern point of the island, in lat. 41° 21′ N., long. 140° 9′ E., having Kakodadi Bay—a secure harbour six miles across, formed by a peninsula three and a-half miles long—between them. These two capes form the limits of the Strait of Sangar, which separates Yezo from Nipon, and is twenty miles broad at the western, and thirty at the eastern entrance.

The western coast of Yezo extends in an irregular undulating line to the north for above 100 miles to Cape Simawoi: about fifteen miles from this coast lies the small triangular island Okosiri, about fifteen miles long and ten broad; the still smaller islands Usimra and Kusimra are placed respectively thirty and ten miles from the southern part. To the north, between Capes Simawoi and Wofui, Stroganoff Bay extends for forty miles, receiving the water of the largest river of the island, Isikari, which, rising in the centre of the island, may have a course exceeding 150 miles, and receives from the right an affluent which makes its course, parallel to the west coast of the island, for about forty miles, at an average distance of fifteen miles, throughout which the coast is steep. To the north of Cape Wofui the coast forms two arms, terminating in Capes Tornamoi and Isya, distant respectively about forty miles. Ten miles distant from the former are two small islands, and about the same distance from the latter, Risiri, the Langle of La Perouse, about ten miles in diameter: and the same distance beyond it, Refunsiri, which is rather larger. To the south of Cape Isya another considerable river falls into the sea. The northern extremity of the island forms a bay, called Romanzov, between Capes Nossyab and Soya, which are distant about twelve miles. The latter, the north point of the island, is in lat. 45° 31′ N., long. 141° 51′ E., and is distant from Cape Nottoro, the south point of Saghalin, thirty miles.

A volcanic band appears to run through this island from Cape Siretoko to the western coast; many of the peaks are lofty, but their elevation is not ascertained: even the names differ so much in different accounts, that identity is impossible; but the Saddle Mountain, near Kakodadi, exceeds 3000 feet in elevation, and it is probable that many exceed 5000, and some 10,000 feet, since the Pic de Langle, in the island of the same name, is estimated as exceeding 5000.

The Island of Nipon, or Niphon, gives its name, which it derives from the sun, to the whole archipelago, of which it is the largest; its western side forms an irregular arc, 600 miles from north-east to south-west; while its south and east sides are respectively about 400 miles long; and in the centre, where it is broadest, it does not exceed 200 miles from Cape King to Cape Noto, the extreme points north and south; while towards the north the breadth decreases to seventy-five, and to the west to sixty miles. The northern extremity of this island is formed by two peninsulas, enclosing the double Bay of Awomori; the western bay, opposite the entrance, being twenty miles long by seven broad; and the eastern, or inner, twenty miles long by as many in extreme breadth; the entrance is about seven miles wide. The eastern peninsula is triangular, having its sides about twenty-five miles long, and terminating in Cape Toriwisaki, the most northern point of the island, twelve miles south of Cape Siwokulu in Yezo. Both peninsulas present elevated though insulated masses, on the north-east culminating 3200 feet above the sea: the land round the Bay of Awomori being flat, and in many parts marshy. Twenty miles to the south of the bay a mountain range commences, which, running nearly north and south, divides the island for about 150 miles, and presents numerous elevated peaks, and giving rise to the Akita and Sakuda Gawa rivers; the latter of which is the largest, and may have an irregular course exceeding 100 miles, through a country presenting some considerable elevations. On the east the Figami Gawa rises among detached mountains, and flows for more than 100 miles parallel to the mountain chain already noticed; in the lower part of its course it flows through level marshy land. To the south of the mountains, under the thirty-eighth parallel, level land appears across the whole breadth of the island, broken only by some detached hills; and here the Sugawa rises from a lake about ten miles long, and receiving the Datami Gawa from the left, flows in a broad stream for about eighty miles to the sea, through low marshy lands; while to the west the Suiano Gawa, rising in the centre of the island, flows through the same marshy plain after a course exceeding 180 miles. The mouths of these rivers are covered with islands, probably formed by the deposit from their waters. To the east, the Tene Gawa and other streams falling from the opposite slopes of the same watershed as the rivers already named, unite in a network of canals and lakes, and find their way to the sea by two channels; the eastern, called the Sassa Gawa, about seventy miles to the north of Cape King, the south-east point of the island, and the western, called the Toda Gawa, into the Bay of Yeddo. These drain a semicircular plain, fifty miles in diameter. Of the height of the mountains in the centre we know nothing; but it may be conjectured that they are not of very considerable elevation, for further west the valleys of the Frine Gawa to the north, and another smaller river to the south, stretch across the island; and though to the west of the former there appears a range of some elevation, yet the greater portion of the country seems low and marshy; and still further west a deep gulf stretches from the south to within thirty miles of the northern coast, and within twenty of Lake Biwano-oumi, which is only twelve miles distant from the northern shore, is thirty-five miles long, and approaches within thirty miles of the Bay of Amagasoky, into which it discharges its surplus waters. The western extremity of the island is low, but also presents detached eminences, giving rise to several rivers, but none of course of any size.

The eastern coasts of this island are for the most part low and marshy, forming numerous indentations and bays; some, as those of Nambo and Usima, of considerable extent, the former being about ten miles wide and the latter seven, both containing islands. At the mouth of the River Figami lies the island of the same name, thirty-five miles by twelve in extreme length and breadth, with very irregular and indented coasts. Several small islands lie off to the east, and to the south Kuskoa Sau, and some smaller islets; to the west is the Bay of Sanday, twenty miles wide and as many deep, and containing several islands, the principal of which are Tazioro and Nagafama. Within Cape Kennis, and in the river Samagawa, to the south of Cape Kona, under the thirty-seventh parallel, deep inlets appear, as also at the mouth of the river Nawagawa; but of the value of these little can be said.

At the south-east angle of the island is the Bay and harbour of Yeddo; the former extending in breadth sixty miles from east to west, from Cape King to Cape Idsui, and more than forty miles in depth, the latter forming a land-locked basin twenty miles in diameter, but said to be very shallow, which is approached by a strait twenty miles long and about eight broad, the entrance being on the east side of the outer bay, which is called by Krusenstern Odawara Bay. From the centre of the outer bay, a range of small islands, known as the Brisees, or Broken Islands, stretches to the south; these are volcanic; the second, named after Vries, is about five miles in diameter; Fiatsizin, the most southern but one, twelve miles long; the others small; the most southern small isle is in lat. 32° 30′: they are about twelve in number, besides islets, extend for 150 miles, and are from ten to forty miles distant from each other.

Cape Idsui is the extremity of a peninsula thirty miles long by fifteen wide, from which the volcanic snow-covered cone of Mount Fusi rises more than 10,000 feet above the sea; it separates the Bay of Yeddo from another extensive gulf to the west, which is about thirty-five miles deep, and thirty broad at the mouth; and about sixty miles further west is the still more extensive gulf already alluded to: it receives the water of two rivers at the extremity, at the mouths of which are several islands, probably deltic, Kando, the most southern, being about eight miles long; from the southern point of which the gulf stretches forty miles to the mouth, with an average breadth of eighteen, but forming at the east another bay, the entrance of which is ten miles wide, and situated immediately behind Cape Irako Saki, the south-eastern extremity of both bays, which is distant from Moukari Island, the south-western limit of the larger, only twelve miles. From this gulf a very irregular coast stretches south and west to the southern point of the island, off which is the small island, Oosima, about five miles in length. From hence the coast stretches north and west for fifty miles, and north and east for forty, and forming the deep Bay of Avasima, in which lies the island of the same name, terminating in a smaller bay leading to the harbours of Amagasaky and Oosaka, within the mouths of the rivers already mentioned, by which the waters of Lake Biwano are united with the sea; the mouths of these rivers are not, however, accessible to large vessels. From hence the coast trends westward for 200 miles, and on the bight thus formed lies the Island of Sikok, separated from Avasima by a narrow strait about five miles wide, obstructed by several islands, and both difficult and dangerous from the violence of the currents which flow through the narrow channels thus formed. Avasima is mountainous, triangular in shape, thirty miles long and fifteen broad.

King Channel separates Sikok from Nipon; on the east, in the narrowest part, between Capes Awa and Sira-saki, it is ten miles broad; from the former to the south point of Avasima is about twenty miles; while from the north coast of that island to the small island at the entrance of the great Bay Suwonada, a distance of 200 miles, the breadth of the northern or minor channel varies from eight to thirty miles. The Bay or sea of Suwonada is formed by the shores of the Island of Kiusiu, which here approach so closely to those of Nipon as to leave only a very narrow entrance into it from the west; it is about twenty miles wide at the entrance, and within about thirty in diameter.

The north-west coasts of Nipon differ from the southern: they are covered with reefs, rocks, and islets, in some places rising high, as at Cape Louisa 1800 feet, above the sea; here the bays of Tamada and Oo-oura may be mentioned, also a land-locked basin to the west, and the Gulfs of Motuye and Yoneko to the east of Cape Itsuomo; the former being twenty miles deep by eight in breadth, the latter twelve by four, and access being obtained to both by the same entrance, which is about two miles wide, formed by two projecting peninsulas, the one covering the latter lying at the bottom of a bay ten miles wide, the other stretching eastward for nearly forty miles, off which, at ten miles' distance lie the Oki Islands, extending fifty miles from north-east to south-west, and twenty-five from north-west to south-east, and culminating 300 feet above the sea.

From hence the coast trends east for 150 miles, it is deeply indented, and here the bays at the mouth of the River Karou-gawa at Wakasa and Kobama may be noticed, also a deep bay to the east of Cape Tati Yissi, which forms the east angle of the coast, and approaches within twelve miles of Lake Biwano; from hence the coast trends north and west for more than 100 miles, and here several deep inlets present themselves,—Daisioozi Bay, that at the mouth of Alaka-gawa River, Minato Bay, Moto-gawa Bay, and Fakuura Bay, to the north of which a promontory stretches north and west to Cape Noto, where the hills on the coast gradually rise from 800 to 2000 feet, terminating in 700 at the Cape itself, within which is Samaura Bay, a deep inlet containing a considerable island, to the east of which is Toyama Bay, fifteen miles in extent, which receives the waters of two rivers, the mouths as usual forming deltic islands. From Cape Yetsiu, the eastern limit of this bay, the coast trends north-east, north, and north-east, to the extremity of the island, 300 miles; here Takala Bay may be named, and the islands of the delta of the Sinano and Ditami Rivers, forming numerous channels, and Lakes Niegata and Toreganc, and extending for thirty-five miles, off which lie the Sadi Islands, two in number, the inner being mountainous, and culminating 4500 feet above the sea, the outer, separated from it by a strait fifteen miles wide, forty-five miles long, by twenty broad, having on the south the land-locked basin of Sawami Bay, eight miles in diameter, and rising in the centre in high mountains.

Beyond these islands, to the north, the coast is more regular, though having Awa Sima Island off its southern part, and broken by the mouth of the River Sakada and by Kara Matusake and Minata Bays, the latter receiving the waters of a river which rises from Lake Fatsirugata, distant about thirty miles from the coast. To the north of Minata Bay is an islet twenty miles deep and five wide, but of irregular form, approached by a strait five miles long by about one in breadth, both formed by the Peninsula of Ogasima, the coasts of which are curves having chords respectively of twenty and twenty-five miles in length, attached to the land by an isthmus not more than two miles wide, but ten miles wide at the extremity, and forming a semicircular bend to the north; at the south of a bay extending forty miles to Cape Hokiri, the north-west angle of the island, from whence, to Cape Tatsupi-saki, the west entrance of Tsugar Strait, is fifty miles, and from that to Cape Sirikani, the opposite point of Yezo, twelve miles. This strait opens to the south in Awomori Bay, and to the north in Hakodadi Bay.

The Island of Sikok is of rectangular form, about 130 miles long by fifty broad; on the east, the rivers Tosing-gawa and Nanga-gawa fall into King Channel: the mouth of the former is covered by deltic islands, and opens in a bay ten miles deep and five wide; and from thence to Cape Awa, a group of islets cover the coast. The southern coast is deeply indented, especially to the east, presenting several bays and islands, of which Kabouto-oura may be the most important; to the east of which a peninsula extends to the south twenty miles, terminating in Cape Muradono-saki. Further west is the deep Gulf of Takatsi, enclosing the island of the same name, and beyond this the River Yetsitsu falls into another gulf forming two bays, covered by the Peninsula Kouatoumsaki, and near the south extremity of the island, Cape Tosa, another river falls into the sea. The western coast presents deep bays, formed by projecting tongues of land, and has several islands off it; of the former, the most worthy of notice is that of Misaki, which extends for twenty miles, with a breadth not exceeding two, and approaching within ten miles of the little island Takesima, which lies close to the peninsula of which Cape Boungo is the north extremity. Misaki Point forms with Cape Oogakino, to the south, a deep bay, ten miles wide at the mouth, and several small bays indent both sides of the peninsulas, of which Mikino Bay, to the north-west of Misaki Point, is the most important. From hence to Cape Yemafar the coast trends north-west comparatively unbroken, but having several islands off it, of which Okoey may be noticed as lying in mid-channel between the Sikok and Nipon. There is a small bay to the east of Cape Yemafar, and more easterly one extending for twenty-five miles; beyond this the coast is more broken, as is the north-east side, off which lies the island of Sioodo Sima.

Sikok, although for the most part low, has several mountains of considerable elevation, which lie in a semicircular arc, extending from the east coast between the mouths of the two principal rivers, to the south-west part of the island; the south extremity, Cape Tosa, is high, but the land sinks behind it, and the bays on the west coast open in level valleys surrounded by steep mountains, at least, this is the description given of Semitsououra Bay and Kenti Bay, behind the Island of Oki, to the north-west of Cape Tosa; the rivers appear to flow for nearly their entire length through wide and level valleys.

The island of Kinsiu, as that hitherto most accessible to Europeans, is better known than the others in this Archipelago, but its very irregular form makes its description difficult; and indeed the outline, especially to the north-west, is in many parts very uncertain: its extreme length is about 180 miles, its extreme breadth 120; a range of lofty mountains extends through its entire length from north to south; its rivers, though numerous, are small, the largest, that of Saga, being scarcely fifty miles in length, and the quantity of level surface much less in proportion to its size than in the other islands. The bays and harbours on the coasts are too numerous to mention. At the north-east angle is one covered by the island, Fine-sima; to the north of Cape Boungo is FeriodeBay, fifteen miles deep, and at the south another bay nearly as extensive; and the west coast of the Boungo Channel is, like the east, formed by several projecting tongues of land; near the entrance, which is seventy miles wide from Cape Tosa, lies the Gulf of Nob-ioka, inclosing the island of the same name; and further south a deep inlet, near Chirikoff, receiving a small river. The estuaries of Rasngawa and Tutsi-garo rivers may also be noticed; and to the north of Cape Nagaeff, Oosumi Bay, fifteen miles broad and as many deep, in which is the small island, Birro-sima. A peninsula, thirty miles long and fifteen broad, terminating in Cape Tchichagoff, separates this bay from the Gulf of Kagosima, which is about thirty miles deep and eight broad at the entrance, forming a circular basin at the extremity, the area of which is nearly filled by the island Sakura; this has a lofty hill in the centre, and the bay is marked by Mount Mitake, rising on the east side, as the lofty cone of Mount Horner marks the western point of the entrance to the gulf. This bay, the country round which is described as beautiful, fertile, and well-wooded, opens into Van Dieman's Strait, formed by several small islands, of which the largest and most easterly, Tanega-sima, is about eighteen miles long, level, and covered with trees; from this, Take, Iwoga and Kero stretch to the west; these are volcanic and lofty, rising more than 2000 feet above the sea, as does Yarabu-sima to the south; while Motorni, between that island and Tanega, attains an altitude of nearly 6000 feet; from these a chain of islets and rocks stretches to the Loochoo Islands, forming the eastern part of the cincture of the Yellow Sea. From Cape Rono, the south-west extremity of the island, the coast trends north, forming a deep bay, and beyond, the entrance of the Gulf of Simabara or Saga, extends for fifty miles, within which lies the Island of Amakera, eighteen miles long, and several other islands, and across which from the north-west the Peninsula of Simabara stretches, twenty-five miles long, fourteen broad, and attached to the land by an isthmus about three miles wide, and forming deep bays to the north-east and south-west. This peninsula is marked by the volcano Wiugen-dake, or "Peak of Hot Springs," which created great devastations by an eruption in 1792, and is still in constant action; its elevation is 4110 feet. Within this the Gulf of Saga extends for thirty miles in depth and about twenty in width, receiving at its extremity the largest river of the island, besides some smaller streams.

From the isthmus which attaches the Peninsula of Simabara to the land, a similar isthmus joins it to that of Nagasaki, which extends north and south for thirty-five miles, with an average breadth of ten. Between these peninsulas is a bay extending twenty miles, with the small island, Kaba-sima, near the south-west point, whence the land extends westward for eight miles to Cape Nomo, to the north of which lies the Bay of Nagasaki. Cape Nomo is marked by a hill cleft in the summit, and from it the mountains gradually increase in height round the Bay of Nagasaki. Several islands lie off the coast, some rocky, others covered with wood from the base to the top. The harbour of Nagasaki is one of the best in the world, the islands which cover its entrance forming safe roads, and the inner harbour being quite land-locked; this is about five miles long by two broad, with depth of water for the largest vessels, and soft, oozy bottom. The northern extension of the peninsula covers a deep gulf twenty-five miles long by eight broad, having the island Koura at its entrance, and beyond an irregular coast trends to the north and west, until with the south extremity of Nipon it forms a deep bay, connected with Suwonada Bay by the narrow strait already mentioned, and having Fiki and other islands within it. This coast and the western part of Nipon are covered by a chain of numerous islets, recently surveyed by Mr. Richards, which range from 300 to 800 feet in elevation; at the south extremity of the chain are four or five larger than the rest, one of which obtained the name Harbour Island, from Port Lindsey at its southern extremity. Beyond these lie the Gotto Islands, covering an area of sixty miles in length and ten in breadth, and forming the east limit of the archipelago. The south point, Cape Gotto, is distant from Cape Nomo forty-five miles, and from Quelpart Island more than 100; as the name implies, they consist of five principal, with numerous islets, especially to the north. About thirty-five miles to the south of these islands, a group of lofty rocks rise out of the sea; and twenty miles from the south-west coast of Kinsiu lie the Koski Islands, the largest of which is ten miles long, the second about five, and the others mere rocks; and at the distance of eight, twenty-five, and twenty-two miles respectively are Tsukurase, Roche-Poncie, and Ingersoll rock, which unite the northern chain with that forming the southern limit of Van Dieman's Strait. Roche-Poncie Island is 1050 feet high.

In the centre of the Strait of the Corea lie the islands Tsus-sima and Tutchin, separated by a very narrow strait, and occupying an area thirty-eight miles in length and twelve in breadth; a chain of lofty hills runs through the whole length, opening to the east and west in fertile valleys; the coasts are much indented. They are distant from the Gotto Islands thirty-five, and from the Corea thirty miles.

The Peninsula of the Corea is above 300 miles long, and from 100 to 150 broad; it is for the most part low, but rising to the north, and on the north-east, mountains 6000 feet in height approach the coast; of these, Cape Ducos forms the south-east extension, in lat. 38° 10′; they extend round the west and north sides of the Sea of Japan, and in Mount Hienfoung attain an elevation exceeding 8000 feet. The coasts, which are lofty, rise in Cape Bruat, near the 43rd parallel, 1500 feet above the sea. Of the bays, those of Broughton and Yong Hing may be mentioned in the centre, and that of Pinghai, in which are the small islands Fan-ling and Tchian-shan. Cape Clonura, nearly under the 38th parallel, terminates the Strait of the Corea to the north-east, and from it the southern coast of the peninsula extends south and west 175 miles; it is much indented; Chusan harbour, seven miles deep and about two wide, terminating in a beautiful sandy bay, opens on the north point of Tsus-sima Island; farther west the coast is covered with islands which form an archipelago between the Corea and Quelpart Island, shutting in the entrance to the Yellow Sea, into which they extend, and cover 150 miles of the west coast of the peninsula.

3 *The Yellow Sea.*—If this sea be, as is usual, estimated as within a line drawn from the Corea to Chusan Island, it will extend about 350 miles in breadth, and as many in depth, to the peninsula which covers the entrance of the Gulf of Pechelee, while that gulf and the Gulf of Leotung extend from north-east to south-west about 250 miles, and from east to west 180. The characteristic of this basin is its comparative shallowness and muddy bottom, and, receiving as it does the deposit from the waters of two of the largest rivers in the world, as well as many smaller, this may be expected to increase.

The line of islands extending from Quelpart to Formosa would, however, seem to indicate that this basin should have a larger area, and that its cincture to the east must be looked for in them: and within these limits its extent would be 900 miles from north to south, and 700 from east to west; an area less important, probably, from its extent, than from the greatness and variety of the interests centred in it.

Quelpart Island, the east limit of this sea, may be considered the south of the Corean Archipelago; for although apparently detached, the presence of rocks and shoals, and decrease of depth in the water, indicate their connexion; it is about forty miles long by twenty-five broad, lofty, well-wooded, and fertile; and the southern islands of the Corean chain are of similar character. The coast of the Corea is little known, but Chui-yieng or Basil's Bay is fit for small vessels, as Gankeang or Marjoribanks Harbour, formed by Amherst and other islands, is for those of the largest size. Here the river Ya-lu-kiang joins the sea: it is navigable for twenty-two miles, and beyond this, in Sir James Hall's group under the thirty-eighth parallel, there is also good anchorage.

The long slope of the Corea being to the west, several rivers fall into the Yellow Sea from this side; and, although the climate is severe in winter, the valleys of the Corea may be noted for their fertility. The orange, citron, mulberry, and grape are found in abundance in a wild state, and fir timber is plentiful and of fine quality: copper also is found, as are gold, silver, iron, and coal. Animal life, both on land and water, is varied and abundant; whales and seals multiply on the shores; caymans and serpents of great size are found in and upon the banks of the rivers. Horses, deer, oxen, wild boars, panthers, and fur-bearing animals, with water-fowl and game, sufficiently attest the natural richness of this peninsula.

The north-east portion of the Yellow Sea, the Gulf of Leo-tung, is little known; its shallowness, the severity of the climate, the intricacy of the navigation, and the poverty of the inhabitants, presenting barriers to the extension of commerce into it; it may have an extent of 100 miles in either direction; its eastern coast is, like that of the Corea, covered with rocky islands: the water deepens towards the western coast, and here the hills approach the shore.

The Gulf of Pechelee is better known; it is formed by the projection of the peninsula Shang-tung, the extremity of which is in lat. 37° 23′ N., 122° 45′ E. Off this point is Alceste Island, and to the north, the Mei-tao, or Black Islands, form, with the continental shore, a strait of the same name.

Under the parallel 37° 30′, the Island Leu-chung-tow covers a deep bight, and forms an excellent harbour: and seventy-six miles from the north-east of Shang-tung, and to the south of the bold headland Che-fow-tao, is the harbour of the same name, also known as Ki-san-seu Bay, which, though covered by a group of islands, does not afford secure harbourage. Seven miles to the north-east lie the Cung-cung-tao Islands, two miles and a-half only from the land; and thirty-six miles from Che-fow-tao, is Yang-chow-foo, a harbour of some importance, though not of great natural capabilities. Numerous islands lie off these and the other harbours of this coast, and extend in the Sha-loo-poo-tien Islands. Towards the Gulf of Leo-tung Lea-chow-foo is a port at the mouth of a river on the south side of the gulf, marked by bold cliffs. The Pei-ho, or White River, though flowing through a bold country, is remarkable for the level surface of its channel: at a few miles from the sea, it is only half-a-mile wide; it is navigable for nearly 100 miles, to Tong-chow-foo. The junction of the Eu-ho or Yun-liang-ho, with the Pei-ho, forms the Ta-kao, or Great Mouth; this is obstructed by a bar nearly dry at low water. To the north and east, distant about twenty miles, are the Sha-loo-poo-tien Islands, or, as the name implies, Thunder and Lightning Sands.

The Whang-ho, or Yellow River, has, from the colour of its waters, the same name as the sea; it has already been described as a deep, rapid, turbulent stream, offering few advantages for navigation; its principal mouth is narrow, but it enters the sea by several, none of which are much known. Between this river and the Yang-tse-kiang is a vast alluvial deposit, extending 150 miles along the coast, from which shoals project for fifty miles to seaward. The mouth of this river forms a triangular bay, presenting a base of sixty miles to the sea; on the south side is the Island of Taun-ming, fifteen miles long by five broad, which is also low, and of alluvial formation. Within the channel formed by this island and the main is the inlet of Woo-sung, or Shanghai, eighteen miles from Cape Yang-tse. This inlet or river is about half-a-mile wide, but has not deep water for large ships within five miles of the port of Shanghai. The fresh water of the Yang-tse-kiang is often perceptible out of sight of land. Hang-chow Bay opens to the south of the Great River, extending about sixty miles from Yang-tse Point to Chusan Point; on the northern side is the harbour of Cha-poo, which, though shallow, is thought superior to many on the coast. Here the land is still low, but rises in the interior into undulating and hilly country. The true mouth of the river Tchin-tang is eighty miles from Cape Yang-tse; Chusan Island, giving name to a small archipelago, lies near the southern entrance. This island is twenty miles long by ten broad; it has four ports—Ting-hae, Ching-kea-mun, Ching-keang, and Shaavu. The first is difficult of entrance, from the rapidity of the tide among the islands which cover it. The second may be noted for its fisheries: the harbour, covered by the Island Lokea, is good, though small. The Chusan Archipelago is rocky—rising 500 feet above the sea. Ching-hae and Ning-po are situated on a creek, to the south of Chusan; of these, the latter is the port; and they are eleven miles distant by the river, which is shallow and about two-thirds of a mile in width. To the south is Nimrod Sound: here the coast partakes of the elevated character of the Chusan group. Nimrod Point being high, the sound is thirty miles deep by two and a-half broad. The principal entrance to the south of Lu-whang Island being ten miles broad; the south face of this island has two deep indentations with sandy bays; it is about ten miles long and six broad, and rising in peaks, the highest of which exceeds 900 feet.

Shei-poo Harbour to the south forms an extensive basin at high water, but at low tide dwindles to a narrow channel; it is covered by Tung-mung Island, and is connected with San-moon Bay to the west; off it are the Kweshan Islands, eleven in number; the largest is three miles long, and rises 500 feet above the sea; its coast is steep, with high cliffs. On the main the hills rise 1000 feet abruptly from the sea, and off it are numerous small islands. San-moon Bay extends twenty-five miles, and to the south is another wide opening, into which the River Tai-chow is discharged. Similar in character is Wan-chew Bay, having Great Samp-wan Island to the north, and Wan-chew River to the west; this river is not navigable for vessels of burden. To the south lie Pi-quan and Nam-quan Harbours; the latter with a tortuous channel for more than fifteen miles and deep water, the former open to the south-west with only fifteen feet. The country here is lofty, and very irregular in outline, and well marked by the Peak of Pi-quan. Sam-sah Inlet is one mile and three-quarters wide, and about twenty deep; and to the south, another gulf, ten miles deep, opens. More southerly still, is the entrance of the River Min. This river presents a narrow, difficult, and changing channel, trending southward for about ten miles, and then westward for about as many more, to Fou-chow-fou. The land here rises 2000 feet above the sea, and the islands, which form a belt about twenty-five miles from the coast, are all lofty and of well-marked forms. Hae-tan Island forms with the main the strait of that name: the island is of irregular shape, and about fifteen miles long; to the south is the Hung-wha Channel and Sound, receiving the river of the same name. The coast here is very much indented, but Matheson Harbour is not well sheltered, and Chin-chew Harbour is shallow. The most important inlet of this coast is Hooe-tow Bay, which extends to the south in Amoy Harbour, from which it is divided by Quemoy Island. At the entrance of the harbour are six islands, of which Tae-tan is the highest, rising in a conical peak; under this island is the principal anchorage, the water within being shallow, and after encompassing Amoy Island, forms Lung-seu Bay, seven miles in depth. This bay offers shelter for any number of vessels. The coast to the south is marked by the Pagoda of Nantai, 1720 feet above the sea. Ton-sang Harbour is one of the best on the coast of China, and marked by a saddle-shaped hill, rising 930 feet above the sea; the east side of the entrance is steep to, but the banks within are shoal. Several isolated peaks mark this coast; none, however, reaching 1000 feet in height. Owick Bay and Chauan

Bay are good anchorages, but partially exposed; southward are Hau-hae-mun and Tungas Rivers; Hieehachin Bay extending twenty miles, and Hang-hai Bay still farther south, forty miles wide; on the north side of which is Tysami Inlet; the channel is 200 yards wide, but shallow. Tysami Mound, an artificial cone, on the hills to the south-east of Hang-hai Bay, is 960 feet above the sea.

Numerous islands lie off this coast, rising about 300 feet; and at the west point of Bias Bay the hills on the main attain an elevation of 2800 feet. The south point of this bay is an irregular peninsula, forming on the north Typoong Harbour, which is covered by Lokaup Island, and affords secure anchorage. On the north of Bias Bay is Fan-lo-kong Harbour, the entrance to which is one mile and a-half wide; it is about six miles long, and deep enough for large vessels. This bay is studded with islands, and Pedro Blanco Island lies twenty-five miles east of its north point.

The beautiful island of Formosa, called by the Chinese Tai-wan, is about 200 miles in length and sixty in breadth, of an oval form, and separated from the mainland by a strait, eighty miles wide in its narrowest, and 150 in its broadest part. A range of mountains runs through the entire length of the island; to the south-east these appear volcanic; one volcano, fifteen miles from the coast, rises 1850 feet above the sea, and the other peaks do not probably exceed 2500; in the centre, however, Mount Morrison rises 10,800 feet, and towards the north the greatest elevation is above 12,000 feet; many of the peaks are covered with perpetual snow, and the east side of the island is generally mountainous and the coast precipitous; on the west, however, an undulating plain extends from the mountains to the sea, the soil of which is abundantly fertile, and produces with most tropical fruits those common to temperate regions. The island abounds in timber, and one of its chief products is sulphur.

The coast of Formosa is seldom visited, as it lies in the centre of the district of typhoons. The west coast has inlets, but they are covered by sand banks, Tyowan Harbour, at the south, only admitting small vessels; at the north-west is Tamsin Harbour; and at the extreme north, Kelong or Killon Harbour, of which the outer bay is spacious, but the inner has only three fathoms of water over the reefs which cross the entrance. The east coast is rocky, and comparatively unbroken. Formosa Channel, between the island and the Pescadore and Formosa banks, is about forty miles wide, while the Pescadore Channel between those islands and the main is 110. This group consists of several islands, mostly united by reefs; the largest of which is named Ponghou or Pehoe; it has a harbour to the west, between it and Fisher's Island, extending six miles long by two broad; many small islands lie off the west coast of Formosa.

The east side of Formosa is remarkable for a volcano, seen in 1853 in active operation, fifteen miles to sea. On this side, also, the Miacosima Islands form in two groups, of which the western is 100 miles from Formosa, and consists of two principal islands, Kokien and Patchung, the former twelve miles long by ten broad, the latter twenty by ten. the strait between being six miles wide; and some smaller islands, extending thirty-five miles, with a navigable channel between them; in the former is Port Cockburn, and in the latter Ports Haddington and Providence. The north-east group consists of the island Typing and some small islets; it is fifty miles distant from the other. Typing is triangular, having a base of fifteen miles. Off the reefs to the north, Broughton was wrecked in the *Providence* in 1797. Twenty miles to the south lies the solitary island Ysima.

The Leucheu or Luchu Islands are distant from Typing 150 miles, and 420 miles from the main, measured from Koomisang, a small island lying forty-five miles to the west of Great Luchu. This island is sixty miles long and twelve broad. The northern end is high, bold, and well wooded, the north-east abrupt and barren, the south-east low, the south, south-west, and west of moderate elevation and very fertile. Napa-kiang Road on the south-west, and

Port Melville on the north-west, are the principal ports; both are protected by reefs, as is also the deep inlet called Barrow's Bay; on the east side, and to the south-east, shoals and reefs cover the coast. Port Melville is separated by a rocky peninsula from Deep Bay, so called from the depth of water. A chain of islets and reefs unites Luchu to the Japan Islands, from which it is distant 300 miles.

CHAPTER XLII.

THE CHINA SEA AND ISLANDS.

§ 1. The east coast.—2. The islands.—3. Borneo.—4. The volcanic belt.*

The China Sea.—This extensive sea is formed on the west by the coast of China, and on the east by Borneo and the Philippines, while its southern limits are the islands of Sumatra, Banca, and Billiton, to the south of the Equator, and its northern, Formosa and the district of Fokein, under the twenty-second parallel N.L. As the eastern cincture is marked by the irregular coast of its islands, so, correspondingly, the west is by two deep gulfs, viz., those of Siam and Tonkin; these are separated by the peninsula of Cochin China, 400 miles in length, and about the same breadth, and bounded to the south and west by the Malay Peninsula, stretching south and east 600 miles, covered by the large island of Sumatra to the south. This sea is characterized by the shallowness of its water, its numerous banks and shoals, and by groups of small islets to the south, where fifty fathoms is the extreme depth; in the Gulf of Siam it is not so deep, nor does it exceed that depth in the Gulf of Tonkin; indeed, the south extremity of the peninsula of Cochin China is one vast alluvial deposit. The entire length of this sea is 1600 miles, its breadth in the centre 500 miles, and from Palawan to the head of the Gulf of Tonkin 900 miles, and nearly as much from the coast of Borneo to the head of the Gulf of Siam.

The north-west coast of the China Sea forms a series of irregular curves, more or less indented to Canton River; of these, the principal are Hie-che-chin, Hong-hai, Bias, and Mirs Bays. The former is extensive, but open to the south; it is shallow and with a muddy bottom. The anchorage of Ten-guen, near the eastern point, and the land surrounding the great bay, is covered by the rocky island Kemsue; there are here numerous rocks, and indentations spacious enough but too shallow to form good harbours. Hong-hai Bay is also large, its surface dotted with islets, of which Hong-hai, in the centre, is the largest; it has a harbour, Tysammu, of moderate depth and capacity, on the east side. This bay is also shallow and open to the south-west. Pyramid Point, the south extremity of Lokaup Island, marks the entrance of a deep and safe harbour, called Bias Bay or Tyloso; between this point and Woong-mon Island the entrance is three miles wide; the harbour is nine miles deep and four and a-half broad, with ten fathoms at the entrance, but shoaling towards the shore, which is formed on the north and east by high lands, and on the south by islands which separate it from Typoong Harbour. This harbour lies to the east of Mirs Bay; it is double, the outer affording good and safe anchorage for large vessels, the inner, only fit for small craft and boats. Mirs Bay, the Ty-po Bay of the Chinese, is extensive, and affords good anchorage, but is open to the south and west; its water is deeper than the others already named, having ten fathoms near the east shore, which is bold; the entrance is five miles wide, but divided by a rock near the centre. Off the whole length of this coast are numerous islets.

* See Crawfurd's *Indian Archipelago.*

The Canton River is in extreme breadth across the mouth nearly sixty miles, but carries only nine fathoms water in the entrance, which is divided into one broad and one narrow channel by the triangular island of Macao, called by the Chinese Gaow or Osmoon, which terminates to the south in a high peninsula, on which the town of the same name is built; it is about thirty-five miles long and fifteen broad. Several small islands lie off to the south-east, and others are continuous to the north-west, up the channel of the river. The south-west side of the island forms with the main a bay at the mouth of the Typa passage, and the harbour of Macao is formed by the peninsula and the island Tweelien ; it is large, deep, and safe. Lintin Island and shoal lie to the east of the main channel; the entrance to which is between Macao Island and the Grand Ladrone, which are twelve miles apart; this is a long, narrow, and lofty island, about fifteen miles long. To the east of Lintin is the Fan-sheeak Channel, with deep water for large ships. The Bocca Tigris, or Hoo-tow-moon, forms the approach to Canton River. Near the middle of this is the island Wang-tong, between which and Anunghoy Point is the principal entrance : about twenty miles above is the second bar, where large ships used to receive part of their cargoes ; and about halfway between this and Wampoa anchorage, is the first bar, formed by a sandbank and reef, stretching eastward. This anchorage is safe, but confined; covered on the south by two low islands, and on the north by the island of the same name ; these divide the main stream from Junk River, the channels of which separate a little below Canton. This river, called by the Chinese Choo-keang, is easy and safe of access to large vessels, as far as Wampoa; but from thence to Canton the water is only deep enough for vessels of moderate size.

Of the islands about the entrance to Canton River, the Grand Ladrone, already referred to, is the most remarkable, as directly fronting the entrance ; it is steep and bold, culminating in a bold dome to the north-west. There are several channels and anchorages among these islands ; of the latter Urmstons Bay or Toonko Harbour may be mentioned, as well as Tonghow Cove ; this, situated on the north-west of the island of the same name, is a small but very secure harbour, capable of receiving large ships. Another cove is found on the north-east of Lamma Island.

Hong Kong Island, distant from the north-east of Lamma Island two miles, is about ten miles long by five wide, of irregular shape to the south and east, forming safe bays for small vessels. Tylam, or Hong Kong Harbour, formed by the south-east point of the island, is one mile wide, with six fathoms water. This island is mountainous.

To the west of Canton River are the St. John's Islands, extending about thirty miles from north-east to south-west, forming a deep bay in the centre, where they are united by an isthmus of sand ; to the south is the Island of Hawcheun, or False St. John's, which, with the Island of Namoa, forms the harbour indifferently known by both names. These islands are lofty, as are the others to the west, as the name Hai-lui-shan indicates ; here is also a safe harbour, but the most important harbour on this coast is that of Tie-pak, or Tie-pie-hien ; this is shallow, and unsuited to large vessels, terminating in extensive mud flats ; yet the country rises boldly round it.

A peninsula, eighty miles long by fifty broad, separates the Gulf of Tonkin from the China Sea, off which, to the south, lies the Island of Hainan, of an oval figure, 150 miles long by eighty broad ; the channel, separating it from the main, is thirty miles long and ten broad, with a cluster of shoals at the east entrance, and the small group of Tyshan Islands on the west. The twentieth parallel of north latitude intersects the western extremity of this channel, and the centre of the Gulf of Tonkin, marked by Nightingale Island, which is of triangular shape, and ten miles long by three broad. The east coast of Hainan does not present any good harbours ; it is marked by the lofty peak of Tongeu near the centre, off which is the island Tinhora. Galong Bay and Yuliu-kan Bay, near the south extremity, afford anchorage for small vessels. The coast is said to be covered with rocks and shoals: the interior is high and irregular in outline; the mountains are covered with forests, but extensive plains afford space for the cultivation of rice, sugar, tobacco, &c. The east coast is steep, the west low, with shallow water. The entrance to the gulf is due north from Cape Happoix to Hainan 160 miles, from Frakaki Island to Hainan east 145, and from the line thus formed to the head of the gulf, 200 miles. This gulf is little frequented. From Point Canis, in 20° 10′ N. lat. and 109° 50′ E. long., the coast trends north ninety miles. Off the centre of this coast lie the small islands Guie-chow and Chayung, distant about 30 miles. The north coast is irregular in outline—probably of alluvial formation—and covered by groups of islands; of these Houang is the most important: it is ten miles long by five broad. The north-west coast is higher, and has numerous islands off it; of these, Gowtou, or Pirate Island, to the north may be mentioned: it is about ten miles long. Here are two deep bays, one of which, Chokum, receives the Sang-koi River.

Hue River is the most important on the Gulf of Tonkin; it is situated near the southern extremity of the entrance; it has good anchorage, but a bar at the mouth, with only two fathoms water. The city of the same name is some four leagues higher up the river. To the south of Point Happoix is Port Quiquick, lying at the foot of high mountains; it is six miles broad and four deep, and affords good anchorage. Happoix River extends some distance inland. The Island of Pulo Canton, or Collaoray, lies off this coast, which is high and bold, rising in mountains inland. Qui-chow Harbour affords good anchorage to the west of Cape San-ho, and there are other small coves and harbours; but Phuyen Harbour is esteemed one of the best in the world; it forms two outer and one inner harbours; the former known as Xuandai and Vung-lam afford good anchorage; but the latter, Vung-chao, is entirely land-locked, encircled by mountains, and has good anchorage in five fathoms water. The country here is very beautiful and fertile. Phuyen Bay is bounded to the south by Cape Varela; a steep cape, marked by a lofty mountain. To the south of this is Hone Cohe Bay, surrounded by mountains, and the entrance covered with islands. Farther south is Nhiatrang Road, receiving the river of the same name; and still farther, Camraigne Harbour, the southern limit of which is Cape Varela-false; or Muidavlaich. This harbour is double; the outer covered by Tagne Island, the inner an extensive lagune, both safe for all vessels. Into the north extremity of the lagune a river, having its rise near Nhiatrang, flows through a sandy plain, having its course parallel for thirty miles to the coast, from which it is only separated by sand hills. Southward of Cape Varela-false is the deep basin Vung-gang, surrounded by lofty mountains. Phauran Bay extends to Cape Padaran, to which point the coast has a southerly trending, but beyond which it turns to the west and south. The land here is high, marked by Mounts Guio and Taicon; off it there are reefs, and at about seventy miles distant Catwick, Pulo Sapata, Pulo Ceicer, and other islets and rocks form a dangerous group. They are, however, mostly lofty, and can be seen from some distance.

Cape St. James, in lat. 10° 16′ N., long. 107° 4′ E., forms the north point of the entrance of Saigon River, called also Gagneray Bay, and, indeed, of the estuary of the Ma-kiang also, which, across the deltic islands at the mouth of the latter, is sixty-five miles. The mouth of the Saigon is twenty-five miles wide, and the river is navigable for the largest ships. Gagneray Bay receives also Cualop River, navigable for small vessels. The Ma-kiang or Cambodia River has three principal mouths, the westernmost being the ship channel; its entrance is, however, impeded by sand banks and deltic islands, which extend for 100 miles up the channels, and for fifty miles in breadth. From the entrance of this river to Pulo Oby, ninety miles, the coast is of alluvial formation, perfectly flat, and traversed by channels, connected probably with the Ma-kiang, some of which open into the Gulf of Siam. This extensive deltic formation is covered with trees.

Pulo Condore, the principal island of a group of the same name, is about nine miles long and four broad; has on the south-east a considerable bay, covered by islands. The harbour here is well sheltered; the island is hilly, culminating 1800 feet above the sea, and covered with timber. This group lies fifty-five miles south of the entrance of the Ma-kiang.

Pulo Oby, the north-east point of the entrance of the Gulf of Siam, is formed of several hills, of which that in the centre is the highest, and is twenty miles long by eight broad; from hence to the coast inside the Great Redang, the entrance of the Gulf of Siam is 200 miles wide, and from thence to Bankok, at the head of the gulf, exceeds 450 miles in length. At the head of the gulf Points Liant and Cin contract the width to sixty miles, forming an inner gulf or bay. The east coast of the Gulf of Siam is but little known. Pulo Oby-false Island lies off the coast thirty miles north-west of Pulo Oby, and the coast forms a deep bight of 130 miles, inclosing a considerable island, named Koh-tron, twenty-five miles long by ten broad. Beyond this is Kapousong River, and thirty-five miles farther, Cape Samit, 120 miles from Cape Liant; off this coast, are Chang-koh-koot and Koh-kong Islands; the latter about fifteen miles long. There are also islands off Cape Liant as well as within it, of which Bamphasoi, the largest, is fifteen miles long.

The delta of the river of Siam occupies sixty miles of coast, and extends inland thirty miles; the best navigable channel is that to the east, where the land rises; the entrance is about a mile wide, and large vessels can ascend to the island of Bankok, about thirty miles from the sea. Twenty-six miles south of the entrance to this river a group of islands form Ko-se-chang Harbour; to the west the coast is nearly straight for ninety miles to Point Cin, trending southerly, beyond which a deep bay stretches for 175 miles to Point Carnam; here the coast is hilly. Within this bay are several islands, of which the principal are Bardia, Sancori, and Carnam, besides the numerous islets of the Larchin Archipelago. Sancori is ten miles in diameter, and Carnam is lofty. Numerous rivers break the coast line to the south, of which Carnam, Ligor, and Boudelon may be noted. Off the coast, between these latter, lies the island Tantatam, forty miles long by twenty broad; the channel between it and the main is ten miles wide, forming a deep bend to the south, called Sangosi Bay. To the south, again, the Gulf of Patani, opening to the north, extends for fifty miles. From Cape Patani the coast trends north-east for ninety miles, broken only by the mouths of Bigana, Calanam, Blanam, and Tringany Rivers, none of which are navigable for vessels. The Redang Islands lie from ten to twenty miles off this coast. North of this are the Printian, Latinga, and other groups, and off Cape Patani, Pulo Sonu, fifteen miles long. The Great Redang is high, of considerable extent, and has a harbour fit for small vessels. Below this the coast, although it is slightly indented, becomes hilly, and is broken only by Tingeram and Pahang rivers, distant sixty-five miles; the former is barred with rocks, and the latter with sand-banks. Of the coast from this river to Singapore Strait (140 miles) nothing need be said.

2 *The Islands.*—To the south and east are several groups of islands; of these Tambelan, situated just north of the Equator, and distant sixty miles from Borneo, and 120 from Bintang, extends for seventy-five by sixty miles in area; the easternmost is Great Tambelan, having a sheltered channel on its west side, and an extensive basin or harbour on the east. These islands are mostly elevated. The Anamba group cover about the same area, but the islands are larger, and form two groups, the north-east consisting of Mata, Miobour, Siantan, and others, of which Mata is ten miles long; and the south-west consisting of Djimaja, about the same size as Mata, and some smaller islands. This island is 120 miles from the Malay coast, seventy from the island of Tioman, and thirty from the north-west group. These islands are high and fertile, and the northern group affords convenient anchorage.

The Natuna group lies about 100 miles north and west of Mata; the largest is called Pulo-Hong-soran by the Malays; it is about thirty-five miles long by twenty-five broad, high rocks and cliffs at the north, and its coasts covered with reefs. Sixty miles south-east of the Great Natuna lie the South Natunas, a group extending over an area of above forty miles square. The two principal islands are Souli and Sirbassen; these are surrounded by numerous islets and coral reefs, the most southerly of which is distant from Point Api, on the coast of Borneo, only fifteen miles. To the north and east these shoals extend off the west coast of the islands, bounding the China Sea for 700 miles in length by 300 in breadth. Of the other shoals, Macclesfield bank, extending 100 miles by seventy-five, and the Paracels sixty miles by thirty, both lying off the Gulf of Tonkin, should be mentioned, as also the Pratas shoal off the mouth of the Canton River.

The southern cincture of the China Sea is formed by the islands of Bintang, Lingen, Banca, and Billiton; the former is separated from the main by the Strait of Singapore, and from the second by Brio Strait; it has several others surrounding it, especially to the south and west; it is of irregular form, thirty miles long by twenty broad, and presenting two deep bays on the south; it is lofty, culminating 1300 feet above the sea, and watered by five small rivers; it is distant ten miles from Romania Point, the south extremity of the Malay Peninsula. Mallan and four smaller islands lie to the west, Pajang to the south and east, and some islets to the east; Linga or Lingen, the most lofty of this chain, culminating 3750 feet above the sea, is distant fifty miles; it is covered with primeval forest, and extends thirty-five miles in length by fifteen in breadth, presenting a deep bay at the eastern extremity; Lobau and some other islands lie to the north, and Sinkro to the south; it is distant from Banca eighty-five miles.

Banca is an island of irregular shape, but exceeding 100 miles in length and thirty in breadth, having a deep inlet at its northern, and a small island covering its southern extremity; its south-west point is opposite Palembang River, on the coast of Sumatra, and gives name to the principal strait by which the Strait of Malacca and the China Sea are entered from the south; the strait which separates it from Sumatra varies from three to eight miles. The Bay or gulf of Klabat, at the northern extremity, is more than twenty miles deep, and the chain of mountains which runs through the island culminates above it in the peak of Maras; Mount Monopin does not reach 1000 feet. Much of the surface of the island is marshy; it has no lakes, but numerous streams, and is covered for the most part with fine timber, yet is not considered fertile; it produces most minerals, and especially iron and tin. Banca is separated from Billiton by Gaspar Strait, which is about sixty miles wide, and marked by two small islands, lying off the two principal islands, and one with some rocks in the middle of the Strait. Billiton is a quadrangular island, about forty miles in diameter; it is lofty, and resembling Banca in its productions, and especially tin, which is not found eastward of this island. The coast of Billiton is indented by three bays—one at the north point, at the mouth of Tieroti River, Linga Bay to the south, and one at the south-east extremity, but on this side the water is shoal; it is separated from Borneo by the Carimata Channel, 130 miles in width, measured from the east point of Billiton to Sambas Point on the island of Borneo.

3 *Borneo.*—Borneo may be considered the largest island in the world, Australia alone excepted; it forms an irregular triangle, having its base to the south 480 miles, its western side 600 miles, and its eastern 650; its coast line is estimated at 2000 miles, its greatest breadth is under the first parallel of north latitude, where it extends 600 miles from east to west; its extreme length is 700 miles.

This island has four well-marked divisions: the north-west coast separated from the rest of the island by a mountain range, which extends from the north angle for two-thirds of its length; a south-west, south and east basin, separated from each other by two spurs from the chain already noticed, which stretch towards Capes Sambas and Salatan on the south-west and south-east.

Of the interior very little is known, but the exploration about to be commenced will, if successful, leave little to be desired.

Borneo is separated from Palawan, the south-westernmost of the Philippines, by the Strait of Balabac, so named from the small island of that name, which lies off the south point of Palawan, as that of Balambangan does off the north point of Borneo. The former is fifteen miles long and ten broad, and has a harbour on the east side called Dalawan; the latter, more correctly Blambangan, so named from its palm trees, is about fifteen miles long by three broad; it is hilly, and has two small harbours; on the east side it is sterile. The neighbouring island of Bunguy is more than double the size of Balambangan; it is mountainous, and culminates 5000 feet above the sea. The strait leading into the Sooloo Sea is twelve miles wide, and marked in the centre by Sandy Islet.

To the south of Balambangan the coast of Borneo forms a deep bay, extending southwards twenty-five miles, and fifteen in width, with an inner harbour at the south-west; from hence a broken, irregular coast stretches 150 miles to the south-east, in the centre of which is the deep bay of Lambook, thirty miles wide; to the south again is Sandakan Bay, about ten miles across, landlocked, and having some islands within it. The north-east extremity of Borneo is a peninsula projecting sixty miles, and twenty in width; it covers Darvel Bay, an extensive sheet of water thirty miles wide at the mouth, with numerous islands; a feature continuous along the east coast of the great island. In the centre of this coast a great bight or bay, nearly 100 miles wide, seems to extend to the south, and beyond the peninsula or island which forms its southern extremity, Cape Kumungun, the eastern extremity of the island, projects at ninety miles distance. Within the bay or gulf thus formed, two considerable rivers flow into the same estuary, as do several smaller streams, into the more northern bay. This coast is low.

To the south of Cape Kumungun or Kaneeoungan, the coast trends to the west and south, encircling the island Pamarong, thirty-five long by twenty broad; to the south of which the River Goti or Coti enters the sea by several mouths. Southward still is the Gulf of Passir, seventy miles distant from the Goti River, receiving a smaller stream.

Off the south-east point of Borneo lies the island Laut or Laut Pulo, the west limit of the entrance to Macassar Strait; it is of oval form, fifty miles long by twenty broad, and forming a deep bay at the northern extremity. This island is mountainous and covered with forest; the strait which separates it from the larger island is ten miles wide. From thence to Cape Salatan, the southern point of Borneo, is eighty miles; here the principal spur from the main chain of mountains reaches the sea, and to the west of the cape is the River Banjer or Burito. The mouth of this river may be seven miles wide, and its estuary extends inland more than twenty miles, where it divides, receiving the waters of the small river of Martapura from the east; beyond are Little and Great Dyak Rivers, the former of which may have a course of 300 miles, and the latter of not so many, but its mouth is the more extensive. The rivers Mendawi and Pembuan also break this coast to the east of Flat Point, which is distant respectively from Cape Sakatan 170, and from Cape Sambas or Sambar 110 miles; between these latter, the river of Kotta Waringin falls into the sea; it rises in the Lake Muwara Kajung, about fifty miles inland, and probably twenty-five miles long.

The south-west coast of Borneo is more indented than the south; and to the north of Cape Sambas are Laag, Kimpal, and some other small islands, and to the north of Cape Brie, seventy-five miles from Cape Sambas, a considerable river enters the sea to the south of the Bay of Sitkadana; north of which, again, is the mouth of the Simpang River, from whence the coast trends west round the island Mayang, which is of triangular form, and about twenty miles long; from which, towards the south-west, distant about forty-five miles, is the small island Carimata, or Kerimata, about nine miles long; it is lofty, rising 300 feet above the sea; and between these are several small islands and reefs. This island gives name to the passage to the west, between it and Billiton, from which it is distant seventy-five miles.

To the north, the river Pontianak disembogues by several mouths, which appear to cover about seventy miles of coast. The south-east mouth seems to be the Niejak River, and the northern, where another smaller river is confluent, the Poutianak. This river, under whatever name it should be mentioned, is the largest in Borneo, both as to length and drainage area; it is also remarkable as having one of its sources in Lake Malayu, which is estimated at twenty-five miles long by twelve broad, but not exceeding twenty feet in depth; it is distant from the west coast 135 miles. Beyond is the inlet of Kubu or Booboo, lying in the centre, to the south of Cape Sapu, and farther north are the Mampawa and Sambas Rivers, the latter, though small, having a considerable estuary. This coast is low, deltic, and has many reefs off it; it terminates at Api Point, about 170 miles from Magany Island; from this point the coast trends east twenty miles to Cape Datou, then south-east forty, to Capes Sipang and Sarawak River, and thirty more to the river Loepar or Lupar, at the extremity of the bay formed between Cape Datou and Cape Sirik, which are 100 miles distant. The river Sarawak is formed by two streams, which from their confluence flow for twenty miles to the coast, and enter the sea by two principal and several smaller mouths, forming a delta about fifteen miles in extent. The eastern channel, called Morotabas, is navigable for large vessels, and is about three quarters of a mile broad. The Lupar has an estuary extending thirty miles in direct distance into the land; the river is small. Between Cape Sirik and Barrow Point, distant 200 miles, the coast is almost unbroken, as it is also from the latter to Bruni Bluff, distant seventy-five; within this, however, is the most important bay, and, in a commercial sense, the most important river and island on the coast of Borneo. Bruni, or Brunai Bluff, is distant from Kalias Point, the opposite side of the entrance to the bay, twenty-five miles; the bay is double with that at the entrance of Bruni River, lying to the south; the point of divergence of the channels surrounding the island Muasi, by which the Bruni reaches the sea, is fourteen miles. Here rich seams of coal are found, as also in the island of Labuan, off Point Kalias, fourteen miles north-east of the mouth of the Bruni, forming a sheltered and safe harbour; it is triangular and about twelve miles long by five wide; the southern shore is about six miles long, and has a small harbour, covered by the island Daat, which, with nine more, lie off to the south; part of the island is high and covered with timber; much, however, is marsh land, producing only mangroves, rattans, and palms; the coal, which is excellent and found in thick seams, is for the most part at the northern extremity. From hence to Sampanangi Point, 130 miles, Gaza Bay, behind Yangaut Point, and Amboug Bay, lying at the base of Mount Kinibalu, may be mentioned. This mountain, an isolated mass of sandstone, resting on syenite, rises more than 10,000 feet above the sea, and has, it is said, a considerable lake at its base. The western chain of mountains culminates to the south near Lake Malo, 6,000 feet above the sea; a Mount Tebang, in the centre, is also considered lofty; the other ranges vary from 2000 to 3000 feet in elevation. The vegetation of Borneo might be taken as a type of the whole archipelago; it is covered with a rank dense forest; benzoin, eagle-wood, and gutta percha abound; gold is found on the west coast, and the mountains are said to be rich in minerals. Its widest part is under the Equator.

4 *The Volcanic Belt.*—Beyond the southern cincture of the China Sea the great volcanic belt of Sumatra, Java, and their accompanying islands, stretches with a gentle sweep to the south-east and east, between the 95th and 130th meridian of longitude, and uniting the great island of Australia to South-eastern India and the peninsula of Malaya.

The great island of Sumatra is separated from the Malay peninsula by the Strait of Malacca, which is 500 miles in length, while in breadth it varies from 300 to fifty miles; at the south-east extremity the available passage is narrowed by the small islands lying to the south and west of Bintang, to about twenty miles; and several islands lying on the north coast of Sumatra also contract its channel. The strait proper is, however, the portion included between the south coast of the Malay Peninsula and Sumatra, which is about 160 miles long, fifty in extreme breadth, and thirty from the coast of the islands Roupat, &c., to the main; the passages between Lingen and Banca must be considered as separate straits, and may be named from these islands.

The island of Sumatra or Samatra lies nearly south-east and north-west, is about 1000 miles long, terminating in a peak to the north-west, and being 180 miles broad at the east; its most northerly point is in N. lat. 5° 45′, its most southerly in S. lat. 5° 55′, and it lies between the 95th and 106th meridians of East longitude; it is in size next to Borneo, which it much exceeds in length, and is nearly double the size of Great Britain.

A range of mountains stretches through the island near its western coast; its eastern is formed by vast alluvial deposits, and its principal rivers flow into the Straits of Malacca, Lingen, and Banca. The mountains, many of which exceed 10,000 feet in height, culminate in Lusé, near the northern extremity, 11,000 feet above the sea; in the centre are five active volcanoes; of these Talang rises 10,250 feet, Marapi 9500, and Barapi 6000 feet; 15,000 feet has, however, been given as the elevation of Singallang in the centre, and others in proportion. The mountain region affords plains and valleys of considerable extent, those of the volcanic district being fertile, but much of the other partially, if not wholly, sterile. This appears to be caused by a strong dry wind, which, for the most part, prevails over the whole; the plateaux are thus sterile; but the valleys are fertile and beautiful, the mountains well wooded, and the alluvial plain, which extends for 600 miles along the north-east coast, with an average breadth of nearly 100 miles, is entirely covered with forests of gigantic growth, in which open glades are only found on the banks of the rivers. The rivers of Sumatra are known only by name. Those of the north-east coast are the Assahan, Baruman, Rakan, Siak, Kampur, Indragiri, Jambi, and Palembang; of these the Siak and Palembang are the most important, inasmuch as the bars at the mouths and the bore of the tide prevent the others from being accessible to shipping: the mouth of the first is formed by four considerable islands, separated from Sumatra by Brewer Strait, which does not exceed five miles in width; the latter is formed by three streams, the Kamring, Lamtan, and Palembang; has several anastomosing branches in its lower course, and a considerable delta, extending twenty-five miles along the coast.

The Indragiri has its rise in Lake Sinkara, which is about twenty miles in length by fifteen in breadth, and twenty-four fathoms deep. There are several other mountain lakes in Sumatra, the most important of which is that of Sapulu Kota at the foot of Mount Marapi, and in one, the name of which is uncertain, the Kamring has its rise. The rivers of the east coast are the Masruji and Pagadungan; on the west coast there is only the Singkel.

The mineral products of this island are of considerable importance: fine seams of coal are reported at Retch and Palembang; the iron ore is of excellent quality; gold is also found, and the metals known in the neighbouring islands may reasonably be expected here.

The coast line is but little broken, and there are few extensive bays; the most important is that of Tapanuli, on the west coast, which contains several good harbours, and to the north the roads of Soosoo, Bacoogong, and Tourooinang may be mentioned, as also the port of Qualla-battoo: in Si-leaga Bay there is anchorage, protected by the island of the same name, as there is at Baroos, behind the island Pouchang-cacheel, and in a harbour formed by islands at the south-east end of Mensular Island. The next harbour of importance is Boongas Bay, and further east Pulo Saytan Harbour, between the islands Sabadda and Troosan, should be named. At Bencoolen there is only an open roadstead, but at Rat Island there is a safe harbour formed by an encircling coral reef, as also at Paolo Bay; but the latter is unhealthy. Billimbing Bay, near the south extremity of the island, is also to be noted.

Several islands of considerable size front the west coast of Sumatra, at an average distance of fifty miles; of these, Hog Island, the most westerly, is about forty miles long by ten broad, hilly, and covered with trees; and about thirty miles to the east is the group of Pulo Baina, or many islands, formed of two principal and several smaller. The largest island off the coast is, however, Pulo Nyas, about sixty miles long by twenty broad. This island lies south from Pulo Baina, distant thirty miles; Nyas River is on the east side, and another further south, into both of which ships may enter. This island is also hilly and wooded. Sirambo Bay, on the south side, has also good anchorage, protected by a group of small islands, but the chain of islands which covers the west coast renders approach to it dangerous. A small island, named Clapps or Clappers, lies south of Pulo Nyas nearly under the Equator; and the northern point of Pulo Batou, or Mintar, is also without latitude. This island is like the others, and affords shelter within the numerous small islands which cover its shores; it is about forty miles long by fifteen broad, and distant from Pulo Nyas nearly fifty miles. See Beeron or Sibiru, is distant from Mintar twenty-five miles; it is also called North Poora; it is little known, but must be more than fifty miles long and fifteen broad, and similar in character to the others. South Poora is a smaller island to the south, in which must be noted Hurlock's Bay, a landlocked harbour near its northern extremity; it is separated from North Poora by Seaflowers Channel, twenty miles in width. North Pagai and South Pagai follow in close succession, and about half-way between them and the south-east extremity of Sumatra, Pulo Engam stands out by itself; it differs little from the others, is surrounded by a coral reef, and has an excellent harbour at the south-east side; it is of triangular form, and twenty miles long.

On the west coast of Sumatra the south-east, or dry monsoon, blows from May to September, the north-west beginning early in October and continuing till April, being most violent in January, with storms, thunder, and lightning.

The southern extremity of Sumatra is formed by two deep bays, extending fifty miles across the westernmost. Keyser Bay is about fifteen miles deep; it is marked by a high conical peak, named Samanco, from which the bay is sometimes named: between that and Lampong Bay is another, Calambyan Harbour, at the east side of Keyser Bay, which is small, but safe. Lampong Bay is very extensive; its western shore is covered by a chain of islands. Sunda Strait, sixty miles wide at its southern, but narrowing to twenty at its northern extremity, separates Sumatra from Java.

Pulo Rondo, a high rocky islet off Acheen Point, at the north-west of Sumatra, is distant eighty-four miles from Great Nicobar Island. This is the south-west limit of Malacca Strait, which at this entrance is 240 miles wide; it is marked on the south by Golden Mountain, a conical peak, nearly 7000 feet high. The alluvial character of the north-east coast of Sumatra prevents it from having many harbours. Toboo Samwoi, Lanksa Bay, Qualla Harbour, Delhi, Batubarra, and Rakan River, may be noted.

The Island of Java, with those of Bali, Lombok, and Sumbawa, form the southern cincture of the Java Sea, which is 840 miles long by 250 broad; of rectangular shape, and limited to the north by Borneo, to the east by Celebes, and to the west by Sumatra; the western half is almost entirely clear of islands; the eastern has several small islands and groups on its surface. Detached off the coast of Borneo is the Laurot group, under the fifth parallel of south latitude, and near the centre of the sea the Solombo Islands; of these, the southern is high and the northern low and well wooded. Arentes Island lies eighteen miles to the north-east. About one hundred miles from the coast of Celebes is a range of five islands, Edam, Bankodang, Amsterdam, and Rotterdam, and the Hen and Chickens. The reefs stretch fifty miles to the west, and occupy much of the area between the islands and Celebes. But the most important islands of this sea are those which stretch from the north-east point of Java into the Flores Sea, ranging parallel to Lombok, Sumbawa, and Flores.

Madura, the most important of these, is separated from Java by a strait from one to two miles broad, forming a deep but narrow channel, opening into an extensive bay to the south, about sixty miles in width, and more than 100 in length, but here the depth is not so great. The extreme length of this island is ninety miles, and its breadth about thirty. A low chain of mountains runs through the island, but it has no elevated peaks; and though, like Java, of volcanic formation, the soil is of comparatively poor quality.

Gohur and Sapali, with other islets, lie between Madura and Kangelang, or Kangayang, remarkable for its excellent harbour on the south-west, and the extensive reefs which stretch fifty miles to the northward of it; it may be twenty-five miles in length. Hastings Island lies about half-way between Kangelang and the Paternosters, a group of wooded coral islands and reefs, extending east and west 100 miles. Similar in character, but covering a much less extensive area, are the Postilions; to the south of Celebes, Salayer, Tonin, and Schiedam Islands, bound Java Sea to the east; the former is a fertile island about thirty miles long; the Tonin Islands are small, but connected with extensive shoals; the latter are two in number, about ten miles each in extent, and about twenty distant from each other.

The Island of Java, or Jawa, is in many respects the most important in the Eastern Archipelago; it lies between 105° 12′ and 114° 4′ E. long., and 5° 52′ and 8° 40′ S. lat.; it is 575 miles in extreme length, and 120 in extreme breadth. It is remarkable as having its southern coast open to the entire ocean, nothing being present between it and the Antarctic Sea; it is bold and precipitous, but the northern coast low; the entire coast line is estimated at only 1200 miles, and is not, therefore, deeply indented. On the northern coast are several islands besides Madura, but they are mostly small; on the south only two, Baron and Kambangan, requiring mention, the others being scarcely more than islets.

The west end of Java forms the east side of Sunda Strait, of which Java Head is the south-east limit; four miles off this lies Prince's Island, which is high and well wooded. This coast of Java forms three deep bays, but they do not present any feature worthy of notice. The north-west extremity is marked by the rocky mountain Gurung Karang, which rises 6000 feet above the Bay of Bantam, which forms an extensive harbour, enclosing several islands, of which Pulo Panjary is the largest; they are low and well wooded. At Batavia there is only a road covered by some islands, Edom, Hoorn, and Onrust, the latter of which is the naval station; and eastward the coast presents no harbours, but at Cheribon and Samarang are roads, and between them the coast forms a deep bight 125 miles in length.

Japara Point, marked by the volcano of the same name, extends forty miles to the north, and beyond this to the east lie Rembang, Lassem, and other small ports, noted for ship-building, as is Samanap in Madura; but Sourabaya, in the strait between Madura and Java, is the most important of any in the island.

The east end of Java forms Bally, or Bali Strait, which is only one mile and a-half wide. The south coast presents but few harbours; Pachitan is small, and but little sheltered; Segara Anakam, behind the west side of Kambangan Island, is preferable. The extensive bay, Wynkoofs, at the south-west end of this island, is of no importance.

The west end of Java is more mountainous than other parts of the island, though the general elevation is not so great, consisting almost entirely of mountains separating small valleys. The middle portion of the island, corresponding to the height between Cheribon and Japara, is the narrowest, and here the mountains are higher and the plains more extensive, and both here and to the east a low alluvial plain stretches along the northern coast. The eastern extremity is again more mountainous. Java is one of the most remarkable among the volcanic islands of the world, traversed throughout its entire length by a range of mountains, in which there are forty-six volcanic cones, of which twenty are in active operation. They vary from 4000 to 12,000 feet in height, those of the south and east being the most lofty; the extinct cone of Semero has been estimated at 13,000 feet; Sumbang, another crater, at 11,000; Slamat, in the centre, at 11,300, and Gedee, to the west, at 9850; some of the craters are of great size; the most remarkable is that of the Tenger mountain at the east end of the island, having a diameter of three miles, a level bottom, and a conical peak rising from the centre 600 feet. To the south of this central range is another of remarkable basaltic formation and not exceeding 3000 feet in elevation, and the south shore often presents precipitous cliffs of eruptive rocks. Hot springs are frequent, and mud volcanoes are found in the low lands yielding salt for common use. Java has no considerable lakes, but several small mountain lakes of great beauty; there are some extensive marshes; the rivers are numerous, but small, and not navigable. The mountain valleys of Java are extensive, and in the centre extend into plains. The vegetable and animal life of Java is probably more varied and vigorous than in any island of the Archipelago, differing remarkably in many respects from that of Sumatra; the teak, so abundant in the former, does not grow in the latter, and the difference of their zoology is much more remarkable, Sumatra having the elephant, tapir, and orang-otang, and the Argus pheasant; Java the Sunda ox and the pea-fowl.

The island of Bali, or Bally, is about seventy-five miles long by fifty broad, and of triangular form; it is of volcanic formation, culminating in the well-known peak of the same name, more than 12,000 feet above the sea. Of the chain which runs through the island, many peaks are volcanoes in present or recent action; of the former, Batem, 6000 feet in elevation, may be mentioned. On either side of this chain, to the north and south, fertile plains are found, and one group of calcareous hills. The island is remarkable for its natural fertility, increased as it is by irrigation from its numerous mountain lakes, situated at considerable elevations. The flora of Bali is similar to that of Java, but the fauna is deficient in the elephant, rhinoceros, and tapir. The rivers of Bali are numerous but small. Balabonang Bay, five miles deep on the Java side of the island, affords anchorage.

Bali is separated from Lombok to the east by a strait from four to five miles in width, at the entrance of which is the small island Nousabali. Like the other islands, Lombok is of volcanic formation; a chain of mountains, evincing recent action, running through the island on the north side, and a lower chain of calcareous formation parallel to it on the south; between the two is a plain studded with small volcanic cones. Gunung Rinjani, known commonly as the Peak of Lombok, on the east side of the island, rises more than 12,000 feet above the sea. Like Bali, this island has many mountain lakes, some probably occupying extinct craters, and one of these more than 8000 feet above the sea. The rivers are small, and useful for little but irrigation. The flora of the island is not so rich as that of those to the west, the teak tree is wanting, and the timber generally inferior. Lombok is about sixty miles in extreme diameter. Ampanan is a large open bay, on the west side of the island, and Laboan Treeang, or Labuhan-pring, a small harbour within it; Sumbawa is separated from Lombok by the Strait of Allas from six to nine miles in breadth. Though much larger than Bali or Lombok, it is of less importance, but not dissimilar in character: it is, like them, of volcanic formation, culminating in Tomboro more than 9000 feet above the sea, an eruption of which, in 1815, caused great devastation. The surface is much broken by ridges of eruptive rocks, and the quantity of water is less than in the other islands, lakes not being found there. The flora is, however, improved by the presence of teak, and its fauna by the horse, and there are many small but fertile valleys.

The island is 140 miles long by fifty broad; the southern coast is continuous, but the northern broken and indented, one deep bay, named Bima, stretching forty miles into the land, and giving the eastern portion a peninsular character; it is on the irregular extension which forms the northern side of this bay that the Tomboro volcano is situated; and off this is the small island of Mayo. Here is the strait of Salee, and to the west lies the bay of Sumbawa, affording good anchorage.

Sapy Strait separates Sumbawa from Flores; it is divided into two channels by Commodo Island, which rises high and steep, about thirty miles long from north to south, and ten broad, of volcanic formation, and separated from Flores by Mangderai or Mangarai Strait, about twelve miles broad; Sapy Strait is about eighteen miles broad, and divided to the north by Galibanta Island. Gounong Api, another small island, lies off the north-east point of Sumbawa.

Flores, Mangarai, or Eude, continues the volcanic band to the east; it is 200 miles long, fifty broad. The mountains are covered with forests, and rich, it is said, in mineral wealth; near the south-west point is Alligator Bay, forming a good harbour. Towards the centre of the south coast, which forms a wide bay, are two volcanoes 7000 feet in elevation; there is another marked on the charts near the west end.

To the south of Flores, distant thirty-five miles, is Sumba, Chandana, or Sandalwood Island, near the centre of which the meridian 120° East, intersects the parallel 10° North; it may be sixty miles long by thirty broad, is mountainous but fertile, abounding in buffaloes and horses. Padewahy Bay, to the north-east of the island, at the mouth of the river of the same name, affords good anchorage; to the south is a group of rocky islands.

Five small islands separate Flores from Timor; these are Admora, Solor, Lombata, Pantar or Putar, and Ombai; they are all bold and high, of volcanic formation, and comparatively barren. The last is forty-five miles long by ten broad, the others rather smaller; the passages between them are all navigable, and the Strait of Flores, to the west, and the Ombai passage, or Timor Strait, to the east, are well known; the latter separates Ombai or Ombay from Timor. This island lies north-east and south-west, and as the direction so the character of this island differs from those already noticed; it is not volcanic, and approaches more nearly in character and productions to Australia than to the other islands of the Eastern Archipelago. The surface is hilly, the valleys small and narrow, but the elevation not exceeding 5000 feet; the rivers are very small; there are no lakes, and, like the flora, the fauna of the island is comparatively thin and poor; it may be 370 miles long by fifty broad. Copang Bay forms a good and extensive harbour at the north-west angle, off which are the islands Semas and Rottee; the former, similar in character to Timor, separated from it by a narrow but navigable strait, and about eighteen miles long, the latter about sixty miles long and thirty-five broad; it is very rugged and rocky, yet produces excellent horses and buffaloes, and the usual tropical vegetables.

The insular encircled sea, which stretches its long narrow waters for 2000 miles east from Sumatra to New Guinea, has its south-eastern cincture in the double chain of islands which trend north-east and north from Timor and Wetter to New Guinea and Banda. Its eastern extremity, called the Banda Sea, is about 200 miles in width, and is marked by the singular volcanic island Gounong Api, about sixty miles north of Wetter Island, which rises 2500 feet above the sea, and is one of the most active volcanoes in these seas. The inner chain consists of five principal and some smaller islands; they are high, and well wooded. The outer are more important. The Serwati group is small but fertile, and extends for 150 miles from the north point of Timor to within fifty miles of Timor Laut, which is the most southern and largest of the group called Tenimber; it is about ninety miles long and thirty broad, low and of coral formation, surrounded by reefs, and without shelter for shipping. The rest of the group are of similar character, but much smaller. Laral is the next in size. To the north of these are the Kei Islands, which are high, rocky, and well wooded. Of these the largest may be forty miles long, and two others are of considerable size. Boen and other rocky islets connect them with the island of Ceram by the little islands of Goram and Kessing to the south-east.

The Banda or Nutmeg Islands are ten in number, forming, as their name implies, a compact group. The largest, Loutar, or Great Banda, is only seven miles long and two wide; they are of volcanic formation, fertile, and well wooded.

CHAPTER XLIII.

§ 1. The Philippines.—2. The Moluccas.—3. New Guinea.—4. Australia.

THE Philippines.—The northern point of the great eastern Archipelago is distant more than 1500 miles from its southern limit, the volcanic band. Over the northern half of this, the Philippine Islands extend, between the 5th and 20th parallels of north latitude, covering a triangular area having its sides 750 and 900 miles, and its base about 550. Their western coasts, as already noticed, form the eastern limit of the China Sea. This group consists of three large and several smaller islands; the largest, Luzon, being to the north, and the next in size, Mindanao, to the south; Hummock Island, to the south of the latter, is in lat. 5° 24′ N., and the Isles Babuyanes, to the north of the former, in 19° 38′, thus extending over more than 14° of latitude.

Luzon, or Luconia, is of very irregular shape; the northern portion being of primitive formation, the southern wholly volcanic; its estimated area exceeds 50,000 square miles; its extreme length may exceed 400 miles, but the southern peninsular extremity is very narrow in more than one place: without this the island may be estimated as above 300 miles from north to south, and above 100 from east to west; the surface is mountainous, but well-wooded, and culminates in Banajao, 6200 feet above the sea; it has several active volcanoes; the coasts are for the most part rocky: the eastern, with the small island, Catanduanes, forms a bay 200 miles in extent, within which there are said to be numerous bays and harbours, one of which, S. Miguel di Naja, fifty miles west of Catanduanes, is covered by islands and reefs, and about half-way between them, Port Seesceran, also sheltered from the sea by a group of islands, the largest of which, Quinalazag, or Ticao, is a secure harbour. On the south coast of Luzon are Sorsogon Harbour and Batangas Bay; both are safe, and have good anchorage; so have Port San Jacinto, at the north-east end of Ticao, Tardugan, to the north, and San Miguel, to the north-west of the island. Manilla Bay, being above thirty miles wide and as many deep, offers only an open roadstead, but the Port of Carite on the north side is well sheltered. This bay receives the navigable river Passig, which flows through a fertile plain. The north-west coast of Luzon is for the most part bold, though in some places level, and covered with trees. To the east of Cape Bolnios is the bay of Lingagen, about the same size as that of Manilla; it also receives a river bearing the same name, as also two others called St. Fabian and St. Thomas; indeed this island is remarkable for the number of its rivers, the largest of which, however, the Tayo or Aparri, which flows through the plain of Cagazan, is only fifty-five miles long; it has also several lakes. Began Road, marked by a gap in the mountains, Solousolou Bay and Salomogne Bay, are also on this coast. Coal is found on the north of Luzon.

The island of Mindoro lies off the south-east point, and that of Samar off the south-west point of Luzon, the former at about twenty miles distant; its estimated area exceeds 4000 square miles, and its extreme length may approach 100 miles: it is also called Mindora; it is very mountainous, but not volcanic, and is traversed throughout its entire length by three ranges; it is well watered and well wooded. The west coast is steep; there is good anchorage in Calapan Road, at the northern extremity, under shelter of the Baco Isles. The island of Samar is also distant twenty miles from Luzon; it is 150 miles long and eighty broad, remarkable for its fertility, and producing excellent timber. Cape Espiritu Santo, the north-east, in latitude 12° 40′, is high and bold; and to the east is the port of Palapa, covered by the island Batag. The channel between this island and Luzon is known as the Embocadero, and is much frequented, though narrowed by islets and reefs. To the west of Samar are Burias and Masbate; the latter is seventy miles long by twenty broad, and has two ports, Barreras and Catayugan. Port Magna is in the middle of the north-west side, and between this and Mindora, Marieduque and Bemtou, the former forty miles long by ten broad. The harbour of St. André is near the north-west point. Panay, or Pany, to the south of Masbate, is about 100 miles long, of irregular triangular shape, with the apex to the south. The south point, Naso or Nasog, is high and bold; near it there is a safe harbour at Yloylo, and another to the north called Antique Bay. The coasts of this island are for the most part low, but a chain of mountains runs through its whole length. To the south of this is Buglas or Negroes' Island; this is about 150 miles long, but very narrow, high, and bold; on the west side, near the south point, Siatou, there is good anchorage in an extensive bay.

To the east of Panay is the group of rocky islets known as the Cuyo Islands. Of these only one, the Grand Cuyo, need be noted; but this is of some size, and fertile. To the east of Panay is likewise the island Guimaras. There are also one large and several small islands between Negroes' Island and Leyte, which lies to the south of Samor; this is 130 miles long by thirty broad, is high, and very fertile. To the south-west lies Bohol, which is about forty miles in diameter; and to the east, between Leyte and Mindanao, a chain of islands, among which may be named Camiquimo, Aliguay, and Silmo; Omokou, and Soloan, and Panoan, and Surigao, near the coast of Mindanao, between which is the passage to the Pacific.

Mindanao, or Magindanao, is of irregular shape, the principal portion being of an oval form, 250 miles long from north to south, and above 100 broad; and to the west of this a peninsula extends 180 miles, having a breadth of about seventy-five, making the island in this direction about 300 miles in length; its area is estimated as exceeding 35,000 square miles. This island is mountainous, but wooded and fertile; much of it is volcanic, and there are extensive plains in the interior; the northern coast is steep and bold, and very deeply indented: here is Vligan Bay, and beyond, to the east of the north point, Surigao Road, covered by a chain of islands. The east coast of this island is but little known, though there are several good harbours there. Near the south point is the large bay of Tayloc, within which lies Illana, or Bongo Bay, which receives the river Mindanao or Pelangy, which is navigable, but has a bar with only twelve feet water. Pollock Cove is also a good harbour, and to the west of Illana many rivers fall into the sea; here is also Kamaladan Bay, within the island Pulo Lutangan, and Sugud Boyan Bay, to the north-west of the Serangain Islands: here are wide and fertile plains, abounding with deer, and marked by a high conical mountain, rising to the east; on the north-west is Butnan Bay, into which the surplus waters of the great Lake Mindano are carried by a considerable river; there are also several other lakes and rivers, known only by name.

The Philippines are connected with Borneo by Palawan on the west, and the Sulu or Suluk Islands on the east, enclosing a quadrangular area 400 miles long by 200 broad, known as the Mindoro or Sooloo Sea. Like the rest, Palawan is lofty in the interior, but flat on the coast; its length may be taken at 250 miles, and its average breadth at thirty; it is of long, irregular form, and little known. Cape Booleyloogan, its south-western extremity, is in lat. 8° 25′ N., long. 117° 11′ E.; the east and west coasts are covered by small islands, and a chain of low wooded islands connects it with the island Balabac to the south; this is about fifteen miles in length, and marked near the middle by a short peaked hill: Delaware Bay, to the south, affords good harbourage. To the south of Balabac are the islands Balambangan or Berobangan, and Banguey, near the coast of Borneo: the former is about the same size as Balabac, high to the south, and has two good harbours to the east; it is three miles distant from Banguey, which is rather larger; it has a conical peak on the north-west side, and there are many islets off the west, east, and south sides. The passage between Balabac and Balambang is the best entrance into the Mindoro Sea.

The Sooloo or Suluk chain consists of above sixty islands, the largest of which, Sooloo or Jolo, is near the centre; it is thirty-six miles long by twelve broad. Sooloo Road offers but insecure anchorage, but Toolyan Bay, near the south-east, is large and well sheltered: there are many islets on its coasts. The island Cagayan Sooloo, with its surrounding reefs and inlets, lies about fifty miles to the north of Borneo; it is only ten miles long, and seven broad. Mambahenawoer is situated thirty miles to the south of Cagayan Sooloo, and is connected with the reefs and islets which cover the north-east coast of Borneo. The Tawee Tawee Islands are very numerous, as are the Leegetan Islands, which lie beyond them. Seteoge and Tamlagan lie to the east, and have a passage one mile and a half broad, with deep water between them. The rock here is coral. Pangastaren, in latitude 6°15′ N., the most northerly island of the chain, is low, covered with trees, but has deep water to the south.

Off the south of Mindanao are the Sangir, Meangis, and Tulour Islands, the former connected with Mindanao by a chain of small islands, which yet have passages between them for ships. The Tulour or Salibabo Islands are of considerable size, three in number, and moderately high, with some contiguous islets; they are eighty-five miles distant from Sangir: Tulour, or Karkalang, the largest and most northern island, is about thirty miles long; Kabruary is the most southern, and Salibabo or Lirog, situated to the north-west of Kabruary and marked by a table hill, has the best known anchorage in the group in the road of the same name. The Meangis Islands are also three in number, with many rocks, reefs, and islets off them. The Serangani Islands, two in number, and one already noticed as Hummock Island, and named from a remarkable hill on it, are distant fifteen miles from the south point of Mindanao, which is sometimes called from them, Serangani Point.

Sanguir, or Sanguey, is a mountainous island, above twenty miles in extent, lying about half-way between Salibabo and the north point of Celebes. There is a good harbour on the east, and the west is deeply indented. To the south of this, again, are the small islands Salo or Siao, and Tagalonda; of these the former is the largest, and is marked by a high conical volcanic peak: it is distant from Tagolanda ten miles, and the same distance from Bejaren, which is fifteen miles from Banca, separated from Celebes by the strait of the same name; there are many islands to the west known under the same name. The area contained between Mindanao, Borneo, and Celebes approaches in form to a right-angled triangle, having its base and perpendicular about 400 miles long; it is sometimes called the Sea of Celebes.

The very singularly-shaped island of Celebes, and its miniature counterpart, Gilolo, separate the large eastern from the western group of the Eastern Archipelago. Of these two islands very little is known; the former is, however, frequently passed by the Molucca, Salagir, and Macassar passages. The four great peninsulas which form this island, of which three are about 250 miles long, and the fourth, the northern, more than 350, render its shape familiar to all. The north point is Cape Coffin, and to the west is Manado Bay; this coast is high and bold; to the east is the anchorage of Kema, marked by Mount Clobat, to the south of which is the Strait of Limbe, between the island of the same name and Celebes; this, though dangerous as a passage, affords anchorage as a roadstead; the mountains here are very conspicuous. The northern peninsula forms Goomengtela, or Goomeng Bay, into which, from the north, a river of the same name flows; here are two coves, and anchorage within the mouth of the river. This bay, or gulf, is 250 miles deep, and above 100 broad, and is also known as Tomi or Tominie Bay. To the south is a triangular area formed by the two eastern peninsulas, which are distant from each other more than 200 miles; within it are several islands, and in the angle is Tolo Bay. The southern peninsulas form Boni, Bonny, or Bugges Bay or Gulf, above 200 miles deep and fifty broad, very irregular, and full of rocks and shoals; the river Boni falls into the bottom of the gulf, which also receives the river Chinrana, navigable for small vessels to Lake Labaya. The area of Celebes is estimated at 73,000 square miles, and it is said that no point on its surface is distant fifty miles from the sea; it is not so much wooded as many of the other islands, but has a large teak forest; the northern peninsula is volcanic. The principal ports are Mangkassar, or Macassar, on the south-west, Menado on the north, and Kema on the east. The harbour of Macassar has a very difficult entrance among the shoals which cover it. The south-west point of Celebes is called Layk, or Layken Point; here is Bontheai Bay, marked by Lompobatang, a peak rising 8000 feet above the sea; and Boele Comba Bay, receiving Dennelong River, which is partially navigable; this coast is dangerous from coral reefs.

Salagir, or Zalagir, and Boeton, or Bouton Islands, lie off the southern extremities of Celebes; the former, called Boegeroens by the Dutch, is about thirty miles long, hilly, and very fertile. From it the Tonin or Baglawang Islands stretch to the south. Bouton Island is of middling height, more hilly to the south; it is of crescent form, and about fifty miles long; the west side forms a strait with the island Pangasum, formerly much frequented, though only one mile wide. The east side forms a deep bay, called Dwaal, or Deval, in the north part of which is Calansaesoe Harbour; to the north is Waganwang or Weywongy Island, the first of the chain which covers the east coast of Celebes. Toeambaso, called by sailors Token Bessy's Island, with many others, lies outside of Bouton. They are for the most part high, rocky, and abound in cocoa-nut trees. St. Matthew's, Vilthoeus, and the Xullas Islands lie between Bouton and the Moluccas; the latter form a group of four, of which the largest is above twenty miles long; they are high and fertile.

2 *The Moluccas.*—The Moluccas, or, as they were formerly called, the Spice Islands, lie between Celebes and Papua, or New Guinea. This name is extended by some to the islands of Gilolo, Ceram, Waygeo, Booro, besides Amboyna, Oby, and the Banda Isles, but is properly confined to the five islets lying in a chain north and south on the west coast of Gilolo, viz., Ternate, Tidor, Mortir, Makian, and Bachian; they are volcanic cones, Ternate, to the north, being still active; Bachian, the southern, is the largest. These islands are the native country of the clove, where only it can be brought to perfection; the others, although not suited to the growth of this spice, are of the greatest fertility, especially in nuts, fruits, and roots; the sago palm abounds, as do many valuable woods; and the pearl fisheries round them are very productive.

Booro, the most westerly, is high, and marked by a semicircular, dome-like mountain on the north-west; it is about forty miles south of Xulla Basi; its area is estimated at about 2000 square miles, and it may be about thirty miles in diameter. Cajeli Bay, on the north side, affords good anchorage, and is marked by the small high island Manipa, which lies to the east, about half-way between Booro and Ceram; as also by two rugged peaks on the south side. Wood of excellent quality is found at Booro, and Caipooty or Cajeput oil is obtainable in large quantities. The small island of Amblau lies five miles from the south-east point of Booro. The passage to the north-west is called Pitt's Passage, and is much frequented. Ceram, the largest of these islands, is 160 miles long by forty broad, and consists of one lofty mountain range of about 7000 feet general elevation, but culminating about 9000; it is covered with continuous forests, and its coasts are deeply indented. Lahoo Deep Bay is formed by the peninsula of Hoewama at the western extremity; Sawa Bay, on the north, is covered by several islets; and Waroo Bay, on the north-east, affords good anchorage. Ceram is mountainous, culminating in Nusa Keli, nearly 10,000 feet above the sea, and is covered with dense forests. The island of Amboyna lies in the mouth of Lahoo Bay, and is the largest of a group of five, situated off the west point of Ceram. It has been described as consisting of " a main body and a narrow peninsula parallel to it, the isthmus which joins them not being more than a mile and a half in breadth," forming a bay fourteen miles deep, forming two harbours, the outer remarkable for the great depth of water, the inner for the malaria arising from the marshes which surround it. This island is hilly, formed of granite and plutonic rocks, fertile, and for the most part covered with wood.

The island of Oby, called Major, to distinguish it from another in the China Sea, is situated about 100 miles to the north of Booro, and lies at the entrance of Dampier's Strait on the east, and the Giloli Passage on the west; it is, like Xulla Basi, of moderate size, and high; several other islands lie between it and Gilolo: of these the Dammer Islands and Ordel are close to the south, or Cocoa-nut Point, which is in lat. 0° 48′ S. To the west of Gilolo are the small islands Tawally and Maregolang; between which and Batchian, or Battyang, is the strait of the latter name; as between Batchian and Gilolo is that of Patientia, in which are several safe anchorages: these islands are high, and Batchian may be nearly fifty miles long. Xulla or Chulka Mangola extends for above 100 miles between Pulo Oby and Celebes, limiting the Molucca passage to the south; it is very narrow, and with Talyabo and Basi form the group known as the Xulla or Horn Islands; they are high, fertile, and have bold rocky shores. Another group, consisting of three smaller islands, lies between the Xulla Islands and Celebes.

Gilolo, or Halmahera, like Celebes, presents three peninsular extensions to the east; the west coast is nearly linear, and from north to south may be nearly 200 miles in length, while from east to west the greatest extension is about 100; its estimated area is only 6500 square miles: it is mountainous, well wooded, and fertile, rising to the north in three remarkable volcanic peaks, of which Kanore exceeds 6000 feet in height. The Talendiny Isles, which are numerous and only of moderate height, face the western coast. Off the north point is the island Mosty, or Mostay; this is about forty miles long; and the little island of Riow lies to the west. Mosty is high and fertile, and abounds in wild animals. The south-east extremity of Gilolo is Point Taho, which slopes gradually towards the sea, terminating in a bluff; the land about is hilly. Off this point is the islet Moar; and, about twenty miles to the south-east, the island Geby, about twenty miles in length, lies under the Equator, in the centre of Gilolo Passage; and between this point, also known as Jabo or Patany, and the north-east extremity of the island, is the great Bay of Ossa; in it are numerous islands offering shelter and anchorage; the shores also offer shelter. Ayer Watchy River is partially navigable, and the waters brackish for a mile from the sea. Maha River is at the bottom of the bay.

Close to the west shore of Geby, and forming two good harbours, is Fow or Faux Island: here nutmegs are abundant: and other small islands lie to the south; of which Eye Island bounds the east side of the north entrance of the Gilolo Passage. A range of islands also stretches towards Waygiou, of which the southernmost, Rouib, is the largest and highest; Eeu the most easterly; and Wyang the most northerly: they are mostly high.

Waygiou or Waygeeou, called Quarido by the natives, is high and rugged, about eighty miles long by thirty broad, very fertile, and presenting to the north several excellent harbours; of which Piapis is distant two miles from the west point of the island, which is called Cape Forrest. Ports Duperrey and D'Urville are separated by a peninsula terminating in Point Coquille. Offak Harbour, marked by two remarkable peaks, is about thirty miles distant from Piapis, and between them is Arago Bay; and Ranak Bay is twelve miles to the east; this is covered by the island Ranak; and to the north-west, distant four miles, is Manoaran. Boni Harbour, near the north-east point of the island, is also formed by an island of the same name. More than twenty miles to the east is Ceram Laut, a group of small low islands, about twenty in number, surrounded by a reef distant from two to three miles from them; these form three groups, of which the south is the larger, and consists of five, extending east and west fifteen miles: they are all low, and the outside of the reef so steep, that at thirty yards from the breakers no bottom was felt with sixty fathoms of line.

Gamen or Gemi Island covers the Great Bay of Chabral, on the south-east coast of Waygiou, and sometimes gives name to the strait better known as Dampier's; it is the largest of several islands on the north side of the strait. Chabrol Bay extends far into Waygiou, approaching within about two miles of both Offak Harbour and ports Duperrey and D'Urville; the shores of the bay are deeply indented on the north. Port Blosseville forms a good harbour. Popa and Mysole Islands are also to be noted, the former fifteen miles long, with reefs attached, the latter about forty miles long and twenty broad; it is forty miles distant from New Guinea, and about it are many small islands: of these, the most important are the Kanary Islands, to the north; they are low and wooded. Buttanta Island, thirty miles distant from Waygiou, forms, with Salwally Island, Pitt's Channel, about ten miles wide. This island is about twenty-five miles in length and breadth, and separated from New Guinea by the narrow passage called Galowa Strait; it lies in a deep bay formed by points Salee and Spencer, the foremost being the south-west point of the great island.

3 *New Guinea.*—New Guinea, also called Papua (a corruption of Puat-puat, referring to the woolly heads of some of its inhabitants), is about 1400 miles long, and of very irregular breadth; its greatest diameter may be 350 miles, but it extends from twenty miles north of the Equator 500 miles to the south, and is separated from Australia by Torres Strait, which does not exceed eighty miles in breadth. This island is formed; its greatest mass lies to the east, and is nearly 1000 miles long. To the east of this is the great bay of Geelvink, more than 200 miles wide at the mouth, and about the same depth; beyond which are two peninsulas, separated by a deep gulf, called M'Clure's Inlet, which approaches within forty miles of Geelvink Bay, as that does within twenty of the Arafoura Sea. Of this great island we know but little; to the west the mountains do not attain a great elevation, but through the centre a snowy range is reported, which must approach 20,000 feet in altitude; and as the entire island is covered with forests of gigantic growth, the peaks of the mountains alone excepted, the interior cannot be known until fully explored. No rivers of any size have as yet been discovered, no lakes are known or reported; yet, with so much wood, the interior cannot be destitute of water.

The north-eastern coast of New Guinea is remarkable for the lofty conical islands which lie off it, probably the craters of extinct volcanoes, the sides of which are now covered with wood; of these, Rocky or Lottin Island is about 4000 feet in elevation, Crown Island and Sir R. Rich's Island about 2000; but Dampier's Island not less than 5000 feet in elevation, and having a circumference at the base of 40 miles; and beyond this are many others, one group forming the Schouten Islands: they are all of the same character, and contrast remarkably with the coast of New Guinea, which is here low, and in many parts presents open savannahs and glades in the forest. Towards the north-east the Finisterre mountains approach the coast, and are estimated at 13,000 feet in elevation. The coast is in many parts deeply indented. Humboldt Bay, four miles wide, penetrates deeply into the land, marked by lofty mountains on either side. Matterer Bay, fourteen miles westward, is larger and deeper.

In the mouth of Geelvink Bay are several large islands. Jobei is of very regular outline, 90 miles long, high, but decreasing in elevation to the west, and well wooded, separated from Bultig or Hump Island by a strait six miles wide; this and Quoy Island are of the same character, but smaller, the latter separated from point Geelvink by a strait only three miles wide. The harbour of Dorei, the best known portion of New Guinea, is situated within the westernmost point of Geelvink Bay, and formed by the peninsula of Mamosi and the islands of Mauasouari and Masmapi; it is only about half a mile deep and 200 yards in width, but capable of receiving the largest vessels; the surrounding lands are low, and covered with luxuriant vegetation. There is no appearance in New Guinea either of extinct or recent volcanic action; slate and limestone are the principal known rocks, and from the appearance of the country, as well as the animals found on the coasts, the island may be considered as the connecting link physically, as it is apparently, between the Eastern Archipelago and the semi-continent of Australia. The zoology is remarkable: no bovine animal, deer, monkey, or carnivora have been found. The hog and kangaroo are the chief mammals; birds and reptiles are abundant.

As New Guinea is the connecting link with Australia, so the Solomon range connects that island with the groups of the Central Pacific.

New Britain and New Ireland, separated from New Guinea by Dampier's Strait, about fifty miles wide, may be considered as the extension of the volcanic range of the north-east coast of that island already noted; they form a deep bay, 250 miles broad and 100 deep, opening to the north-west, the former having a curved outline from east to north-east, and the latter from north to north-west. New Britain may be nearly 300 miles long, but very narrow; New Ireland, 180 from north-west to south-east, and 75 from north to south. The north-east point of New Britain is evidently of volcanic formation, and the elevation considerable, the mountains being visible sixty miles to sea; it forms a peninsula, and the coasts are deeply indented; there is Port Montague, the country about which is well wooded and well watered. To the north the coast is rocky; to the south the ascent from the shore gentle, and the woods broken by savannahs, above which rise lofty detached mountains. New Ireland is of the same character as New Britain; it has an excellent harbour, named Carteret, at the south-eastern extremity.

Many smaller islands lie off their coasts; there are many within the great bay, and several of considerable size to the north; they are all mountainous and well wooded; the most northern are Squally and Mathias islands. New Hanover lies off the north-west extremity of New Ireland; it is about thirty-six miles long, and of great fertility and beauty. Admiralty Island, the largest of a group of the same name, is about fifty miles long; it is mountainous, and the coast covered with islets and rocks, and about 150 miles distant from the coast of New Guinea and from New Hanover.

The Salomon Islands form a long chain, commencing 100 miles to the east of New Ireland, and reaching to within about 200 of Santa Cruz, in all about 600 miles. This chain consists of ten principal and several smaller islands, which are formed by a range of mountains having its axis in the direction of the length of the islands, i.e., from north-west to south-east; they are covered with luxuriant vegetation, and considerable rivers are reported. Of these islands, Santa Anna is the most southern, and also the lowest, not exceeding 500 feet in elevation: Banka Island is the most northerly; it is also comparatively low, well wooded, and fertile: Bougainville Island is lofty and well wooded; to the north the mountains approach in elevation to the region of perpetual congelation; a long extent of low land borders it to the north-west, and Mount Cornwallis is reported to be a volcano; it may be 100 miles long by twenty-five broad, and is separated from Choiseul Island by the strait of the same name, in which lies the small island Shortland. Choiseul Island is on the north-east, very high, and its coast rugged and inaccessible; but about the north and east points there is low land: Choiseul Bay is on the north-west side, and Warrior's River, on the same side, is accessible to boats; the land is almost entirely covered with wood; it may be sixty miles long, and of irregular breadth, not exceeding twenty miles. It is separated from Ysabel Island by Manning Strait. This island is 120 miles long, and about twenty-five broad; it is mountainous, but its shores are for the most part low, and covered with mangroves. St. George's Island, thirteen miles long, to the west of the southern extremity, Black Cape, covers the bay named by Ortega "Des Milles Vaisseaux," within which is the small but very secure harbour, Astrolabe; and to the north-west is Mount Gaillard, 2050 feet high.

To the east the chain is double, Georgia, Guadalcanar, and San Christoval islands, lying on the south, and Gower, Carteret, the Arsacides, and other small islands to the north. These are similar in character to those already described, but San Christoval may be noted as presenting two harbours, Port Philip on the south-west, and Leoné Bay, which is landlocked, capacious, and affording wood and water. Rennell's Island lies about eighty miles south-west of San Christoval. The Louisiade archipelago consists of a range of islands and reefs extending above 400 miles to the south-east of New Guinea; the easternmost, Adele Island, is a mere rock; but the next, Rossel Island, is large: of this it may be said that it is formed of lofty mountains, the sides of which are covered with thick forests, and the shores deeply indented, and faced with coral reefs and numerous islets. St. Arguan Island, twenty-seven miles long, is remarkable for the abruptness of its shores. D'Entrecasteaux islands and Trobriand islands lie to the west.

Between the south-west coast of New Guinea and Australia is the Arafoura Sea, the entrance of which, between Melville Island and Timor Laut, is 180 miles wide, and about the same between Cape Valche and Wessel's islands on the east; it is of circular form, and about 450 miles in diameter. Near the centre are the Arrow or Aroe islands, or Pulo Arau, so named from the casuaria which is abundant there; they are little known, though forming a group 100 miles long by fifty broad; they are of limestone formation, and very low. Mr. Wallace has lately visited them.

4 *Australia.*—The island of Australia, when first discovered, was, as has been already noted, supposed to form part of the great Terra Australis, the illusive existence of which was dispelled by the voyages of Cook; the discovery of different portions of the coast has also been recorded. Of the interior, scarcely even Africa, to the northern and southern portions of which it bears much resemblance, has proved more difficult of access, and after many years of toil the central portion still remains unexplored; Sturt having, in 1845, scarcely reached the twenty-fifth parallel, and not crossed the 138th meridian, leaving more than 1200 miles of unknown country to the west, and more than 400 to the north; while Mitchell, in 1846, though having explored the country parallel to the east coast, did not extend his journey into the interior more than 150 miles; and the recent exploration of Gregory from the north-west up the Victoria River has not reached further south than the twentieth parallel.

With the exception, therefore, of the south-east angle forming the basin of the Murray River, it may be said that only a strip of country round the coast has been examined. We are not, however, ignorant of the character of the interior: Sturt's journey terminated in an arid desert to the north-west; Gregory's, in country of the same character to the south-west; in such a country to the north, Leichardt perished; and it may now be safely asserted, as the geological structure of the country has indicated, that the desert tract in the centre extends over more than two-thirds of the entire area of the island, which consists of a basin of schistose rocks enclosing a vast tertiary deposit, on the outer flanks of which rest, to the north, secondary, and to the east, rocks of the primary and transition series, through which numerous eruptive and volcanic rocks make their appearance. The tertiary deposits of the centre reach to the southern coast, and also the centre of the western coast; about Swan River the primary series again appears. From the character of the winds blowing on the coast from the interior, these being at one season dry and hot, and at the opposite waterbearing winds, it has been assumed, and with some appearance of probability, that the centre of this desert region is at one period a shallow lake, but much further observation will be necessary before this can be satisfactorily determined.

The country intermediate between the east coast and the basins of the Darling and Lachlan was first explored by settlers in search of pasture lands, and subsequently by searchers for gold. The valleys and plains of the north-east were also opened in the search for pasture, and it was supposed that others to the south of the Gulf of Carpentaria extended far inland, and presented a country desirable for settlement; but the recent visit of Lieutenant Chimmo (1856) has proved the proximity of the north extremity of the great desert to the shores of the gulf. On the west the hills approach the coast so closely that no available land can be expected in that quarter, save what is known on the Swan River to the south and the Albert to the north. The promontorial extension to the east of the Gulf of Carpentaria remains indeed to be explored, but it may without hesitation be said, that the Australia of commerce and history is the eastern and south-eastern portion of the island.

This great island, intermediate in size, though not in character, between other islands and the continents, lies between the 10th and 40th parallels of south latitude, and between the 112th and 154th meridians of east longitude, and is therefore above 1800 miles in extreme length from east to west, and nearly 1600 from north to south in extreme breadth. These estimates, however, give, when compared with most other portions of the earth's surface, but an inaccurate idea of the size of this island; the coast line being very short in comparison with the area, which exceeds 2,500,000 geographical square miles, the coast line being estimated at 7600. Great Britain, with an area of about 70,000, has a coast line exceeding 2500 miles in length, and estimating, which is below the mark, twenty-five miles of area to one mile of coast in Great Britain, Australia will have 350 to the same length of coast line. The description of such an island must needs be concise, notwithstanding its vast size.

Coasts.—The most marked feature of the north coast, if not of the rest of the whole island, is the great Gulf of Carpentaria, exceeding 400 miles in depth from north to south, and 300 in breadth from east to west, while the entrance between Capes York and Arnhem is about 330 miles across. From Cape York to the bottom of the Gulf the coast trends nearly north and south, and is but little indented, though to the south are some large inlets, of which Bynoe and Van Diemen may be mentioned; the coast here is low, sandy, and destitute of vegetation. To the south, the Gulf receives the waters of Flinders and Albert rivers; the former of little importance, although it gives indications of being at some seasons a torrent, and opens into lake-like reaches; its banks are well wooded. The second is of some consequence in a country so destitute of water as is Australia, yet it is not navigable for vessels of any size, having only eleven feet on the bar at high water. An extensive mud flat covers the mouth, which is nearly straight for three miles. It has apparently two branches, but that to the south is a mere creek; the true river has its course from the west, is 250 yards wide and from two to five fathoms deep; its banks are fringed with mangroves, and it has several islands; about six miles from the sea it is about a quarter of a mile wide, and here the banks are covered with gum trees and acacias; here also the river winds much, and there are several islands; above, it opens into lake-like expanses; the country gradually rises, and the scenery becomes picturesque; palm trees, and bamboos fifty feet high, diversify the outline of the wooded banks, beyond which stretch vast plains covered with coarse grass, and dotted at long intervals with clumps of small trees; these are the Plains of Promise of Stokes, though apparently scarce worthy the name; the soil is light, and in some places rich, but in others stony. The Albert rises in two sources, and is navigable for boats two miles above their confluence. The entrance of the river is marked by a high clump of mangroves, with which indeed all the southern shore of the Gulf is fringed, and behind this fringe, over which the land is not seen, are extensive mud flats, which at low water are uncovered one mile from the shore, the water shoaling very gradually. The temperature at the bottom of the Gulf ranges about 90°, but falls to 62° at night and morning: it is remarkable that here, as in some places to the north and west of Australia, only one tide is felt in twenty-four hours, while in others there are four.

The west and south-west coast of the Gulf of Carpentaria is more indented, and has many islands off it; the Wellesley Group, of which Mornington Island is the largest, lies at the south of the Gulf; they are wooded; the shores are principally coral and sandstone, and where low covered with mangroves. Sir E. Pellew's Islands lie 130 miles to the north and west; and about eight miles to the north of these is the Groote Eylandt of Tasman, which may be about twenty-five miles across. On the coast are some considerable bays.

To the west of Cape Arnheim is Melville Bay, and to the west, again, Arnheim Bay; an extensive sheet of water, covered by Wessel Islands on the west, and English Company's Islands on the east; and there are other bays to the west, the most important of which is Port Essington, remarkable no less for its size than its security; it consists of two basins, the inner of which is five miles in diameter, though its available surface is narrowed by a sandbank; the outer harbour is one mile in width thirteen miles from the mouth. This harbour is situated to the north of Coburg Peninsula, attached to the main by a narrow isthmus, and forming Mount Morris and Van Diemen's bays to the north and south; the prevailing rock here is red sandstone, but Bedwell and Rose mountains are of trap and rise 400 feet; the country and soil are poor, but on the east well wooded; the climate, though not absolutely pernicious, is unsuited to European constitutions.

Van Diemen's Gulf is about eighty miles in extent, and covered by Melville and Bathurst islands, which are separated by the narrow channel of Apsley Strait. Melville Island presents low points and sandy bays, with patches of mangrove to the north; but on the south are cliffs sixty feet high, of red sandstone and ironstone, with white marl or pipe-clay; one round hill rises 320 feet. Clarence Strait, fifteen miles wide, separates these islands from the main; and the Vernon Islands, surrounded by a coral reef, lie in the entrance of the strait. About Cape Hotham, the south-east limit of Van Diemen's Gulf, the country is of red sand and iron stone, and very poor; the sandstone cliffs on the coast are fronted by a coral reef. To the south of Cape Hotham is Adelaide River, having a course of eighty miles from the confluence of its two sources; its banks are fringed with mangroves for fifteen miles, but above that, are, like the Albert, well wooded; but beyond them the country is one wearisome level, dotted with islands of timber; wherever the water is fresh there the thickets are interspersed with bamboos. This river falls into Adam's Bay, six miles deep and ten broad, by many creeks, and has many anastomosing branches; the main channel at the mouth has more than three fathoms water. Beyond this the country is a thirsty level, the coast for the most part fringed with mangroves, but occasionally broken by cliffs of fine grained sandstone, interspersed with clays and calcareous matter. Talc has also been found imbedded in quartz rock. Ports Darwin and Patterson must here be mentioned; the former extends for thirty miles, and is remarkable for its cliffs of slate, granite boulders, and singular detached hills; the latter is twelve miles long and seven wide, and within it Bynoe Harbour, having an entrance two miles and a half wide, winds round to the south-east for nine miles, with five fathoms water.

Point Pearce is a level cliffy projection, at the entrance of Queen's Channel, which is twenty-eight miles wide, and marked by Clump and Quorn islands. This channel receives the waters of Fitzmaurice and Victoria rivers, and has an extensive mud-flat between it and the former, which is scarcely more than a creek; beyond which Macadam range rises 700 feet above the sea; it extends inland thirty miles, with a breadth of half a mile; the latter has a breadth of two miles, and flows through a sterile country of red sandstone near the mouth, but which improves thirty miles higher up, where it flows between rocky banks. The water is not fresh for seventy miles from the sea; being navigable for vessels of burden for about the same distance, and for boats 125 miles, this must be considered a river of much importance in a country so ill watered as Australia. At the mouth of the river, between Pearce and Turtle points, the coast is bold, but presenting extensive mud-flats at low water, over which the tide, which rises twenty-four feet, comes in with a bore; these are fringed with mangroves, as are the banks of the river for thirty-five miles on the right bank, the left being bold: here the character changes, presenting a defile about two miles wide between rocky ranges of compact sandstone, 500 feet high; and thirty-miles above, a similar defile is found. The sea range is, however, the highest, culminating at about 800 feet; and between these a rich, well-timbered alluvial plain extends seventeen miles in width, through which two affluents, the one from the south, and the other from the north, named respectively Norton Shaw and Saunders, flow to the main stream. The parallel ranges of hills which stretch north-east and south-west, and bound the valleys, are flat-topped, presenting cliffs thirty to forty feet high, and culminating at less than 700 feet above the sea; the plains consist of light soil on compact clay. The thermometer ranges higher here than at the Albert, the ground never cooling, and the country being less healthy.

From the north of Sea range, Ellesmere range stretches north-east, forming extensive table-lands 900 feet above the sea, and on the opposite side of the river, Murchison range, of similar character, extends to the south-west. Stokes and Fitzroy ranges form the eastern limit of Green Valley, and beyond them the river has hollowed a channel for its waters one mile in width, and 500 feet in depth; here shale and débris lie at the base of sandstone cliffs, rising 300 feet above them; these, like the other ranges, extend in table-lands. Wickham River flows into the Victoria from the south-west, in latitude 16° 30′, through a plain crossed by sandstone ridges; and between this and the main stream, as well as about the latter, which has its rise in two sources from the south, the trap formation affords a good grazing country, extending for many miles, but crossed by sandstone valleys. There is a small affluent between Wickham River and the main stream, and the confluence of the two sources is in latitude 17°, longitude 131° 20′.

The south-west source of the Victoria is in latitude 18° 20′, longitude 130° 50′; and beyond this, Mr. Gregory has penetrated eleven miles to the south: he found the source in a level grassy plain of red sandstone; and beyond, a vast plain, extending to the south, without water or vegetation, formed of loose red sand. From the source of Wickham River, he found the ridge dividing the waters in latitude 17° 42′, and crossing this, in longitude 129° 58′, in latitude 17° 55′, a creek, the waters of which flowed south and west for thirty miles; thence, west for thirty miles more, its channel was dry; in longitude 120°, latitude 18° 25′, he found brackish water flowing to the south: on the north-west of this plain, named by him Denison's, and to the south-east, sandstone ranges 150 feet high; but beyond, a sandy desert extended on both sides, and the creek terminated in the dry bed of a salt-lake, about ten miles across, having indications of inundation 20 feet above it, and surrounded by low ridges of drift sand, and an acacia forest to the north: the centre of the depression was in latitude 20° 16′ south, longitude 127° 35′ east, and 900 feet above the sea.

Fifty miles to the west of Queen's Channel is another deep inlet stretching into a hilly country, called Cambridge Gulf, beyond which the coast trends west and north for eighty more to Cape Londonderry, from whence it again takes a south and west direction, and presents a very broken outline, covered with islands for 150 miles to Prince Regent's Inlet, which receives the waters of the small river Glenelg. The intermediate country presents schistose and slate rocks with siliceous sandstone, and its surface is rugged and broken; and near Glenelg River enormous granite boulders are found, though about the river there is some good land.

On this coast are high rocks of the transition series, and table-topped sandstone hills rising 900 feet above the sea, are continuous at the same elevation to Fitzroy River, but the prospect is cheerless, notwithstanding Stokes remarked that the fragrance of the gum trees was perceptible at sea. Hanover Bay, Brecknock Harbour, and Collier Bay may be noted; the second is six miles deep, and nearly two wide, at the entrance, the width increasing to five at the head; the latter, twenty miles wide at the mouth, narrows to six, and its shores are fringed with scattered mangroves. To the south, a sterile region of white siliceous sandstone lies between Collier Bay and King's Sound; the coast is covered by a string of small islands, on which slate and granite appear; and here Port George the Fourth offers extensive and excellent harbourage. Within King Sound, the only safe anchorage on the east side is in Port Usborne; it is covered by an island and nearly surrounded by rugged sandstone ridges, the gorges between which are densely wooded; it is one mile deep, and three-quarters of a mile wide, with deep water. Coral banks cover the islands off this coast. Cape Leveque, the western extremity of King's Sound, is a red sandstone point, sixty feet high; here red is the prevailing colour of the country, which is sandy and barren. This coast, as well as off Yampee Point, to the east of the sound, is remarkable for the irregularity of the sea-bottom, and consequent irregularity and strength of the currents. Roe's Archipelago also presents fantastic outlines of primitive rock. Within the gulf, cliffs of white concretionary sandstone are found, and portions of the country are covered with delightful verdure, but mangroves fringe the coast, which rises gradually to an elevation of 200 feet.

The sandstone cliffs terminate at Foul Point, beyond which, about Fitzroy River, the coast, as at the mouths of the other rivers already noticed, is low and muddy, Cape Torment at the entrance, consisting of banks of mud and sand, bound together with long grass, being three miles wide, flooded at high water, and deeply intersected by narrow creeks. The bar has only two feet depth at low water, but six miles up the river the depth is fourteen feet, and the stream 400 hundred yards wide; Stokes found here evidence of inundations in which the rise of water had been twenty feet. This river also rises from two sources, the largest of which is the southern; it is navigable for boats ninety miles from the coast in direct distance to the south and west; twenty-two miles beyond this, the country presents one wearisome level, open to the west, but more wooded towards the east. This river, like those of Northern Australia, opens in lake-like reaches; the banks are often twenty feet high; in its middle course cliffs of fine-grained red sandstone are found, about which the country is heavily timbered: on the east bank, near the mouth, quartzose sandstone prevails, and the country is almost destitute of animal and vegetable life. The thermometer here ranges about 100°.

The peninsula which forms King's Sound has been named Dampier's Land, from the navigator of that name, who discovered it in 1688; its coast is straight and rocky, marked at Cape Emerian by tall white cliffs, with ledges of dark rock at its base; the country rises gradually in undulating well-wooded heights, the coast still fringed with mangroves to the south. Cape Baskerville, 200 feet high, forms the limit of Beagle Bay, which is three miles wide and seven deep; and here the country is low and open, marked by great ant-hills and palm-trees. Roebuck Bay, marked by Cape Villaret, a cliff of red sandstone 150 feet high, in latitude 18° 18′ south, is sixteen miles across; its north-east shores formed of red cliffs twenty to thirty feet high, above which are extensive plains, with scattered clumps of trees, which appear to be flooded at some seasons; to the south the coast is low, formed of mud-banks fringed with mangroves. The climate here was remarked by Stokes to have a peculiarly depressing effect, which he thought not due solely to the heat, although the thermometer rose to 118°. From hence a low coast trends to the south and west 300 miles, to Cape Lambert, where the coast is dreary and sterile, rising occasionally in red sandstone cliffs and stony-topped hills, 200 feet high, and indented with muddy mangrove creeks. Off this coast lies Dampier's archipelago, the small islands composing which are formed of greenstone, and present a dreary and desolate appearance. This chain extends above 170 miles to North-west Cape, the limit of Exmouth Gulf; they are connected with the main by extensive reefs, which have, however, deep water over them. They appear to be the ruins of a vast promontory, the sea bottom presenting terraces, on which, at forty miles from land, there is a depth of 110 fathoms, and the same distance from the islands fronting it about 200 fathoms. Burrow Island is the largest, being twenty miles long and twelve broad; some of these, as Tremouille Island, are high, approaching 150 feet; most are protected by coral reefs. Deputch Island, the centre of the Forresters' group, lying beyond Cape Lambert, and which may be considered as the north-east extremity of the archipelago, is of columnar greenstone, and a corresponding hill of the same formation is conspicuous on the main opposite to it; it is eight miles in circumference, and 514 feet high. Turtle Islands are low banks of sand and coral.

Exmouth Gulf is formed by a narrow rocky peninsula, extending north from Cape Coates to North-west Cape; fifty miles from thence a level country extends 100 miles to Cape Cuvier, the northern extremity of Shark Bay; it would appear probable that the whole of the coast is frequently inundated, the inundations extending to Shark Bay, and isolating the rocky peninsula west of Exmouth Gulf. Cape Cuvier is distant 120 miles from Steep Point, the southern extremity. This extensive bay, or gulf, is divided into two harbours, named respectively Hamelin and Freycinet, by Peron peninsula, which is about sixty miles long and twenty broad, and connected with the main by a narrow isthmus. The former and more northern is about thirty miles wide at the mouth, and has Faure Island in the centre; the latter, about ten miles wide at the mouth, expands towards the bottom. Dirk Hartog, Dore, Bernier, and Koko islands, stretch nearly across the entrance of the gulf from Steep Point; Geographe Channel, the broadest entrance, is to the north of the latter, and Naturaliste Channel, to the north of the former, which is about thirty miles long and five broad; the others being much smaller. The three small groups forming Houtman's Abrolhos are 120 miles to the south of Steep Point; of these Wallabi Islands are the most northern; these are separated from Easter Islands by a channel six miles wide; and these, again, from Pilsart group by a channel four miles wide. They extend in a north-west direction for forty-eight miles, and stand on a rocky platform, having thirty fathoms of water, but sinking precipitously to the west into 250. Easter group is remarkable for its excellent harbour, named Good Friday Harbour, and for its rocks of cream-coloured limestone on Rat Island; some of these islands are coral lagunes. Between the Abrolhos and the main is Geelvink Channel, named after Vlaming's ship. Moresby's flat-topped range marks this coast; the similarity of which to the sea range on Victoria River, Cape Flattery on the north-east coast, and the cliffs at the head of the great Australian bight on the south, have been noticed by Stokes. Wizard Peak culminates 715 feet above the sea; it is a solitary pyramidal hill, formed of blocks of ironstone, as is great part of the range to the north. Mount Fairfax, at the south extremity of the range, is 585 feet high. Here the country is all arid and barren, and the coast hills, which extend to the Darling range on the south, culminate in Mounts William and Seaward, respectively 1720 and 1270 feet above the sea. This coast has no secure harbours, nor any rivers worth notice.

The most important river on the west coast is Swan River. Its principal source is the Avon, a string of water holes, which, after receiving the Dale, Toodyoy, Howick, Ellenborough, Helena, and Canning, after a course of about 200 miles, falls into the extensive estuary of Melville water, a lake-like expanse surrounded by park-like meadows, studded with clumps of trees.

This river, like others in Australia, is subject to terrible inundations; but the soil deposited is deep and rich, and bears continuous cropping for many years. The country about the Swan River consists principally of dull green-looking downs, backed by hills 2000 feet high; three miles from the coast calcareous concretionary ridges extend parallel to it; beyond which are sandy forest land and low hills, which rise 2000 feet in the Darling range, consisting of red cellular sandstone, and detached granitic hills having an appearance indicating the action of fire, with undulating woody country at base; and in the interior the Talbanop culminate 5000 feet above the sea. Basalt is found at Geographe Bay on the south, and from thence coal formations extend to Shark Bay on the north, nearly 600 miles. The geology of the Swan River is marked by the absence of secondary and transition rocks; tertiaries of the newest kind resting on primary rocks from Darling to Sea range; this latter containing shells of existing species traceable north to Shark's Bay, and the same formation, with clays and gypsum, found in Abrolhos. Slate is found on Canning River. Melville Water opens in Gages Road, an insecure anchorage covered by Rotte-nest Island, from which a shoal extends one mile and a half to the north. The tide here rises thirty-one inches, while farther north it exceeds twenty and often approaches thirty feet; but along the whole west and north coasts there is only one tide in twenty-four hours.

Cape Leuwin (Lioness), the south-west point of Australia, appears like an island; it is steep and rocky, and the coast to the east picturesque and well wooded; between this and D'Entrecasteaux Point the coast is low and sandy. Eclipse Islands lie off Peak Head; they are low and barren, the largest only one mile and a half long; beyond these is King George's Sound, offering by far the greatest advantages of any port in West Australia; within it are two excellent harbours, Princess Royal for large, and Oyster for small vessels; the former has an entrance only a quarter of a mile wide, but with deep water, and is marked by Mount Clarence on the east, rising 520 feet. Breaksea and Michaelmas islands cover the entrance of the sound; these islands are small, but elevated, with a deep water channel between them.

Eastward the coast becomes sandy and barren; Cape Shoal, formed of white sandhills, with other similar points, breaking the coast line; here is Recherché archipelago, extending for 135 miles, and consisting of small islands and reefs. Esperance Bay, fifteen miles wide and twelve deep, is full of rocky islets, and beyond this Cape Le Grand projects five miles into the sea; and further east Cape Arid, from behind which a bank of sand, from 400 to 600 feet in height, extends eastward and forms the coast line at the head of the Great Australian bight, projecting in cliffs at Culver and Dover points. This bight may be estimated as 600 miles from point to point, and 200 miles deep; its shores, which in the centre are low and covered with dense scrub, are unbroken by rivers, but towards the east Fowler Bay presents good anchorage, as do also Denial, Petrel, and Coffin bays, the latter marked by Mount Greenly, rising 800 feet and clothed with wood. These bays are covered by the islands of Nuyt's archipelago, the most considerable of which are the isles of St. Peter, off Denial Bay; they are, like the coast, low and sandy; the largest is six miles long and about four broad; the south-westernmost group are the isle of St. Francis, formed by a sandy isthmus uniting two rocky hills; it is three miles long, and affords good anchorage in a bay on the north-east.

Whidbey Point forms the extremity of the peninsula at the western side of Spencer Gulf, having Coffin Bay on one side and Port Lincoln on the other, and extends for about fifty miles, forming two open bays and rising in an elevated ridge to the east, from which Cape Catastrophe projects its round summit covered with trees. Port Lincoln is an excellent harbour, with deep waters, and well sheltered; the entrance is five miles and a half wide, but divided by Barton Island, four miles in length. Thistle Island, twelve miles in length, lies off Cape Catastrophe, from which it is separated by Thorny Passage, about five miles in width, and from thence Spencer Gulf extends to the north and east 160 miles, with an extreme breadth of seventy-five; it is about thirty miles wide at the mouth, from Thorny Island to Cape Spencer. The surface of this gulf is unbroken, except by the Sir Joseph Banks' Islands, about thirteen in number, the largest about five miles long; and as well as the shores for the most part low and sandy; there are convenient anchorages, especially at ports Germain, Yatala, and Augusta. Hardwicke Bay, formed by the west trending of York Peninsula, on the east of the gulf, is twenty-seven miles in breadth and eighteen in depth. The Gambier islets lie in the centre of the passage between Thistle Island and Cape Spencer. This gulf has originally received the waters of Lake Torrens, which extends in a horseshoe-like bend for above 400 miles round the hills at the head of the gulf, with a breadth of about twenty-five miles. This very peculiar feature in the geography of Australia may be considered as forming the centre of a great saliferous district, extending from the Murray to the Swan River; it is approached from the east through rugged passes, over the débris of shivered quartzose rocks, which extend north-east and south-west in parallel ranges not exceeding 1600 feet in elevation; on the flanks of these lie plains of sandstone and clay, and lower ridges marked by long narrow belts of pine trees; to the north, the rocky flat-topped ranges formed of compact quartzose rise 2000 feet above the sea, and there is an extensive pine forest to the east of Mount Lyell, while some park-like prairies are found to the west, and towards the north, occasional grassy woodlands separated by sandy ridges: on the whole, however, the country is hopelessly barren, and destitute of water. Near the tropic, the extent of our knowledge in this direction, Sturt found the same undulating plains of red sandstone which Gregory found forming the watershed of the Victoria. The banks of Lake Torrens form a gentle slope studded with bushes; deep soft clay and gypsum form the bottom, on which is a coating of salt; it does not receive the waters of any considerable stream, and has no surplus to discharge. The country here is of the best character, except about the head of the gulf, and the harbours most excellent; it is 300 feet above the sea, and its southern extremity about fifty miles from the bend of the gulf; a branch has also been traced to the northward, into which it is not improbable that the Victoria River, rising near the source of the Maranoa, once fell.

York Peninsula, about eighty miles long, separates Spencer and St. Vincent's Gulfs; Kangaroo Island, about eighty miles long and thirty broad, high, well wooded, and fertile, lies twenty-three miles from Cape Spencer, forming Investigator Strait. It has an excellent harbour at Kingscote, on the north side; St. Vincent Gulf is about forty miles wide at the mouth, and 100 deep, and receives Wakefield, Torrens, and Oukaparinga rivers; the former has good anchorage in its mouth, but the country round is poor and destitute of timber: at the head of the gulf the Torrens forms the harbour of Adelaide, giving shelter to vessels of considerable size, but having its entrance obstructed by a bar. To the east of Cape Jervis is Encounter Bay, eighteen miles broad and seven miles deep, communicating by the dangerous Goolwa Channel with Lake Alexandrina, or Victoria, which receives the waters of the rivers Murray, Bremer, Angus, and Finnis; this lake is thirty miles long and about the same in breadth, and connected with Lake Albert by a strait five miles long; it contains several islands. The country round is level; the entrance is narrow and shallow and obscured by sandhills, which extend along its entire length.

The Murray River, formed by the confluence of the Murray and Darling, is by far the most important in Australia; in direct line from the mouth to the source of the Darling it extends 750 miles, and its basin is 500 miles both in length and breadth. The affluents of the Darling are principally in its upper course; of these, the Kindeer, Keraula, Nammoy, Gwyder, Macquarie, and Castlereagh may be named; but the most important is the Condamine, from the north, which has its affluents, the Cogoon and Maranoa, in close proximity to the waters falling into the sea by the north-east coast. The Darling is the secondary source of the Murray, and rises in the grassy range of Darling Downs, 2000 feet above the sea, within fifty miles of the eastern coast. Its head waters are beautiful clear rapid mountain streams, which not unfrequently flood the level country, about its middle and lower course, 300 miles from its sources; here, however, the river more frequently consists of strings of pools, which, in its affluents, are not always connected; it is of little breadth, and frequently the current imperceptible, having a tortuous course through plains of ferruginous sandstone, having verdure only in the narrow slip in breadth not exceeding two miles, and sometimes not a quarter of a mile, which is affected by the inundations, the country beyond being sandy, desolate, and scrubby. The plains of the lower Darling are only 250 feet above the sea. This river does not receive any affluents from the north-west, and its junction with the Murray is under the 34th parallel of north latitude, and in longitude 142° east. The Bogan, its last affluent from the south-east, has its waters saline, and flows through a barren country.

The Murray has its rise in the Australian Alps, at probably double the elevation of the sources of the Darling; it has several affluents from the south, rising close to the south coast: its northern affluent, the Lachlan, is formed by the confluence of the Lachlan and the Murrumbidgee, which also have several affluents, and have their upper courses in the western slope of the main watershed of Australia, and in their valleys are the principal localities where gold has been discovered. These streams are like the sources of the Darling, but the stream of the Murray is perennial, and not subject to sudden floods, but rising gradually about one inch daily from July to December, when it is usually seventeen feet above its lowest level, but after its junction with the Darling, and for some distance above, it partakes of the character of other Australian rivers. Lake Bonney is a shallow basin, annually filled by the waters of the Murray, and connected with it by Hawkins' Creek, a winding channel six miles long; the lake is only ten miles in circumference, its shores wooded towards the river, but formed of low arid sandhills; on the other side there is also a branch of the Darling, up which the water flows northward into it; and the country about the mouth of that river is marked by water meadows, creeks, and lagunes. Lake Victoria, which though shallow and often nearly dry, has a basin twenty-four miles in circumference, and is surrounded by park-like country, beyond which, however, is an arid salt desert. The lower course of the Murray may be said to commence under the 34th parallel; here are sandy ridges covered with pine trees, the banks of the river rising to a flat tableland about 300 feet above the sea level, the bed of the river, at 200 miles from the coast, not exceeding 100 feet in elevation.

Lines of granitic formation occur near Lake Victoria, and volcanic influences are apparent in the deep crater-like lake at Mount Gambier. There is a dense mass of scrub about ninety miles above the mouth of the Murray, and a very extensive and singular fossil deposit, which appears again near Lake Victoria, a range of metalliferous hills intervening. This river is navigable for two-thirds of its course, but although with depth and capacity for large vessels in its lower course, it is inaccessible to them from a bar at the mouth.

The ranges of mountains in which these rivers have their sources extend for more than 1000 miles along the eastern coast of Australia with much continuity, and proceeding to the north and north-west in extensive table-lands of considerable elevation; and have their southern extension from Port Philip, to the west in Mount Alexander, the Pyrenees, and the Grampians. The rocks here are principally trappean, and about Mount Alexander much gold has been found; between the Murray and St. Vincent Gulf are slate quarries, and the richest copper deposit in Australia.

Beyond Encounter Bay, Guichen Bay affords safe anchorage, and from hence to nearly Cape Bridgewater, a bold headland, the coast is low and sandy, but marked by Mounts Gambier and Schanck, of volcanic formation, and the latter having the remains of an extinct crater; here Glenelg River falls into the sea, and beyond, Portland Bay, thirty-two miles wide and nine deep, affords excellent anchorage; to the S. E. is Percy Island. At the mouth of Bass Strait, the northern shore of which, extending from Cape Otway to Wilson Promontory, 150 miles, forms a deep bight, is Port Philip, sixty miles from the former, and twenty-four miles farther to the east is Port Western; Port Philip extends thirty miles from north to south, and eighteen from east to west, having depth of water for large vessels, while its entrance, only two miles wide, is contracted by reefs. The principal anchorage in this extensive area is Hobson Bay to the north, sheltered by Gellibrand Point, which receives the Yarra-Yarra River, about fifty yards broad at the mouth, but inaccessible to large vessels, and having a rapid and broken course. The country round is famed for its park-like appearance; here sandstone rocks and tertiary deposits prevail; the hills in the immediate neighbourhood rise 1300 feet. Geelong and Corio Harbours, far superior to Hobson Bay, are formed on the western side of Port Philip.

Port Western is separated from Port Philip by the narrow promontory terminating in Cape Schanck; it is of irregular form, its entrance covered by Grant Island, and French Island, surrounded by a narrow muddy channel, occupying its upper part. Grant Island terminates to the east in Cape Wollamai, remarkable for its wedge-like shape and red colour. This bay offers the most accessible and secure harbourage; the country round it is remarkable for the luxuriance of its vegetation; the rocks are of the carboniferous series.

From the entrance of Bass Strait, at Wilson Peninsula, the coast of Australia trends in a concave sweep for more than 180 miles to Cape Howe; the land here is low, sandy, and partly covered with small trees, behind which, about fifty miles distant, elevated mountain-ranges are seen. Cape Howe is the south-east point of Australia, and is marked by a rounded hill of the same name, which rises 1250 feet. Twenty-five miles beyond is Red Point, the southern entrance to Twofold Bay (so named from containing two bays within it), to which the coast is for the most part bold and rocky. This bay affords in Snug Cove the only harbour on this part of the coast. Its shores consist of steep headlands, rocky points, and sandy beaches; at the back of which, ponds and lagunes are mostly found. It is marked by the double heads of Mount Dromedary, which rises 2700 feet, and the corresponding hummock of Mount Finlay, 2910 feet above the sea.

From Twofold Bay the coast is indented with small creeks; here Montague Island is found three miles from the coast, it is about two miles long and 210 feet high. Bateman Bay receives the Clyde and McLeay rivers; both are inaccessible from bars at their mouths. This part of the coast is marked by a conical hill, called by Cook the Pigeon-house, and to this point its character does not change, the interior being mountainous and well wooded, but from hence it becomes low and thickly wooded, with sandy beaches, rocky ledges, and islets as far as Cape St. George, seventy-five miles from Port Jackson; beyond this point is Jervis Bay, seven miles long and four broad, its entrance between Perpendicular Point, which rises 275 feet from the sea, and Bowen Island, about one mile and a half wide; the anchorages are in Montagu Road, on the east side of the bay, and Darling Road, to the south. Bowen Island, separated from the south point of the bay by a narrow chasm, is high, with rocky coasts, partially wooded and fertile throughout the coast of the Illawarra district, the garden of New South Wales.

A few miles north of Perpendicular Point is the north extremity of the peninsula, that forms the east side of Jervis Bay, with the bight behind called "Crookhaven." Thence to Black Point is fourteen miles, passing the outlets of the Shoalhaven Rivers. Red Point is about six leagues north of Black Point. Next come Wollongong and Cape Solander, forming the south point of the entrance to Botany Bay, as Cape Banks does the northern. Port Jackson is a safe and excellent harbour between Botany Bay, about four leagues to the south, and Broken Bay five leagues to the north of it. Fifteen leagues from Broken Bay is Newcastle Harbour, and eight leagues from thence Stephens Point and Port Stephens, nearly seventy-nine from Port Jackson.

From Bass to Torres Strait, the coast is bounded by a ridge of mountains, which in some places approach to within a few miles of the coast, leaving only a comparatively narrow strip of land. The coast line itself presents often bold perpendicular cliffs of sandstone, in horizontal strata. These cliffs are occasionally interrupted by low sandy beaches, some of which stretch to a considerable distance inland, and appear to have been covered at no very remote period by the sea. The indentations on this coast are more remarkable on account of their number and the excellent harbours which they form, than for the extent of surface which they occupy. From its supposed resemblance to our own South Wales, Cook named this part "New South Wales." Proceeding southwards from Cape York, we find Shelburne Temple, Princess Charlotte, Bathurst, Trinity, Rockingham, Halifax, Repulse, Shoalwater, Hervey, and Wide Bays—the last, in lat. 25°. Thence continuing southwards and entering the settlements still comprised under New South Wales, are found Glasshouse, Moreton, Broken, Botany, Jervis, Twofold Bays and Corner Inlet. From the north are Capes York, Grenville, Weymouth, Sidmouth, Melville, Flattery, Bedford, Tribulation, Grafton, Cooper, Sandwich, Cleveland, Bowling Green, Upstart, Gloucester, Palmerston, Townsend, Clinton, Manifold, Capricorn, Sandy, Moreton, Lookout, Danger, Byron, Lennox, Smoky, Plomer, Hawke, Elizabeth, Sugar-loaf, Blackhead, St. George, Dromedary, Green, Howe, Ramhead, Point Hinks, and Wilson Promontory. Hervey Bay to the north cedes in importance to Moreton Bay, which is formed between the mainland and the islands of Moreton and Stradbroke. This district has been called by some, Cooksland. For several degrees south, no great indentations are found until we arrive at Port Stephens, when a succession of noble harbours occur, destined evidently to form great emporia of commerce.

Barrier Reefs.—Along the east coast lie the "Barrier Reefs," forming a vast submarine buttress, skirting the shore. The great Barrier Reef extends from Break-sea Spit, in 24° 30′ latitude, and 153° 20′ longitude, to Bristow Island, near New Guinea, in 9° 15′ latitude, and 143° 20′ longitude, a distance in a straight line of about 1100 geographical miles—being the longest known coral reef in the world. This reef affords two passages for ships sailing from Sydney, *viâ* Torres Strait, for India, Singapore, and China; *firstly*, the *Inner* passage, between the mainland and the Great Barrier; and *secondly*, the *Outer* passage between the Great Barrier and the numerous other reefs extending towards New Caledonia.

Islands.—Australia, like other continents, has islands of some magnitude attached to it—the largest is Tasmania. The other principal ones are Flinder and King Islands in Bass Strait; Kangaroo Island at the mouth of the Gulf of St. Vincent; Dirk Hartog Island, forming the west side of Shark Bay; Bathurst and Melville Islands, off the north coast of Arnhem Land; Groote and Wellesley Islands, in the Gulf of Carpentaria; Great Sandy Island, on the east coast. Besides these—Prince of Wales' Group off Cape York; the Pellew and others in the Gulf of Carpentaria, Wessel and English Company Islands near Melville Bay; Buccaneer Archipelago to the south-west of Cape Londonderry; Dampier Archipelago; Barrow and others off De Witt Land; Bernier and Dorre Islands off Shark Bay; Récherche Archipelago on the south coast near King George Sound; Nuyt Archipelago; Stradbroke and Moreton Islands, are found between Wilson Promontory to Moreton Bay and the Solitary Isles north of Port Macquarie. Howe and Ball Pyramid Isles lie about 400 miles east of Port Macquarie. To the north, along the east coast, commence the coral islets, including Bunker, Keppel, Northumberland, Cumberland, Percy, Hill, and other minor islands.

Rivers.—Commencing from Cape York, a small stream, the Escape, flows into Newcastle Bay; and to the south of Cape Bedford, Endeavour River flows through a comparatively good country. We next reach the Brisbane, navigable for seventy-five miles; and the Logan, both of which discharge themselves into Moreton Bay. The Clarence and Tweed flow into Shoal Bay; the Manning and the Hastings next follow. The Karua flows into Port Stephens; the Hunter into the port of the same name; the Hawkesbury, and its tributary the Nepean, into Broken Bay; the Shoalhaven into the Bay of that name; the Clyde into Bateman Bay. On the east of Gipps Land is seen the common estuary of the Thomson, Riley, and Arthur Streams; the Perry, Dunlop, and Barney unite also in one stream, and next the Machonochie and Latrobe unite their waters before falling into the ocean. The Yarra-Yarra empties itself into Port Philip, the Geelong also; the Hopkins, Shaw, and Fitzroy flow into Portland Bay; the Glenelg into Discovery Bay about longitude 141°. The Murray, the Darling, and Murrumbidgee have already been described. Among others may be mentioned the Dumaresque, Gwyder, Peel, Castlereagh, Macquarie, Culgoa, Bogan, Lachlan, and Bazungun. Farther north flow the Barwan, Condamine, Warrego, Barcu, Belyando, Burdekin, Suttor, &c., in the interior. The Torrens and the Gawler are only small streams flowing into the east side of the Gulf of St. Vincent. In *Western* Australia the Kalgan runs south into King George Sound, the Denmark into Wilson Inlet; next comes the Shannon, and then the Blackwood, emptying itself near Port Augusta into Hardy Inlet. Proceeding northwards, the Preston and Collie Rivers flow into Leschenhault Estuary, the Murray into Peel Inlet; the Canning into Melville Water, and the Swan River, already mentioned, into the same. The Moore, Arrowsmith, Hull, and Murchison, flow by short courses into the sea. Between the Gascoyne and King Sound few, if any, streams are laid down on our best maps. The Fitzroy flows into King Sound, and the northern Glenelg was discovered in 1837 by Grey and Lushington. Stokes' Victoria and the Murray have already been mentioned.

Lakes.—Few large lakes are found in Australia, and then only under a state of temporary inundation. Of these lakes or swamps, the most remarkable is Lake Alexandrina, fed by the Murray; the next is the Dambeling, discovered in 1843 by MM. Lander and Lefroy in Western Australia. L. Torrens, to the north of Spencer Gulf, is said by Eyre to be 400 miles in length, with an average breath of 15 to 20 miles; this lake in the dry season is, however, a mere salt marsh. The same will probably be the case with the newly discovered "L. Gairdner." This district has besides been explored by Sturt, Frome, Babbage, Freeling, Goyder, Hack, Warburton, Gregory, and others. Many smaller lakes present often only beds of dry rushes after long-continued drought. Pits of brine are frequently seen in the interior, which after heavy rains are so diluted as to become nearly, if not quite, fresh.

Mountains.—On the east coast the mountains continue from Cape York in a S.S.E. direction, with apparently several interruptions to Cape Wilson, intersecting the district of Moreton Bay or Cooksland, and thence New South Wales, in which it separates the waters flowing west into the interior from those flowing east to the coast. The Liverpool range is the most northern portion, and under the 32nd parallel inclines from the general direction towards a more west and east course. The highest summits, which are of greenstone, approximate to 5000 feet in height. Proceeding south, the range assumes the name of the "Blue Mountains," about forty miles west of Sydney, presenting some very striking scenery, with enormous chasms, ravines, and precipices. Farther south, from the 33rd parallel of latitude to Bass Straits, these mountains are called the Warragong, or Australian Alps. Approaching the Straits, they assume a still bolder appearance, and the syenitic peak of Mount Kosciusko is said by Clarke, the latest authority on the subject, to attain the height of 7308 feet, and several detached peaks are reported to reach the line of perpetual snow. Another range, commencing near the south coast at Portland Bay, in latitude 36° 52′ S. and longitude 142° 25′ E., after pursuing a northern course for some distance, connects itself with the Australian Alps. Still another smaller range occurs in South

Australia, running north from Cape Jervis to the singular horseshoe depression of Lake Torrens. On the west side of Australia, successive ranges run northwards nearly on the meridian of 116° E. from Point d'Entrecasteaux to Cape Preston, near the Dampier Archipelago. This range, called the Darling, averages from thirty to forty miles in breadth, but does not attain a higher elevation than about 2000 feet. Another range, to the east of the Darling range, has its southern termination near King George Sound, where, according to Mr. Gregory, along the coast near Mount Barren, it rises to a height of 3000 feet, with barren rugged summits.

Climate.—Two-thirds of Australia are within the temperate zone, the other third belongs to the torrid, and the localities occupied by Europeans are, generally speaking, healthy. The climate of New South Wales is particularly salubrious. The temperature of Sydney is rather above 65°. At Perth, on the west coast, it is rather below 67°, while at Melville Island, on the north, the winter average was in 1827-8 about 80°. The officers of the late expedition up Stokes' Victoria River report favourably of the climate. The summer months are December, January, and February; the autumnal, March, April, and May; June, July, and August form the winter; and September, October, and November the spring. Speaking generally, the climate of the districts south of the Tropic may be considered dry, and years of almost uninterrupted drought sometimes occur; but dews are also frequent, falling during the heats of summer like drizzling rain. Hailstorms occasionally occur, and frost and snow in the more elevated districts. The rapid transitions from heat to cold are remarkable. North of the Tropic the rains increase in density, and at Arnhem Land and Cape York the quantity is often very great.

Vegetation.—Generally speaking, the vegetation assumes a dark and sombre hue, and along the coast presents a dull and monotonous colour, tiring to the sight. More inland, however, amid the sameness of the forest, are often spots teeming with luxuriant vegetation, sometimes laid out in stately groves, free from thicket or underwood, at other times opening on glades and slopes intersected by rivulets and carpeted with the softest turf. The southern portion exhibits to a certain extent the vegetation of other temperate climes, while Northern Australia appears capable of yielding the usual products of tropical countries. The plants, however, seem more novel than useful. In New South Wales many of the woods take their names from the predominating trees, such as Iron-Bark Forest, Stringy-Bark Forest, &c. The eucalyptæ or gum-trees are numerous, also acacia, casuarina, banksia, &c. The orange, lemon, fig, banana, guava, pine-apple, yam, peach, vine, olive, mulberry, &c., are found in abundance. Tobacco and maize are also grown, and the wild oat and rice have been found by Stokes and Gregory. The native flowers, often exceedingly beautiful, are, with few exceptions, inodorous. In the more favoured parts of the country, pasturages of the best quality are numerous, and admirably adapted for the rearing of vast herds of cattle and flocks of sheep.

History.—Although the Spaniards, Qviros and Torres, saw the north coast of Australia as early as 1606, the Dutch were the first who became acquainted with any considerable extent of the coast. In 1618, Dirk Hartog arrived at the island of the same name on the west coast. In 1618, Zeachen ran along the north coast; Edel Land was, in 1619, discovered by the navigator of that name; Lewin Land followed in 1622. In 1623, Arnhem Land, on the north coast, was sighted by the *Pera* and the *Arnhem;* and in 1627, Pieter de Nuyt fixed the position of various points on the south coast. In 1628, De Witt and Carpenter were on the south-west and north coasts, and in 1629, Pelsart was cast away on Houtman Shoals in latitude 29°. Tasman coasted the north-west coast in 1644, and was followed, in 1697, by Vlaming, who made the land in latitude 31° 58' S. and longitude 136° 13' E., and afterwards saw Swan River. In two expeditions in 1688 and 1689, Dampier visited and described the west and north-west coasts. In 1710, Rogers, with

Dampier, passed along the north coast; and in 1721, Roggewecn lost a ship on the east coast near Aurora Island. Bougainville, in 1768, visited the coasts, and was followed in 1772 by Marion du Fresne. From 1770 to 1774, Cook, in several voyages, surveyed the east coast, passed through Torres Strait, and proved the insularity of Australia from the north. In the years 1786-7, La Perouse navigated along the east coast, in 1788, Shortland; and in 1791 Vancouver and Broughton explored 110 leagues of the south-west coast, and discovered King George Sound. In 1793, D'Entrecasteaux and Labillardière, with Beautemps-Beaupré, discovered Port d'Entrecasteaux and several other places. Bligh, in 1788, and Hayes, in 1794, visited various spots on the east coast. In 1797-8, Bass and Flinders proved the insularity of Australia from the south, and in 1804, the China fleet passed in safety through Bass Strait on its voyage to China. Flinders, in 1802, surveyed the south-west coast, and afterwards the north-east, passing through Torres Strait to the Gulf of Carpentaria, having circumnavigated Australia in eighteen months. From 1800 to 1802, Grant and Murray saw the south-east coast, and discovered Port Philip. Baudin explored the south-west coast in 1802; and between 1818 and 1822, King surveyed the unexplored coasts to the west of the Gulf of Carpentaria, delineated the coast line between Cape Hillsborough and Cape York, and also Melville and Bathurst Islands. From 1837 to 1843, the surveys of Wickham and Stokes included the east coast, also the Gulf of Carpentaria, Torres Strait, the north-west coast, Dampier Archipelago, the Abrolhos, Swan River, Bass Strait, and South Australia.

Among the later marine surveyors may be named Blackwood, Stanley, Yule, Bremmer, Chambers, Heywood, Hobson, Denham, &c.

Inland Discovery.—New South Wales includes the whole eastern side of the Continent from Wide Bay, in south latitude 26°, to Cape Howe, the south-east extremity, a distance of 1000 miles; thence along the coast about 500 miles to the 141st meridian, which separates it from the Colony of South Australia. It is divided at present into three districts: 1st, New South Wales, the capital of which is Sydney; 2nd, Moreton Bay, the chief town of which is Brisbane; and 3rd, Port Philip, or Victoria, with Melbourne as its capital. The capital of South Australia is Adelaide.

From the commencement of the settlement at Port Jackson, strenuous endeavours were made to penetrate beyond the Blue Mountains, long considered an impregnable barrier between the colonists and the interior. The efforts of Bass, Caley, Barallier and others, were ineffectual, until the year 1813, when, urged by a fearful drought, Blaxland, Lawson, and Wentworth succeeded in penetrating about twenty-five miles to the west of the Nepean River, whence from the rugged brow of a precipice these enterprising adventurers were gladdened by the view of a well-watered district extending towards the west. Evans was next dispatched, and the Downs of Bathurst, with the Rivers Lachlan and Macquarie, were shortly made known. During the following year, a road was made by the convicts, extending 148 miles W.N.W. of Sydney, in places over precipitous ridges several thousand feet above the level of the ocean. In 1817, Oxley and Cunningham, failing to trace the Lachlan, penetrated beyond the 144th meridian, E., a distance of 400 miles inland. The next year, Oxley, disappointed in following the Macquarie, proceeded from Mount Harris easterly, in latitude S. 31° 15′, and discovered Liverpool Plains. Reaching finally Port Macquarie, he proceeded along the shore to Port Jackson. In these journeys, Oxley had penetrated 500 miles to the west of the Blue Mountains. In 1819, the Murrumbidgee River, and in 1823, the Brisbane Downs, were discovered. In 1824, Hovell and Hume, passing S.W., discovered the Hume, Ovens, and Goulburn Rivers, and were the first to perform the overland journey from Sydney to Port Philip. Logan, in 1826, discovered the Logan and other rivers. Cunningham, in 1827, discovered the Darling Downs, Peel, and Canning Plains; and in 1828, a practicable route from Darling Downs to Moreton Bay. Sturt and Hume, in 1828, succeeded in exploring the dried-up surface of the Macquarie marshes, and ascertained that about thirty miles below Mount Harris the Macquarie River ceased to flow; its floods communicating, however, after heavy rains, with the Castlereagh. Sturt also traced the Darling River some distance. In 1829-30, Sturt followed the course of the Murrumbidgee to its junction with the Murray. Passing down this noble river, he saw the mouths of the Darling and of the Lindesay; and after a voyage of thirty-two days, entered Lake Alexandrina or Victoria. In 1831, Mitchell, in latitude 29° S., found *fresh water* in the Darling; and in 1835-36, traced the Lachlan into the Murrumbidgee, and the Darling into the Murray. He also explored much of the fine country now called Port Philip or Victoria, which he named Australia Felix. Strzelecki, in 1840, with Riley and Macarthur, discovered and named Gipps Land, into which M'Millan had before penetrated; Tyers surveyed the country between Port Philip and the Glenelg, and Dixon that at Moreton Bay. In 1839, Eyre, having discovered Lake Torrens and Mount Eyre, proceeded again, in 1840, to the Lake. During his prolonged routes, he explored Flinders Range, named Mount Serle and Mount Hopeless, and crossed the country to Baxter Range and Port Lincoln to Streaky Bay. Thence proceeding west along the south coast, he reached King George Sound, having proved the astonishing fact, that along a coast-line of more than 800 miles not a single river enters the ocean. In 1842, Frome explored the country east of Flinders Range, to the west of Lake Torrens; and in 1844, Grey and Burr journeyed along the coast from Adelaide to Mount Schanck. During the years 1844, 1845, and 1846, Sturt, with Poole and Browne, on his expedition to the interior from Adelaide, passed the Barrier Range, and ultimately succeeded in reaching the east portion of Lake Torrens. Imprisoned from January to July, 1845, at Frome Creek, on the west side of Grey Range, in S. latitude 29° 40′, and E. longitude 141° 30′, he examined the country around in various directions. Released, at length, by the brief rains, he succeeded in escaping to the N.W. in August, and proved, by a gallant dash into the interior as far as latitude 24° 30′, and longitude 138°, that the country to the north of Lake Torrens was for a great distance nothing but an endless stony desert. In 1844, Leichhardt, with Gilbert, left Moreton Bay, and after a perilous journey of 1800 miles, during which 3000 miles were traversed, reached Port Essington in North Australia, having discovered and named the Belyando, Burdekin, Lynd, Mitchell, Albert, Roper, Alligator, and other rivers. Early in 1846, Mitchell started from Sydney, reached the junction of the Macquarie with the Darling, crossed the Darling, and reached the Narran Swamp. In longitude 148°, and latitude 28° 31′, the Balonne was found to separate, to the south, into various channels. Its main and most westerly branch, the Culgoa, joined the Darling thirty miles above Fort Bourke. The expedition ascended the Balonne and the Cogoon, and discovered the Maranoa, Nogoa, and struck the Belyando in longitude 147°, latitude 24°; and afterwards followed, during ten days, as far as latitude 24°, longitude 144° 34′, the Bareu, which river Kennedy, in 1847, afterwards traced to latitude 26° 15′ S., and longitude 142° 20′, where it lost itself in the sands. On this journey Kennedy discovered the Thompson and the Warrego Rivers. Kennedy next, in 1848, explored the peninsula from Rockingham Bay to Cape York, where he was speared by the natives. Leichhardt, in 1848, started from Moreton Bay on his hopeless endeavour to cross the Continent to Swan River.

West Australia.—The name Swan River was given to a portion of the country by Vlaming in 1697. In 1801, the "Naturaliste" visited this coast; and in 1829, Fremantle took possession of the territory. Prior to this, however, Lockyer had, from Sydney, taken possession of the country at King George Sound. Bannister, in 1831, proceeded from Fremantle to King George Sound. Grey and Lushington, in 1837, explored a portion of the Glenelg River, and the country between that and the Prince Regent River in N. W. Australia. Landing, in 1839, at Shark Bay, Grey next discovered the Gascoigne and the

Murchison Rivers, and returned by a harassing overland journey along the coast, southwards to the settlements of West Australia. In 1848, Gregory and Fitzgerald surveyed the country from Perth towards the Gascoigne; and in 1849, Roe extended his surveys from Perth to the south-east, as far as the Russell Range. Austin, in 1854, explored the interior from Perth, west, as far as the 119th meridian, and north, to latitude 27° 50′. F. Gregory, in 1858, proceeding northwards from Perth along the coast, crossed the Murchison River, along the north bank of which he ascended, passed over to the Gascoigne, and descended to Shark Bay. He next proceeded along the north bank of the latter river, discovered the Lyons River, and explored a fine country, naming a peak, in latitude 24° 24′ S., and longitude 117° 25′ E., 3400 feet in height, Mount Augustus.

In 1855-56, A. Gregory, with his brother, F. Gregory, Elsey, Baines, Wilson, Mueller, and party, was despatched from Moreton Bay with two vessels to explore the Victoria River, discovered by Stokes. After extending the survey of the Fitzmaurice River, Gregory explored the Victoria to its sources, in S. latitude 18° 12′, and E. longitude 130° 39′, and named the Norton-Shaw and Saunders Rivers. Proceeding onwards towards the interior, the party reached latitude 20° 20′, and longitude 127° 35′, at an elevation of only 900 feet above the level of the sea. The distance between the farthest point attained and the Great Bight was nearly 800 miles; to the Fitzroy River, 300 miles; to the settlements of Western Australia, 900 miles; and to Sturt's northernmost point, 700 miles. To this latter point, however, the party at Hooker Creek was 600 miles, and afterwards at the sources of the Nicholson, only 450 miles distant. After leaving the Victoria, Gregory reached the Albert River, at the southern extremity of the Gulf of Carpentaria; and taking a circuitous route into York Peninsula, continued his journey along the Burdekin to the Belyando, proving the identity of the latter with the Sutter of Leichhardt. The journey from the north-west coast into the east settlements was performed within five months.

Mr. Gregory was next despatched from Moreton Bay west in search of Leichhardt. Steering for the Barcu River, he found, in S. latitude 24°, and E. longitude 146° 6′, on the left bank of the river, the letter L cut through the bark of a large tree. Having searched at the junction with Alice Creek, he next traced the Thompson River to the Tropic, in vain. Following then along the Barcu, the party arrived at Cooper Creek, and eventually explored the dry channel of the Barcu into Lake Torrens, crossing which, they proceeded southwards, and finally reached Adelaide.

In South Australia, Hack and Harris started from Streaky Bay in 1851, reached Yarlbinda, proceeded east to Warrea, and thence again south-east to the shores of the great salt lake "Gairdner," whence they returned to Port Augusta. Swinden, Thompson, and Campbell found that there exists an isthmus between Lake Torrens and Spencer Gulf. Goyder found the waters of the northern portion of Lake Torrens to be fresh; and Oakden was repelled from his position on fresh-water lakes, west of Lake Torrens, afterwards changing into salt lagoons. To the north and west of Fowler and Denial Bays, Miller and Dutton have explored a grassy country. Frome explored the country north from Adelaide to Mount Serle; Freeling that from Port Augusta to Mount Hopeless; and Warburton along the southern shore of Lake Gairdner. Babbage has passed on from Port Augusta to the north-west, with the object of exploring the country between Lake Torrens and the newly-discovered Lake Gairdner.

Tasmania and Islands.—Bass Strait extends from King Island to Flinders Island, nearly 200 miles east and west. The extremities of the former being about fifty miles distant from Capes Otway and Grim, the opposite points respectively of Australia and Tasmania, while the northern point of the latter is about seventy-five miles from the Australian coast.

Flinders Island is the northern and largest of the Furneaux group, the southern of which, Clarke Island, eight miles long and five broad, is separated from Cape Portland, the nearest point of Tasmania, by Banks' Strait, eleven and a half miles wide. Flinders Island is rugged and barren, thirty-six miles long by twenty-one broad, rising in Strzelecki peaks 2550 feet above the sea, with many small islands and rocks; it is separated from Barren Island, twenty-four miles long and eighteen wide, by Franklin Strait, four miles wide, but strewed with rocks and shoals; the island is marked by Mount Munro, 2300 feet in elevation, and is separated from Clark Island by Armstrong Channel, eight miles long, and in extreme breadth four miles.

These islands are extended to the north in others of similar granitic formation; the most important of which, the Kent group, consisting of two islets and some rocks, lie about half way between Flinders Island and the main, on which the same formation appears in Cape Liptrap and Wilson Promontory, which form isolated hills connected with the land by banks of sand; five miles and a half from the latter is Rodondo rock, a conical mass of granite, 1130 feet in elevation, on the east side; Waterloo Bay is to the east of the promontory, extending in a valley three miles long, on the north side of which Mount Wilson rises 2350 feet: here rugged but densely-wooded mountain ranges present themselves, 2000 feet in elevation, with trees of large size, and small valleys opening on the coast in quiet sandy beaches. The sides of Mount Wilson are strewed with enormous granite boulders. King Island is thirty-six miles long and fifteen broad, and its northern extremity rises 595 feet above the sea; it is, like those already mentioned to the east, a continuous ridge of granite; it has three bays, which only offer partial security for shipping. The northern coast of Van Diemen Land, or Tasmania, forms the southern shore of Bass Strait, and extends for more than 150 miles, forming one great bight; to the north-east, it is singularly low, and is formed of sand-hills, from which rises the isolated peak William, 730 feet high, beyond which a rocky ridge culminates in Mount Cameron, 1730 feet above the sea.

The river Tamar is formed by the confluence of the North and South Esk. Thirty miles from the sea to Launceston, the river is navigable for small vessels, and large vessels may ascend to within a short distance, but the entrance is difficult on account of sand-banks and shoals. The tidal wave is felt for ten miles up the North Esk, but the South Esk falls into the Tamar by a cataract. The valley of this river is narrow, with steep sides, and densely wooded, formed by two ranges which strike off in a north-west direction from the central mountains of the island. From Cape Portland to the Tamar is fifty-eight miles, and within this distance, at eight, eighteen, twenty-nine, forty-eight, and fifty-three miles, the Currie, Piper, Forester, Tomahawk, and Ringaroma rivers fall into arid bays, increasing in width towards the east, the two last being named Anderson and Waterhouse, the latter being fifteen miles broad and seven deep, with boggy land at the head, and round wooded hills separated by narrow valleys. Mounts Barrow and Arthur, only nine miles apart, are 4300 feet in height; this is a district of primitive rocks, but Stony Head is basaltic

To the west of the Tamar the character of the coast is similar; the Sorel, Mersey, Don, Forth, and Leven rivers, with the exception of the first, fall into the sea by a low sandy coast; hills 2000 feet high rise between the Sorel, which falls into Port Sorel and the Tamar, eleven miles apart, the others being respectively eighteen, twenty, twenty-three, and twenty-seven miles beyond. The mountains culminate in Valentine Peak, a mass of bare granite, 4000 feet above the sea; here Blyth River falls into Emu Bay, and thirteen miles beyond Inglis River is an inconsiderable stream. Circular Head presents a flat-topped mass of trappean rock, 490 feet high. Cape Grim is a steep black headland, from whence a low sandy beach and reefs extend to Hunter group, which consists of three principal and many smaller islands; these rise 250 feet, and culminate in three hummock islands 790 feet above the sea, are steep, rocky, and barren to the north, but more fertile and wooded to the south.

The prevailing winds in Bass Strait are south-westerly, those from the opposite quarter being only experienced from December to March, the current then generated being dominated over by the tide, is not felt until to the east of the Furneaux group. This strait is navigable to the west when Torres Strait is not, a fact remarkable in the physical geography of this region.

The west coast of Tasmania is rocky and sterile, the most westerly point of the island is a sandy projection, in E. longitude 144° 40', called West Point, to the north of which is a wide open bight; to the south, sandy beaches broken by rocky points are found, a ridge of low barren hills rising two miles from the shore, and beyond this are others more lofty and well wooded. Cape Sorell is a rocky projection forming the south point of a wide bay, within which is Macquarie Harbour, the entrance of which is on the north-west, marked by two elevated peaks, Heemskerk and Zeehaan, and high ridges extend between it and the Derwent. The entrance to the harbour is shallow, but it widens out, occupying a space of nearly eighteen miles in length with two to four miles in width. The water gradually deepens, in a south-east direction, to twenty fathoms, whence it again decreases to four fathoms off the mouth of Gordon River, a distance of nearly eighteen miles from the entrance of the harbour; the country around is irregular in outline, but covered with magnificent timber. Birch River also falls into this harbour, and, with the Gordon, is supposed to have its source in a triangular lake about fifty miles in circumference, situate among the hills between it and the Derwent, which also derives some of its waters from the lake.

From Cape Sorell the coast continues rocky, with fronting reefs to the bare white peaks of De Witt, the elevation of which exceeds 1000 feet. Here is a most remarkable harbour, Port Davey, four miles wide at the entrance, and extending inland in two arms to the north and east; in the latter are two secure anchorages, Bramble Cove and Bathurst Harbour, which receive the waters of Spring River; the Stephen also falls into this port; above is an extensive plain, probably the basin of a former lake, surrounded by heavily timbered heights.

The south-west cape of Tasmania has a sharp rugged outline, and the lands in the vicinity are desolate and barren in appearance. The southern coast is of similar character, the projecting headlands being basaltic. The Maatsuyker Islands lie off the south-west cape, and there are many other islets and rocks off the southern coast, but about fifty miles east of south-west cape is the extensive bay into which the Derwent and its tributaries from the north, the Dee, Ouse, Shannon, Clyde, and Jordan, discharge their waters; on the west side is Bruny Island, of irregular form, twenty-five miles long, presenting basaltic formation, well wooded, and fertile; it is separated from Tasmania by D'Entrecasteaux Channel, ten miles in length, and from three-quarters of a mile to seven miles in width; its northern shore is deeply indented, and forms several harbours; Récherche Bay is three miles wide and two deep, to the south of which is South Port. Port D'Entrecasteaux is a most excellent harbour, embosomed in gently sloping wooded heights, with three and a half fathoms water and muddy bottom, on which ships may ground without danger; beyond Récherche Bay are Actæon Islands and Mussel Bay, six miles beyond which is Port Esperance, two miles and three-quarters deep, and one and a quarter wide; and four miles farther, Huon River, the entrance of which is two miles wide, and opens into several bays, of which Swan Port is perhaps the most commodious, having deep water close to the shore, which is steep, rising with gentle acclivity to a well wooded and very fertile country. Huon Island, marked by a perforated rock, lies at the entrance to the river. North-west Bay is two miles wide by five deep.

From Tasman Head, the south point of Bruny Island, to Cape Pillar, the opposite point to the north-east, is thirty-four miles; this is the entrance to Storm Bay, in the north-west corner of which is the estuary of the Derwent; to the north is North Bay, extending into Pitt-Water and Norfolk Bay, the latter of which is eight miles long and four broad, affording anchorage to the largest fleet, in smooth water and good ground, on the east side of Storm Bay. Burnett Harbour is fit only for small vessels, but the coves in Port Arthur afford shelter to the largest. The entrance to the river Derwent, between Cape Delasorte and Cape Direction is two and a half miles wide, and this breadth is continued for five miles to the south point of Ralph Bay, which extends six miles in depth. The river is accessible for the largest vessels for eleven miles; and beyond this, at Risdon Cove, four miles higher up, it becomes contracted to less than half a mile. The headlands in Storm Bay are mostly basaltic, and round Port Arthur a chain of lofty mountains extends; about three miles from the shore, within the Derwent Valley, the ground rises gradually towards the hills in the interior. The east coast of Tasmania extends from Cape Pillar to Cape Portland for 156 miles; Cape Pillar is a succession of high basaltic columns; from hence the coast forms a succession of bays until to the north Fleurien Bay, fifteen miles wide and ten deep, affords good anchorage. It extends between Cape Bailly and Schouten Island, which is separated from Freycinet Peninsula by Geographe Strait; these are high toward the sea, but low and well-wooded at the land side.

The mountains appear to belong to the cordillera of Eastern Australia, the channel of Bass Strait merely interrupting the continuity above water between Capes Wilson and Portland. A range of lofty mountains runs through the island from north to south, the highest peaks of which are Quamby Bluff, overhanging Norfolk Plains, Mount Field, Mount Wellington near Hobarton, and the high Peaks near Port Davey. Other lofty points are the Western or Platform Bluffs, Table Mountain, the beautiful eminences of Ben Lomond, Ben Nevis, and St. Paul Dome; the Three-thumb Mountains near Prosser Bay, and the rocky heights on Maria Island, called the Bishop and Clerk. Along the west coast, a minor range extends at Mounts Heemskerk and Zeeham towards the Western Bluff, where it joins the north and south range.

History.—Discovered by Tasman in 1642, and named by him, after the Governor of the Dutch East Indies, "Van Dieman's Land;" its shores were visited by Cook and Furneaux in 1773, and again by Cook in 1777, without discovering its insularity, which was proved afterwards by Bass and Flinders in 1797. In 1803, a detachment under Bowen from Sydney landed on the north bank of the Derwent, with a view of founding a penal settlement at a spot called Rest Down, since termed Risdon. The next year Collins arrived from England, took formal possession of the island, and selected the present site of Hobarton as his head-quarters. Other settlements were made at the mouth of the Tamar, and afterwards, higher up the river, at Launceston. In 1813 the restrictions upon its communications with the mother country and other colonies having been raised, the tide of emigration from England began gradually to set in, and the colony extended itself in various directions. In 1817 the population amounted to only 2000, the majority of whom were convicts; while in 1824 it had increased to 12,000; in 1834, to 40,000; and in 1851, to 70,000, of whom the bond population was under 20,000.

In form, the island is somewhat triangular, covering an area of nearly twenty-four thousand square miles, or about fifteen millions of acres. Approached from the east, it presents a picturesque and beautiful appearance, including a succession of lofty mountains, covered to their summits with wood, the highest of which, from April to October, are capped with snow. Viewed from the west side, the island appears rugged and wild. The island consists of a succession of mountain ridges and valleys, the former rising often into grand and fantastic peaks: it is copiously irrigated by numerous streams issuing often from beautiful mountain lakes, among which may be mentioned Lake Clair, from which the Derwent receives a portion of its waters.

From its higher latitude and its insularity, the climate of Tasmania may be considered superior to that of Australia, and the atmosphere, though warm, is comparatively free from the withering aridity of the latter; hence also the greater vigour of its vegetation and density of its forests. The mean annual heat at Hobarton is 52° : the mean of summer being 63°, and that of winter 42°. Frosts are sometimes severe in exposed situations, but snow rarely continues in the lower grounds during a whole day. The spring months are July, August, and September; summer, October, November, and December; autumn, January, February, and March; and winter, April, May, and June.

Vegetation.—The natural vegetation of Tasmania resembles that of Australia; the trees being evergreens, and the foliage generally of a dark and sombre hue. The trees often attain a vast height and size, with little variety, however, in their forms. The gigantic blue-gum is the prevailing; next in frequency are the acacias, black and silver mimosas, Huon pines, myrtles, and pencil-cedars. The dogwood, pinkwood, and muskwood are fine-grained trees. The timber is often of the best description, and dense forests, many miles in extent, are found in various parts of the island. The myrtle often forms thick forests, single trees of which attain thirty to forty feet in circumference. In the interior, a species of *ficoides*, producing an edible fruit, is found. The variety of shrubs is great, some of which, more particularly the fern and the native cherry, are very beautiful. The indigenous botany is, however, like that of Australia, scanty in articles fit for human sustenance. A species of *plantago*, from which a good salad is made, grows in the sandy districts; and a large species of truffle, weighing sometimes not less than fourteen pounds, forms a good substitute for bread, and has been used in soups and otherwise by Europeans. The apple, gooseberry and currant have been introduced and thrive well; likewise other European plants and flowers; the scarlet geranium grows luxuriantly, the sweetbriar adorns the hedges, and altogether the settled districts present more the aspect of England than any other of the Australian colonies.

INDEX.

THE END.

LONDON:
SAVILL AND EDWARDS, PRINTERS, CHANDOS STREET,
COVENT GARDEN.