# THE BRIDGEWATER TREATISES

## ON THE POWER, WISDOM AND GOODNESS OF GOD, AS MANIFESTED IN THE CREATION.

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## TREATISE VII.

## ON THE HISTORY, HABITS AND INSTINCTS OF ANIMALS.

BY THE REV. WILLIAM KIRBY, M.A.

" C'est, la Bible a la main, que nous devons entrer dans le temple auguste de la Nature, pour bien comprendre la voix du Créateur."

*Gaede.*


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2
3

ON THE

# POWER, WISDOM AND GOODNESS OF GOD,

AS MANIFESTED IN THE

# CREATION OF ANIMALS,

AND IN

## THEIR HISTORY, HABITS AND INSTINCTS.

BY THE

REV. WILLIAM KIRBY, M.A. F.R.S. ETC.
RECTOR OF BARHAM.

PHILADELPHIA:
CAREY, LEA & BLANCHARD.
1836.

TO THE RIGHT HONOURABLE

CHARLES,

BARON FARNBOROUGH,

KNIGHT GRAND CROSS OF THE ORDER OF THE BATH, A MEMBER OF HIS MAJESTY'S MOST HONOURABLE PRIVY COUNCIL, AND ONE OF THE TRUSTEES OF THE BRITISH MUSEUM,

THE FOLLOWING TREATISE,

BY HIS PERMISSION,

IS RESPECTFULLY INSCRIBED,

BY HIS LORDSHIP'S OBLIGED AND OBEDIENT SERVANT,

THE AUTHOR.

# NOTICE.

The series of Treatises, of which the present is one, is published under the following circumstances:

The Right Honourable and Reverend Francis Henry, Earl of Bridgewater, died in the month of February 1829; and by his last Will and Testament, bearing date the 25th of February 1825, he directed certain Trustees therein named to invest in the public funds the sum of Eight thousand pounds sterling; this sum, with the accruing dividends thereon, to be held at the disposal of the President, for the time being, of the Royal Society of London, to be paid to the person or persons nominated by him. The Testator further directed, that the person or persons selected by the said President should be appointed to write, print, and publish one thousand copies of a work *On the Power, Wisdom, and Goodness of God, as manifested in the Creation; illustrating such work by all reasonable arguments, as for instance the variety and formation of God's creatures in the animal, vegetable, and mineral kingdoms; the effect of digestion, and thereby of conversion; the construction of the hand of man, and an infinite variety of other arguments; as also by discoveries ancient and modern, in arts, sciences, and the whole extent of literature.* He desired, moreover, that the profits arising from the sale of the works so published should be paid to the authors of the works.

The late President of the Royal Society, Davies Gilbert, Esq. requested the assistance of his Grace the Archbishop of Canter-

bury and of the Bishop of London, in determining upon the best mode of carrying into effect the intentions of the Testator. Acting with their advice, and with the concurrence of a nobleman immediately connected with the deceased, Mr Davies Gilbert appointed the following eight gentlemen to write separate Treatises on the different branches of the subject as here stated:

THE REV. THOMAS CHALMERS, D. D.

PROFESSOR OF DIVINITY IN THE UNIVERSITY OF EDINBURGH.

ON THE POWER, WISDOM, AND GOODNESS OF GOD AS MANIFESTED IN THE ADAPTATION OF EXTERNAL NATURE TO THE MORAL AND INTELLECTUAL CONSTITUTION OF MAN.

---

JOHN KIDD, M. D. F. R. S.

REGIUS PROFESSOR OF MEDICINE IN THE UNIVERSITY OF OXFORD.

ON THE ADAPTATION OF EXTERNAL NATURE TO THE PHYSICAL CONDITION OF MAN.

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THE REV. WILLIAM WHEWELL, M. A. F. R. S.

FELLOW OF TRINITY COLLEGE, CAMBRIDGE.

ASTRONOMY AND GENERAL PHYSICS CONSIDERED WITH REFERENCE TO NATURAL THEOLOGY.

---

SIR CHARLES BELL, K. G. H. F. R. S. L. & E.

THE HAND: ITS MECHANISM AND VITAL ENDOWMENTS AS EVINCING DESIGN.

---

PETER MARK ROGET, M. D.

FELLOW OF AND SECRETARY TO THE ROYAL SOCIETY.

ON ANIMAL AND VEGETABLE PHYSIOLOGY.

THE REV. WILLIAM BUCKLAND, D. D. F. R. S.

CANON OF CHRIST CHURCH, AND PROFESSOR OF GEOLOGY IN THE UNIVERSITY OF OXFORD.

ON GEOLOGY AND MINERALOGY.

---

THE REV. WILLIAM KIRBY, M. A. F. R. S.

ON THE HISTORY, HABITS, AND INSTINCTS OF ANIMALS.

---

WILLIAM PROUT, M. D. F. R. S.

CHEMISTRY, METEOROLOGY, AND THE FUNCTION OF DIGESTION, CONSIDERED WITH REFERENCE TO NATURAL THEOLOGY.

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His Royal Highness the Duke of Sussex, President of the Royal Society, having desired that no unneccessary delay should take place in the publication of the above mentioned treatises, they will appear at short intervals, as they are ready for publication.

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# INTRODUCTION.

The *Works* of God and the *Word* of God may be called the two doors which open into the temple of Truth; and, as both proceed from the same Almighty and Omniscient Author, they cannot, if rightly interpreted, contradict each other, but must mutually illustrate and confirm, "though each in different sort and manner," the same truths. Doubtless it was with this conviction upon his mind, that the learned Professor,[1] from whom I have borrowed my motto, expresses his opinion—that in order rightly to understand the voice of God in nature, we ought to enter her temple with the Bible in our hands.

The prescribed object of the several treatises, of which the present forms one, is the illustration of the Power, Wisdom, and Goodness of the Deity, as manifested in the Works of Creation; but it is not only directed that these primary attributes should be proved by all reasonable arguments derived from physical objects, but also by discoveries ancient and modern, and *the whole extent of literature.* As the Holy Scriptures form the most interesting portion, in every respect, of ancient literature; and it has always been the habit of the author of the present treatise to unite the study of the *word* of God with that of his *works;*[2] he trusts he shall not be deemed to have stepped out of the record, where he has copiously

1 The pious Heinrich Moritz Gaede, Professor of Natural History in the University of Liege.

2 See *Monographia Apum Angliæ*, i. 2, and *Introd. to Ent.* i. *Pref.* xiii. &c.

drawn from the sacred fountains, provided the main tenor of his argument is in accordance with the brief put into his hands.

Those who are disposed to unite the study of Scripture with that of nature, should always bear in mind the caution before alluded to, that all depends upon the *right* interpretation, either of the *written word* or *created substance.* They who study the word of God, and they who study his works, are equally liable to error; nor will talents, even of the highest order, always secure a man from falling into it. The love of truth, and of its Almighty Author, is the only sure guide that will conduct the aspirant to its purest fountains. High intellectual powers are a glorious gift of God, which, when associated with the qualities just named, lead to results as glorious, and to the light of real unsophisticated knowledge. But *knowledge puffeth up*, and if it stands alone, there is great danger of its leading its possessor into a kind of self-worship, and from thence to self-delusion, and the love of hypothesis.

It is much to be lamented that many bright lights in science, some from leaning too much to their own understanding, and others, probably from having Religion shown to them, not with her own winning features, nor in her own simple dress, but with a distorted aspect, and decked meretriciously, so that she appears what she is not, without further inquiry and without consulting her genuine records, have rejected her and fallen into grievous errors. To them might be applied our Saviour's words, *Ye do err not knowing the Scriptures.* These observations apply particularly to two of the most eminent philosophers of the present age, one for the depth of his knowledge in astronomy and general physics; and the other in zoology. It will be easily seen that I allude to La Place and Lamarck, both of whom, from their disregard of the word of God, and from seeking too exclusively their own glory, have fallen into errors of no small magnitude. It is singular, and

worthy of observation, that both have based their hypothesis upon a similar foundation. La Place says, "An attentive inspection of the solar system evinces the necessity of some central paramount force, in order to maintain the entire system together, and secure the regularity of its motions."[1] One would expect from these remarks, that he was about to enforce the necessity of acknowledging the necessary existence of an intelligent paramount central Being, whose goings forth were co-extensive with the universe of systems, to create them at first, and then maintain their several motions and revolutions, so as to prevent them from becoming eccentric and interfering with each other,[2] thus—*Upholding all things by the word of his power.* But no—when he asks the question, What is the primitive cause?[3] instead of answering it immediately, he refers the reader for his hypothesis to a concluding note, in which we find that this *primitive* cause, instead of the Deity, is a nebulosity originally so diffuse, that its existence can with difficulty be conceived.[4] To produce a system like ours, one of these wandering masses of nebulous matter distributed through the immensity of the heavens,[5] is converted into a brilliant nucleus, with an atmosphere originally extending beyond the orbits of all its planets, and then gradually contracting itself, but at its successive limits leaving zones of vapours, which, by their condensation, formed the several planets and their satellites, including the rings of Saturn!![6]

It is grievous to see talents of the very highest order, and to which Natural Philosophy, in other respects, is so deeply indebted, forsaking the *Ens Entium*, the God of Gods, and ascribing the creation of the universe of worlds to a cause which, according to his own confession, is all but a non-entity. He speaks,

1 *System of the World*, E. Tr. ii. 330.
2 *Ibid. Appendix*, concluding note.
3 *System of the World*, E. Tr. ii. 328.
4 *Ibid.* 357.
5 *Ibid.* 332.
6 *Ibid.* 358.

indeed, of a Supreme Intelligence, but it is as Newton's god,—whom he blames for attributing the admirable arrangement of the sun, of the planets, and of the comets, to an Intelligent and Almighty Being,[1]—and of an Author of Nature, not, however, as the preserver and upholder of the universe,[2] but as perpetually receding, according as the boundaries of our knowledge are extended;[3] thus expelling, as it were, the Deity from all care or concern about his own world.

While the *philosopher* thus became *vain in his imaginations*, the *naturalist* attempted to account for the production of all the various forms and structures of plants and animals upon similar principles. Lamarck, distinguished by the variety of his talents and attainments, by the acuteness of his intellect, by the clearness of his conceptions, and remarkable for his intimate acquaintance with his subject, thus expresses his opinion as to the origin of the present system of organized beings. "We know, by observation, that the most simple organizations, whether vegetable or animal, are never met with but in minute gelatinous bodies, very supple and delicate; in a word, only in frail bodies almost without consistence and mostly transparent." These minute bodies he supposes nature forms, in the waters, by the power of attraction; and that next, subtle and expansive fluids, such as caloric and electricity, penetrate these bodies, and enlarge the interstices of their agglutinated molecules, so as to form utricular cavities, and so produce irritability and life, followed by a power of absorption, by which they derive nutriment from without.[4]

The production of a new *organ* in one of these, so formed, animal bodies, he ascribes to a new *want*, which continues to stimulate; and of a new movement which that want produces and cherishes.[5] He next relates how this can be effected.

1 *System of the World*, E. Tr. ii. 331.
2 *Ibid.* 332.
3 *Ibid.* 333.
4 *Anim. sans Vertèbr.* i. 174.
5 *Ibid.* 181.

Body, he observes, being essentially constituted of cellular tissue, this tissue is in some sort the matrix, from the modification of which by the fluids put in motion by the stimulus of desire, membranes, fibres, vascular canals, and divers organs, gradually appear; parts are strengthened and solidified;[1] and thus progressively new parts and organs are formed, and more and more perfect organizations produced; and thus, by consequence, in the lapse of ages a monad becomes a man!!!

The great object both of La Place and Lamarck seems to be to ascribe all the works of creation to *second* causes; and to account for the production of all the visible universe, and the furniture of our own globe, without the intervention of a *first.* Both begin the work by introducing nebulosities or masses of matter scarcely amounting to real entities, and proceed as if they had agreed together upon the *modus operandi.*

As Lamarck's hypothesis relates particularly to the animal kingdom, I shall make a few observations upon it, calculated to prove its utter irrationality.

When, indeed, one reads the above account of the mode by which, according to our author's hypothesis, the first vegetable and animal forms were produced, we can scarcely help thinking that we have before us a receipt for making the organized beings at the foot of the scale in either class—a mass of irritable matter formed by *attraction*, and a *repulsive* principle to introduce into it and form a cellular tissue, are the only ingredients necessary. Mix them, and you have an animal which begins to absorb fluid, and move about as a monad or a vibrio, multiplies itself by scissions or germs, one of which being stimulated by a want to take its food by a mouth, its fluids move obediently towards its anterior extremity, and in time a mouth is obtained; in another generation, a more talented individual discovering that one or more stomachs and other

1 *Anim. sans Vertèbr.* i. 184.

intestines would be a convenient addition to a mouth, the fluids immediately take a contrary direction, and at length this wish is accomplished; next a nervous collar round the gullet is acquired, and this centre of sensation being gained, the usual organs of the senses of course follow. But enough of this.

Let any one examine the whole organization and structure, both internal and external, of any animal, and he will find that it forms a *whole*, in which the different organs and members have a mutual relation and dependence, and that if one is supposed to be abstracted, the whole is put out of order and cannot fulfil its evident functions. If we select, as a well known instance, the *Hive-bee* for an example. Its long tongue is especially formed to collect honey; its honey stomach to receive and elaborate it either for regurgitation, or for the formation of wax; and other organs or pores are added, by which the latter can be transmitted to the wax pockets under its abdomen; connected with these, are its means and instruments to build its cells, either for store cells to contain its honey and bee-bread, or its young brood, such as the form of its jaws, and the structure and furniture of its hind legs. Now here are a number of organs and parts that must have been contemporary, since one is evidently constructed with a view to the other: and the whole organization and structure of the whole body forming the societies of these wonder-working beings, that I mean, of the males, females, and workers, is so nicely adjusted, as to concur exactly in producing the end that an intelligent Creator intended, and directing each to that function and office which he devolved upon them, and to exercise which he adapted them. Were we to go through the whole animal kingdom the same mutual relation and dependence between the different parts and organs of the structure and their functions would be found.

Can any one in his rational senses believe for a moment that all these adaptations of one organ to another, and of the whole

structure to a particular function, resulted originally from the wants of a senseless animal living by absorption, and whose body consisted merely of cellular tissue, which in the lapse of ages, and in an infinity of successive generations by the motions of its fluids, directed here and there, produced this beautiful and harmonious system of organs all subservient to one purpose; and which in numerous instances vary their functions and organs, but still preserving their mutual dependence, by passing through three different states of existence.

Lamarck's great error, and that of many others of his compatriots, is materialism; he seems to have no faith in any thing but *body*, attributing every thing to a physical, and scarcely any thing to a metaphysical cause. Even when, in words, he admits the being of a God, he employs the whole strength of his intellect to prove that he had nothing to do with the works of creation. Thus he excludes the Deity from the government of the world that he has created, putting nature in his place; and with respect to the noblest and last formed of his creatures into whom he himself breathed the breath of life; he certainly admits him to be the most perfect of animals, but instead of a son of God, the root of his genealogical tree, according to him, is an animalcule, a creature without sense or voluntary motion, or internal or external organs, at least in his idea—no wonder therefore that he considers his intellectual powers, not as indicating a spiritual substance derived from heaven though resident in his body, but merely as the result of his organization,[1] and ascribes to him in the place of a soul, a certain *interior sentiment*, upon the discovery of which he prides himself.[2] In one of his latest descriptions of it, he thus describes the office of this internal sentiment: "Every action of an intelligent individual, whether it be a movement or a thought,

1 *N. Dict. D'Hist. Nat.* xvi. Artic. *Intelligence*, 344. comp. *Ibid.* Artic. *Idée*, 78, 80.

2 *Ibid.* 332.

or an act amongst the thoughts, is necessarily preceded by a want of that which has power to excite such action. This want felt immediately moves the internal sentiment, and in the same instant, that sentiment directs the disposable portion of the nervous fluid, either upon the muscles of that part of the body which is to act, or upon the part of the organ of intelligence, where are impressed the ideas which should be rendered present to the mind, for the execution of the intellectual act which the want demands."[1] In fact Lamarck sees nothing in the universe but bodies, whence he confounds sensation with intellect. Our eyes certainly show us nothing but bodies—their actions and motions, their structure, their form and colour; our ears the sounds they produce; our touch their degree of resistance, or comparative softness or hardness; our smell their scent; our taste their flavour; but though our senses can conduct us no further, we find a very active substance in full power within us that can. At a very early period of life we feel a wish to know something further concerning the objects to which our senses introduce us, which often generates a restless desire in the mind to gain information concerning the causes and origin of those things perceived by them; now this is the result of *thought*, and thought is no body, and though the thinking essence inhabits a body, yet we cannot help *feeling* that our thoughts are an attribute of an immaterial substance. Thought, discursive and excursive thought, that is not confined to the contemplation of the things of earth, things that are immediately about us, but can elevate itself to heaven, and the heavenly bodies, not only to those of our own system, but can take flights beyond the bounds of time and space, and enter into the Holy of Holies, and contemplate Him who sitteth upon the cherubim, the throne of his Deity. Thought, that not only beholds things present, however distant and removed from

1 *N. Dict. D'Hist. Nat.* xvi. Artic. *Intelligence*, 350.

sense, but can contemplate the days of old and the years of many generations, can carry us back to hail with the angelic choirs, the birth-day of nature and of the world that we inhabit; or looking into the abyss of futurity, can anticipate the termination of our present mixed scene—chequered with light and darkness, good and evil—and the beginning of that eternal sabbath which remaineth for the people of God in the heavenly kingdom of Christ: thought that can not only take these flights, and exercise herself in these heavenly musings; but accompanied as she is, in our favoured race, with the gift of speech can reason upon them with a fellow mind, and by such discussion often elicit sparks of truth, that may be useful to enlighten mankind. Who can believe that such a faculty, so divine and god-like and spiritual, can be the mere result of organization? That any juxta-position of *material* molecules, of whatever nature, from whatever source derived, in whatever order and form arranged, and wherever placed, could generate thought, and reflection, and reasoning powers; could acquire and store up ideas and notions as well concerning metaphysical as physical essences may as safely be pronounced impossible, as that matter and spirit should be homogeneous. Though the intellectual part acts by the brain and nerves, yet the brain and nerves, however ample, however developed, are not the intellect, nor an intellectual substance, but only its instrument, fitted for the passage of the prime messenger of the soul, the nervous fluid or power, to every motive organ. It is a substance calculated to convey instantaneously that subtile agent, by which spirit can act upon body, wherever the soul bids it to go and enables it to act. When death separates the intellectual and spiritual from the material part, the introduction of a fluid homogeneous with the nervous, or related to it by a galvanic battery can put the nerves in action, lift the eye-lids, move the limbs, but though the action of the intellectual part may thus be imitated, in newly deceased persons, still there

are no signs of returning intelligence; there is no life, no voluntary action, not a trace of the spiritual agent that has been summoned from its dwelling. Whence it follows, that though the organization is that by which the intellectual and governing power manifests its presence and inhabitation, still it is evidently something distinct from and independent of it.

Mr Lyell has so fully considered that part of Lamarck's hypothesis which relates particularly to the transmutation of species, and so satisfactorily proved their general stability, that it is unnecessary for me to enter more particularly into that subject, I must therefore refer the reader to that portion of his work.[1]

Let us lastly enquire, to whom or what, according to our author, God has given up the reins; whom he has appointed his viceroy in the government of the universe. *Nature* is the second power who sits on this viceregal throne, governing the physical universe, whom we should expect to be superior in intellect and power to angel and archangel—but no—he defines her to be—"An order of things composed of objects independent of matter, which are determined by the observation of bodies, and the whole amount of which constitutes a power unalterable in its essence, governed in all its acts, and constantly acting upon all parts of the physical universe."[2] And again, Nature he affirms consists of non-physical objects, which are neither beings, nor bodies, nor matter. It is composed of motion; of laws of every description; and has perpetually at its disposal space and time.[3]

With respect to the agency of this vicegerent of Deity, he observes that Nature is a blind power without intelligence which acts necessarily.[4] That matter is her sole domain, of which however she can neither create nor destroy a single

1 *Principles of Geology*, ii. c. 1, 2.
2 *N. Dict. D'Hist. Nat.* xxii. Art. *Nature*, 377.
3 *Ibid.*
4 *Ibid.* 364.

atom, though she modifies it continually in every way and under every form,—and causes the existence of all bodies of which matter is essentially the base ;—and that in our globe it is she that has immediately given existence to vegetables, to animals, as well as to other bodies that are there to be met with.[1]

From these statements, though he appears to admit the existence of a Deity, and that he is the primary author of all things, yet he considers him as having delegated his power to *nature* as his vicegerent, to whose disposal he has left all material subsistences, and who, according to him, is the real creator of all the forms and beings that exist, and who maintains the physical universe in its present state. It is not quite clear what opinion he held with respect to the creation of matter, as he no where expressly ascribes it to God ; though, since he excludes nature from it, we may infer, unless he thought it to be eternal, that he meant it should be ascribed to the Deity ; but, if such was his opinion, he ought to have stated it distinctly and broadly ; which he certainly would have done had he felt any anxiety to prevent misrepresentation. As it is, his God is an exact counterpart of the God of Epicurus, who leaving all to nature or chance, takes no further care or thought for the worlds to which he had given being.

But what is this mighty and next to omnipotent power,

> This great-grandmother of all creatures bred,
> Great Nature ever young, but full of eld;
> Still moving, yet immoved from her sted;
> Unseen of any, yet of all beheld;
> Thus sitting in her throne———

as quaintly sings our great bard of allegory.[2]

Now this great-grandmother of the whole creation, who,

1 *N. Dict. D'Hist. Nat.* xxii. Art. *Nature*, 369, 376.
2 Faërie Queene, B. vii. c. vii. st. 13.

according to our author, takes all trouble off the hands of the God of Gods, sitting as it were in his throne, and directing and upholding all things by the word of her power,—what is she? Is she not at least a secondary spirit, co-extensive with the physical universe which she forms, and the limits of which alone terminate her action? This the various and wonderful operations attributed to her by this her worshipper would proclaim her to be. How then are we surprised and astonished when studying and weighing every scruple of his definitions of this his great Diana of Ephesus, and casting them up, we find at the foot of the account that she literally amounts to NOTHING. That she is a compound of attributes without any subsistence to hang them upon. His primary character of her, on which he insists in every part of his works, declares her to be an *Order of Things*. What idea does this phrase convey to the mind? That of things arranged and acting in a certain order. But no—this is not his meaning. She is an order of things composed of objects independent of matter. These objects are all metaphysical, and are neither beings, nor bodies, nor matter. But if she is not a *being*, she can have no existence. Yes, says our author, she is composed of *motion*. But what is motion considered abstractedly, without reference to the mover or the moved? Like its negative *rest*, it is *nothing*. He, *Whose goings forth have been from of old, from everlasting*, is the First Mover, and the motion which he hath generated in his physical universe, was communicated by Him to existences, which he had created and formed to execute his will, and by them to others, and so propagated, as it were, from hand to hand, according to his laws, till the universe was in motion generally, and in all its systems and their several members. The Deity, at once the centre and circumference of creation, going forth incessantly, all the systems that form the physical universe, severally concatenated into one great system, responding to his action, and revolving

round and contained in that central and circumferential fountain of ever-flowing light and glory,[1] that Spiritual Sun of the whole universe of systems, of which every sun of every system is a type and symbol. To Him be ascribed the Glory, and the Power, and the Kingdom, *in sæcula sæculorum*, Amen.

Another object which Lamarck considers as constituting nature, is *Law*. But law considered abstractedly is also nothing. It may exist in the Divine counsels, but till it is promulgated, and powers appointed and empowered who can enforce it; as likewise other objects brought into existence upon which it can act, or that can obey it; it is a word without power or effect. As in order to motion there must be a mover and something to be moved, so in order to a potential law, as well as a promulgator, there must be a being to enforce it and another to obey it.

With regard to his third ingredient, *space* and *time*, the theatre and limit of Nature's operations; they give her no subsistence, she still remains a nonentity; therefore, as defined by our author, she is *nothing*, and can *do* nothing.

But although nature, as defined by Lamarck, consists merely of abstract qualities, independent of any essence or being, and therefore can neither form any thing, nor operate upon what is already formed; yet would I by no means be understood as contending that there are no *inter-agents* between God and the visible material world by which he acts upon it, and as it were takes hold of it; by which he has commenced and still maintains motion in it and its parts; causing it to observe certain general and local laws; and upholds, in the whole and every part, those several powers and operations that have been thus produced; that action and counteraction every where observable, by which all things are maintained in their places; observe

1 Deus omnium capax, Herm. *Pastor*, l. ii. Mand. l. Iren. *Adv. Hæres.* l. ii. c. 55.

their regular motions and revolutions; and exhibit all those phenomena that are produced under certain circumstances. Whatever names philosophers have used to designate such powers, they have a real substance and being, and are a something that can act and operate, and impart a momentum.

Lord Verulam's two *hands* of nature, whereby she chiefly worketh,[1] *heat* and *cold*, synonymous, according to some, with positive and negative electricity;[2] the *plastic nature* of Cudworth, and some of the ancients; the *spirit of nature* of Dr Henry More;[3] and the *ether* of Sir Isaac Newton, all seem to express or imply an agency between the Deity and the visible world, directed by him. *Attraction* and *repulsion; centripetal* and *centrifugal forces*, or *universal gravitation*, all imply a power or powers in action, that are something more than names and nonentities, that are moving in two directions, and consist of antagonist forces.

If we consult Holy Scripture with the view of ascertaining whether any or what terms are therein employed to express the same powers, we shall find that generally speaking, the word heaven, or the heavens, and symbolically the cherubim, are used for that purpose. But upon this subject, which has considerable bearing upon the doctrine of instinct, I shall enlarge in a subsequent part of this introduction.

Having stated Lamarck's hypothesis with respect to nature, the Goddess which he worshipped, and which he decked with divine attributes and divine power, I shall, as briefly as possible, give some account of his theory of *life*. Life indeed is a subject that hath puzzled, doth puzzle, and will puzzle philosophers and physiologists, probably till time shall be no more. Thus much, however, may be predicated of it, that both in the vegetable and animal, like heat, it is a *radiant* principle, show-

1 Bacon's Works, iii. *Nat. Hist.* Cent. i. p. 69.
2 See *Lit. Gaz.* January 7, 1835, p. 43.
3 See above, p. 323.

ing itself by successive developments for a limited period, varying according to the species, when it begins to decline and finally is extinguished: that sometimes also, like heat, as in the seed of the vegetable and egg of the animal, it is latent, not manifesting itself by development, till it is submitted to the action of imponderable fluids, conveyed by moisture or incubation.

But to return to our author. "We have seen," says he, "that the life which we remark in certain bodies, in some sort resembled nature, insomuch that it is not a being, but an order of things animated by movements; which has also its power, its faculties, and which exercises them necessarily while it exists.[1] He also ascribes these vital movements to an existing cause. Speaking of the imponderable incoercible fluids, and specifying heat, electricity, the magnetic fluid, &c. to which he is inclined to add light, he says, it is certain that without them, or certain of them, the phenomenon of life could not be produced in any body.[2] Now, though heat, electricity, &c. are necessary to put the principle of life in motion, they evidently do not impart it. The seed of a vegetable, or the egg of a bird have each of them, if I may so speak, a *punctum saliens*, a radiating principle, which, under certain circumstances, they can retain in a latent state, for a considerable time; but if once that principle is extinct, no application of heat, or electricity, under any form, can revive it, so as to commence any development of the germ it animated. Experiments have been made upon human bodies; and those of other animals, which, by the application of galvanism, after death, have exhibited various muscular movements, such as lifting the eye-lids, moving the arms and legs, &c. but though motions usually produced by the will acting by the nerves upon the muscles have thus been generated by a species of the electric fluid, proving

1 *Anim. sans Vertèbr.* i. 321. 2 *Ibid.* i. 43.

its affinity with the nervous power or fluid, yet the subjects of the experiment, when the action was intermitted, continued still without life; no return of that power or essence which was fled for ever, being effected by it, which seems to render it clear that neither caloric nor electricity, though essential concomitants of life, form its essence.

I trust I may render some service to the cause of truth and science, if I again revert to the subject which I mentioned at the beginning of this introduction, I mean the study of the word of God, together with that of his works, with the view to illustrate one by the other.

The great and wonderful genius before alluded to, Lord Verulam, who laid the foundation upon which the proud structure of modern philosophy is erected, who banished from science the visionary theories of the speculator,[1] and the unfounded dogmas of the bigot, and made experiment, and, as it were, the anatomy of nature, the root of true physical knowledge; warns the philosopher against making holy scripture his text book, for a system of philosophy, which he says, is like seeking the dead amongst the living.[2] I am disposed, however, to think that this illustrious philosopher, by this observation, did not mean to exclude all study of the word of God, with a view to discover what is therein delivered concerning physical subjects, for he himself speaks of the book of Job, as pregnant with the mysteries of natural philosophy;[3] but his object was to point out the evil effects of a superstitious and bigotted adherence to the *letter* of scripture, concerning which men were very liable to be mistaken, and of inattention to its *spirit*, which is averse to all persecution, so that persons of a philosophic mind might not be interrupted in their investigations of nature, by the clamours or menaces of mistaken men.

In the dark ages, anterior to the Reformation, superstition

1 *Idola Specûs.* 2 *De Augment. Sc.* l. ix. c. 1, § 3.
3 *Ubi Supr.* l. ix. c. 1, § 47, ed. 1740.

occupied the seat of true and rational religion. *Ye do err not knowing the Scriptures*, was an observation almost universally applicable. The armed hand of authority was lifted up against all such as endeavoured to interpret either Scripture or nature upon just and rational principles. Every such effort was rejected, was reprobated *ex cathedra*, and persecuted as a dangerous and pestilent heresy: thus every avenue to the discovery of truth, either in religion or science, was attempted to be closed. This evil spirit it was that proscribed the system of Copernicus, and, because it appeared contrary to the *letter* of Scripture, persecuted Galileo for affirming that the earth moved round the sun. Lord Verulam clearly saw the evil consequences that would result to the cause of true philosophy, if the sober study of nature, and all experimental research into the works of creation, were to be denounced as impious, because of some seeming discordance with the letter of Scripture, or because a narrow-minded theologian could not discern where the writers of the Bible adopted popular phraseology, in condescension to the innocent prejudices and uninformed understandings of those to whom they addressed themselves; and he therefore employed all the energy of his powerful mind to persuade the learned theologian, that for the discovery of physical truth we must have recourse to induction from experiment and soberly conducted investigation of physical phenomena, while for spiritual we should seek to draw living waters from the fountain of life contained in Scripture. The Bible was not intended to make us philosophers, but to make us wise unto salvation.

But it does not follow, because we are to seek for religious truth principally in the Bible, that we can derive none from the study of natural objects; nor, on the contrary, because we are not to go to the Bible for a system of philosophy, that no philosophical truths are contained in it. The Scripture expressly declares that *the invisible things of God* may be under-

stood by the things that are made—and if we may have recourse to the works of creation as well as to revelation to lead us to the knowledge of the Creator, we may, on the other hand, by parity of reason, without meriting any reprehension, inquire into what God has revealed in Scripture concerning the physical world and its phenomena. Lord Bacon himself observes, that Philosophy is given to Religion as a most faithful handmaid; since Religion declares the will of God, and Philosophy manifests his power,—and he applies to this our Saviour's reproof of the Jews. *Ye do err not knowing the Scriptures nor the power of God.* That is, ye have not endeavoured to know him by a right mode of studying either his word or his works. The study of both is necessary to the right understanding of either—we cannot rightly understand God's word without a knowledge of his *works*, and perpetual appeal is made to his works in his word; neither can we perfectly understand his works without the knowledge of his *word.*

The penetrating mind of Bacon clearly perceived, that if supposed statements of Scripture were made the sole test by which philosophical systems were to be tried, there was an end of all progress in science, no use in making experiments, or pursuing a course of inductive reasoning. And this was the temper of the age in which he lived; light was beginning to spring up, and because it was novel, it was thought to be heretical and subversive of Scripture. But men's minds are now much altered in this respect, and there is no danger of persecution on account of heterodoxy either in religion or philosophy. In fact the tide seems turned the other way, and a clamour is sometimes raised against persons who consult the revealed word of God on points connected with philosophy and science. But surely if the Scriptures are, as we believe, a revelation from the Creator of that world concerning which we philosophize, and if some parts of them do contain mysteries of natural philosophy, as Bacon himself contends they do, some

respect and deference are due to the word of God, and some allowance may be claimed by those who appeal to it on any point of science, even if their appeal originates in a misconception and misinterpretation of any part of it; the same allowance as is made for those, and they are many, who misinterpret nature.

In the observations here made upon some dicta of the illustrious sage, who, unless we admit his venerable namesake, Friar Bacon, to a share in that distinction, may be termed the first founder of modern philosophy, I have not the most distant thought of detracting from the splendour of his merits, or of deducting any thing from the amount of the vast debt which science owes him; but, as I have before observed, mankind, from the earliest ages, have been prone almost to idolize those to whom they were indebted for any weighty benefits, or to whom they looked up as inventors of useful arts, or masters of hitherto occult sciences. Gratitude, indeed, demands that great and original geniuses, whom God has enriched with extraordinary talents, by the due exercise of which they have become benefactors of the human race, should be loved and valued highly for their services; but when we look only at the instrument, and see not the hand of Supreme Benevolence that employs it for our benefit, we then overvalue man and undervalue God; putting the former into the place of the latter, and making an idol of him: and if any will not worship this idol, a clamour is raised against them, and they are almost persecuted. Our great philosopher himself complains of this tendency to overvalue individuals as the cause and source of great evils to science: he considers it as a kind of fascination that bewitches mankind.[1]

1 Rursus vero homines a progressu in scientiis detinuit, et fere incantavit reverentia antiquitatis, et virorum, qui in philosophia magni habiti sunt, authoritas.———Itaque mirum non est, si fascina ista antiquitatis, et authorum, et consensus, hominum virtutem ita ligaverint, ut cum rebus ipsis consuescere (tanquam maleficiati) non potuerint. *Nov. Organ.* l. i. aphor. 84.

Since the time of Bacon, philosophers and inquirers into nature have for the most strictly adhered to his rule, if such it may be deemed; and, with the exception of a single sect, who perhaps have gone too far in an opposite direction,[1] have made little or no inquiry as to what is delivered in Scripture on physical subjects, or with respect to the causes of the various phenomena exhibited in our system, or in the physical universe: but surely it is a most interesting, as well as novel field of study, for the philosopher to ascertain what has really been revealed in Scripture on these great subjects. The opinions of the ancients upon this head have been investigated and canvassed, and an approximation traced between them, in some respects, to those of modern philosophers:[2] if the same diligence was exercised upon the Scriptures, we might arrive at information with regard to the great powers that, under God, rule the physical universe, which it is hopeless to gain by the usual means of investigation.

But the great difficulty lies in the interpretation of those passages of Scripture that relate to physical Phenomena. Bacon often repeats these words of Solomon,—*It is the glory of God to conceal a thing.* As Moses, when he descended from the mount, was obliged to veil his face, because the Israelites could not bear its effulgence;[3] so the Deity was pleased to conceal many both spiritual and physical truths under a veil of figures and allegory, because the prejudices, ignorance, and grossness of the bulk of the people could not bear them, but they were written for the instruction and admonition of those in every age whose minds are liberated from the misrule of prejudice, and less darkened by the clouds of ignorance; but still it requires, and always will require, much study and comparison of one part of Scripture with another, to discover the

1 The Hutchinsonians.
2 See Prof. Daubeny's *Introd. to the Atomic Theory*, 13.
3 *Exod.* xxxiv. 29, &c.

meaning of many of those passages of Scripture which relate to physical objects.

The Apostle to the Hebrews observes that the manner in which God revealed himself to the ancient world and the Jewish nation, was by dividing his communications into many parcels, delivered at different times;[1] and by clothing them in a variety of figures, and imparting them under different circumstances,[2] so that in order to get a correct notion of them it is necessary to compare one part of Scripture with another, and to weigh well the various figures under which they are concealed, and the use of them on other occasions; and also to consider the modes in which they were communicated to the mind of the prophet, whether in a vision exhibited to him when entranced; in a dream when asleep; or under certain acts, which he was commanded, or by immediate inspiration excited, to perform. So that if we wish to ascertain the meaning of any particular symbol, or of the terms in which any communication is made from God in Holy Scripture; we must not be satisfied by studying merely the passage under our eye, but, comparing spiritual things with spiritual, *hunt* out the meaning, as it were, by considering all those passages where the same thing is alluded to.

It is to be observed, that in all the communications which it has pleased the Deity to make of his will to mankind, respect is had to the then state of society, and the progress of knowledge, arts, and civilization—light was imparted to them as they were able to bear it; they were fed with milk when they could not digest strong meat. Prejudices take usually so firm a hold upon the bulk of any people, that to attack them directly, instead of opening, closes all the avenues to the heart. Even the most enlightened in some respects, in others are often under their dominion; and, therefore, it is only by imparting

1 Πολυμερως.

2 Πολυτροπως.

truth *Here a little and there a little*, as circumstances admit, and embroidering the veil, under which we are obliged to soften the effulgence of her light, with varied imagery, darkly shadowing out her mysteries, that a way is prepared for her final triumph and universal reception. She is often *A light shining in a dark place*, gradually expelling prejudice and error, and *shining more and more unto the perfect day.*

It was not so much necessary for the conversion and reformation of mankind to make them *philosophers* as to make them *believers.* The great bulk of mankind were ignorant and uninstructed persons, whence in order to win their attention, it was necessary to address them in a language which they understood, and in a phraseology, with respect to physical objects, to which they were accustomed, and as those objects appear to the senses. Thus the moon is called a *great* light, because she appears so and is so to us, though really less than the planets and fixed stars; the sun is said to *rise*, and other parallel expressions, which are true with respect to us, and to the appearance of the thing, though not with respect to the fact physically considered. When the sacred writers speak of the Deity in terms borrowed from the human figure, as if he had hands, eyes, feet, and the like, and as if he was agitated by human passions, it is for the sake of illustrating the Divine attributes and proceedings by those passions, faculties, senses, and organs in man, by which alone we can gain any idea of what may be analogous to them in the Divine Nature.

But though such condescension is shown by the Holy Spirit to the ignorance and imperfections of his people, by adopting, as it were, a phraseology founded upon their innocent errors, and those misapprehensions of things into which they were led by their senses: it is not thence to be concluded that this popular language pervades the whole of the Holy Word; or that it is impossible, or even difficult, to distinguish things spoken *ad captum*, from statements relating to the physical

constitution of nature which are to be received as spoken *ex cathedra*, and as dictated by the Holy Spirit. It should not be lost sight of, that the great object of Revelation was to reclaim mankind from the debasing worship of those that were not gods by nature; of those powers in nature, or their symbols, selected from natural objects, which God employed and directed as his agents in the formation and government of the globe we inhabit, and of the whole universe. "But we," says Bacon, "dedicate or erect no capital or pyramid to the pride of men; but, in the human intellect, lay the foundations of a holy temple, an *exemplar of the world*."[1] This passage is capable of an application that may lead us into an avenue terminating in such a temple, which, though not erected *in* the human intellect, may enlighten it in several points relating to physical truths concerning which it is now in darkness. The Mosaical tabernacle and the Solomonian temple were both erected not after the imaginings of the spirit of man; but the former after a *pattern* which was shown to Moses in the mount;[2] and the latter after another given by David to Solomon, which it is expressly stated *he had by the Spirit*, and which *Jehovah made him understand in writing* (or commit to writing) *by his hand upon him*.[3] Now, if these holy places were erected after a pattern divinely furnished, that pattern doubtless was *significant*, and intended to answer some important purpose. The great end which the Deity had in view by the selection of the Israelitish nation, was to prevent all knowledge of himself, as the Creator and Governor of the world, from being totally obliterated from the minds of men, and to keep alive the expectation of the promised seed, who was to effect the great deliverance of mankind from the yoke and consequences of sin, and the dominion of Satan. Had it not been for this step, the

1 *Nov. Org.* aphorism. 120.
2 Exod. xxv. 40, xxvi. 30.
3 1 Chron. xxviii. 12, 19.

worship of those powers and intermediate agents by which God acts upon the earth and the world at large, and produces all the phenomena observable in the physical universe; of their symbols; or of deified men and women, would have entirely superseded the worship of their Almighty Author, and the whole earth would have been so covered by this palpable darkness, that no glimpse of light would have been left to foster the hope and prove the germ of a future day of glory. The great object, therefore, of the Godhead being the assertion of his own supremacy, and to proclaim his own agency by the powers that are known to govern in nature, it was to be expected that a tabernacle or temple erected after a pattern furnished by the Deity would conspicuously do this.

But before I enter further into this mysterious subject, it will be proper to obviate an objection that may be alleged, viz. that it is incongruous and out of place to introduce, into a work like the present, any inquiry into the nature and contents of the Jewish temple, especially the meaning of those symbolical images placed in the Holy of Holies and called the *Cherubim*, but when it is further considered that these symbols are represented as winged *animals* with four faces, and that these faces are those of the kings and rulers, as it were, of the *animal kingdom*:—namely, the *ox*, the chief amongst cattle; the *lion*, the king of wild beasts; and the *eagle*, the ruler of the birds; and lastly, *Man*, who has *all things put under his feet*,—there seems to be no slight connection between the cherubim and the animal creation. If we regard the antitypes of these images as exclusively *metaphysical*, this argument will not hold; but if, as I hope to prove from Scripture, they consist of *physical*, as well as metaphysical objects, by which the Deity acts upon the whole animal kingdom, and particularly in all *instinctive* operations, I trust I shall be justified in entering so fully into this interesting subject. In this inquiry I have endeavoured to guide myself entirely by the *word* of God *com-*

*paring spiritual things with spiritual;* at the same time taking into consideration those arguments, where the case seemed to require it, that his *works* supply.

The Jewish tabernacle, which, as Philo calls it,[1] was a portable temple, every reader of Scripture knows was divided into two principal parts, or, according to the apostle to the Hebrews, *tabernacles*; the first of which was called the Holy Place; and the second, the Most Holy Place, or the Holy of Holies. This last tabernacle is expressly stated in Scripture to be a figure of heaven. "*For Christ is not entered into the holy places made with hands, which are the figures of the true, but into Heaven itself, now to appear in the presence of God for us.*"[2] Where allusion is evidently made to the annual entry of the Jewish high priest into the second tabernacle, as representing Christ's entry into heaven itseif, where the presence of God was manifested. Now if the second tabernacle represented the Heaven of Heavens, the first we may conclude, in which the ordinary service and worship of God were transacted, was a symbol of this world or our solar system.[3]

If we consider the furniture of the two tabernacles, we gain further instruction on the subject we are considering. In the first was the golden candlestick with its seven lights, the table, and the show-bread. Amongst the Jews, the candlestick seems to have been regarded as a kind of *planetarium*, representing the solar system, at least those parts of it that were visible to the unassisted eye.[4] It is worthy of remark that the central lamp, which appears to be four times the size of the rest, is stated by Philo to represent the *sun*. The table and the show-bread, in a physical sense, may perhaps be regarded as symbolizing the earth and its productions, the table which

1 Ἱερον φορητον. *De Vita Mosis*, l. iii.
2 Heb. ix. 24. 3 Ἁγιον κοσμικον.
4 Joseph. *Antiq.* l. iii. c. 7, comp. Philo. *De Vita Mosis*, l. iii. 518, B. C. Ed. Col. All. 1613.

God spreads and sets before us. But as well as a physical, these things have a metaphysical or spiritual meaning. The candlestick symbolizing the church and its ministers, who are characterized as "*Lights in the world*,"[1]—the churches as candlesticks, and the principal ministers of Christ as stars.[2]

The contents of the second Tabernacle, or Most Holy Place, are now to be considered; these were an ark or chest containing the two tables of the decalogue, over which was placed a propitiatory or mercy-seat of pure gold, at each end of which, and forming part of the same plate, was fixed a *Cherub*, or sculptured image so called. The directions for the fabrication of these images are not accompanied by any description of them. They are spoken of as objects well known to the Jews; but in the prophecy of Ezekiel, they are described as each having four faces and four wings; the faces were those of a man and a lion on the right side; the face of an ox on the left side; and the face of an eagle; with regard to their wings, two were stretched upwards, and two covered their bodies. Many other particulars are mentioned by the prophet, which I shall not here enlarge upon.[3]

A great variety of opinions have been held, both in ancient and modern times, concerning the meaning of these symbols, and what they are designed to represent, some of which I shall mention in another place. By most modern theologians they seem to be regarded as *angels* of the highest rank. The first mention of them in Holy Scriptures is upon the occasion of the expulsion of our first parents from Paradise. "*And he drove out the man; and he* placed *at the east of the garden of Eden cherubims, and a flaming sword which turned every way, to keep the way of the tree of life.*"[4] The word which in our translation is rendered *placed*, means properly *caused to dwell, or placed in a tabernacle*,[5]

1 Philip. ii. 15. Φωστηρες εν κοσμω. 2 Revel. i. 20.
3 Ezek. i. 6. 10, 11. 4 Genes. iii. 24. 5 Heb. ישכן

and it was on this account probably that in the Septuagint translation, the expression is referred to Adam. "*And he cast out Adam, and caused him to dwell opposite the garden of Eden. And he placed in order the cherubim, and the flaming sword which turned to keep the way of the tree of life.*"[1] The word in question is used by Jeremiah to denote God's presence in his tabernacle in Shiloh.[2] It may be remarked also that, in the original, the phrase is not simply that God placed cherubim at the east of the garden of Eden, but, as is evident from the particles prefixed to it, that he placed there *the* cherubim, namely such objects as were generally called by that name, and were familiar to the Jews. Had God given it in commission to angelic beings to keep watch and ward at the gate of Paradise, it would surely have been said upon this, as upon other occasions, that he *sent* them. When we reflect that these mystic beings, when only sculptured images, were symbols of the divine presence, and that God manifested himself in his tabernacle and in his temple by a cloud and glory when the work was finished according to the pattern, and the cherubim with the ark and mercy-seat were in their places,[3] surely some suspicion must enter our minds that these cherubim, before the gates of Paradise, might be stationed there for purposes connected with the worship of God after the fall. Indications of this are discoverable in other passages, as where it is said of Cain and Abel, that they *brought* an offering unto the Lord; a term implying that sacrifices were not offered in any place, according to the fancy of the worshipper. Again, after the murder and martyrdom of righteous Abel by his brother's hand, and the divine sentence passed upon the latter, he says, "*Behold, thou hast driven me out this day from the face of the earth, and from thy face shall I be hid.*"[4]

1 Gr. Και εξεβαλε τον Αδαμ, και κατωκισεν αυτον απεναντι τε παραδεισε της τρυφης. και εταξε τα χερεβιμ, και την φλογινην ρομφαιαν, την ςρεφομενην φυλασσειν την οδον τε ξυλε της ζωης.

2 Jerem. vii. 12. 3 Exod. xl. 18—38. 2 Chron. v. 7—14.

4 Genes. iv. 14.

And it is subsequently stated, "*And Cain went out from the presence of the Lord.*"[1] From these passages it seems to follow evidently that God was present, in some restricted sense, in one particular place, by departing from which Cain was hid from his *face*, whatever was intended by that expression. In this local sense, a temple or tabernacle dedicated to his worship, as prescribed by himself, might be called his *presence;* or in a still more peculiar sense, it might be so denominated, if in its sanctuary it contained any symbolical representation of God's universal dominion, and of his action every where ; or if any cloud or irradiation of his glory was there manifested to his worshippers.[2]

With regard to the flaming sword, which our translation seems to put into the hands of the cherubic watch, and which Milton has so finely paraphrased :

> And on the east side of the garden place,
> Where entrance up from Eden easiest climbs,
> Cherubic watch, and of a sword the flame
> Wide-waving, all approach far off to fright
> And guard all passage to the tree of life.

And again,

> They looking back all the eastern side beheld]
> Of Paradise so late their happy seat,
> Waved over by that flaming brand, the gate
> With dreadful faces thronged, and fiery arms.

The words in the original may either be understood metaphorically of a flame like a sword, or it may be translated a consuming flame, a flame of burning heat ; the original word[3] often signifying an exhausting and violent heat. The word which we translate *turned every way*,[4] is in Hithpael, and signifies an action upon itself ; it is used in the same conjugation

1 Genes. iv. 16.
2 Exod. xl. 34—38.
3 Heb. חרב
4 Heb. המהפכת

in other passages, where the sense seems to be that of revolving or rolling.[1] Ezekiel in his vision of the cherubim, describing the fire that preceded their appearance, says that it infolded itself.[2]

The last words of the passage in question, *to keep the way of the tree of life*, admit of two opposite interpretations—either to shut it up from all access, or to prevent it from being wholly closed. Perhaps the following interpretation—that the end for which the cherubim and flaming sword were placed at the east of the garden of Eden, was to close for ever the way to the *old* tree of life, and also to open the way to one better suited to man's altered circumstances and situation—will reconcile both interpretations. As soon as man was expelled from Paradise, the original covenant was ended, and he was cut off from all the means of grace and spiritual life that it held forth; and therefore it might be expected that his merciful and beneficent Creator would, in pursuance of the great scheme of salvation, through the promised seed of the woman, which he had thrown out to him as an anchor of hope, would supply him with other means suited to his fallen state, by which he might be renewed unto holiness, and gradually nourished in grace, so as at last to be prepared to undergo the sentence passed upon him with a prospect before him of entering into that rest that remaineth for the people of God.

Having, I trust, not upon slight grounds, made it appear probable, that the cherubim, by the Deity himself, were placed in the original temple or tabernacle, and were intimately connected with that form of worship which was instituted by him in consequence of that sad event, the fall of man from his primeval state of holiness and happiness; I shall next endeavour to ascertain what these multiform images represented.

1 Judges vii. 13. Job. xxxvii. 12.
2 Ezek. i. 4. Heb. אש מתלקחת

But I must first premise a few observations upon the legitimate mode of collecting truths of this description from Holy Scripture, and I must here recall to the reader's recollection the observation of Solomon before quoted—*It is the glory of God to conceal a thing*. A number of important truths are delivered in Holy Writ, which are veiled truths, which we shall never discover if we adhere to the *letter*, and content ourselves with admiring the richness and beauty of the setting, without paying any attention to the gem it encircles or conceals. Some writers require a clear, distinct, and explicit statement, before they will admit any thing as revealed in Scripture, be the circumstantial evidence of the fact ever so strong. For instance some eminent theologians deny the Divine origin of *sacrifices*, because no command of God to Adam or Noah to offer them is recorded to have been given ; yet one should think the practice of *righteous* Abel, and of Noah, *perfect in his generations*, and God's acceptance of their respective sacrifices,[1] was a sufficient proof that this was no act of will-worship, but one of obedience to a Divine institution. The circumstance that God clothed Adam and Eve in the *skins* of *beasts*, proves that beasts had been slain, which were most probably offered up as victims representing the great atonement, the promised seed—and the clothing of them in their skins was an indication that they wanted garments, in the place of their own innocency and righteousness, to cover their nakedness, and that they now stood as clothed in the righteousness of Him whose heel was to be bruised for them. The distinction also of *clean* and *unclean* beasts directly sanctioned by the Deity, and which alone might be offered in sacrifice,[2] is another circumstance confirmative of the common opinion.

God, both in his word and in his works, for the exercise and improvement of the intellectual powers of his servants, and

1 Genes. iv. 4. viii. 20, 21.

2 *Ibid.* and vii. 2, 3.

that—"*By reason of use they may have their senses exercised to discern both good and evil;*"[1] has rendered it indispensable that those who would understand them, and gain a correct idea of his plan in them, should collect and place in one point of view things that in Nature and Scripture are scattered over the whole surface, so that by comparing one part with another they may arrive at a sound conclusion. Hence it happens that, in Scripture, when any truth is first to be brought forward, it is not by directly and fully enunciating and defining it, so that *he who runs may read* and comprehend it, but it is only incidentally alluded to, or some circumstance narrated which, if duly weighed and traced to its legitimate consequences, puts the attentive student in possession of it. Such notices are often resumed, and further expanded, in subsequent parts of the sacred volume, and sometimes we are left to collect that an event has happened, or an institution delivered to the patriarchal race, without its being distinctly recorded, from circumstances which necessarily or strongly imply it. In a trial in a court of justice it very commonly happens that no direct proof of an event can be produced, and yet the body of circumstantial evidence is so concatenated and satisfactory as to leave no doubt upon the minds of the jury as to the nature of the verdict they ought to deliver. It would be a great and irreparable loss to the devout and sober student of Holy Scripture, if in his endeavours to become acquainted with the different parts of it, he is to be precluded from forming an opinion as to certain events and doctrines, because it has pleased the Wisdom of God to record and reveal them not directly and at once, but indirectly, in many parcels, and under various forms.

To apply this reasoning to the subject I am discussing. Having rendered it probable that the cherubim placed in a tabernacle at the east of the Garden of Eden, represented the

1 Heb. v. 14.

same objects, and were so far synonymous, with those afterwards placed in the Jewish Tabernacle in the most holy place overshadowing the mercy-seat, and that the Divine Presence was more particularly to be regarded as taking there its constant station, and there occasionally manifesting itself by a cloud and a fiery splendour, I shall next endeavour to show what the cherubic images really symbolized.

The word Cherub, in the Hebrew language, has no root; for the derivation of it from a particle of similitude and a word signifying the mighty or strong ones, which is proposed by Parkhurst and the followers of Mr Hutchinson, seems to me not satisfactory. Archbishop Newcome[1] and others derive it from a Chaldee root, which signifies to plough, and the radical idea seems to be that of *strength* and *power*, which will agree with the nature of the derivative, as indicating the powers, whether physical or metaphysical, that *rule* under God. Other divines, as God is said to *ride* upon the cherubim, and they are called his *chariot*, would derive the word, by transposition, from a root which signifies to ride;[2] but if a transposition of the letters of the word may be admitted, I should prefer deriving it from a root which signifies to *bless* or to *curse*,[3] since, as we shall see, the cherubim are instruments of good or evil, according as God sees fit to employ them; fruitful seasons and every earthly blessing being brought about by their ministry.

The word *Cherub*, pl. cherubim, considered as derived from any of the roots last mentioned, conveys therefore the idea of *strength* and *power;* of God's action upon and by them, expressed by his *riding* or *sitting* upon them, and *inhabiting* them; as likewise by his employing them as instruments both of good or evil, of *blessing* and *cursing*.

That the cherubim are *powers* or *rulers* in nature is evident,

1 Newc. *Ezek.* c. i. 10, note. 2 רכב 3 כרך

as was before observed, from their symbols—the man, the lion, the ox, and the eagle. It is singular that amongst the descendants of the three sons of Noah, the three last animals should be adopted into their religion,—the *ox*, the Egyptian Apis, by the descendants of *Ham*;[1] the *lion*, as a symbol of light, by the Persians,[2] derived from *Shem;* and the *eagle* by the Greeks and other nations descended from *Japhet.*[3]

These powers, be they what they may, are described in Scripture as forming a *chariot* on which the Deity is represented as riding, and sometimes in such terms as bring to our mind, to compare great things with small, the chariots and charioteering of mortals. Thus we are told of *The chariot of the cherubim that spread out their wings, and covered the ark of the covenant of the Lord.*[4] And in Ezekiel's mystic visions, the glory of Jehovah sometimes went up from the cherubic chariot to the temple, when *The house was filled with the cloud, and the court was full of the brightness of the Lord's glory.*[5] And again, the glory of the Lord departs from the house, and stands over the cherubim, when mounting on high from the earth, *The glory of the God of Israel was over them above.*[6] A common epithet of God, as king of Israel, was that of Insessor of the cherubim,[7] *Whose name is called by the name of the Lord God of Hosts that dwelleth* between *the cherubim;* or he that sitteth upon, above, or between the cherubim; or, as it may be rendered, *Inhabiteth the cherubim.* These expressions allude, not

1 Other descendants of Ham, as the Phœnicians, regarded the ox or heifer as a sacred animal. Baal was worshipped as an ox as well as a fly. (Tobit, i. 5.)

2 Mithras is to be seen with the head of a *lion* and the body of a man, having four wings, two of which are extended towards the sky, and the other two towards the ground. *Montfaucon*, i. 232. Comp. *Ezek.* i. 11.

3 Every one knows that the eagle was sacred to the Grecian Jupiter.

4 1 *Chron.* xxviii. 18.

5 *Ezek.* x. 4. 6 *Ibid.* 19.

7 1 *Sam.* xiv. 4. 2 *Sam.* vi. 2. 2 *Kings*, xix. 15. *Ps.* lxxx. 1, xcix. 1, &c.

only to the presence of God in his tabernacle and temple between or above the sculptured and symbolical cherubim, but to his riding upon, sitting upon, or inhabiting, that is ruling and directing those powers of whatever description, which are symbolized by those images, or signified by that name.

When the Lord came to deliver David from his enemies, it is stated that he rode upon a *cherub*;[1] and the prophet Habakkuk, alluding probably to the delivery of the Israelites by the destruction of the Egyptians in the Red Sea, exclaims, *Thou didst walk through the sea with thine* horses, *through the heap of great waters*;[2] and again, with a prospective view before him, perhaps, of some still mightier deliverance of the church from her enemies, "*Was the Lord displeased against the rivers? was thine anger against the rivers? Was thy wrath against the sea, that thou didst* ride *upon thy* horses *and upon thy* chariots *of salvation?*"[3] He uses the same instruments when his will is to inflict a *curse* and execute *judgments. The Lord will come with fire, and* with his chariots *like a whirlwind, to render his anger with fury and to rebuke with flames of fire.*[4] In Ezekiel's vision, coals of fire were taken from between the cherubim to scatter over Jerusalem.[5]

Having noticed the ideal meaning of these mystic symbols, and their connection with and subservience to Jehovah of Hosts, as the God of Israel, of Israel both according to the flesh and the spirit;[6] our next inquiry must be whether there are no physical or metaphysical beings or objects, concerning which the same things are predicated in Holy Scripture, as concerning the cherubim; for if there are, as equals of the same are equal to one another, it follows that these things must be synonymous.

Every student of Holy Writ, when he turns his attention to this observation, will immediately recollect passages in which

1 2 *Sam.* xxii. 11. *Ps.* xviii. 10.
2 *Habak.* iii. 15.
3 *Ibid.* 8.
4 *Isai.* lxvi. 16.
5 *Ezek.* x. 2.
6 1 *Cor.* x. 18.

the same things are predicated of the *heavens;* thus it is said of God, as the God of Israel—*Who rideth upon the* heavens *in thy help, and in his excellency upon the sky.*[1] And again, *Extol him that rideth upon the* heavens.[2] *Him that rideth upon the* heaven of heavens *that were of old.*[3] Every one knows that, in Holy Scripture, God is also perpetually described as he who *sitteth* upon the *heavens;*[4] that the *heaven* is God's *throne*, and the *earth* his *footstool;*[5] that *The Lord hath prepared his* throne *in the* heavens,[6] that he dwelleth in the heavens, though they cannot contain him;[7] that he filleth heaven and earth.[8]

With regard to *Blessings* and *Curses*, that the *Heavens* are the primary instruments by which God bestows the one and inflicts the other, is evident from many passages of Holy Writ. Thus it is said in Deuteronomy,[9] *The Lord shall open unto thee* his good treasure the heavens,[10] *to give the rain unto thy land in his season, and to* bless *all the work of thine hand.* The prophet Hosea has a passage, in which the hands by which blessings and fertility are transmitted to man step by step are strikingly described. *And it shall come to pass in that day, I will hear, saith* the Lord, *I will hear* the heavens, *and they shall hear the* earth, *and the earth shall hear the* corn and the wine and the oil; *and they shall hear* Jezreel.[11] Thus the blessing descends from God by the heavens to the earth, producing abundance for the support and comfort of man. And with respect to *curses* it is said, *The* heaven *that is over thee shall be brass.*[12] *Ye are* cursed *with a* curse, saith Malachi *for ye have robbed me, even this whole nation.* The *curse* alluded, was the shutting of the windows of *heaven.*[13]

From all these passages, it is evident that the same things

1 *Deut.* xxxiii. 26.
2 *Ps.* lxviii. 4.
3 *Ibid.* 33.
4 *Ibid.* ii. 4.
5 *Matth.* v. 34, 35.
6 *Ps.* ciii. 19.
7 *Ibid.* cxxiii. 1. 1 *Kings*, viii. 27.
8 *Jerem.* xxiii. 24.
9 *Deut.* xxviii. 12.
10 Heb. את אוצרו הטוב את השמים
11 *Hos.* ii. 21, 22.
12 *Ibid.* xxvii. 23.
13 *Malach.* iii. 9, 10.

are predicated both of the *Heavens* and the *Cherubim*, and that, therefore, they are synonymous terms, and signify the same powers. But this leads to another inquiry. What are the *heavens?* This is a query which at first every one thinks he can answer, but yet when the term comes to be sifted, it will be found that few have any definite idea of its real meaning. Generally speaking, the expanse over our heads, and the bodies it contains, are understood by the word *Heavens;* but when analysed, it will be found chiefly to indicate powers in *action* contained in that expanse, and which act upon these bodies; powers that in the various systems of the universe have various centres dispersed throughout space, each having a local or partial action upon its own system, and all derived originally, and still maintained, from and by one parent fountain, the centre of all irradiation, of all light, of all life and energy.

In order to ascertain what the word heaven, or heavens, really means, the most satisfactory way is to submit it to analysis. In the Bible there are *three* terms employed to signify the heavens and heavenly powers, one of which[1] is usually rendered the *Heavens;* another,[2] the *Sky;* and a third,[3] the *Firmament.* I shall consider each of these terms.

1. *Heaven, or the heavens.*—This word, in the Hebrew language, is derived from a root,[4] which signifies to *dispose* or *place*, with skill, care, and order, as say the lexicographers; so that literally the common plural term would be the *disposers* or *placers.* It is singular, and worthy of particular notice, that the Pelasgians, according to Herodotus, gave no other names to their deities than that of *gods*,[5] so calling them because they were the *placers*[6] of all things in the world, and had the universal *distribution* of them.[7] We see here that the Grecian

1 שמים 2 שחקים 3 רקיע 4 שם
5 Θεοι. 6 Θεντες.
7 Θεας δε προσωνομασαν σφεας απο τε τοιουτε, ὁτι κοσμω θεντες τα παντα πρηγματα και πασας νομας ειχον. Euterp. c. 52.

gods—which, as has been proved in another place,[1] were *subsequent* to the original chaotic state of the heavens and the earth when the one was without light, and the other *without form and void*—were really synonymous with those ruling physical powers which God employed as his instruments first in the formation of the heavenly bodies, and next in that of their organized appariture, whether vegetable or animal; and lastly, in maintaining those motions or revolutions in the bodies just named, which he had produced, and other physical phenomena which were necessary for the welfare of the whole system and its several parts. These powers, whatever name we call them by,[2] form the *disposers* or *placers*, the heavens in action: these are the Jupiter, Juno, and Minerva of the Greeks and Romans, and the various deities of other nations: *For all gods of the nations are idols*, saith the Psalmist,[3] *but Jehovah made the heavens*, or the powers symbolized by the idols of the nations. These are those powers which, under God—who, as the charioteer of the universe, directs them in all their operations, whether in heaven or on earth, to answer the purposes of his providence—execute the laws that have received his sanction. These are the physical cherubim represented by the earthly rulers—the man, the lion, the ox, and the eagle—these the chariot and throne of the Deity; the hands also by which he taketh hold of material things; the feet by which he treads on the earth and other planets.

Those sublime metaphors of the prophet Nahum—*Jehovah hath his way in the whirlwind, and in the storm and the clouds are the dust of his feet*[4]—though at first sight appearing only magnificent figures, when analyzed will be found literally true. *Knowest thou the ordinances of the heaven? canst thou set the dominion thereof in the earth?*[5] saith God; showing that he, by his instruments

1 See Appendix, note 1.
2 See above, p. xxxiv.
3 *Ps.* xcvi. 5.
4 *Nahum*, i. 3.
5 *Job*, xxxviii. 33.

the heavens, rules the earth: this is said in stronger terms, when the heaven is declared to be God's throne, and the earth his footstool, which implies that God acts upon the earth by what are called symbolically his feet—those powers therefore that produce whirlwinds and storms in our atmosphere; that by their impact upon our planet cause evaporation, and consequently form the clouds, are the metaphorical feet of Jehovah, so that the clouds with strict propriety may be called the dust excited by the tread of his feet. When the Psalmist says of God, *He sitteth upon the cherubim, let the earth be moved*, what beauty, propriety, and force is there in the expression when it is recollected that the physical cherubim are those powers that have complete dominion over the earth, and cause its motions.

2. The *Sky*.—The word we render by the term *sky*, or skies, for it is always used in the plural, is derived from a root,[1] which signifies to *comminute*, grind, or wear by friction, implying powers that come in contact from opposite directions, so as to be antagonist or conflicting powers. The cherubim placed at each end of the mercy seat had their faces inward, or looking towards each other,[2] so that they appeared to symbolize antagonist powers, as if one was a *vis centrifuga*, and the other a *vis centripeta*. *The pillars of the earth are the Lord's, and he hath set the world upon them;*[3] and these two antagonist forces, that which flies from and that which seeks the centre, form that, so called, universal gravitation, which, under God, upholds the universe, keeps all its wholes and their parts in their places, maintains their motions, and mutual actions upon each other. But though these, as moving in an opposite direction, may be called antagonist or conflicting powers, yet their opposition is not enmity, but universal harmony and love. This Philo seems to intimate, when he says—a station,[4] over against

1 שחק 2 *Exod.* xxxvii. 8, 9. 3 1 *Sam.* ii. 8.
4 *De Cherubim.* 85. F. G. Ed. Col. Allobr. 1643.

Paradise, was assigned to the cherubim, and the flaming sword, not as to enemies about to struggle and fight, but as to those that were most intimate and friendly. It is said of the cherubic animals, in Ezekiel, that they *ran and returned as the appearance of a flash of lightning*,[1] which seems to intimate a constant efflux and influx of inconceivable rapidity. Accordingly the effluxes of light and heat from the solar orb in our own system are never intermitted, and their velocity, for that of light has been measured, exceeds that of any other moving substance. With respect to the fuel, if I may so express myself, that maintains this constant expenditure, little seems yet to be known of it philosophically; and we can only form conjectures with respect to it derived from the general analogy of nature, as far as it is submitted to the observation of our senses. On earth we know that there can be no combustion or evolution of light and heat without the access of *air* to an ignited body; and that a constant supply of some *combustible* substance to replace the constant expenditure of fuel is also necessary. Therefore, reasoning from analogy, something similar must take place at the great focus of light and heat. There must be an influx of air and a supply of combustible matter. That there is such an influx is rendered further probable by other analogical arguments. In man, who is called a *microcosm*, or world in miniature, there is as incessant a return of the blood to the heart in a negative state by one set of vessels, as there is an issue of it in a positive state by another. The lungs also inspire the air in one state, and expire it in another: and by this alternate flux and reflux life is maintained; but suspend it beyond a certain period and death is the result. Again, the rivers are constantly discharging their waters into the sea by one channel and receiving them back again by another. Plants likewise, and animals, derive their

1 *Ezek.* i. 14.

nutriment from the earth and from the heavens, and under other forms return it again to the sources from which it flowed. So that it seems to be a general law that where there is an efflux there must also be an influx.

3. The *Firmament.*—The proper translation of the word, which our version, after the septuagint, renders *firmament*, is—the *expansion. And God said, Let there be an* expansion, *and let it divide the waters*, &c. The cause of expansion is *heat*, which naturally divides and separates that in which it acts; as we see in the case of evaporation and the ascent of steam: and not only this, but the expansive force consolidates that whereon its impact is, whence our translation renders the word, after the Greek, στερεωμα, the *firmament*, that which renders all things *firm*, the action of which produces the cohesion of the atoms of bodies, and their agglomeration round a partial or general centre: in this last acceptation it is synonymous with the term *attraction*, and in the former with that of *repulsion.* From these considerations we may readily understand why the Psalmist calls it, *The Firmament of his power or strength.*[1]

The terms *expansion*, then, and *firmament*, express the matter of the heavens in a state of action, going from or returning to its central fountain; for every system, as well as its own sun and planets, has doubtless its own heavens, probably never stagnant, but incessantly issuing from a centre of irradiation, as the blood from the heart in a positive state, and returning in a negative state to that centre where it is, as it were, again oxygenated, and circulates to the *flammantia mœnia mundi;* and so

*Labitur, et labetur in omne volubilis ævum.*

But though every system probably forms a distinct portion of creation, yet, reasoning from analogy, and the general plan of

1 *Ps.* cl. 1.

the Deity, as far as we are acquainted with it, there is every reason to believe that the universe consists of systems so *concatenated* as to form one great whole, the centre of which may be the Heaven of Heavens, the presence-chamber of the God of Gods and Lord of Lords; in whom and from whom is all motion, light, and expansion. What may be the links that connect the several systems can only be conjectured. It has been observed with regard to *comets*, that *they wander from one solar system to another*;[1] if this be the case they evidently belong to *two* systems, and their perihelion in one, will be their aphelion in another, and thus they may form connecting links between them. This concatenation of systems may also have a common motion round their glorious centre, forming the grand cycle, or year, of the Universe.

Having, I trust, made it evident, or at least extremely probable, that the Heavens and the Cherubim, physically considered, indicate the same powers, I shall next advert to some passages of Scripture that seem to lift up the veil which covers these mysterious symbols, and show us expressly what they represent.

In that sublime description of the descent of the Deity for the help and deliverance of David in the eighteenth Psalm, we have these words; *He rode upon a* cherub *and did fly; yea, he did fly upon the* wings *of the* wind. Here we have one of these symbolical beings introduced and explained—as the latter hemistich of the verse is clearly exegetical of the former—by the phrase, *The wings of the wind.*[2] If we next turn to the hundred-and-fourth Psalm, in a parallel passage, we find an explanation of this latter metaphor. *He maketh the* clouds *his chariot, and walketh upon the* wings *of the* wind. Whence it appears that the *wings of the wind*, by an elegant metonomy,

1 La Place, *System.* &c. by Harte, ii. 337.

2 Parkhurst renders these words, *The wings of the Spirit*, but he stands alone in this.

mean the *clouds*, consequently the clouds are a cherub. In various parts of the Old Testament, God's presence and glory are manifested by and in a *cloud*. When he led his hosts from Egypt through the Red Sea, he went before them by day in a pillar of a *cloud*, and by night in a pillar of fire;[1] when he was about to descend upon Mount Sinai, he said—*Lo, I come unto thee in a thick* cloud.[2] When the tabernacle was set up in the wilderness, and the work was finished, *Then a* cloud *covered the tent of the congregation, and the* glory *of the* Lord *filled the tabernacle.*[3] When Solomon's Temple was built, and the ark brought into the oracle, and placed under the wings of the cherubim, and the priests were come forth, then *The* cloud *filled the house, so that the priests could not stand to minister because of the cloud: for the* glory *of the* Lord *had filled the house of the* Lord.[4] As God thus came of old in a cloud, and by it manifested his presence to his people and in his house; so likewise when he spoke to them, it was from a cloud, as in the passage above quoted—*Lo, I come to thee in a thick* cloud, *that thy people may hear when* I speak *with thee.* And again, *And a* cloud *covered the mount; and the* glory *of the* Lord *abode upon Mount Sinai, and the* cloud *covered it six days; and the seventh day he called unto Moses out of the midst of the* cloud.[5] And in another place, *And the Lord* descended in the cloud, *and stood with him there, and proclaimed the name of the Lord.*[6] *And the Lord came down in a* cloud, *and spake unto him, and took of the Spirit that was upon him, and gave it unto the seventy elders.*[7] And in the New Testament, at the Transfiguration, *Behold a bright* cloud *overshadowed them, and a* voice *out of the cloud.*[8] From these passages it appears to follow, that when the Deity thought proper to address his prophets or his people by *the voice of words*, it was from a *cloud.*

1 *Exod.* xiii. 21.
2 *Ibid.* xix. 9, 16. 1 *Kings*, viii. 12.
3 *Exod.* xl. 33, 34.
4 1 *Kings*, viii. 6—11.
5 *Exod.* xxiv. 15, 16.
6 *Ibid.* xxxiv. 5.
7 *Numb.* xi. 25.
8 *Matth.* xvii. 5.

But not only did God descend to communicate with his people, and to reside as it were amongst them in a *cloud;* but when our Saviour went up into Heaven, it was upon a *cloud,* which Athanasius calls mounting the *cherubim;*[1] and when he comes again, it will be in the same manner, attended by his holy angels. When he is said, in the Apocalypse, to ride upon a White Horse, and the armies which were in heaven to follow him upon white horses;[2] by these *white horses* are meant *white clouds,* as is evident from other passages of Holy Writ; as where it is said—*Behold, he cometh with* clouds.[3] Again, God's going to execute judgments upon any nation is sometimes represented by his riding upon a *cloud.* So when the prophet pronounces the burthen of Egypt, his exordium is—*Behold, the Lord rideth upon a swift* cloud, *and shall come into Egypt.*

So immediate is God's action upon the clouds described to be in the Bible, that the thunder is called his voice, as in Job —*Hear attentively the noise of his* voice, *and the sound that goeth out of his* mouth. *He directeth it under the whole heaven, and his lightning unto the ends of the earth——God* thundereth *marvellously with his* voice:[4] and when he descended upon Mount Sinai, it was with mighty thunderings.[5] Considering the benefits and blessing that God confers upon mankind by the ministry of the *Cherub-clouds,* his horses and chariots of salvation, we need not wonder at the Psalmist's expression—*His strength is in the clouds*[6] Acting by them, he causes it *to rain upon one city and not upon another.*[7] *Are there any,* says Jeremiah, *among the vanities of the Gentiles that can cause rain? or can the Heavens give showers? Art not thou He, O Lord our God.*[8]

The Deity superintends his whole creation, not only sup-

1 *Opera,* ii. 3017, D.
2 *Revel.* xix. 11, 14.
3 *Ibid,* i. 7, comp. *Dan.* vii. 13. *Rev.* xiv. 14. *Acts,* i. 11.
4 *Job,* xxxvii. 2—5.
5 *Exod.* ix. 28.
6 *Ps.* lxviii. 34.
7 *Amos,* iv. 7.
8 *Jerem.* xiv. 22.

porting the system that he has established, and seeing that the powers to which he has given it in charge to govern under him, execute his physical laws; but himself, where he sees fit, in particular instances dispensing with these laws: restraining the clouds, in one instance, from shedding their treasures; and in another, permitting them to descend in blessings. Acting every where upon the atmosphere, and those secondary powers that produce atmospheric phenomena, as circumstances connected with his moral government require. Thus it is that *his strength is in the clouds;* that his presence, either to bless or to curse, is manifested by them; that his voice is heard from them; his glory irradiates from them. On this account also they are called his *paths.*[1]

The Lord is said to come with *fire*, or rather in fire;[2] to descend in fire;[3] to be a consuming fire;[4] to speak out of the fire;[5] from all which passages it seems to follow, that *fire* or heat form also one of the physical cherubim upon which the Deity sitteth, or which he inhabiteth, and by which he acteth.

*Light* appears entitled to the same distinction; for God is said to dwell in the light that no man can approach unto,[6] and to cover himself with light as with a garment.[7]

Lastly, *air* or *wind*, which God bringeth out of his treasury; which is the type, and, on the day of Pentecost, was the precursor of the Holy Spirit, both in Hebrew and Greek[8] is expressed by the same word distingushed only by its adjuncts; and is one of the main instruments by which God acts upon our globe, both in dispensing blessings and curses, and without which our life could not be sustained a moment, is evidently a

1 *Ps.* lxv. 14.
2 *Isai.* lxvi. 15. Heb. כאש, the Septuagint seem to have read כאש.
3 *Exod.* xix. 18.
4 *Deut.* iv. 24.
5 *Ibid.* 36.
6 1 *Tim.* vi. 16.
7 *Ps.* civ. 2.
8 רוח πνευμα.

*cherub*, or ruling physical power, of the same rank with heat and light.

The statement I have here given of the physical cherubim, is singularly confirmed in Ezekiel's vision. *I looked*, says he, *and behold a* whirlwind *came out of the north, a great* cloud, *and a* fire *infolding itself, and a* brightness *was about it.*[1] Here we see the appearance of the symbolical animals was preceded by that of the physical agents they symbolized—the *wind*, the *cloud*, the *fire*, and the *light*. The reason why the *clouds* are particularly signalized as God's chariots, appears to be because they are *instinct* with all those principles by which God acts upon the earth; and therefore they are described as carrying him, since they are the instruments by which his will has full accomplishment.

It is singular, and worthy of particular notice, that God is also said to dwell in *darkness*. *The Lord hath said that he would dwell in the thick* darkness;[2] and again—Moses drew near to the thick darkness where God was.[3] In the Psalms it is said —*He made* darkness *his secret* (or hiding) *place.*[4] Darkness was the state of the original heavens, before God formed the light, to which this passage seems to be an allusion. In Isaiah, the term *create* is applied to darkness, and *form* to the production of light;[5] from which it appears that it was out of darkness that light was formed; and these two opposites seem to bear the same relation to each other as positive and negative electricity, or heat and cold. Darkness was that in which the Divine Spirit operated, when by incubation motion, followed by light and expansion, was educed, and the sea brake forth from the crust of the earth as from the womb; when the cloud was the garment thereof, and thick darkness a swaddling band for it.[6]

In the different visions of the appearance of the Deity, as

1 *Ezek.* i. 4.
2 2 *Chron.* vi. 1.
3 *Exod.* xx. 21.
4 *Ps.* xviii. 11.
5 *Isai.* xlv. 7.
6 *Job*, xxxviii. 8, 9.

the Insessor of the chariot of the cherubim, it is stated, that expanded over their heads was a firmament like crystal or ice; that *above* this firmament was a sapphire throne; that one sat on this throne, round about whom was the appearance of a rainbow.[1] So likewise in the vision of the apostolic prophet, St John—A throne was set in heaven, and one sat upon it, and there was a rainbow round about the throne, and before the throne was a sea of glass like unto crystal; and in the midst of the throne and round about the throne were four cherubic animals, which proclaim the *Trisagium.*[2] When Moses, Aaron and his sons, and the elders of Israel went up into Mount Sinai, and saw the God of Israel, He stood upon what was like a pavement of sapphire and as it were the body of heaven in its clearness.[3] In all these passages, the same idea seems to prevail with respect to the firmament—it is like ice or the terrible crystal in one—a sea of glass like crystal, or crystallizing, emitting the splendour of crystal in the other—like the body of heaven in its clearness in the third.

The footstool of the Deity, the pavement on which his throne is placed, is over or above the heads of the cherubim; and though we cannot comprehend exactly the precise meaning of the figures employed, yet the general idea seems to be that of *irradiation;* and by these representations the claim of Jehovah the God of Israel is indicated to supremacy and entire dominion over the physical cherubim, or the heavens in a state of action, and as the sole fountain and centre of that incessant radiation and glory, and of those constant effluxes by which the whole universe of systems and worlds is maintained.

It seems probable, therefore, that one of the principal reasons why the cherubic symbols were placed in the adytum of the Jewish tabernacle and temple was not only to represent those

1 *Ezek.* i. 22, 26, 28.
2 *Revel.* iv. 2, 3, 6, 7, 8.
3 *Exod.* xxiv. 10.

powers that govern under God in nature, but likewise to indicate his Supreme and only Godhead, and that his people were to beware of worshipping these powers or their symbols, because they derived so much benefit from their ministerial agency, but to worship Him alone who created them, employed them, and operated in and by them.

The ancients seem generally to have regarded the name and symbols as indicating and representing more than one object. Philo Judæus, who has written a treatise upon those placed at the east of the garden of Eden, sometimes interprets them *physically*, and sometimes *metaphysically*. Physically, in one place, he considers one cherub as representing the sphere of the fixed stars, and the other that of the planets,[1] and in another he asks, whether they may not signify the two hemispheres,[2] both of which amount to the whole universe.[3] The flaming sword, he conjectures, either represents the general motion of the heavens and planets, or else is a symbol of the sun.[4] Metaphysically, he considers the two cherubim as symbolizing the Power and Goodness of the Deity, and the flaming sword the Logos or his essential Word; and this interpretation he seems to think was divinely suggested to him.[5] Clement of Alexandria, in some degree, seems to incline to the opinions, on this subject, of his compatriot Philo, but he expresses himself obscurely,[6] and, after alluding to other interpretations, concludes with mentioning "*The doxologising spirits whom the cherubim symbolize.*"[7] Irenæus, the learned Bishop of Lyons, who had conversed with Polycarp, St John's disciple, regards these mystic objects as physical and ecclesiastical symbols, taking chiefly into consideration their *number*. The *four* quarters of the globe, the *four* winds, the *four* gospels, the *four*

1 *De Cherubim*. 1613. 86. A. B. 2 *Ibid*. D.
3 *Ibid*. 85. G. 4 *Ibid*. D. E. 5 *Ibid*. 86. F. G.
6 Clem. Alex. *Stromata*. l. v. 241. ed. Sylburg. 1592.
7 In allusion probably to *Isaiah* vi. 3, and *Revel*. iv. 8.

universal covenants given to man—each of these he appears to regard as figured by the cherubic animals;[1] and he might have added the *four* physical cherubim, spirit or wind, light, expansion, and the clouds. Justin Martyr has a singular opinion on this subject. He thinks Ezekiel's cherubim symbolized Nebuchadnezzar when he was driven out from the society of man as a beast:[2] when, according to the Septuagint which Justin used, he eat grass like an *ox*, his hair was like a *lion's*, and his nails like a bird's or *eagle's*. Athanasius has a remarkable passage, before alluded to, in which he says of Christ, that when he appeared upon earth, *He bowed the heavens and came down*, and that he again mounted the cherubim, and ascended into heaven,[3] from whence it should seem that he had adopted the opinion, that the heavens, and the clouds were antitypes of the symbolical cherubim: yet in another passage of his works, he expressly places the seraphim and cherubim amongst the highest of the heavenly essences. "As we know," says he, "that there is a distinction of rank in the powers above, so there are also differences of station and knowledge. The *thrones*, both the *Seraphim* and the *Cherubim*, learn from God immediately, as higher than all and nearest to God, and they instruct the inferior orders—but the lowest rank are the *angels*, which are also the instructors of men."[4]

It seems evident from this statement of the opinions of both ancient Jews and Christians, that the sculptured Cherubim, in their opinion, represented *physical* as well as *metaphysical* objects; in fact, the most general interpretation seems to be—that those powers that rule under God, either in his physical universe, or which, with regard to our planet, have power in his church, or over his people; and also those *spiritual* essences

1 *Adv. Hæres.* l. iii. c. 11.
2 *Quæst. et Resp. ad Orthodox.* Quæst. xliv.
3 *Quæst. ad Antioch.* cxxxvi.
4 *De commun. essent.* ed. Paris, 1627, i. 238.

that approach nearest to him, in the purity of their natures, are the antitype of the cherubic forms. St Paul, describing the creation of all things by the Son of God, whether *visible* or *invisible*, mentions particularly *four* ruling powers in nature and grace—*Thrones, dominions, principalities,* and *powers.*[1] This may be *interpreted* of all rule and government both in heaven and upon earth; which is all derived from Christ, as King of Kings and Lord of Lords, to whom *All power is given in heaven and earth:*[2] who therefore is the Insessor of the cherubim, acting by all the powers that he hath created, whether physical or metaphysical, whether civil, ecclesiastical, or spiritual; for *He upholdeth all things by the word of his power.*[3]

In the prophecy of Isaiah, and in the Apocalypse,[4] the six-winged beings called by the former *The seraphim,*[5] and by St John *living-creatures*[6]—which by most ancient writers are thought to be synonymous with the *cherubim*—are represented as repeating the *Trisagium;* the latter says—*They rest not day and night, saying,* Holy, Holy, Holy, *Lord God Almighty.* This triple ascription of Holiness is thought by many to intimate a Trinity of Persons in the Godhead, and that the physical cherubim or seraphim symbolically represent that mystery. Archdeacon Sharp, and after him Archbishop Newcome,[7] have observed, that this opinion is inconsistent with these symbolical animals *falling down and worshipping the Lamb, and ascribing their redemption to him;* an objection which appears to me not

1 *Coloss.* i. 16.
2 *Matth.* xxviii. 18.
3 *Heb.* i 3.
4 *Isai.* vi. 3. *Rev.* iv. 8.
5 Heb. שרפים This name, which literally may be rendered *burners, physically* would signify the heavens in the most intense state of action; they are stated to have *six* wings, the upper pair veiling their faces, the lower pair covering their feet, the intermediate pair being used for flight. See *Isai.* vi. 2. When our Saviour says of the *wind—Thou hearest the sound thereof, but canst not tell whence it cometh and whither it goeth;* may not the same thing be meant as by Isaiah's Description of the Seraphim?
6 Gr. Ζῶα.
7 Sharp *On the Cherubim,* 305. Newcome's *Ezekiel,* i. 10, note.

to have been satisfactorily answered. It should, however, be taken into consideration that the cherubim are symbols not solely of *physical*, but of all *governing* powers; and that, therefore, in order to interpret rightly any act of theirs, the circumstances attending upon it should be carefully examined. If we consider the passages in the Apocalypse here alluded to, we shall find that when praise is to be rendered to God as *Creator and Upholder of the universe*, they then are stated to proclaim his Triune Deity, by saying—*Holy, Holy, Holy, Lord God Almighty, which was, and is, and is to come.*[1] This they do as the physical powers, under God, upholding the universe, especially as fire, light, and air; all of which, in passages of Scripture above noticed,[2] appear to represent the Three Persons of the Holy Trinity. But when they are introduced as representing the *governing Powers* of the universal *Church*, as they are when they fall down and worship the *Lamb*, the case is altered; for those they then represent are amongst the redeemed.

One of my objects in treating so much at large upon this mysterious subject, was to counteract that tendency, often observable in the writings of philosophers, to ascribe too much to the action of second causes, and the mechanism of the heavenly powers; as if they were sufficient of themselves, and without the intervention of the First Cause, to do all in all, and keep the whole machine and all its parts together and at work. Instead of regarding Him as receding further and further from our observation,[3] my desire is to bring Him nearer and nearer to us, that we may see and acknowledge Him every where, as the main-spring of the universe, which animates, as it were, and upholds it in all its parts and motions—

> Lives through all life, extends through all extent,
> Spreads undivided, operates unspent.

1 *Revel. ubi supr.* 2 See above, p. lxiv. 3 See above, p. xxiv.

Maintaining his own laws by his own universal action upon and by his cherubim of glory. WITHOUT HIM THEY CAN DO NOTHING.

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I cannot conclude this Introduction without returning my grateful acknowledgements to the Board of Curators of the Hunterian Museum, for their kind permission to have drawings taken of such subjects in that superb collection as might answer my purpose; and to Messrs. Clift and Owen, the conservator and assistant-conservator of the museum, for their readiness, on all occasions, to show and explain to me such articles under their care as I had occasion to inspect; to the friendly attentions of the latter gentleman I am particularly indebted, not only for his exertions to serve me in the museum, but for his valuable information on numerous scientific subjects, on which I had occasion to consult him, which his deep knowledge of comparative anatomy, and familiar acquaintance with the classification of the animal kingdom, enabled him to give me. To the gentlemen connected with the British Museum and that of the Zoological Society, I have to make similar acknowledgments for the kindness and information with which my inquiries on several subjects have uniformly been answered.

As one half of this work was printed before the publication of Dr Roget's admirable Treatise, it will not be deemed wonderful that, in some instances, we have treated of the same subject. The history, habits, and instincts of animals, are so intimately connected with their physiological structure, especially their *external* anatomy, that it is scarcely possible, in order to prove the adaptation of means to an end, to treat satisfactorily of the former without occasional illustrations from the latter. After the doctor's work appeared, I removed many things of this kind from my MS., upon which

he had enlarged. The moult of Crustaceans, however, seemed to me, and to every friend whom I consulted, so necessary to make the history of that Class complete, that, though mostly derived from the same source as that of my learned Co-nominee, I did not expunge it.

THE

# HISTORY, HABITS, AND INSTINCTS OF ANIMALS.

## CHAPTER I.

### *Creation of Animals.*

In no part of creation are the POWER, WISDOM, and GOODNESS, of its beneficent and almighty Author more signally conspicuous than in the various *animals* that inhabit and enliven our globe. The infinite diversity of their forms and organs; the nice adaptation of these to their several functions; the beauty and elegance of a large number of them; the singularity of others; the variety of their motions; their geographical distribution; but, above all, their pre-eminent utility to mankind, in every state and stage of life, render them objects of the deepest interest both to rich and poor, high and low, wise and unlearned, so that arguments in proof of these primary attributes of the Godhead, drawn from the habits, instincts, and other adjuncts of the animal creation, are likely to meet with more universal attention, to be more generally comprehended, to make a deeper and more lasting impression upon the mind, to direct the heart more fervently and devotedly to the maker and giver of these interesting beings, than those which are drawn from more abstruse sources, though really more elevated and sublime.

The history of the animal kingdom naturally commences with the *creation* of animals, and the great events preparatory to it, for when the ALMIGHTY CREATOR, in his wisdom, and by the word of his power, had first brought into being, and after-

wards set in order, the heavens and the earth ; had caused the latter to bring forth grass, and herb, and tree, and then had placed his sun in the former, that by constant irradiations of light and heat from that central fountain, the life,[1] and motion, which the FIRST MOVER had begun by the incubation of his Spirit, and which now manifested itself in the vegetable kingdom, might be maintained till it had run its destined course. When all things were thus prepared, his next care was to people and enliven the earth with a different and higher class of beings, in whom—to organization, and life, and growth, and reproductive powers,—might be added sensation and voluntary motion. Uupeopled by animals, the verdant earth in all its primitive and untarnished beauty, though inlaid with flowers exhibiting, in endless variety, every mixture and shade of colour that can glad the sight; though fanned by gales breathing Sabean odours, to gratify the scent; though tempting the appetite by delicious fruits of every flavour, still would be a scene without the breath of life. No motions would be seen but of the passing clouds, of the fluctuating waters, and the waving boughs; no voice heard but of the elements.

Was a single pair placed in this paradise, though at first it would seem that there was gratification for every sense, and joy would possess the heart, and admiration fill the soul with pleasure; yet after the novelty of the spectacle had ceased, and the effect of its first impression was obliterated, a void would soon be felt, something more would seem wanting to animate the otherwise lovely scene; a longing would arise in the mind for some beings, varying in form and magnitude, furnished with organs that would enable them to traverse and enliven the lower regions of the atmosphere, others that might course over the earth's surface, and others that could win their easy way through its waters, so that all, by their numbers, and the variety of their motions, might exhibit a striking and interesting contrast to the fixed and unconscious vitality of the vegetable kingdom.

But it was not the will of the beneficent Creator to leave such a blank and blot in his creation; before he created man in his own image, and enthroned him king of the new-made world, he decreed that his dominion also should be an image of his own, over innumerable creatures of every form and grade, each in its place entrusted with a peculiar office and function, and furnished with organs adapted to its work, contributing to its own and the general welfare; so that all should

1 See Appendix, note 1.

operate, "though each in different sort and manner," to accomplish the great plan of an All-wise Providence.

What was the precise order of creation in the animal kingdom is no where clearly revealed in Holy Scripture; and we can only conjecture, since the most perfect animal, and he who alone belonged to the spiritual and invisible world by his soul, as well as by his body to the visible, was created the last, that the progress was from those that were at the foot of the scale to those that were at the summit. We are told, indeed, in general terms, that on the fifth day, at the divine bidding, the waters, hitherto barren and untenanted, produced abundantly "*the moving creature that hath life*," and *fowl* to traverse the firmament. In an instant, in obedience to that quickening word, by the operation of Almighty Power, and under the guidance of infinite Wisdom and Goodness, the boundless ocean with all its tributary streams became prolific, and brought forth by myriads, in endless and strange diversity, its destined offspring, beginning, perhaps, with the viewless animalcule or the senseless polype, half animal and half plant, and ending with the half fish and half quadruped, cetaceans, and their kindred monsters.[1] Nor was the Ocean prolific of aquatic animals alone, and those whose habitation was the restless world of waters, with all its streams, its caves, and its abysses, it also gave birth to all the winged and feathered tribes—from the brilliant humming bird to the mighty eagle and the giant vulture—that people and enliven the atmospheric sea, and make it the field of their excursions. The animals created on this day were destined to dwell or move, independent of the earth, in a fluid medium of greater or less tenuity, and for that purpose were fitted with appropriate and peculiar organs, in one case both for respiration and locomotion, in the other for locomotion only.

Again the word of power was spoken,—"*Let the earth bring forth*," and instantly the various tribes of quadrupeds issued from her teeming womb, varying infinitely in size, from the minute harvest-mouse[2] to the giant bulk of the elephant and hippopotamus; then also the earth-born reptiles, whether four-footed, six-footed, eight-footed, or many-footed, started into life, and connected the terrestrial tribes with those produced from the waters. In the majority of these, the fins of the fishes and cetaceans, and the wings of the birds, were replaced by legs best fitted for motion on the theatre on which they were to act their part, and to fulfil the will of their Creator.

1 See Appendix, note 2.

2 *Mus messorius.*

The earth was now completely furnished and decorated to receive her destined king and master. The sun, the moon, and the stars were shedding their kindly influences upon her; she and her fellow planets had commenced their annual and diurnal revolutions; the plants and flowers, her first born progeny, had sprung out of her bosom, and covered her with verdure and beauty; and the fruit, and forest trees flourishing in all their glory of leaf, blossom, and fruit, were ready to minister to the support, comfort, and enjoyment of their future lord: the sea, the air, the earth, were each filled with their appropriate inhabitants, and throughout the whole creation was beauty, and grace, and life, and motion, and joy, and jubilee. But still, in the midst of all this apparent glory and activity of vegetable and animal life in the new created world, there was not a single being endued with reason and understanding; one that could elevate its thought above the glorious and wonderful spectacle to the great Author of it, or acknowledge and adore its Creator. Amidst this infinite variety of beings there was not a single one which to a material body added an immaterial immortal soul; so that there was still a great blank in creation. A wonderful and magnificent temple was reared, and shone in glory and beauty, but there was as yet no priest therein to offer up incense to the Deity to whom it was dedicated.

We are now, therefore, to consider the creation of him for whom this high office was reserved, who, as king and priest, was to render to the common Creator the praises due from all created things, and be the spokesman for all the inhabitants of this terrestrial globe.

The vast distance, on this account, intervening between man and the highest animals in the scale of being, appears evident from the different circumstances attending their creation. When they were brought into existence, the word was —"*Let the waters bring forth—Let the earth bring forth*," from which it should seem that God did not act *immediately* in their creation, except by his agency on those powers that he had established as rulers in nature, and by which he ordinarily taketh hold, as it were, of the material universe. But when a being, combining the spiritual with the material world, is to be created, all the persons of the Godhead unite *immediately* in the work, and without the intervention of any other agent, "*Let* US *make man.*" He was therefore neither sea-born nor earth-born, as some ancient nations claimed to be, but born of God; though, as Christ moistened clay when he was about to

exercise his creative power, in the re-forming of an eye;[1] so was the humid earth used in the creation of the body of man by his Maker, and when that wonderful machine, with its complex apparatus of organs, both external and internal, was finished; when a throne and presence chamber were prepared for the intellectual and spiritual, and governing part of his nature, and that wonder-working pulp the brain, with its silver spinal cord and infinitely divaricated threads, already fitted for the mastery of every motive organ, was in a state to transmit without obstruction, each flux and reflux of that subtile fluid, intermediate, as it were, between matter and spirit,[2] which so instantaneously conveys and causes the execution of the commands of the will by every external bodily organ; when the heart was ready to beat; the lungs to play; the blood to circulate; and every other system to start for the fulfilment of its prescribed errand. "*Then the Lord God breathed into his nostrils the breath of lives, and man became a living soul.*" He was now installed into his kingdom over the globe which he inhabited, and dominion was given him over the inhabitants of the water, of the air, and of the earth; and the divine image, in which he was to be created, was rendered complete.

Now, the generations of the world were perfect and healthful, and God saw every thing that he had made, and behold it was very good. That is,—every individual essence, whether inanimate or animate, was fitted in every respect to answer the end of its creation, and perform its allotted part in contributing to the general welfare. The entire machine was now in action, every separate wheel was revolving, and the will of Him who contrived and fabricated it had full and uninterrupted accomplishment. The instincts of the whole circle of animals urged them, by an irresistible impulse, to fulfil their several functions; I mean those that were necessary to the then state of things: for if the instinct of the predaceous ones was not restrained, they would soon have annihilated the herbivorous ones, even if, as Lightfoot supposes, they were at first created by sevens.[3] They must, therefore, originally have eaten grass or straw like the ox, and neither injured nor destroyed their fellow-beasts of a more harmless character; this, indeed, appears clearly from the terms of the original grant, "*To every beast of the earth, and to every fowl of the air, and to every thing that creepeth upon the earth, wherein there is life, I have given every green herb for meat.*" And to this vegetable diet, before

1 John, ix. 6.
2 See Appendix, note 3.
3 See Appendix, note 4.

the close of the present scene, we are assured they shall again return so as to render the last age of the world as happy as the original state of man in Paradise.[1] This harmony of the animal creation, continued probably long enough, after the fall, to allow sufficient time for such a multiplication of the flocks and herds, and flights and shoals of the gregarious animals, as would secure them from extinction—but then, as the poet sings:

> ——— Discord first
> Daughter of sin, among th' irrational
> Death introduced through fierce antipathy:
> Beast now with beast 'gan war, and fowl with fowl,
> And fish with fish; to graze the herd all leaving,
> Devoured each other; nor stood much in awe
> Of man but fled him, or with countenance grim
> Glared on him passing. These were from without
> The growing miseries which Adam saw.

Had Adam not fallen, this sad change would, probably, never have taken place, for as the author of the book of wisdom argues:—"*God made not death, neither hath he pleasure in the destruction of the living. For he created all things that they might have their being; and the generations of the world were healthful: and there is no poison of destruction in them, nor the kingdom of death upon the earth.*" When we consider the relative position of man and the animal kingdom, by the divine decree, subjected to his dominion, the harmony and good will that subsisted between them, it appears improbable that immortal man would have been afflicted by the appearance of death and destruction amongst his subjects from any cause, especially by the strong, and those armed with deadly weapons, attacking and devouring the weak and helpless. Even now, fallen as we are from our original dignity, there is no creature so fell and savage that we have not more or less the power to subdue and tame; no natures so averse, that we are not skilled to reconcile; we can counteract even instinct itself, and make a treaty of peace and mutual good will between animals, whom nature, by a law, has placed in the fiercest enmity and opposition to each other.[2]

The Creator, indeed, foreseeing the fatal apostacy that plunged our race in ruin, and providing for the circumstances in which our globe would eventually be placed from the too rapid increase of various animals most given to multiply, fur-

1 Isaiah, lxv. 25.

2 See Appendix, note 5.

nished the predatory tribes with organs and offensive arms, which, when he gave the word and let loose the reins, would urge them to the work of destruction, and impel them to attack and devour without pity, those amongst the weaker animals, that were likely to increase in a degree hurtful to the general welfare, thus fulfilling his great purpose of generally maintaining those relative proportions, as to number, of individual species, that would be most conducive to the health and mutual advantage of all parts of the system of our globe.

This too is the place to consider another circumstance connected with the appointment by Providence of certain animals to certain ends. There are, as must be evident to every one who thinks or observes at all, large numbers of the animal kingdom, which, considered in their individual capacities, may be regarded as positively injurious to man; and seem to have been created with a view to his *punishment*, either in his person or property. Of this description are those predatory tribes of which I have just spoken: but I here mean, more particularly, to advert to those *personal* pests, that not only attempt to derive their nutriment from him by occasionally sucking his blood when he comes in their way, as the flea, the horse-fly, and others, but those that make a settlement upon him or within him, selecting his body for their dwelling as well as their food, and thus infesting him with a double torment.

Besides those insects of a disreputable name[1] which, under more than one form, inhabit his person externally; and those that, burying themselves in his flesh, annoy him and produce cutaneous diseases,[2] a whole host of others attack him internally, and sometimes fatally. Can we believe that man, in his pristine state of glory, and beauty, and dignity, could be the receptacle and the prey of these unclean and disgusting creatures? This is surely altogether incredible, I had almost said impossible. And we must either believe, with Le Clerc and Bonnet, that all those worms now infesting our intestines existed in Adam before his fall, only under the form of eggs, which did not hatch till after that sad event: or that these eggs were dispersed in the air, in the water, and in various aliments, and so were ready to hatch when they met with their destined habitation: or, as some parasites are found in the earth,[3] or the water,[4] as well as in the human species, that

1 *Pediculi.*
2 *Sarcoptes Scabiei, Pulex penetrans, &c.*
3 *Lumbricus.*
4 *Gordius aquaticus.*

they are in general formed for living in different stations:[1] or, lastly, that they were created subsequently to the fall of Adam, not immediately or all at once, but when occasions called for such expressions of the divine displeasure.

With respect to the first of these hypotheses, it seems to me very improbable for this reason, that it supposes the first pair to have in them the germs of all these animal pests, which although, before the fall, they were restrained from germination, after that event, were left to the ordinary action of physical laws, so that then every one of these scourges must have inhabited them and preyed upon them. Fallen indeed they were from glory and grace, but who can think that all the accumulated evils that their sin introduced into the world fell with concentrated violence upon their own heads, that all the various ills that flesh is heir to were experienced by them in their own persons before they were divided, some to one and some to another, amongst their posterity? It is scarcely to be supposed that any single individual, from that time to this, was subject to the annoyance of every one of these animals, and it seems incredible that Adam and Eve had experience of them all.

That they had their existence originally either as germs or as perfect animals in the air, the earth, or the waters, and were taken in by man with his food, with respect to some species may, perhaps, be true. The earth-worm is often voided by children, and some other that infest animals are found in the water, but of those that are appropriated to man internally, none have as yet been found, except that just mentioned, in any other habitation. Linné indeed assigns an aquatic origin to the fluke, the ascarides, and the tape-worm, but he seems to have adopted this opinion upon very slight grounds. Bonnet very justly asks, with respect to the last of these animals, which Linné states he found once in a kind of ochre. "M. Linné is the only one that has made this discovery, now it is certain that if tape-worms existed out of the body of man and other animals, would it be possible, after the numerous researches that naturalists of every country have made in a variety of places, both in the earth and the water, none should ever meet with that insect?"[2] All Helminthologists seem now to be of opinion that the sole natural habitation of these animals is that in which they are usually found, the human viscera.

We now come to the last hypothesis, that these animals

1 See *Introd. to Ent.* iv. 229. 2 *Œuvr.* iii. 138.

were created subsequently to the fall: a single instance from Scripture of such a creation will be sufficient to render it probable that others may have taken place when occasions called for such expressions of Divine displeasure. Every one is aware that God by the wonder-working rod of Moses converted all the dust of Egypt into some punitive animal or genus of animals, for they attacked man and beast, concerning the kind of which interpreters differ;[1] but this does not affect the question, it is evident that here is an instance of the creation of an animal in great numbers, and what is worthy of particular observation, that this animal was not afterwards again annihilated as the frogs, and others were. What has evidently been done once under circumstances that required it, though not recorded, may have been repeated, and thus all the punitive species in question may have been produced.

This is given merely as an hypothesis, to account for the existence of these animals, without doing violence to probability; and rather in accordance with the word of God, than controverting any thing delivered therein—and if it excites a discussion that may throw new light upon the subject, which ever way the question is determined, I shall be well pleased—my object being rather to elicit *truth*, than to uphold *opinion*.

Another inquiry also suggests itself with respect to the original animal creation. Are any of those animals with which God peopled the earth, air, and waters, preparatory to the creation of man, now extinct? The answer to this question will principally depend upon that to another. Did any alteration take place in the climate and productions of our globe in consequence of the fall of man from his original state? We learn from the inspired penman, that God, induced by that sad event, pronounced a curse upon the ground, and predicted that it should produce in abundance noxious plants for the annoyance of the offending race of man, and that whereas the primeval earth brought forth spontaneously her fruits and flowers, and afforded man a pleasant and delightful recreation and employment, without subjecting him to toil and weariness; this state of things should cease, and man, for the future, should earn his bread with difficulty by the labour of his hands and the sweat of his brows. From hence it seems to follow that at this time some great change took place, both with respect to climate, and to that blessing from atmospheric influences which produces plenty and fertility with the lowest

1 See Appendix, note 6.

amount of labour. Geologists have observed, from the remains of plants and animals embedded in the strata of this and other northern countries, that the climate must formerly have been warmer than it now is.[1] Some change or changes of this kind therefore would sooner or later produce the extinction of such animals and plants, inhabitants of northen countries, as could not bear such a change of temperature, and at the same time could not escape from it; and admitting this—it would enable us to answer in the affirmative to the query above stated —namely, that there were species of animals originally created which have since ceased to exist. Being no longer necessary to bear a part in carrying on the general plan of Divine Providence with regard to our globe, they were permitted or caused to perish.

One circumstance, which I have not seen adverted to, seems to confirm this hypothesis: that so few fossil remains, if any, of tropical *birds* have hitherto been discovered in cold countries, while such numbers of the quadrupeds of warm climates, both viviparous and oviparous, are met with every day in a fossil state. Now the birds could readily shift their quarters southwards, when the temperature grew too cold for them, while the quadrupeds might be stopped by seas, rivers, and other obstacles.

Another question may be asked with respect to the subject I am discussing; might not the animals now become superfluous have been excluded from the ark at the time of the general deluge, and so left to perish? This would furnish a very easy solution of the difficulty, but the text of Scripture seems too precise and express to allow of such a supposition. For the command to Noah is—"*Of every living thing of all flesh, two of every sort shalt thou bring into the ark.*" But yet the terms here employed must be limited to those animals that required such shelter to preserve them from destruction by the diluvial waters; so that the expression—"*of all flesh*"—necessarily admits of some exceptions.

But there are doubtless very many animals still existing upon the earth and in its waters, that have not yet been discovered. When we consider the vast tracks of terra incognita still shut out from us in the heart of Africa, that fatal country hitherto as it were hermetically sealed to our researches, and from whose bourne so few travellers return; how little we know of Central Asia, of China, and of some parts of North America; we may well believe that our catalogues of animals are still

1 See Appendix, note 7.

very short of their real numbers, even with respect to those of the largest dimensions. Burchell and Campbell appear to have met with more than one new species of rhinoceros in their journey from the Cape of Good Hope into the interior;[1] the same country may conceal others of the same gigantic or other tribes, which, when it is more fully explored, may hearafter be brought to light.

Again, with regard to the productions of the various seas and oceans that occupy so large a portion of our globe, we know comparatively few, especially of its molluscous inhabitants. What are cast up on the shores of the various countries washed by their waves, and what the net or other means may collect in their vicinity, find their way indeed into our cabinets; but what are these compared with such as inhabit the depths and caves and bed of the infinite ocean, which net never dragged, nor plumb-line fathomed. Who shall say what species lurk in those unapproachable recesses never to be revealed to the eye of man, but in a fossil state. The giant *Inocerami*, the singular tribe of *Ammonites*, and all their cognate genera, as even Lamarck seems disposed to concede:[2] the *Baculites*, *Hamites*, *Scaphites*, and numerous others there have space enough to live unknown to fame, while they are reckoned by the geologist as expunged from the list of living animals. I do not mean to assert that these creatures are not extinct, but I would only caution the student of nature from assuming this as irrefragably demonstrated; since we certainly do not yet know enough of the vast field of creation, to say dogmatically with respect to any species of these animals that this is no longer in being.

But besides the unexplored parts of the surface of the earth, and of the bed of the ocean, are we sure that there is no receptacle for animal life in its womb? I am not going here to revive the visionary speculations of Athanasius Kircher in his *Mundus subterraneus*, but merely to inquire whether there are any probable grounds for thinking that some creatures may be placed by their Creator at such a depth within the earth's crust, as to be beyond all human ken.

When Laplace says, "It is certain that the densities of its (*the earth's*) strata increase from the surface *to* the centre," it seems to follow that, in his opinion, there is no central cavity in our globe; but as his object was chiefly to assert the increasing density of the strata as they approach the centre, perhaps his words are not to be taken strictly, especially as in

1 See Appendix, note 8. 2 In N. D. D. H. N. vii. 553.

another place he speaks of it merely as *probable* that the strata are more dense as they are *nearer* to the centre. Sir I. F. W. Herschel makes a similar, but less exclusive observation, using the terms, "*towards* the centre," which is not inconsistent with a cavity.

But after all this is matter of conjecture built upon the attraction of the earth, and cannot be ascertained by actual examination; as far as that has been carried, it does not appear that in the present state of our globe the strata always lie exactly in the order of their densities; in the original earth probably they did. But now we tread upon the ruins of a world that has been almost destroyed and reformed. "The structure of the globe," observes an eminent geographer, "presents in all its parts the features of a grand ruin; the confusion and overthrow of most of its strata, the irregular succession of those which seem to remain in their original situations, the wonderful variety which the direction of the veins and the forms of the caverns display, the immense heaps of confused and broken substances, the transportation of enormous blocks to a great distance from the mountains of which they appear to have formed a part,"[1]—do not lead us as he would intimate "to periods far anterior to the existence of the human race," but to a mighty catastrophe by which the whole structure of our globe has been dislocated, and its ancient strata broken up, and separated by the intervention of new ones formed of animal and vegetable remains.

When the Almighty formed our globe from the original chaos, and projecting it into space bade it perform its diurnal and annual revolutions, he first weighed it in his balance, and moulded it so as it might answer to the action of those mighty powers by whose constant impulse or impact those revolutions were to be maintained; and if a central void was necessary he wanted not the means to produce and maintain it. When the power called attraction tended to drive all to the centre, the repellant principle might be so stationed as to counteract it, and keep the earth's crust at its assigned distance. To compare great things with small, he who made the rain-drop made also the air-bubble,—the one to fall, the other to rise.

The word of God, in many places, speaks of an abyss of waters under the earth, as distinct from the ocean though in communication with it,[2] and also as contributing to form springs

1 Malte-Brun *Syst. of Geogr.* L. i. 192.

2 Comp. Job, xxviii. 14, xxxviii. 16, 17.—Genes. xlix. 25.—Deut. xxxiii. 13.—Jonah, ii. 6, &c.

and rivers.[1] Scientific men, in the present day, appear disposed to question this; the Geologist, though he may regard the granitic strata as forming the base, as it were, of the crust of the earth, seems rather to view it as containing a focus of heat, than a magazine of infinite waters; from whence are partly derived the springs and rivers that water the earth's surface, and ultimately make good to the ocean its whole loss by evaporation.[2] "Springs," says the author above quoted, "are so many little reservoirs, which receive their waters from the neighbouring ground, through small lateral channels." He allows, however, that the origin of springs cannot be referred to one exclusive cause, and associates with that just mentioned, the precipitation of atmospheric vapours attracted by high lands, the dissolving of ice, the filtering of sea-waters, and the explosion of subterraneous vapours. He makes no direct mention of a store-house of waters in the bosom of the earth as in any case the source of springs and rivers, but allows that "the phenomena of capillary tubes may obtain in its interior. The sea-waters, deprived of their salt and bitter elements, may ascend through the imperceptible pores of several rocks, from which, being disengaged by the heat, they will form those subterraneous vapours to which many springs owe their origin." A very slight alteration of this passage would make it harmonize with the Scripture account of the matter. If, for "some rocks," we substitute *through the rocky strata*, and to the "sea-waters" add *received into the abyss*, it would amount to nearly the same thing. It was an ancient opinion, mentioned in Plato's Phædon, that there is a flux and reflux of the waters of our globe, a kind of systole and diastole, into and from Tartarus or the great abyss, which produce seas, lakes, rivers, and fountains.[3] That all the causes mentioned above contribute to the formation of the rivers that water the earth, especially the clouds and vapours that gather round the tops of the mountains and high hills I am ready to admit, at the same time I must contend that the principle reservoir from which they are supplied has its station *under the earth.*

Writers on this subject seem to speak as if the source of all rivers was in mountainous or hilly countries, but though the mightiest rivers of the globe originate in such situations, there is a very large number of considerable streams whose source is not particularly elevated, especially in the flat parts of England; and there are few rivers that do not receive some supply

1 Ps. lxxviii. 15, 16.—Prov. viii. 24. 2 See Appendix, note 9.
3 Platonis *Dialogi*. Ed. Forst. *Phædon*. § ξ.

from lesser ones, having their rise in low grounds, in their course. The practice, in all countries, of digging wells indicates a downward source of water.

In the Mosaic account of the deluge it is stated, that the waters prevailed above the tops of all the mountains fifteen cubits—now the highest mountain in the globe, Dhawalagiri, a peak of the Himmaleh range in northern India, is five miles above the level of the sea, this will make a sphere of waters, inclosing the whole globe as its nucleus, of five miles in depth above the level of the sea, but in calculating the immense additional body of water thus burying the whole globe, deductions must be made for the mountains and the lands elevated above that level, which would considerably decrease the total amount. But, even then, how vast would be the increase. If two-fifths of this body were deducted, a deluge of rain for forty days and forty nights over the whole globe, would fall infinitely short of the amount of water required to cover it to this height. The mean quantity of rain that now falls upon the earth in the course of a whole year is short of three feet; there must therefore have been an outbreak of waters from a source which could supply all that was necessary to accomplish the will of the Almighty, and make the earth itself a ruin, as well as sweep off its inhabitants; and where shall we look for this but to the abyss that *coucheth beneath* the earth, whose fountains, as the sacred historian tells us, were broken up. If we consider the diameter of our globe, and that the ocean in depth is not supposed to exceed the highest mountains, we may conceive that in a spheroid, whose diameter is 8000 miles, allowing for the depth of the crust of the earth, there is space for a treasure-house of water, of sufficient amplitude to supply what the heavens could not furnish, to raise the diluvial waters to the height decreed in the Divine counsels. It seems now agreed amongst geologists and mineralogists that traces of the action of fire, as well as water, are very visible amongst the present strata of this globe: when the waters of the abyss were sent out from their hidden receptacle, it must be by the agency of some potent cause employed by the Deity, equal to the production of the effect he intended.

In the present state of the globe, volcanoes, or their traces are visible in various regions in all climates, and in the islands of various seas, and in Iceland, near Hecla, the subterranean furnace sends vast columns of water into the air, sometimes to the height of a hundred feet, and at the base of half that diameter.[1] These circumstances render it probable that fire was

1 See Hooker's Recollections of Iceland, 120.

the agent, or one of the agents, employed to send out the waters from the abyss; and this is no new hypothesis. "It is the opinion of geologists," says Laplace, "that, originally, there existed in the interior of the crust of the earth, a great magazine of fire, which according to them was the cause of the deluge." Some writers suppose that the air was driven downwards into the earth, being forced through those chasms which opened towards the sky, and that then by its expansion it drove out the waters.[1]

He who willed the deluge, and the destruction of the primeval earth and heavens by it,[2] kept in his own hands the reins, and guided the whole body of means that he employed to fulfil the great purposes of his Providence, saying to every agent, "*Thus far shalt thou go, and no further.*" It must always be kept in mind that this was not an event in the ordinary course of nature, and a result of the enforcement of her established code of laws, but a miraculous deviation from it, in which their action was suspended, and in consequence of which, perhaps, some were abrogated and new ones enacted in their room. I may here further observe, that probably, the whole body of waters which before the creation of the firmament or expanse, with the earthly atoms suspended in it, formed the primeval chaos, were now again its masters; descending and ascending from every receptacle or store-house to which that powerful expansion had been the means employed to guide them. Whatever waters were suspended in the atmosphere, or could be formed in it, whatever were contained in the ocean, or the womb of our globe, now united their forces and subdued and destroyed the primitive earth, till they reduced it to the state, for the most part, in which we now behold it.

I am next to inquire what has been said in Scripture on the subject of subterranean animals. In the second commandment we are forbidden to "*make any likeness of any thing that is in the waters under the earth.*" These words, however, may be merely used to indicate the animals that inhabit the ocean, considering the waters under the earth as forming a part of it. But there is a passage in the Apocalypse, where the creatures under the earth are distinguised from those in the sea. "*And every creature which is in heaven and on the earth, and under the earth, and such as are in the sea, and all that are in them, heard I saying, Blessing, and honour, and glory and power, be unto him*

1 Rev. W. Jones's *Works*, x. 264.
2 Pet. iii. 6, 7, and see Appendix, note 10

*that sitteth upon the throne, and unto the Lamb for ever and ever.*"[1] Some interpreters understand this passage as relating to those men that were buried under the earth, or in the sea, but admitting they were meant in the *spirit*, the creatures in general are expressed in the *letter*, and therefore the outward symbol must have a real existence, as well as what it symbolized.

There is another place in Scripture, which though highly metaphorical, seems to me, to point, if rightly interpreted, at subterranean animals, and even a particular description of them. The passage I allude to is in the xlivth Psalm, "*Though thou hast sore broken us in the place of* dragons *and covered us with the* shadow of death."[2] In these words the *place of dragons* and the *shadow of death* evidently mean the same thing; and the object of these metaphors is to express the lowest degree of affliction, depression, and degradation; equivalent to being brought down to hell or hades in other passages. The *shadow of death*, properly speaking, is in the hidden or subterranean world. This appears from the passage of Job before quoted, in which the *abyss* the *gates of death*, and the gates of the *shadow of death*, are used as synonymous expressions.[3] The place of dragons, then, according to this exposition, will be subterranean. In another Psalm, David couples *dragons* and *abysses*.[4]

We must next inquire what is meant by the word *dragons*. The Hebrew word usually thus translated, but in some places rendered *whales* and *sea-monsters*, and in others serpents,[5] is derived from a root, which signifies to wail or lament; probably, alluding to the noise at certain times emitted by those animals, that are more properly regarded as *dragons*, by which I would understand the Saurian race, without excluding the others, which are sometimes certainly intended by that word. Thus, when Jeremiah alludes, under the name dragons, to animals that give suck to their young, it is clear that he meant some of the whale or seal kind, which are mammiferous. Our translators, therefore, very properly rendered the word *sea-monsters*, or as in the margin, *sea-calves*. I may here observe, though at first sight, the crocodile and the whale seem widely separated from each other, that there are certain species, at present found only in a fossil state, and fitted with paddles instead of legs, which are stated to combine characters observable in the Cetaceans with those of the Saurians, particularly the

1 Revel. v. 13.
2 Ps. xliv. 19.
3 Job, xxxviii. 16, 17.
4 Ps. cxlviii. 7.
5 Genes. i. 21. Lament. iv. 3. Exod. vi. 9, 10.

*Plesiosaurus*;[1] the *Testudo* also of the Greeks[2] seems to approach some of the seals. The word we are considering, in the first chapter of Genesis, is rendered by our translators, *whales*. In the version of the seventy, a word is used,[3] which the Greek writers employ to signify any aquatic monster; thus, Theocritus, when he describes the Nile as abounding in monsters, means the crocodile. Our Saviour, when he speaks of Jonah in the belly of the fish, uses the same word, probably, for a shark, the dog Carcharias of the Greeks, which was fabled to have swallowed Hercules, a fable, no doubt, derived from the history of Jonah.

It appears clearly that the word is also used for a serpent, for it is employed to express the animal into which the rod of Moses and those of the Egyptian magicians were transformed as related in the book of Exodus.

The typical animal, however, if I may so employ that term, or the dragon proper of Scripture, is undoubtedly a Saurian, especially the amphibious ones, such as the crocodile and its affinities. In the Septuagint version the Hebrew word is sometimes rendered by the term Siren, which in other places is used for the ostrich,[4] derived from a root which relates to its noise, but the Siren of the Greeks is very different from that of these Jews—the former being a fabulous, the latter a real animal. Travellers describe the noises of crocodiles and alligators as horrible. Crocodiles, during the whole summer, says Bosc, but especially immediately after they emerge from the earth, that is in the spring and the epoch of their amours, frequently send forth lowings almost as loud as those of an ox. They respond to each other often by hundreds, especially in the evening, which makes in the swampy forest a frightful and thundering din. Captain Jobson says, that those of the river Gambia utter cries that may be heard from a great distance, which seem as if they issued from the ground.

The whale also, when it expels the water, is related to make a frightful noise, like distant thunder. Captian Cook represents the walrus, when in herds, as roaring or braying very loud, and some species of seals are stated to bellow like bulls.

The hissing of serpents agrees less with the radical idea of the word *dragon*, than the noises of either of the preceding tribes of animals. The aquatic and amphibious Saurians occupying, as it were, a middle station between the Cetaceans

1 Mantell's *Age of Reptiles*.—Sussex Gazette.
2 *Sphargis coriacea*.
3 τα κητη τα μεγαλα.
4 Isai. xiii. 21.—Job, xxx. 29, &c.

and Ophidians, may be regarded, therefore, as the *dragons* par excellence.

These, then, are the animals that I conjecture may not improbably be still in existence in the subterranean ocean; I shall now, therefore, bring forward some arguments, independent of what I have alleged from Holy Scripture, which seem to afford grounds for such an hypothesis.

It has been calculated that the depth of the sea in any part does not exceed 30,000 feet, or a little more than five miles; this, compared with the diameter of our globe, about 8000 miles, may be regarded as nothing. What a vast space then, supposing it really hollow, may be contained in its womb, not only for an abundant reservoir of waters, but for sources of the volcanic action, which occasionally manifests itself in various parts, both of the ocean and terra firma. Reasoning from analogy, and from that part of the globe which falls under our inspection, it will appear not improbable that this vast space should not be altogether destitute of its peculiar inhabitants. We know that there are numerous animals, on the surface of the globe, that conceal themselves in various places in the day time, and only make their appearance in the night. It would, therefore, be perfectly consistent with the general course of God's proceedings, and in exact harmony with the general features of creation, that he should have peopled the abyss with creatures fitted, by their organization and structure, to live there: and it would not be wonderful that some of the Saurian race, especially the marine ones, should have their station in the subterranean waters, which would sufficiently account for their never having been seen except in a fossil state.

The organization of many reptiles favours the idea of their being fitted for a subterranean habitation. It has been observed of them, that they not only perceive objects at a great distance, but are furnished with a nictitant membrane like birds; and that the greater part can contract the pupil like cats, which enables them to see in the dark. Their other organs furnish them with but few sensations: they communicate less frequently and less perfectly with external objects; their blood is cold, and will circulate a long time without communication with the air. They will bear very long fasts without injury; and those of some tribes, the Chelonians at least, will survive for a time the loss of their brain, their heart, and even their head. These circumstances are found in those that only occasionally seek subterranean retreats, or seclusion from the light and the air; but those whose existence is wholly subter-

ranean, doubtless, like the *Proteus*, would be fitted by their organization for their destined abode. We see, in several of those we are acquainted with, except at certain times, a constant effort to escape not only from observation, but from immediate contact with the light and the air.

This leads me further to observe, that there is one instance of a Saurian, at this time known to be in existence, that is perfectly subterranean, which never makes its appearance on the earth's surface, but is always concealed at a considerable depth below it; and, what is worthy of particular notice, by its structure, is connected with one of the larger Saurians, now found only in a fossil state. It will immediately be perceived that I allude to that most extraordinary animal, the *Proteus anguinus*,[1] which is found in subterranean lakes and caves two or three hundred feet below the surface of the ground in Illyria, breathing both by lungs and gills, and presenting characters which connect it with the Saurian monsters before alluded to, whose remains have occasioned so much astonishment, appear to have puzzled in some measure the most acute geologists, and have given birth to an hypothesis I shall hereafter notice. Sir H. Davy, in his last singular work, thus expresses himself concerning the *Proteus*:—"My reveries became discursive, I was carried, in imagination, back to the primitive state of the globe, when the great animals of the Sauri kind were created under the pressure of a heavy atmosphere; and my notion on this subject was not destroyed, when I heard from a celebrated anatomist, to whom I sent the specimens I had collected, that the organization of the spine of the *Proteus* was analogous to that of one of the Sauri, the remains of which are found in the older secondary strata." Sir Humphry probably here alludes to a celebrated fossil found in the slate quarries of Œningen, which Scheuchzer called an ante-diluvian man, but which Cuvier regards as a giant species of *Proteus*.

All the circumstances above stated being duly weighed, and especially the discovery of a species in the depths of the earth, related to one of the fossil ones, I trust that my hypothesis of a subterranean metropolis for the Saurian, and perhaps other reptiles, will not be deemed so improbable and startling as it may at the first blush appear; at the same time, I would by no means be thought to contend that *none* of these animals are extinct, but solely that *all* may not be so, and that their never having been found in a recent state may have arisen from the peculiar circumstances of their situation.

1 Plate xiv. Fig. 1.

I have been led into this discussion by Mr. Mantell's Hypothesis of an *Age of Reptiles*, which I have seen only in an extract from one of the Sussex advertisers for last year, which he was so kind as to send to me; in which he supposes that the Saurians were the mighty masters, as well as monsters, of the primeval animal kingdom, and the lords of the creation before the existence of the human race. Since this hypothesis, as stated in the above extract, cannot be reconciled with the account of the creation of animals as given in the first chapter of Genesis, I shall not be wandering from the purpose of the present essay if I devote a few pages to the consideration of it.

The hypothesis in question is based by its learned promulgator chiefly upon the supposed age of the beds and strata in which the remains of these fossil Saurians generally have been found, which he states as more ancient than those which contain the remains of viviparous animals; and upon the myriads which appear, when they were the lords of our globe, to have existed. But it is clear from his own statement that with the fossil remains of the *Megalosaurus*, a giant lizard, calculated to have been forty feet in length and eight in height, those of some viviparous quadruped related to the *Opossum* have been found, which he acknowledges cannot be satisfactorily explained. A fact that militates strongly against an insulated Saurian reign. Nor is it altogether true that the remains of these mighty lizards are found solely in what are denominated *ancient* deposites; vertebral joints are not unfrequently found in other situations. I have one between three and four inches in diameter, which, from its being cupped, or deeply concave at each extremity, evidently belongs to one of these animals, which was found in a gravel-pit, at no great depth, in my own neighbourhood; and I have seen similar ones found in other parts of the county of Suffolk. These dispersed bones seem to indicate that the individuals to which they belonged were deposited in situations more exposed to the action of the atmosphere, so as to decompose the ligaments that kept the skeleton entire. The interment of these animals was therefore various, and evidently regulated by circumstances, so that no satisfactory hypothesis can be built upon it. When the whole globe was submerged, and the waters overtopped the highest mountains, the terrestrial animals would, in numberless cases, float upon the surface, and be deposited in countries far distant from those which they inhabited, while those that were aquatic, being in their native element, must have owed their death to other circumstances; they must either have been overwhelmed by some sudden force that they could not resist or escape from; or some

cause that we cannot now appreciate may have overtaken and destroyed them.

With regard to the *numbers* of these animals, which Mr. Mantell thinks prove their prevalence, we can only judge of it by those that are found in a fossil state, and these, certainly, are sufficiently numerous; but surely it cannot be safely affirmed that for one individual found in a fossil state thousands must have been devoured or decomposed. These mighty monsters were more likely to devour than to be devoured; and even the herbivorous ones, such as the vast *Iguanodon*, supposed to be sometimes one hundred feet long and ten feet high! would have puzzled the crocodiles and alligators and other carnivorous ones to overpower and dispatch them.

But, in fact, the question is concerning those that were alive upon this globe at the time when the great convulsion took place that buried them. The skeletons of all that were placed under similar circumstances would be found in a similar state of preservation; their flesh would be decomposed but not their skeleton; the deluge would also interrupt all attacks of one animal upon another, every individual would be seeking to secure its own escape. But, setting aside these arguments upon the uncertain facts on which this hypothesis is built, if we turn our attention to the reason of the thing, who can think that a Being of unbounded power, wisdom, and goodness should create a world merely for the habitation of a race of monsters, without a single rational being in it to glorify and serve him. The supposition that these animals were a separate creation, independent of man, and occupying his eminent station and throne upon our globe long before he was brought into existence, interrupts the harmony between the different members of the animal kingdom, and dislocates the beautiful and entire system, recorded with so much sublimity and majestic brevity in the first chapter of Genesis.

How grand and at the same time how simple is this record, proceeding step by step from one Almighty operation to another! each the natural consequence, as it were, of that which preceded it. When the earth was formed, and planted, and was receiving the influences of the sun and other luminaries, and thus was prepared to welcome and maintain her locomotive inhabitants, the perfect sphere of animals, if I may so speak, adapted to the wants of the primeval state of the globe of dry land and sea, both external and internal, and to the instruction and uses of man, each individual form gifted and fitted to play the part assigned to it in the general plan of Providence, was brought into existence. The supposed ex-

tinct animals all exhibit a relationship to those that we now find existing, and many of them evidently fill up vacant places in the general system, and therefore there is no cause to suppose that they were originally separated from and anterior to their fellows. It is observed that those herbivorous Saurians now inhabiting the surface of our globe, as the *Monitor* and *Iguana*, though these can scarcely be called herbivorous since they live principally on insects, are pigmies compared with their affinities, the *Megalosaurus* and *Iguanodon;* and a similar disproportion obtains between the existing *Proteus* and the fossil one. If any of these races are subterranean, perhaps these smaller ones may be regarded, as inhabiting the outskirts of the proper station, or metropolis of their tribe.

It appears, I hope, from what has been observed, in the present chapter, on the subject of animals brought into being subsequent to the fall, and upon those that have since that sad event become extinct from whatever cause, that Divine Providence, after the first creation of man and the animal kingdom, did not leave all things to the action of the original laws which had received his awful sanction before the fall, but altered those by which this system, especially our own globe, was guided and governed before that fatal event, to suit them to what had taken place, and to the altered and deteriorated moral state of man. We learn from the Apostle Saint Peter, that the primeval globe and its *heavens* or atmosphere, *perished* at the deluge,[1] by which expression less cannot be intended, than that the atmosphere and the earth were then, as it were, new mixed, so as to render the former less friendly to life and health, whence would gradually follow the shortening of human, and probably animal life; and subject to raging storms and hurricanes; to the fury and fearful effects of thunder and lightning; to the overflowing violence of torrents of rain: while the latter, from the breaking up, inversion, mixing, depression, or elevation of its original strata, and the addition of new ones from animal and vegetable deposites,[2] was rendered in many places utterly barren, and in others much diminished in fertility, so that the general productiveness of the globe must have been considerably diminished, and the permission to eat flesh must have been extremely useful in increasing the amount of food, and diminishing that of labour. Such a change having taken place, both in the heavens and the earth, and vast countries being essentially altered both in the temperature of the atmosphere, from whatever cause, and the productions of

1 Gr. απωλετο. 2 Pet. iii. 6.

2 See Appendix, note 11.

the soil, the extinction of many of the original animal forms, that were extra-tropical, or at least were inhabitants of high latitudes, and were incapable of bearing the changes, whether it was ante-diluvial or post-diluvial, would necessarily follow; and again as man was become by his nature prone to *sin*, he as necessarily was made subject to *evil*. Hence he became exposed, from the new constitution of the earth and atmosphere, to various diseases and sundry kinds of death, the term of his existence was shortened, and it was chequered with days of darkness as well as of light: and he was infested by various animals, either newly created, or then first let loose against him and his property.

All these things indicate a change in the mechanical as well as other original powers set and kept in action by the Creator, and a certain dependence of two distinct classes of events upon each other. If a great alteration generally takes place in the moral condition of man, a corresponding change affects his physical one; and this alternation and conflict between good and evil, in this double series, after a long and arduous struggle, will finally be determined by the destruction of this diluvial earth and heavens, which we are assured will, in the end, be replaced by "*New Heavens and a new Earth wherein dwelleth righteousness.*"

## CHAPTER II.

### *Geographical and Local Distribution of Animals.*

HAVING considered the first creation of the animal kingdom, and the larger features of its history to the time of the Deluge, bringing us to that era when our globe had assumed its present general characters, and its population was in those circumstances that led to their present habits and stations: the next subject to be discussed is their geographical and local distribution.

What had taken place in this respect before the Deluge we have no means of ascertaining. That the original temperature of the earth was once more equal than it is now, seems to be the general opinion of men of science, however they may differ as to its cause.[1] If this was the case, as it probably was, any individual species might have been located in any country, north or south, and suffer no inconvenience from unaccustomed heat or cold, so as to interfere with its complete naturalization: the only other requisite would be a kind of food suited to its nature; and it is singular and worthy of particular attention, that a large proportion of the plants, as well as animals, that are found in a fossil state in our northern latitudes are of a tropical type or character.

After their creation, and perhaps the expulsion of the first pair from Paradise, we may suppose that the various animals of the ante-diluvian world were guided to those regions in which it was the will of Providence to place them, by a divine impulse upon them, which caused them to move in the right direction. Probably before the Deluge took place, the world was every where peopled with animals: and perhaps, as Professor Buckland has suggested, the sudden change of temperature that destroyed the northern animals might be one of the predisposing causes of that event.

Under the present head, the geographical distribution of our post-diluvian races of animals, the first thing to be considered

1 See above, p. 17, &c.

is the means by which, after quitting the ark, they were conveyed to the other parts of the globe. The disembarkation of the venerable patriarch and his family, followed by all the animals preserved with him in the ark, a scene of universal jubilee to man and beast, such as the world till that day had never witnessed, took place on Mount Ararat: the stream of interpreters, ancient and modern, place this mountain in Armenia; but Shuckford, after Sir Walter Raleigh, seems to think that Ararat was further to the east, and belonged to the great range anciently called Caucasus and Imaus, which terminates in the Himmaleh mountains to the north of India. This opinion seems to receive some confirmation from Scripture, for it is said, "*As they journeyed from the* east, *they found a plain in the land of Shinar.*" Now the Armenian Ararat is to the *north* of Babylonia, whereas the Indian is to the *east.* Again, as the ark rested upon Ararat more than *ten* weeks before the tops of the mountains were seen, it seems to follow that it must have been a much higher mountain than the generality of those of the old world. The modern Ararat (Agri-Dagh) is not *three* miles above the level of the sea, whereas the highest peak of the Himmaleh range, Dhawalagiri, is *five*, and the highest mountain in the known world: so that the tops of a great number of mountains would have appeared previously had the ark rested upon the former Ararat, but not so if upon the latter. The traditions also of various nations, given by Shuckford, add strength to this opinion. In addition to these, the following lines, quoted in a late article on Sanscrit poetry, in the Quarterly Review, show what was the creed in India on this subject:—

In the whole world of creation————
None were seen but these seven sages, Menu and the fish;
Years on years, and still unwearied, drew that fish the bark along,
Till at length it came where reared Himavan—its loftiest peak;
There at length they came, and, smiling, thus the fish addressed the sage:—
Bind thou now thy stately vessel to the peak of Himavan—
At the fishes' mandate, quickly to the peak of Himavan:
Bound the sage his bark, and even to this day that loftiest peak
Bears the name of Naubandhana.

Both these opinions have their difficulties, which I shall not further discuss, but leave the decision of the question to persons better qualified than myself to direct the public judgment: I shall only observe, that perhaps the Indian station was more central and convenient for the ready dispersion of men and animals than the Armenian one. Every naturalist is aware

that there are many animals that, in a wild state, are to be found only in particular countries and climates. Thus the Monkey and Parrot tribes usually inhabit a warm climate, the Bears and Gulls with many other Sea-birds, for the most part a cold one. The Kangaroo and Emu are only found in New Holland; the Lama in Peru; the Hippopotamus and Ostrich in Africa. Now we may ask, how were all these local animals conveyed from the place of disembarkation to the countries and climates that they severally inhabit? In considering this question, we must never lose sight of HIM, according to whose will, and by whose Almighty guidance, they were all led to the stations he had appointed for them, and with reference to which he had organized and formed them. Whatever second causes he might commission to effect this purpose, they were fully instructed and empowered by him to accomplish the work intrusted to them. I do not mean here to infringe the rule, *Nec Deus intersit nisi dignus vindice nodus.* Where the faculties, senses, and wants of an animal were sufficient for its guidance, there was no need for Divine interposition, but where these are insufficient guides, the animal must attain its destined station under some other influence.

What brought the various animals to the ark previously to the deluge? Doubtless a *divine* impulse upon them, similar to that which caused the milch-kine to carry the ark of the covenant to Bethshemesh, with the offerings of the lords of the Philistines. Noah, though he probably selected the clean animals, at least those that were domesticated, could have little or no influence over the wild ones to compel them to congregate by pairs, at the time fixed upon for their entry into the ark. So in the dispersion of animals, wherever man went he took his flocks and herds, and domestic poultry, and those in his employment for other purposes, with him: but the wild ones were left to follow as they would, or rather as God directed.

Every one who looks at a map of the world, on Mercator's projection, can easily conceive how the animal population of the greatest part of the old world made their way into the different countries of which it consists, but when he looks at America and New Holland, he feels himself unable satisfactorily to explain the migration of animals thither, especially those that can live only in a warm climate, at least as far as regards the former. How, he might ask, did the Sloths, the Anteaters, and the Armadillos get to South America? If the climate of Behrings Straits, after the deluge, was as cold as it is at this day, they could never have made their way thither,

and in those latitudes the temperature of which was adapted to their organization the vast Pacific presents an insuperable barrier.

The same question may be asked with respect to the indigenous animals of New Holland; the Kangaroo, the Cola, the Ornithorhynchus, the Emu, and several others that are found in no other country; how did they, leaving the continent altogether, convey themselves to this their appointed abode? It is true difficulty is not so great in this last case, on account of the numerous islands interposed between Malacca, Cochinchina, &c. and the North Coast of New Holland, but then it is unaccountable, if the transit of these animals was gradually effected by natural causes, and following that of mankind from island to island, till they reached the country to which their range is now limited, that they should have left no remains of their race in the countries and islands which they must have traversed in their route; and those that would have accompanied man would be a different tribe of animals, more fitted to minister to his wants, so that with respect to these the difficulty still remains—they could not have reached the country unless under the guidance of Providence, and the same power that accomplished their removal to that appointod for their residence, prevented their leaving any of their race in the regions through which they passed.

There is only one supposition that will enable us to account for the transport of these animals in a natural way, which is this, that immediately subsequent to the deluge, America and New Holland, and the various other islands that are inhabited by peculiar animals, were once connected with Asia and Africa, by the intervention of lands that have since been submerged. Plato, in his Timæus, relates a tradition concerning an island called Atlantis, which he describes as bigger than Asia and Africa, situated before the pillars of Hercules, which after an earthquake was swallowed up by the sea. According to his statement, this account was given by the Egyptian priests at Sais, to Solon, the Athenian legislator. Catcott, in his history of the deluge, seems to give some credit to this tradition, and supposes that Phaleg took his name, not from the confusion of tongues at Babel, and the subsequent division of the earth amongst the families of the three sons of Noah, but from its division occasioned by the subsidence of this great island, by which the occidental were separated from the oriental countries of the globe. Philo Judæus speaks of this catastrophe in terms that imply he gave credit to it, as does also Tertullian; but it appears to me to rest on too uncertain a base, and to be

too much mixed with evident fable and allegory, to claim full credit as a real fact in the history of our globe. Still that many violent convulsions have taken place since the deluge is generally supposed. Our own island is thought once to have formed part of the continent, Sicily to have been united to Italy, with many other instances mentioned by Pliny. It is equally probable that the islands of the Indian Archipelago were at one time joined to that part of Asia. Whether such disruptions from the continents were simultaneous, or took place at different periods, is uncertain; but if such an event as the submersion of the vast island of Plato did really happen, it surely would affect the whole terraqueous globe, produce convulsions far and wide, and cause various disruptions in its crust, and elevations in other parts from the bed of the ocean. It throws some weight into this scale, that thus a way would be open, though certainly a circuitous one, for the migration of those animals to America, that are found in no other part of the world, and, supposing Asia to have been disrupted from it at Behrings Straits, could scarcely have ascended to so high a latitude, in search of their destined home.

Malte-Brun, in his geography, after proving that the animals in question could have passed neither from Africa nor Asia, observes—"Nothing, therefore, remains, but the accommodating resource of a tremendous convulsion of nature, with a vast tract of country swallowed up by the waves, which formerly united America with the temperate regions of the old world. Such conjectures as these, however, being devoid of all historical support, do not merit a moment's consideration; consequently we cannot refrain from admitting, that the animals of America originated on the very soil, which, to this present day, they still inhabit."

That it might have been the will of the Creator to people the country in question by the immediate production of a new race of animals, suited to its climate and circumstances, I will not deny, but I would only ask, is it consistent with what occurred at the deluge? Surely the task of Noah would have been much less difficult and laborious, had it been merely necessary for him to construct a vessel fitted for the reception of himself and family, and of food for their sustenance during their confinement; and a new race of animals had been created, adapted to the then state of the earth and mankind. But such was not the will of God, and, doubtless, for wise reasons. He would neither create a new race of men, nor a new race of animals, when the world might be repeopled by those already in being. This would not have harmonized with the ordinary proceedings of his provi-

dence. Whoever examines the animals of North America, will find a vast number that correspond with European species, distinguished only by characters that mark varieties. On the Rocky Mountains, and in the country westward of that range, Asiatic types are discoverable, both in the vegetable and animal kingdoms.[1] Several animals, likewise, of the southern part of that Continent belong to old world genera, and also species. I have received from Valparaiso a beetle, common in Britain,[2] and Molina mentions several other European genera, as natives of Chili; so part of the animal population of the New World appears to have been derived from Europe and Asia; and if so, there is a door open, through which Providence might also have conducted those North American animals that are found in no other country.

But besides the probable, or possible, modes by which the transit of animals to their respective settlements might have been accomplished, Mr Lyell, in the second volume of his Principles of Geology, has suggested one which might, amongst others, have been employed for this purpose.

"Captain W. H. Smyth informs me," says he, "that, when cruising in the Cornwallis, amidst the Philippine islands, he has more than once seen, after those dreadful hurricanes called typhoons, floating islands of (*matted*) wood, with trees growing upon them; and that ships have sometimes been in imminent peril, in consequence of mistaking them for terra firma." Mr Lyell conjectures, not improbably, that by means of such an insular raft, or wandering Delos,—"if the surface of the deep be calm, and the rafts carried along by a current, or wafted by a slight breath of air fanning the foliage of the green trees, it may arrive, after a passage of several weeks, at the bay of an island, into which its plants and animals may be poured out as from an ark; and thus a colony of several hundred new species may at once be naturalized." Thus he accounts for the peopling of the volcanic and coral islands in the Pacific.

It must be borne in mind that nothing really happens by chance, or is the result of an accidental concourse of fortuitous events: second causes are always under the direction of the *first*, who ordereth all things according to the good pleasure of his will; and therefore the elevation of a new island from the bosom of the deep, whether immediately produced by volcanic agency, or by an earthquake, or built by Zoophytes, still may be denominated *his* work; so likewise the same Almighty Guardian of the universe, whose name is Jehovah of

1 See Appendix, note 14. 2 *Sphodrus Terricola.*

Hosts, directs all the actions and motions of the hosts that he hath created, to the full accomplishment of every purpose that, in his wisdom, he hath formed. When we are assured that the hairs of our head are all numbered, and that not a sparrow falleth without our Heavenly Father, we are instructed to look beyond second causes for the direction and management of events that appear at first sight the most trivial, but which, in their immediate or remote consequences, may be productive of effects that are important to be attended to and provided for.[1]

We know that when animals of any kind exceed certain limits, though beneficial in the ordinary exercise of their instincts, they become noxious. God alone knows when they approach these limits; it is he, therefore, that employs man or other animals to destroy a certain number of them, that they may bear a due proportion to other beings on which they act; or if he wills to punish mankind, he suffers their numbers to increase so as to answer this intention. But to all his hosts, he says, "*Thus far shalt thou go and no further.*" Therefore, when the ocean, or fires below its bed, or other causes elevate islands above its surface, it is he that conducts to them the population he intends should occupy them.

The islands of Bourbon and Mauritius both appear to be of volcanic origin: amongst their aboriginal animal inhabitants was a most extraordinary gallinaceous bird, called the Dodo;[2] this bird, like the ostrich and cassowary, had only rudiments of wings, and of course was unable to fly; being unfit for food, though of the gallinaceous order, and a very ugly and disgusting object, it soon became extinct in those islands, and the only remains of it are a leg and foot at the British Museum, and a skeleton of the head in the Ashmolean Museum at Oxford. It has been contended that this bird, having never been discovered elsewhere, was peculiar to these islands, but there are reasons for believing, that it was not the only species of its genus, for Latham has included in it two others,[3] both stated to have been found in African islands. This affords a strong presumption that the head quarters of the genus are on the continent of Africa, and that these three species have been conveyed to the islands they are stated to have inhabited by some accidental cause. By the direction of Providence, a floating island, like that seen by Captain Smyth, might be the means of conveying this and their other inhabitants to them.

1 Appendix, note 15.

2 *Didus ineptus.*

3 *Didus solitarius* and *nazarenus.*

I think, therefore, that there is no necessity to have recourse to a new and more recent creation, to account for the introduction of its peculiar animals into any given country.

The fact itself, that almost every country has its peculiar animals, affords a proof of design, and of the adaptation of means to an end, demonstrating the intervention and guidance of an invisible Being, of irresistible power, to whose will all things yield obedience, and whose wisdom and goodness are conspicuous in all the arrangements he has made. Wherever we see a peculiar class of animals we usually see peculiar circumstances which require their presence. Thus the Elephant and Rhinoceros, the Lion and the Tiger, are found only in warm climates, where a rapid vegetation, and infinite hosts of animals, seem to require the efforts of such gigantic and ferocious devourers to keep them in check: but on this subject I shall have occasion to enlarge hereafter.

There is another point of view, illustrative of the Divine attributes in this partial location of various animals. If every region, or nation, contained within its limits the entire circle that constitutes the animal kingdom, and the remark may be extended to every natural object, how weak and trifling would be the incitement for man to visit his fellow-men. Were the productions of every country the same, there would be little or no temptation for commercial speculation, therefore the merchant would stay at home; the animal, and plants, and minerals would be the same, therefore the naturalist would stay at home; the astronomer indeed, and geographer, and the student of his own species, might be tempted sometimes to roam, but the ocean would be truly *dissociable*, and those ties that now connect the different nations of the globe would, for the most part, be broken. They are now linked to each other, in a bond of amity, by the intercourse which their mutual wants produce, and the body geographical, if I may use such a metaphor, as well as the body natural, is so tempered, and so furnished in every part, that constant supplies of things, necessary or desirable, are uninterruptedly circulating, by certain channels, through the whole system; and thus keep up a kind of systole and diastole, which diffuses every where a healthy temperament, and is universally beneficial. It is, moreover, calculated to generate those kindly feelings which ought to reciprocate between beings inhabiting the same globe, and sprung from the same original father. And the cultivation of these feelings of mutual good will was, no doubt, the principal object of the Deity in the distribution of various gifts to various countries, endowing some with one peculiar production and

some with another: so that one might not say to another, "*I have no need of you.*"

Herein is the Divine wisdom and goodness most conspicuous. Had chance, or nature, as some love to speak, directed the distribution of animals, and they were abandoned to themselves and to the circumstances in which they found themselves in their original station, without any superintending power to guide them, they would not so invariably have fixed themselves in the climates and regions for which they were evidently intended. Their migrations, under their own sole guidance, would have depended, for their direction, upon the season of the year, at which the desire seized them to change their quarters: in the height of summer, the tropical animals might have taken a direction further removed from the tropics; and, in winter, those of colder climates might have journeyed towards instead of from them. Besides, taking into consideration other motives, from casual circumstances, that might have induced different individuals belonging to the same climates to pursue different routes, they might be misled by cupidity, or dislike, or fear. On no other principle, can we explain the adaptation of their organization to the state and productions of the country in which we find them—I speak of local species—but that of a Supreme Power, who formed and furnished the country, organized them for it, and guided them into it.

There is another question relating to local animals which here requires some notice. Are they really distinct species? Have not the characters which separate them from their affinities been produced, in the course of years, by peculiar circumstances in which they are placed, such as climate, temperature, nature of the country, food, and the like? Every person who knows any thing of the history of animals must admit, that great changes do take place in them from the long action of these causes. For instance, some varieties of the common ox are polled, having only rudiments of horns; others have very short and others very long ones; in some they are not fixed to the skull, but attached to the skin, and movable with it. The same thing, likewise, takes place with sheep; some have no horns, others have two, and one breed, the Icelandic, is distinguished by having four. How these variations have been produced, and by what circumstances they are ruled, has not been ascertained, nor what differences, in other respects, obtain between the armed and unarmed varieties. Linné indeed observed, with respect to the polled sheep, which he denominates English sheep,—but whether they are strictly entitled to that name is not clear, for in the

pillars of Trajan and Antoninus, though there are no polled oxen, there are polled sheep,—that their tails and scrotum reach to the knees; but this does not appear a certain and invariable fact. A young zoologist, when his attention is first arrested by these facts, will probably be inclined to think that animals, exhibiting such striking differences, cannot belong to the same species; but in the progress of his experience, especially in what takes place in almost all animals that man has taken into alliance with him, he will see reason to change his sentiments.

Again, the ears of some animals also exhibit differences that might seem to indicate specific distinction. We see this both in the horse and the swine. In the wild horse the ears lie back, in the domesticated or cultivated one they are erect. The horse was not originally a native of America; but when the Spaniards and other nations obtained a footing in that country, they carried this animal with them, which is now become wild, and numerous herds of them are found in the Llanos, these generally, we are told, are of a chestnut bay, and have recumbent ears. Those that are found wild in the Steppes of Tartary, have the hair of the mane and tail very long and thick, and their ears also are recumbent. A writer, quoted below, has concluded from some observations of Xenophon and Varro, that the military horses of the Greek and Roman republics were much nearer those in the wild state, as just described, than in a subsequent period.[1] In all the war horses, however, sculptured in Trajan's and Antoninus's pillars, the ears are erect, as I think also are those of the Elgin marbles in the British Museum—at least, none of them appear to be recumbent; and in some figured in Hamilton's *Ægyptiaca*,[2] from sculptures at Medinet Abou, in Egypt, which are still more ancient, the ears of all are erect.

In England we have two breeds of swine, one with large flapping or pendent ears; of this description are those fattened in the distilleries in and near London; the other with small, erect, acute ears, common in the county of Suffolk.

When it is considered, that the varities of the above animals with erect ears appear to exhibit altogether a better character, if I may so speak, than their less spirited brethren, whose ears are pendent or laid back, and that this circumstance seems to indicate some approach to civilization in them; it may, probably, be deemed to result from some developement of the brain

1 Roulin. *Anim. Domest. Ann. Des. Sc. Nat.* xvi. 26.
2 Pl. viii. ix.

produced by education, and present some analogy to the effects of the latter in the human species.

There is a certain protuberance growing on the back, between the shoulders, and consisting chiefly of fat, which distinguishes the Indian oxen, both the larger and smaller varieties, from our own, which is known sometimes to attain to the enormous weight of fifty pounds; the ox of Surat is stated to have two of these bosses, or humps. Now, Burckhardt has observed, with respect to the camel, that—"While the hump continues full, the animal will endure considerable fatigue on a very short allowance, feeding, as the Arabs say, on the fat of its own hump. After a long journey the hump almost entirely subsides, and it is not till after three or four month's repose, and a considerable time after the rest of the carcass has acquired flesh, that it resumes its natural size of one fourth of the whole body." This conjecture of the Arabs may, very probably, be well founded, for it is known that animals which become torpid in the winter, are very fat and have several cauls abounding in that substance; but when they awake from their long repose in the spring, they have absorbed a large proportion of it, and are comparatively lean, and more fit for action. During their torpidity the fat is absorbed into the system by means of the lymphatic vessels and the ramifications of the veins. It is stated, however, that the Bear comes out of its winter-quarters as fat as it went into them, but that in a few days, it becomes very lean.[1] In this case it would seem as if there was little or no absorption during hybernation, and that it becomes very rapid upon the animal's emersion from its hiding place.

Reasoning from analogy, the hump on the Zebu may have some such use, and during the dry season, when the food is scorched up, may minister to the nutriment of the animal. If this be the case, this variation from the common type is evidently designed, and furnishes a proof of the care of the Creator for all his creatures, and likewise of such an adaptation of means to an end, as evince both the wisdom, power, and prescience of Him who has so arranged circumstances and agents in every climate as to fulfil his benevolent purposes.

The allwise Governor of the universe, when he gave to the sheep its covering, appears to have had in view not solely the protection of the animal from the effects of cold, but more particularly the benefit of him whom he had enthroned at the head of his creation, by thus placing at his disposal a material

1 Dr. Richardson, *Faun. Boreali-Americ.* i. 16, 20.

so inestimable, for his use and comfort, as wool. It has been observed that all the wild sheep are clothed with long hair; but the Guinea sheep,[1] which is found in the tropical countries, both of Africa and India, is the most truly hairy of any, evidently a provision of the Author of nature, suited to the climate in which they are found. The fine fleeces of the cultivated breeds appear to have been engrafted, as it were, on the long hair of the wild ones, which, doubtless, have been very much improved by the attention paid by man to his flocks. The influence of climate, the quality of pasturage, a due supply of wholesome food in winter; and washing and shearing when summer approaches, have all, certainly, contributed to the improvement of this staple of our commerce. But it was God who endowed these animals with those facilities, if I may so speak, of which man availing himself, might produce by culture the valuable article, in its highest perfection, of which I am here speaking. What a difference between the hair of the Guinea sheep, and the beautiful fleece of the Merino, which even seems to be exceeded, in fineness and softness, by the straight wool of the Parnassian breed.

No animal, if indeed all belong to one original species, varies more than one that is most domesticated of any, the dog: some, as the water-dog,[2] being covered with curled hair almost as thick as the fleece of a sheep, while others, the Turkish-dog,[3] are absolutely naked; others again, the grey-hound,[4] being very slender, with long slender muzzle and legs, remarkable for their velocity and the quickness of their sight; others lastly, the hound,[5] more robust in form, less swift in motion, with a short obtuse muzzle, depending chiefly upon their scent in pursuit of their prey. Whoever studies all these supposed varieties, and the diversified functions which they exercise in our service, as our faithful and attached companions, the watchful guardians and defenders of our property, the purveyors of our table, and the ministers of our pleasures, must acknowledge the wisdom, goodness, and power of the Creator in the production of so versatile a race, applicable, in so many ways, to such a variety of purposes, many of them of the first importance. Without them some nations would have no means of conveyance from place to place;[6] and others would scarcely be able to supply themselves with a sufficiency of food.[7]

1 *Ovis aries africana.*—L.
2 *Canis familiaris aquaticus.*
3 *Canis familiaris ægyptius.*
4 *Canis familiaris graius.*
5 *Canis familiaris molossus.*
6 The Kamtchadales.
7 Many of the North American Indians, Esquimaux, &c.

Amongst the birds there is one tribe peculiarly domesticated, which likewise is subject to numerous variations (it will be readily seen that I allude to our common poultry), but the differences that obtain in them are chiefly confined to their plumage; some are crowned with a tuft of feathers; others, as the Friesland-hen, have the feathers on their body recurved; another breed, as the rumplets, have no tail; the generality have their legs naked, but the bantams have them covered with feathers; and, to name no more, the silk-hens, instead of feathers, are clothed with a kind of silken hair.

We cannot state the object of all these differences, but probably it is connected with the climate and other circumstances of the country in which they were produced. India and its islands appears to be the metropolis of this valuable species of fowl, and the jungle fowl is supposed to be the original breed; but this is one of those animals which will live and thrive in every climate except the Polar; and when we consider the benefits we derive from them, we shall be disposed with grateful hearts to adore and glorify our Almighty benefactor, who fitted them, as well as so many other useful animals, to become, like ourelves, denizens of the whole earth. It is a remarkable circumstance, and worthy of particular attention, that the animals most subject to variation, are chiefly those which man has taken into alliance with him from their adaptation to his purposes. Now this tendency to vary multiplies their uses, or, at least, contributes to fit them for following him into different climates, enabling them to accommodate themselves gradually to any change of circumstances to which they may therein be exposed, without diminishing their utility.

Amongst the other races, especially the feline, this appears not to take place, at least only with respect to colour. The cat, though every where domesticated, exhibits no other differences than what obtain in the colour of her fur. If we recollect that this favourite quadruped is principally employed to destroy those minor animals that are noxious in and about our houses, to which indeed her instinct impels her, and that she is solely led by that instinct, and adds nothing to it from instruction, her sole savage object being, like that of her congeners, to seize and devour her prey; that she never assists man, like the dog, as the companion of his sports in various ways, but exercises her single function always in the same way, and under the same influence: if we further recollect that these are the general habits of the genus to which she belongs, which appear subject to very trival modifications from altered

circumstances, and that almost all animals that do not follow in the train of man are equally constant, we may hence infer that the Creator has not gifted them with the capability of improvement, and the developement of latent qualities not apparent in their wild state.

There is one circumstance, however, in which predaceous or carnivorous animals, when domesticated, show some aberration from their instinct, they do not refuse farinaceous food. The cat and the dog will both eat bread with great eagerness and thrive upon it.

It has been questioned by some whether the present races of animals have not all, in the lapse of ages, undergone some alterations from the primitive types. The only way by which this can be at all ascertained is by consulting the oldest descriptions of them, and the oldest sculptures; and these, I think, will prove that no such alteration has taken place.

In considering the general distribution of animals we may further remark that some are stationary, while others, at certain periods, migrate or shift their quarters from one climate or region to another.

In considering the former, I shall not here enlarge on the stations of the different tribes further than as they are connected with the great object, which it is my duty to illustrate. With respect to many it may be observed, that though perhaps widely dispersed, yet they have their metropolis.[1] Thus the gigantic whales, though they are sometimes found in low latitudes, not, however, within the tropics, yet their grand rendezvous is in the arctic and antarctic seas; furnishing a strong proof that in these they find the greatest supply of their appropriate food. The giant terrestrial Mammalia, on the contrary, confine themselves to intratropical regions, where the luxuriance of vegetation best corresponds with their enormous consumption of food. Amongst the birds the Vulture, though one species, the Lammer-Geyer,[2] comes as far north as the Swiss Alps, generally most abounds in hot climates, and is often of essential service in preventing the infection, likely to be produced by putrid animals; to these birds, our Saviour's words, doubtless, allude, "*Wheresoever the carcass is, there will the eagles be gathered together;*" the species he had in his eye, was probably the Egyptian Vulture,[3] the services of which in Egypt are strikingly described by Hasselquist. After noticing its disgusting appearance, he says: "Notwithstanding this, the inhabitants

1 *See Introd. to Ent.* iv. *Lett.* xlix.

2 *Vultur Barbatas*

3 *Vultur percnopterus*, L.

of Egypt cannot be enough thankful to Providence for this bird. All the places round Cairo are filled with the dead bodies of asses and camels; and thousands of these birds fly about and devour the carcasses, before they putrify, and fill the air with noxious exhalations." Belon observes, which proves their prevalence there, that in Palestine they devour an infinite number of mice, which would otherwise be a great pest. The cognate tribe, the eagles, though they are widely dispersed, have their metropolis in more northern climates, and are distinguished also from the vultures, by making living animals chiefly their prey: for this they are gifted with a wonderful acuteness of sight, and indomitable strength of wing, and of legs and talons, fitting them for astonishing velocity of flight, and for resistless force, when they attack and bear off their prey. As they have no scent, their eyes are of infinite use, and enable them to discern a small bird at an almost incredible distance: and often to get a clearer view and more extensive horizon, when they leave their mountain aeries, they ascend to a great height. M. Ramond, when he had ascended the highest peak of the Pyrenees, saw an eagle soaring above him, flying directly in the teeth of a violent south-wester, with inconceivable velocity.

Another genus of a tropical type, but not confined to the tropics, forming a striking contrast with the gigantic forms last adverted to, consists of the numerous species of the brilliant and diminutive Humming birds, which like the butterflies, whose analogues they are, suck the nectar of the flowers. This, strictly, American genus is in great force, also without the tropics, for they abound in Mexico, and go northward as far as Canada, and southward as far as Patagonia. There is no northern metropolis for any analogous form, to these living gems, which constitute the ornament and life of the new world. But the old shares with the new, in another beautiful type in the winged creation, I mean the Psittaceous or Parrot tribes, which chiefly support themselves upon fruits, and abound in all tropical countries, these the Creator has not only invested with the gayest colours and plumage, but gifted also with the power of speech, at least of imitating the speech of man, when brought into contact with him. Their principal residence is within the tropics, but not confined to them, as many are found in New Holland. The Aras[1] are confined to the new world, and one of its greatest ornaments; their plumage being the most brilliant of any of the Psittaceans.

An analogous tribe of mammiferous animals inhabits the

1 *Macrocercus.*

same station, and feeds on the same food with the parrots, these are what Zoologists call the Quadrumanes, or Four-handed beasts, from their often using their hind as well as their fore feet as hands, and many of them even their tail. This tribe includes the Monkeys, Apes, and Baboons, and though these do not imitate man, by catching his *phrases*, like the birds last named, yet they mimic all his *actions*. I have often thought, when I have examined figures of this tribe, that their features are typical of the different kinds of face observable in the human species: as far as relates to *body* they approach us, but in the *spiritual* part of our nature, elevated by high expectations, and by knowledge not confined to this globe on which we tread, but traversing the heavens, and penetrating in thought to the throne of Him who sitteth upon them, we infinitely exceed them.

Those animals that are of a predaceous or carnivorous character, are more widely dispersed, than many of the herbivorous ones, in fact they are co-extensive with their food, I do not mean specifically, but generically. Though the Lion and the Tiger, and the larger feline animals are generally tropical, yet the Cat is naturalized every where. Though the Hyæna and the Jackal shrink from the temperature of the greater part of Europe, yet Wolves and Foxes, as well as the great majority of the canine race, are found indigenous, or have been formerly indigenous, in almost every part of it.

Many more instances might be adduced proving that animals have been placed originally in certain stations, adapted to the habits resulting from their organization and general structure, from which some of them have sent forth their colonies far and wide, while others, owing to peculiarities in these respects, requiring a given temperature and kind of food, or to local obstacles stopping their further progress, have not wandered beyond certain limits.

Having, in the preceding pages, endeavoured to account for the dispersion and present stations of the various members of the animal kingdom at large, not to leave the subject incomplete, I must next make a few observations relative to that of the human race.

It has been a favourite theory of some modern physiologists that God "*hath* not *made of one blood all nations of men for to dwell on all the face of the earth*," but that there are different species of men as well as of animals: others, who do not go quite so far, suspect—that at the last great deluge, besides Noah and his family who were saved in the ark, some others

escaped from that sad catastrophe by taking refuge on some of the highest mountain ridges of Asia and Africa, and seem to insinuate that from these arose the three principal races, the Caucasian, the Mongol, and the Negro, that now hold possession of our globe.[1] I shall say something in controversion of each of these theories, beginning with the last.

This indeed furnishes a clue for its own refutation, since it admits *three* principal stems, which is in accordance with the Mosaic account, that from the families of the *three* sons of Noah, the nations were divided in the earth after the flood. The author of the above theory seems disposed to admit the truth of the Mosaic account, but insinuates that it may have been only intended to instruct the Israelites in the history of the race to which they belonged, while that of other races may have been passed over in silence. It is too much the fashion, in this sceptical age, to evade the facts that are most clearly revealed in Scripture, by saying the language must not be taken strictly nor interpreted literally, even when it is concerning events in which there is no room for metaphor. One would think that the terms in which God foretold the deluge were of this description. "*And behold I, even I, do bring a flood of waters upon the earth, to destroy* all flesh *wherein is the* breath of life *from under heaven; and* every thing *that is in the earth shall* die." And again—"*And the waters prevailed exceedingly upon the earth, and all the* high hills *that were under the* whole heaven *were covered: fifteen cubits* upwards *did the waters prevail, and the* mountains *were covered.*" It is also stated *that every living substance, both man and cattle,* &c., *was destroyed from the earth, and that Noah only remained alive, and they that were with him in the ark.* Can language be more definite and express?

What can be more absurd than that an ark should be necessary for the saving of Noah and his family, and a world of animals, to be stored with a vast supply of provisions, when they might have escaped according to this hypothesis by taking refuge on the summit of some lofty mountain to which Divine Wisdom might have directed them?

There is no occasion whatever for such a hypothesis to account for the dispersion of mankind and their breaking into nations. Two chapters in the book of Genesis[2] set the whole matter in a clear light, both as to the first cause of their separation, and the various tribes into which they separated, in which we can trace the names of many nations still in existence. From Babel each in due time took the course, in that direc-

1 Outlines of Hist. *Cab. Cycl.* ix. 4. 2 Chap. x. xi.

tion, however led by circumstances, that Providence had decreed. Europe became at last the head quarters of the descendants of Japhet, Asia of those of Shem, and Africa of those of Ham; the Shemites in the lapse of ages, passing over to America, were the progenitors of the red or copper race of that continent. Nor were there any insurmountable obstacles in the way to prevent the peopling of the globe from one common stock. Supposing Babel or Babylon to have been, so to speak, the centre of irradiation—how easy was the transit for Ham's descendants into Africa by the Isthmus of Suez; into Europe, the path was still more open for those of Japhet; and as the stream of population spread to the East, the passage to America was not difficult to those who had arrived at Behrings Straits. But in all these countries mixtures with the aborigines have probably taken place, either from the irruption and colonizations of great conquerors, the spread of commerce and similar causes, which naturally tend to produce variations in races from the primitive type. Hence writers on this subject now reckon six races distinguished by their colour, viz. a white race; a tawny race; a red race; a deep brown race; a brown-black race; and a black race.

This leads me to the other theory alluded to above, that there are different species of men as well as of other animals. The principal foundation upon which those naturalists have built their theory, that have adopted the opinion, that there are several distinct species of men originally created, is not only their colour, but likewise certain parts of their structure, which are found to vary in different races, such as the shape of the head; the prominence, more or less, of the jaws, producing different facial angles; the comparative length of some of the bones, and shape of the feet; the degradation of intellect; the peculiar acuteness of the senses; the tenacity of the memory; and, to name no more, the appropriation of a peculiar species of parasitic animal to a peculiar race.[1]

Various are the circumstances, which, in the progress of generations, tend to produce differences between the different races which are now found inhabiting our globe, without having recourse to a theory that boldly contradicts or nullifies the word of God; since the Scripture expressly declares, that God "*hath made of one blood all nations of men, for to dwell on all the face of the earth, and hath determined the times before appointed,*

1 See N. Dict. D'Hist. Nat. xv. 150, Article *Homme*. White's *Regular Gradation in Man*, &c. S. 2.

*and the bounds of their habitation.*" Climate, the elevation of country, its soil, waters, woods, and other peculiarities; the food, clothing, customs, habits, way of life, and state of civilization, often, of its inhabitants, produce effects upon the latter that are important and durable, and contribute to impress a peculiar character upon the different races of men as well as animals, that inhabit our globe, and will account for many distinctions, which indicate that such an individual belongs to such a people. But these circumstances will not explain and satisfactorily account for all the peculiar characters that distinguish nations from each other, without having recourse to the will of a governing and all-directing POWER, influencing circumstances that happen in the common course, and, according to the established laws of nature, to answer the purposes of his Providence. When he confounded the speech and language of the descendants of Noah, congregated at Babel, he first made a division of mankind into nations; "*And from thence did Jehovah scatter them abroad upon the face of all the earth.*" The same Divine Power that effected this distinction, which may be called the origin of nationality, also decreed that nations should be further separated by differences of form and colour, as well as speech, which differences originated not in any change operated miraculously, but produced by *second* causes, under the direction of the FIRST. When we are told expressly that "*The hairs of our head are all numbered,*" and that in God's "*Book all our members are written,*" we learn, what in common parlance we acknowledge, that it is according to God's will that we are made so and so. That persons, who, in some one or other of their parts and organs, exhibit an approximation to races different from that to which they belong, as thick lips, a prominent facial angle, a difference in the relative proportion of certain bones to each other, the curling of the hair, and the like, occur in all places, must be obvious to every one who uses his eyes and intellect. It is evident that all these variations are produced by circumstances that we cannot fully appreciate. Even in animals, there is as much difference in general characters between the Arabian steed of high blood, fine form, indomitable spirit, and winged speed, and the brewer's dray-horse, of a strikingly opposite character, as there is between the European high-bred gentleman and the African negro. The long-legged swine of France, though exhibiting such a marked difference in the relative length of some of their bones, are still the same species with the short-legged swine of England. The same argument is strengthened by the infinite varieties of the dog, the erect ears of the

tame, and recumbent ones of the wild horse.[1] It is evident, therefore, from fact and from what ordinarily happens, that there are powers at work at and after conception, and while the fœtus is in the womb, that can produce variations in the same people, approaching to those that distinguish the Negro, the red man, or the brown man; which, indeed, can produce forms much more singular and extraordinary; for instance, the monsters that sometimes make their appearance in the world, as the Siamese youths, children with two heads, &c. The mysterious influence that the excited imagination, or passions, or appetites of the mother, have over the fœtus in her womb, is well known, and produces very extraordinary consequences, and malformations, and monstrosities. When we consider that all these facilities, if I may so speak—these tendencies to produce variations in the fœtus, are at the disposal of Him, who upholds all things by the word of his power, and turns them to the fulfilment of his own purposes,—we may imagine that thus new types may be produced, which may be continued in the ordinary way of generation; according to that observation of Humboldt, that "The exclusion of all foreign mixtures contributes to perpetuate varieties, or aberrations from the common standard."[2] That what at first were family characters, accompany the race when grown into a nation, is evident from the case of the Jews, who, wherever dispersed, exhibit certain common characters by which they are every where known; and, with respect to complexion, they are said to vary according to the climates in which they reside. A singular exception to this is furnished by the black Jews of Malabar, mentioned by Dr Buchanan. At Cochin, he says, there are two classes of Jews, the white and the black Jews. The latter are supposed to have arrived in India soon after the Babylonian captivity; at least, they have that tradition amongst them, which seems confirmed by the fact that they have copies only of those books of the Old Testament which were written previously to the captivity. The white Jews emigrated from Europe to India in later ages. Now here is a singular fact, that in the lapse of so many ages a white or tawny race has become black. Mr White endeavours to account for such an aberration from his principle, that colour does not result from climate, by an observation not altogether founded in fact—namely, that the Jews have gained proselytes in every country in which they have resided, and, being at liberty to marry those proselytes, this would produce mixed breeds. But though

1 See above, p. 33.

2 Personal Travels, v. ii. 565.

the Jews, in our Saviour's time, would compass sea and land to gain one proselyte, this has not been their character since the destruction of Jerusalem, and we never hear now of their making proselytes. Indeed, these black Jews of Cochin seem to have been settled there long before any white ones came to that place.

With regard to the degradation of the intellect, and the peculiar acuteness of the senses or memory of certain races; these furnish no proof whatever of specific distinctions, or that they could not be descended from the common ancestor of our species.

Humboldt has an important observation which will explain how this might happen without having recourse to such a supposition. Speaking of the barbarism of certain tribes of Americans and Asiatics, he observes:—"The barbarism that prevails throughout these different regions is, perhaps, less owing to a primitive absence of all kind of civilization, than to the effects of a long degradation. The greater part of the hordes, which we designate under the name of savages, descend, probably, from nations more advanced in cultivation."[1] And in another place:—"If it be true that savages are for the most part degraded races, remnants escaped from a common shipwreck, as their languages, their cosmogonic fables, a crowd of other indications seem to prove."

Now, what is it that degrades man, and causes him to make an approach towards the brute? Setting up sense above reason and intellect; sight above faith; this world above the next. Experience teaches us, that those faculties of our nature that are most cultivated, become most acute: if intellectual pursuits are neglected, the intellect itself becomes weakened; in proportion as the senses are exercised, they are strengthened; in proportion as the pleasures they afford us stand high or low in our estimation, we graduate towards the brute, which knows no pleasures but those of sense, or towards the angel who knows no pleasures but what are spiritual. There is a governing principle in man,[2] originally enthroned in him by his Creator, and to whose sway the senses were originally in complete subjection. But when man fell, a struggle was generated, the lower or sensual part of his nature striving to gain the rule over him, and to dethrone the higher or intellectual. This is the "*law in our members warring against the law of our own mind*," mentioned by the Apostle. Now, we know that the same individual, at different periods of life, may be

1 *Personal Travels.* E. T. iii. 208. 2 Το ἡγεμονικον.

directed in his actions first by one and then by the other of these laws; he may begin in sense, and end in spirit, or vice versa. If the former takes place in him, his nature and character are elevated, and he is become more intellectual; if the latter, they are degraded, and he is become more sensual and nearer to a brute, and yet in both cases he remains the same man as before; his species is not altered. Apply this to nations, will it follow, because one is now generally gifted with a greater degree of intellect, and another remarkable for more acute sensation, that, therefore, they cannot be derived from a common origin? Nations are often led by custom as well as individuals; they, therefore, usually walk in the path that their ancestors have trod before them, and, from circumstances connected with this, it happens that some apply their faculties to higher pursuits than others. Those that chiefly cultivate the intellect improve it by that very act; while those who are principally engaged in pursuits that require the constant and skilful use of the organs of sensation acquire a degree of expertness in that use not to be met with in the others; but the intellect being employed only upon low objects, becomes habitually degraded, and loses all taste for things that are not visible and tangible. Though in an individual, or in a long succession of individuals, this might not produce a perceptible contraction and non-developement of the organ of the intellect, or in the chamber that contains it; yet, in the lapse of ages and generations, this effect would gradually be produced, for if an organ is not used for a long course of years, it becomes contracted, and from long habit unapt to perform its natural functions. Some American nations, by the application of boards properly shaped, depress the skull-bone of their infants, thinking a flat head a great beauty, whence the tribe is distinguished by the name of Pallotepallors, or Flat-heads. Others, by the same means, give them a conical form; there is no difficulty, therefore, in conceiving that with a gradual contraction of the brain, that of the skull might take place in the fœtus, which would accommodate one to the other. With regard to the memory, it is not wonderful that a being who occupies his time and intellect with few objects, should have a more distinct recollection of certain events, than one whose attention is more divided. It may be observed of the lower orders in general, that their memory, for the same reason, of matters within their own sphere of comprehension, is often more clear than that of persons better educated and informed.

I remember the case of a negro who resided near Bury St Edmunds, who was an educated man, and published a volume

of poems by subscription, which did him no discredit.[1] Hence, it is evident that there is a difference of capacity in negroes as well as whites, which admits of improvement from instruction and study, when they come among civilized people. Little stress will be laid on the parasite of the negroes,[2] being specifically distinct from that which infests the whites, when we reflect that the horse and the ox have different insect parasites and assailants in different climates. There is a time fixed upon in the divine counsels when the curse shall cease; and it will then be found that by reversing the course that has degraded so many nations, the apostacy, namely, from God to idolatries of the most debasing kind—which has yielded them up a prey to sensuality, clouded their understandings, and, instead of universal good-will, has taught them to regard those that are not of their own tribe or caste as objects of just hatred and injury—when this course has been reversed and they are brought back to God, which will take place in his time and at his word; and by the means and instruments that he empowers and commissions,[3] they will become more elevated in their character, and assume a higher rank among the nations: and they will make good their claim to the same inheritance with the other members of the Christian family. He who decreed the end, decrees also the means. *When the Lord gave the word, great was the company of those that published it.* This was the case at the first preaching of the Gospel, when the gross darkness of heathen idolatry covered the earth; this also was the case at what may be called its republication at the time of the Reformation, when the gross darkness of papal idolatry had almost put out the light of truth in the church; and so shall it be again, should another and perhaps last cloud of error envelope the world with darkness,[4] which seems even now beginning to gather, and may we not hope that it will be followed by that happy time, foretold by the prophet, when—*the knowledge of the Lord shall cover the earth as the waters cover the sea?* The old curse on Ham's offspring shall then cease, he shall no longer be a servant of servants to his brethren; then shall the curse also that has driven the children of Abraham after the flesh into every region of the globe, cease, and they shall look on him whom they pierced, and be restored to the favour of their God, and to their own land;[5] and next, in its own day,

1 He was called *Ignatius Sancho.*
2 *Pediculus Nigritarum.*
3 See Appendix, note 16.
4 See Appendix, note 17.
5 See Appendix, note 18.

the original curse, also pronounced upon Adam and his posterity shall be obliterated and done away for ever.

Taking all the circumstances I have noticed into consideration, I trust I have made it clear, that the variations observable in the different races of men are not of such a nature as to render it impossible, or improbable, that they should all have been derived from a common stock; and that the degradations observable in some of them, and approximation to the highest of the brutes, was caused not by the will and fiat of the Creator, but by their own wilful departure from him, and voluntary self-debasement. *Because they did not like to retain God in their knowledge, he gave them over to a reprobate mind to do those things that are not convenient:* further, that with respect to those characters, which distinguish one nation from another, they may be attributed to the action of physical causes directed by the Deity: who, to use the language of a pious and excellent poet,

> Lives through all life, extends through all extent,
> Spreads undivided, operates unspent.

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THERE is another interesting subject connected with the geography of animals, which may find its place here; a subject than which none shows more evidently or strikingly the hand of a beneficent and ever watchful Providence, holding the reins; and upon certain occasions and at certain seasons, directing various animals to change their quarters, and seek often in distant countries a more genial climate, in which they may give birth to their young, or find a better supply of food for their own support. I shall, therefore, now devote a few pages to the *migrations* of animals.

The most general principle that causes emigration is common to man and animals. When a country is over-peopled, and can no longer maintain its inhabitants, unless some means can be devised at home, by which the pressure may be lightened, and the suffering classes enabled to procure the necessaries of life, there must inevitably be some outbreak; when the rivers can no longer be contained within their natural channel they will overflow, and spread desolation around, till they have passed away and found a place in the great receptacle of waters. Thus, in ancient times, the great northern hive sent forth its numberless swarms, and overturned and divided amongst them a considerable portion of that mighty empire

which extended its iron sway over the fairest portion of the globe.[1]

With regard to their migrations, animals may be divided into two classes. The first will consist of those that migrate *casually*, under a certain pressure; and the second of those that migrate *periodically*, or at certain seasons.

1. Of the first description, are those infinite armies of Locusts, which, when they have laid bare one country, as an overshadowing and dark cloud pregnant with the wrath of heaven, pass on to another; mighty conquerors of old, of whom they were the symbols, from Sesostris to Sennacherib and Nebuchadnezzar, also mark their progress by devastation and ruin; to use the graphic language of the prophet—"*The land is as the garden of Eden before them, and behind them a desolate wilderness.*"[2]

This plague has generally been considered as belonging to the old world, in which they seldom exceed latitude 42°, but in North America, there is a species of Locust or Grass-hopper, as Dr Richardson informs me, according to the report of the Indians, becoming prevalent about once in twenty years, which committed great devastations at lord Selkirk's colony of Red river, as high as latitude 52°. They made their first appearance in vast flights coming from the plains to the westward, and soon destroyed the crops of grain, and every thing green. They re-appeared for three or four successive summers, each year in smaller numbers, and now for several years they have not been seen.

These were evidently insects of the same order and tribe with the locust, though perhaps of a different genus; but, probably the tradition of the Indians might relate to another North American devastator, which is also called there the Locust, but belongs to a genus beloved by the Greeks for its song, and hated by the less imaginative Romans for its stunning noise, which may be called the Tree Locust; a species of which is said to appear, about once in every seventeen years,[3] in such prodigious numbers as to do incalculable damage to the fruit and forest trees, in which it deposits its eggs, and upon which it feeds internally in the grub state, but the oral organs of the perfect insect are only calculated for suction.

Amongst quadrupeds, the analogues, in some respects, of the locusts, are the *Lemmings*, a kind of mouse or rat. These little

1 See Appendix, note 19.

2 See on the Locusts *Introd. to Ent.* 1 Lett. vii.

3 *Cicada septendecim.*—L.

animals, which usually inhabit the mountains of Norway and Lapland, in certain seasons, emigrate in prodigious numbers to the south; the most common species[1] is said not to lay up any winter store, but to form burrows under ground in summer, and under the snow in winter in search of food; but that found in Kamtschatka,[2] which is larger than a rat, is stated to be occupied during the summer in laying up provisions for the winter in holes under the turf divided into compartments, they consist of various kinds of roots, some even poisonous, but which agree with this animal, and of which it collects from twenty to thirty pounds. It is called in Kamtschatka Tegulchitch. In fine weather its instinct teaches it to spread its harvest of roots in the sun to dry and fit them for keeping. When these different species of Lemmings make their excursions, which take place only in certain years and seasons, and in different directions, the species last mentioned going towards the west, the others towards the south, like certain ants, they always march straight forward, neither turning to the right hand nor to the left, and if their course is interrupted by a river, they cross it by swimming. The common Lemmings, when they migrate, are regarded as a terrible scourge; they devastate the fields and gardens, ruin the harvest, and only what is kept in the houses escapes them, into these happily they never enter. Their number is so prodigious, that, when they die, the air is infected, and much sickness is the consequence. All this tribe of mice appear to live on roots, bulbs, grain, nuts, &c. and have generally a very short tail.

The Campagnol,[3] or short-tailed rat of Pennant, is equally destructive; in some years their numbers are so prodigious, that they overflow, as it were, a whole district, and by their ravages produce famine and desolation. This effect is stated to have been produced in certain parts of France where an extent of forty square leagues was devastated by them. In their progress these animals are preyed upon by the predaceous quadrupeds and birds, by whose incessant attacks their numbers, in ordinary seasons, are kept within the bounds assigned them by the Creator, as are the Locusts by the Locust-eating Thrush,[4] and the Aphides or Plant-lice which may be denominated the Locusts of Britain, and which are stated sometimes almost to darken the air, by the ladybirds and aphidivorous flies.

All these migrations are produced by a different cause from

1 *Lemmus vulgaris.*
2 *Lemmus œconomus.*
3 *Arvicola arvalis.*
4 *Turdus gryllivorus.*

those periodical ones which take place, after certain intervals, or at certain seasons, in various other animals of every grade; and though a scarcity of food, or straitened circumstances or accommodations may be the impelling motives, yet these are produced by an unusual increase in the numbers of the migrating species, so that they are driven to seek an outlet by which their supernumeraries may pass off and relieve them from the pressure, or the whole population, deserting an exhausted country, may establish themselves in better quarters.

In all the instances that I have here adduced, the object, at the first blush, as far as the Deity may be supposed to be concerned in these outbreaks, appears rather punitive than beneficent, but when we dip below the surface, and look to ultimate consequences, what appears to be altogether an evil, instead of a dark side, turns round and shows one bright with good. It is true, in some cases, the object is punishment of an offender, and in hopeless cases, the sentence is pronounced, "*Cut it down, why cumbereth it the ground.*" But before this, Divine Mercy, which willeth not that any should perish, employs those correctives, which at the same time that they give pain, and wear the appearance of evil and punishment, tend to produce that change of the mind and conversion of the heart, that will reconcile the sinner to God, and ensure to him the blessed inheritance of his children. But temporal good, as well as spiritual, is often the result of these visitations, the devastations of which they are the instruments, as was observed by Sparrman of the locusts, are often followed by fertility, and the fearful scourge is replaced by Amalthea's horn.

2. We are next to consider those migrations that take place periodically, and usually at certain seasons of every year; the general intention of which appears to be a supply of food, and often a temperature best suited to reproduction. Providence, in this, taking care that their instincts shall stimulate them to change their quarters, when these two objects can be answered at the same time, and by a single removal.

In North America, that ferocious and lion-like animal, the *Bison*,[1] called there the *Buffalo*, forms regular migrations, in immense herds, from north to south, and from the mountains to the plains, and after a certain period returns back again. Salt-springs, usually called salt-licks or salines, found in a clay, compact enough for potter's clay, are much frequented by these animals, whence they are called Buffalo salt-licks. Dr Richardson informs me that the periodical movements of

1 *Bos Americanus.*

these animals are regulated almost solely by the pastures: when a fire has spread over the prairies, it is succeeded by a fine growth of tender grass, which they are sure to visit. How the Bison discovers that this has taken place seems not easily accounted for; perhaps stragglers from the great herds, when food grows scarce, may be instrumental to this.

The Musk Ox, a ruminating animal between the ox and sheep,[1] has the same habit, extending its migratory movements as far as Melville, and other islands of the Polar sea, where it arrives about the middle of May, and going southward towards the end of September, where it has been seen as low as lat. 67° N., which, as Dr Richardson states, approaches the northern limit of the Bison: its food, like that of the Rein-deer, called in North America the Caribou, is grass in the summer and lichens in the winter. Its hair is very long, and, as well as that of the Bison, which has been manufactured both in England and America into cloth, might be woven into useful articles. This animal inhabits strictly the country of the Esquimaux, and may be regarded as the gift of a kind Providence to that people, who call it *Oomingmak*, and not only eat its flesh but also the contents of its stomach, as well as those of the Rein-deer, which they call Norrooks, which consisting of lichens and other vegetable substances, as Dr Richardson remarks, are more easily digested by the human stomach when they are mixed with the salivary and gastric juices of a ruminating animal.

The wild Rein-deer in North America, in the summer, as the excellent man and author lately mentioned states, seek the coast of the Arctic seas: it is singular that the females, driven from the woods by the musquitoes, migrate thither before the males, generally in the month of May (some say in April and March), while the latter do not begin their march till towards the end of June. At this time the sun has dried up the lichens on the Barren Grounds, and the moist pastures in the valleys of the coast and islands of the above seas afford them sufficient food. Soon after their arrival the females drop their young. They commence their return to the south in September, and reach the vicinity of the woods towards the end of October. After the rutting season, which takes place in September, the males and females live separately; the former retire deeper into the woods, while the pregnant herds of the latter remain in the skirts of the Barren Grounds, which abound in the rein-deer[2] and other lichens. In the woods, they feed on lichens which hang from the trees, and on the long

1 *Ovibos moschatus.* 2 *Cenomyce rangiferina.* Achar.

grass of the swamps. The males do not usually go so far north as the females. Columns, consisting of eight or ten thousand of these *Caribous*, so numerous are they in North America, may be seen annually passing from north to south in the spring, infested and attacked in their progress by numbers of wolves, foxes, and other predaceous quadrupeds, which attack and devour the stragglers.

The *Pronged-horned Antelope*,[1] as well as the Rein-deer, appears to go northward in the summer, and return to the south in the winter.

Dr Richardson remarks to me in a letter,—"The Musk-ox and Rein-deer feed chiefly on lichens, and therefore frequent the Barren Lands and primitive rocks, which are clothed with these plants. They resort in winter, when the snow is deep, to the skirts of the woods, and feed on the lichens which hang from the trees, but on every favourable change of weather they return to the Barren Grounds. In summer they migrate to the moist pastures on the sea-coast, and eat grass, because the lichens on the Barren Lands are then parched by the drought, and too hard to be eaten. The young grass is, I suppose, better fitted for the fawns, which are dropped about the time the deer reach the coast." In all this we see the hand of Providence directing them to those places where the necessary sustenance my be had.

The same gentleman has remarked a singular circumstance with regard to the American Black Bear.[2] In general, this species hybernates in the northern parts of the fur countries; but it has been observed in certain years, and very severe winters, that great numbers enter the United States from the northward. These were all lean, and generally males. The natives assert, that a bear that is not fat cannot hybernate; therefore, those that have not acquired sufficient fat when winter overtakes them, necessarily emigrate to a milder climate.[3]

A migration of an animal of the *equine* genus was observed by Mr. Campbell in South Africa. The *Quagga*, a kind of wild ass, travels in bands of two or three hundred, in winter, from the tropics southward to a district, in the vicinity of the Malalaveen river, reported to be warmer than within the tropic of Capricorn, when the sun has retired to the northern hemisphere. They stay here for two or three months, which is called the Bushmen's harvest. The lions, who follow the

1 *Antilope furcata.* 2 *Ursus Americanus.*
3 *Faun. Boreal-americ.* i. 16.

quaggas, are the chief butchers. During this season, the first thing the bushman does, when he awakes, is to see whether he can spy any vultures hovering in the heavens at a great height; under them he is sure to find a quagga, which a lion has slaughtered in the night.

But the animals which are most noted for their migrations, from a cold to a warm climate, and *vice versa*, are the *birds*, which, as having dominion in the air, are enabled to transport themselves with greater ease, and with the interposition of fewer obstacles, than the quadrupeds, the theatre of whose motions is the earth, intersected by rivers and mountain ridges, which renders their periodical transit less easy to accomplish. The number of birds that migrate, if we take Dr Richardson's scale, for those of North America, as a rule, compared with those that reside the whole year in a country, is about five-sixths, a very large proportion; but as the summer residents are replaced by winter ones, the difference is less striking, and the desertion less apparent and annoying. The celebrated Dr Jenner, in a very ingenious posthumous paper, in the Philosophical Transactions for 1824, has produced many arguments to prove that the periodical migrations of birds are the result, not of the approach of the cold or hot seasons, but of the absence or presence of a stimulus connected with the original law, "*Increase and multiply*." That when they feel it they seek their *summer*, and when it ceases its action, their *winter* quarters. In one case, the animal winging its way to a climate and country best suited to the great purpose impressed upon it by its Creator, of producing and rearing a progeny; and in the other returning to a home, most congenial to its nature, and best supplying its wants.

The cause of emigration, in both cases, had previously been attributed to the changes of the temperature gradually produced by the change of seasons, and the growing scarcity of food resulting from it. But Mr Jenner has observed that these cannot be the causes that occasion the migration of those birds that leave us early in the year, as the cuckoo,[1] which disappears in the beginning of July; and the swift,[2] which takes its departure early in the following month. At these times they can feel no cold blast to benumb them, and the food that forms their usual support is in the greatest abundance.

There seems to be some analogy between the birds that migrate annually to warmer climates to spend their winter,

1 *Cuculus canorus.* 2 *Cypselus apus.*

and those animals, which remaining in a country, seek a subterranean, or other close retreat, to shelter them from the rigours of that season, and in which they continue in a torpid state, till spring revives them and they issue from their hiding-places to fulfil the first law of their Creator. Several instances also are upon record, even with regard to birds that usually migrate, of their having been found torpid in the clefts and cavities of trees; and Spallanzani relates experiments which prove that swallows can bear a certain degree of cold when torpid. I do not recollect any observations which serve to prove that hybernating animals are regulated by the temperature as to the season at which they prepare to retire for the winter, except as to insects, which, with few exceptions, are of that description. My learned coadjutor, Mr Spence, in our *Introduction to Entomology*, has some remarks on this subject, which seem, at first sight, to prove that the disappearance of insects, at least those of the *Coleoptera* order or beetles, is not preceded by any remarkable lowering of the temperature; on the contrary, he observed a great number of various genera congregating with this view when the thermometer was fifty-eight degrees in the shade.[1] This was about the middle of October. But there is one circumstance to which he has not adverted, which may tend to reconcile this fact with the received opinion. The nights, at this time of the year are often cold when the days are hot, the latter also are much shortened and the former lengthened, so that the sum-total of heat received from the sun is very much diminished, which may be the exciting cause of their hybernating at this time, when the diurnal temperature is so considerable.

With regard to the *swift*, these birds seem to avoid heat, they lie by in the middle of the day, and only appear in the morning and evening. Their early migration from this country may probably be caused by the heat; and Buffon says that instead of warmer, they seek colder climates. The house-swallow,[2] which remains with us till October, is stated to winter in Africa, so that its object is evidently a warmer climate. It is remarkable that the birds of this tribe, when they visit us in the spring, return to their old haunts. Dr Jenner ascertained this by cutting off two claws from the foot of a certain number, several of which were found in the following year, and one was met with after the expiration of seven. The instinct that directs these little beings so unerringly across continents and oceans, and leads them to their native clime is wonderful, and

1 *Introd. to Ent.* ii. 433.

2 *Hirundo rustica.*

inexplicable under any other principle than that of Divine superintendence. But upon this I shall have occasion to enlarge hereafter.

From what is here stated, it seems most probable, that it is not only the increasing heat of the southern regions which induces the *swallow* to seek a less ardent clime to transact her loves and rear her young; but also a stimulus, caused by the heat, acting upon her organization, which aids to accomplish that important purpose, and is the leading star by which her Creator impels her to the land of her own nativity, and which is destined to be that of her offspring. Only the swift leaves a colder climate for one more genial and better suited to the same purpose, and both return from whence they came, when the errand of their voyage is fully accomplished. One sent away by too great heat, and the other by a gradual decreement of the amount of heat, and also of their customary food.

Vieillot says, that all the swallows do not quit the warm countries to which they betake themselves in winter—that one part migrates, while another remains stationary, during the whole year, in Egypt, Ethiopia, and other tropical countries and islands.

But, besides the insectivorous emigrators, many of the higher and more powerful tribes are accustomed to change one country for another. When the carcasses of animals putrify, and birds multiply under the influence of the northern sun, vultures, eagles, falcons, hawks, &c. leave the south and go to partake of the feasts provided for them in higher latitudes.

But, besides the birds that visit us during the more genial part of the year, and add so greatly to the beauty and music of our groves in spring and summer, there are others, and those a numerous tribe, that wing hither their way when the reign of winter has commenced. The most numerous of these are the birds which the Author of nature has fitted to disport themselves and seek their food in the water, or which frequent humid and watery places. When the Arctic seas, and lakes, and rivers, present an unbroken field of impenetrable ice, the various web-footed birds, the swans[1] and geese[2], and ducks[3] and divers,[4] and coots,[5] and an infinity of others, forming their angular and sometimes triangular phalanxes, each in turn taking the lead and first cutting the air,[6] fly off, often at a great height, to seek in more southern climates, not a region devoid

1 *Cycnus.*
2 *Anser.*
3 *Anas.*
4 *Mergus* and *Colymbus.*
5 *Fulica.*
6 N. Dict. D'Hist. Nat. xx. 544.

of the usual concomitants of winter, frost and snow, but where their rigours are mitigated, so as to afford to these creatures the means of life. Now, also the waders, usually distinguished by their long legs and long beaks, as the woodcock,[1] the curlew, and the snipes,[2] leave their native marshes and haunts to seek others whose unfrozen or partially frozen morasses afford them a supply of the worms and vermicles or similar animals that form their usual nutriment. Many a time, when a boy, I have pursued the field-fare,[3] which is one of our winter guests, from tree to tree, without its affording me an opportunity of taking aim at it, as if it was aware of my purpose, and could smell the contents of my musket; no sooner did I get within a couple of hundred yards, than, with all its company, it flew a little further, and thus kept tantalizing me for hours, without my even being able to secure one. These birds, if the weather becomes very severe here, are said to fly further south in search of food, and to return again.

Thus, we see the change of seasons brings with it a change in the winged inhabitants of every country; and the winter immigration of a vast variety of birds, fit for food and other useful purposes, makes up in some degree for the summer or autumnal emigration of those, which being constantly before our eyes moving in every direction, and rendering vocal every grove or tree and even the very heavens, entertain our senses of seeing and hearing in a most delightful manner. Thus, also, all countries partake in some degree, by this shifting scene of animal life, of the same blessings and pleasures derived from the same instruments.

Though the production and rearing of their young forms a principal feature in most of the migrations before noticed, yet it is most prominent and conspicuous in the animals, whose annual motions I shall next advert to. And here mankind is more conspicuously indebted to the fatherly care and bounty of a beneficent Providence for a supply of their wants, than in any of the cases above detailed; which most of them minister to our pleasures, rather than our sustenance. *When the time of the singing birds is come, and the voice of the* nightingale *is heard in our land;* when the swallow and the swift delight us by their rapid and varied motions, now skimming the surface of the waters, now darting, either aloft or with more humble flight over the earth; when the carolling lark ascends towards

1 *Rusticola vulgaris* Vieill. *Numenius arquatus.*—Lath.
2 *Scolopax Gallinago and Gallinula.* 3 *Turdus pilaris*

heaven, teaching us to look up and learn from her where to direct the best affections of our hearts; these all excite in us delightful sensations, and merit our grateful acknowledgment, but still they contribute little or nothing to the means of life. The locusts indeed, who headed the list of emigrators, at the same time that they lay waste a country, supply its inhabitants with food, and thus make some recompense for their ravages; and a considerable proportion of the winter birds mentioned under the last head, as the swimmers[1] and the waders,[2] furnish our tables with dainty meats; but they come not in such numbers as to add materially to the general stock of food, or to contribute to the maintenance of the poor, as well as to the enjoyments of the rich. The animals I allude to under the present head, form the sole food of some nations, and contribute a vast and cheap supply, that covers the table of the poor man with plenty. The migrating *fishes* are one of the greatest and most invaluable gifts of the Creator to his creature man, by which thousands and thousands support themselves, and their families; and which, at certain periods, form the food of millions. Of the proceedings of the principal of these fishes, I shall now give a brief account.

I begin with one of the *cartilaginous* fishes—the *Sturgeon.* There are two noted species of this fish, which is related to the shark, the one is called the sturgeon[3] by way of eminence, and the other the huso.[4] The latter is found only in the Caspian and Black seas, and the Don, the Volga, and other rivers that flow into them. It is stated to be much larger than the sturgeon: Pallas describes one that weighed 2800 pounds, which it is conjectured must have been nearly forty feet long. Its ordinary length is stated to be twenty-five feet, which is the maximum of the sturgeon. The numbers of this species far exceed those of the latter, the caviar is usually made of its spawn, which equals nearly a third of the weight of the whole fish, from whence we may conjecture the infinite number of eggs that it contains. Professor Pallas gives a very interesting history of the manner in which these enormous fish are taken in the Volga, and the Saiek, which discharge their waters into the Caspian. And it seems really wonderful that so wild and illiterate a people as the Tartars, who have no acquaintance with the arts and sciences, should on this occasion, show as much genius and invention as the most enlightened nations. The huso enters the rivers to spawn earlier than the sturgeon.

1 *Natatores.* 2 *Grallatores.*
3 *Accipenser Sturio.* 4 *A. Huso.*

generally about mid-winter, when they are still covered with ice. At this time the natives construct dikes across the rivers in certain parts, formed with piles, leaving no interval that the huso can pass through ; in the centre of the dike is an angle opening to the current, which consequently is an entering angle to the fish ascending the stream ; at the summit of this angle is an opening, which leads into a kind of chamber formed with cord, or osier hurdles, according to the season of the year. Above the opening is a kind of scaffold, and a little cabin, where the fishermen can retire and warm themselves or repose, when they are not wanted abroad. No sooner is the huso entered into the chamber, which is known by the motion of the water, than the fishermen on the scaffold let fall a door, which prevents its return to seaward, they then by means of ropes and pullies lift the movable bottom of the chamber, and easily secure the fish.

Gmelin has related, in a very lively way, the solemn fishing which takes place at the beginning of winter, in the neighbourhood of Astracan, when these fish have retired into vast caves under the seashore, which form their winter quarters. A great number of fishermen assemble, over whom are placed a director and inspectors, who possess considerable authority and influence ; every kind of fishing is prohibited, in the places known to be the haunt of the husos ; a numerous flotilla of boats are in readiness ; every thing is prepared as it were for an important military operation ; all approach in concert and with regular manœuvres the asylum in which the fish are concealed, the slightest noise is severely interdicted, so that the most profound silence every where prevails. In an instant, at a given signal, a universal shout rends the heavens, which echo multiplies on every side. The astonished husos, in the greatest alarm, rush from their hiding places, and are taken in nets of every kind, prepared to intercept them.

The huso fishery is of great importance, principally on account of the caviar prepared from the roe of these fishes, and the isinglass that is made from their air-vessel. The former is much in demand amongst many nations, as the Russians, Turks, &c.; the Greeks particularly make it almost their sole food during their long fasts, and the latter is almost universally an article of commerce. The common sturgeon furnishes the same articles, as do other fishes also.

The next kind of fishes that migrate for the purpose of spawning, which I shall notice, is one, which though it falls far behind the sturgeons in size, exceeds them infinitely in numbers and dispersion, and in the vast supply of food with which it

furnishes the human race; it will readily be seen that I am speaking of the *Codfish.*[1] This valuable animal belongs to the class of fishes with a bony skeleton, and the tribe of *Jugulars*, or those whose ventral fins are nearer the mouth than the pectoral. It frequents shallows and sandbanks, between the fortieth and sixtieth degrees of North Latitude, both in the Atlantic and Pacific Oceans, where it is taken in infinite numbers. The fishery for it employs both European and American seamen and vessels in abundance. The most celebrated is that on the great bank of Newfoundland, where thousands of men are employed in catching, salting, and barrelling these fish, and whence they are dispersed principally into the Catholic countries, where they form a considerable portion of the food of the people, especially during lent and other fasts.

The cod-fish makes for the coast at spawning time, going northward, this takes place towards the end of winter, or the beginning of spring. Leeuwenhoek counted more than nine millions of eggs in a cod-fish of the middle size; allowing for a large consumption by other fishes which devour them, still enough are left, that when hatched produce a superabundant supply. They are deposited in the inequalities of the bottom amongst the stones.

The *Haddock*[2] is another species belonging to this genus, which frequents our coast in great numbers in mid-winter; they are stated sometimes to form a bank twenty-four miles long by three broad. They pursue and devour the herrings, and are themselves in their turn devoured by Sharks, which follow their shoals.

The next tribe of migratory fishes is one which supplies our tables with a very acceptable successor, when the codfish is out of season, and which at last usually becomes so plentiful and cheap as to form a part of the poor man's bill of fare, as well as of that of his rich neighbour. Every one will see that I here allude to the *Mackarel.*[3] This is one of the *thoracic* fishes, or those whose ventral fins are situated below the pectoral. It is very widely dispersed, being found in the Arctic, Antarctic, and Mediterranean Seas, as well as in the Atlantic Ocean. It hybernates in the seas first mentioned, where it is stated to select certain depths of the sea called by the natives Barachouas, which are so land-locked, that the water is as calm at all times, as in the most sheltered pools; the depth of these asylums diminishes in proportion to the proximity of the shore, and the

1 *Gadus Morhua.*
2 *Gadus Œgelfinus.*
3 *Scomber Scombrus.*

bottom is generally muddy and covered with marine plants. It is in these muddy bottoms that the mackarel, directed by their instinct, pass the winter. They plunge their head and the anterior part of their body in the mud, keeping their tails elevated vertically above it. In the spring they emerge, in infinite shoals from their hiding places, and proceed southward for the purposes of depositing their eggs in more genial seas; more than half a million of these have been discovered in a single female.[1] These fish die as soon as they are taken out of the water, and then they emit a phosphoric light. The *Scomber* is one of the fishes, which, according to Pliny, was used for making the celebrated Roman pickle named *Garum*, and he calls it a fish good for nothing else; if he means our mackarel, it is singular that its value, as an article of food, should not have been discovered. The *Garus* or *Garum* derived its name from a crustaceous animal so called, from which it was sometimes made. Apicius is said by Pliny to have employed the liver of the mullet in concocting it.

What the mackarel is to the north of Europe, the *Thunny* is to the south. It deposits its eggs in May and June, when it enters the Mediterranean, seeking the shores in shoals arranged in the form of a parallelogram, or as some say, a triangle, and making a great noise and stir. They appear to have been much in request with the Greeks and Romans, and are now an important article of food with the inhabitants of the coasts and islands of the Mediterranean.

But no fish is so important a gift of Heaven, as affording employment to a large number of individuals both in the catching and preparing it, and as adding very largely to the general stock of food, especially in Catholic countries, as that of whose history I shall next give a brief sketch.

Three thousand decked vessels, of different sizes, besides smaller boats, are stated to be annually employed in the herring-fishery, with a proportionable number of seamen, besides a vast number of hands that, at certain seasons, are occupied in curing them.

The *herring* to which I now allude belongs to the tribe called *abdominal* fishes, or those whose ventral fins are behind the pectoral, and may be said to inhabit the arctic seas of Europe, Asia, and America, from whence they annually migrate, at different times, in search of food and to deposit their spawn. Their shoals consist of millions of myriads, and are many leagues in width, many fathoms in thickness, and so dense

1 *Scomber Thynnus.*

that the fishes touch each other; they are preceded, at the interval of some days, by insulated males. The largest and strongest are said to lead the shoals, which seem to move in a certain order, and to divide into bands as they proceed, visiting the shores of various islands and countries, and enriching their inhabitants. Their presence and progress are usually indicated by various sea-birds, sharks, and other enemies. One of the cartilaginous fishes, the sea-ape,[1] is said to accompany them constantly, and is thence called the king of the herrings. They throw off also a kind of oily or slimy substance, which extends over their columns, and is easily seen in calm weather. This substance, in gloomy still nights, exhibits a phosphoric light, as if a cloth, a little luminous, was spread over the sea.

Some conjecture may be formed of the infinite numbers of these invaluable fishes that are taken by European nations from what Lacepede relates—that in Norway twenty millions have been taken at a single fishing, that there are few years that they do not capture four hundred millions, and that at Gottenburgh and its vicinity seven hundred millions are annually taken; "but what are these millions," he remarks, "to the incredible numbers that go to the share of the English, Dutch, and other European nations."

Migrations of these fishes are stated to take place at three different times. The first when the ice begins to melt, which continues to the end of June; then succeeds that of the summer, followed by the autumnal one, which lasts till the middle of September. They seek places for spawning, where stones and marine plants abound, against which they rub themselves alternately on each side, all the while moving their fins with great rapidity. According to Lacepede, William Deukelzoon, a fisherman of Biervliet, in Dutch Flanders, was the first person who salted herrings, this was before the end of the fourteenth century; others attribute this invention to William Benckels or Benkelings of Bierulin. To show his sense of the importance of this invention, the Emperor Charles V. is stated to have visited his tomb, and to have eaten a herring upon his grave. The smoking of this valuable fish, we are told, was first practised by the inhabitants of Dieppe in Normandy.

Next to the herring, the pilchard[2] is valuable to our own country, especially to the inhabitants of Cornwall and Devonshire, to whom this fish is as important as the herring to other parts of the kingdom; they frequent the southern coasts from the middle of summer to the end of autumn, and many thou-

1 *Chimæra monstrosa.* 2 *Clupanodon Pilcardus.*

sand barrels are annually cured. Lacepede says that, in one year, a milliard[1] of these fishes has been taken.

The sprat[2] and the anchovy,[3] are two other fishes of the present tribe, the former, at certain seasons, furnishing a considerable supply of food to the lower orders, and also a fertilizing kind of manure to the farmer and hop-grower, though, it must be confessed, very annoying to the traveller passing through a country where it is so employed, by its disagreeable stench, and to those who inhabit it by its putrid effluvia, which I have known to produce fevers; the other ministering to the enjoyment and luxury of the wealthy by its piquancy when pickled, or reduced to an essence; but on these I shall not further enlarge.

The next tribe of migratory fishes is one whose several species are intermediate between marine and fresh-water fishes, roving indifferently in the sea, and rivers, and lakes, and thus is fitted by Providence to make up to the inhabitants of inland countries their distance from the other migrators, by a supply brought, as it were, to their very doors. The fishes in question belong also to the abdominal class, and form the salmon genus, including the salmon,[4] the salmon-trout,[5] the trout,[6] the grayling,[7] the charr,[8] the smelt,[9] the hucho,[10] and many other species. I shall, however, confine my observations principally to the king, as it may be called, of the river migrators,—the *Salmon.* In our own country this noble fish is too high-priced to form a general article of food, and may be reckoned amongst the luxuries of the rich man's table; but in others, especially amongst some of the North-western American tribes, they are gifts of Providence, which form their principal food at all seasons. One, which Sir George Mackenzie fell in with, in his journey from Canada to the Pacific, were perfect Ichthyophagites, and would touch no other animal food. These people construct, with great labour and ingenuity, across their streams, salmon weirs, which are formed with timber and gravel, and elevated nearly four feet above the level of the water; beneath machines are placed, into which the salmon fall when they attempt to leap over the weir. On either side is a large frame of timber-work, six feet above the level of the upper water, in which passages are left for the salmon, leading into the ma-

1 One thousand million.
2 *Clupea Sprattus.*
3 *C. encrasicolus.*
4 *Salmo Salar.*
5 *S. Trutta.*
6 *S. Fario.*
7 *S. Thymallus.*
8 *S. Alpinus.*
9 *S. Eperlanus.*
10 *S. Hucho.*

chines. When they catch their salmon they string them and suspend them, at first, in the river. The women are employed in preparing and curing these fish; for this purpose they appear to roast them first, and then suspend them on the poles that run along the beams of their houses, in which there are usually from three to five hearths, the heat and smoke from which contribute, no doubt, to their proper curing.

The salmon, indeed, frequents every sea, the arctic as well as the equatorial; it is found even in great lakes and inland seas, as the Caspian, into which it is even affirmed to make its way by a subterranean channel from the Persian Gulf—it goes as far south as New Holland and the Australian seas; but, it is said never to have been found in the Mediterranean, and appears to have been unknown to Aristotle. Pliny mentions it as a river fish, preferred to all marine ones by the inhabitants of Gaul. It traverses the whole length of the largest rivers. It reaches Bohemia by the Elbe, Switzerland by the Rhine, and the Cordilleras of America by the mighty Maragnon, or River of Amazons, whose course is more than three thousand miles. In temperate climates the salmon quits the sea early in the spring, when the waves are driven by a strong wind against the river currents. It enters the rivers of France in the beginning of the autumn, in September; and in Kamtschatka and North America still later. In some countries this is called the salmon wind. They rush into rivers that are freest from ice, or where they are carried by the highest tide, favoured by the wind; they prefer those streams that are most shaded. They leave the sea in numerous bands, formed with great regularity. The largest individual, which is usually a female, takes the lead, and is followed by others of the same sex, two and two, each pair being at the distance of from three to six feet from the preceding one; next come the old, and after them the young males in the same order.

The noise they make in their transit, heard from a distance, sounds like a far off storm. In the heat of the sun and in tempests, they keep near the bottom; at other times they swim a little below the surface. In fair weather they move slowly, sporting as they go at the surface, and wandering again and again from their direct route; but when alarmed they dart forward with such rapidity that the eye can scarcely follow them. They employ only three months in ascending to the sources of the Maragnon, the current of which is remarkably rapid, which is at the rate of nearly forty miles a day; in a smooth stream or lake, their progress would increase in a fourfold ratio. Their tail is a very powerful organ, and its muscles have wonderful energy; by placing it in their mouth they

make of it a very elastic spring, for letting it go with violence they raise themselves in the air to the height of from twelve to fifteen feet, and so clear the cataract that impedes their course; if they fail in their first attempt, they continue their efforts till they have accomplished it. The female is stated to hollow out a long and deep excavation in the gravelly bed of the river to receive her spawn, and when deposited to cover it up, but this admits of some doubt.

Amongst the migrations of fishes, I must not neglect those that take place in consequence of the water in the ponds or pools that they inhabit being dried up: some of these are very extraordinary, and prove that when the Creator gave being to these animals, he foresaw the circumstances in which they would be placed, and mercifully provided them with means of escape from dangers to which they were necessarily exposed.

In very dry summers, the fishes that inhabit the above situations, are reduced often to the last extremities, and endeavour to relieve themselves by plunging, first their heads, and afterwards their whole bodies, in the mud to a considerable depth; and so, though many in such seasons perish, some are preserved till a rainy one again supplies them with the element so indispensable to their life. Carp, it is known, may be kept and fed a very long time in nets in a damp cellar, a faculty which fits them for retaining their vitality when they bury themselves at such a depth as to shelter them from the heat.

But others, when reduced to this extremity, desert their native pool, and travel in search of another that is better supplied with water. This has long been known of eels, which wind, by night, through the grass in search of water, when so circumstanced. Dr Hancock, in the Zoological Journal, gives an account of a species of fish, called, by the Indians, the Flathead Hassar, and belonging to a genus[1] of the family of the Siluridans, which is instructed by its Creator, when the pools, in which they commonly reside, in very dry seasons, lose their water, to take the resolution of marching by land in search of others in which the water is not evaporated. These fish grow to about the length of a foot, and travel in large droves with this view; they move by night, and their motion is said to be like that of the two-footed lizard.[2] A strong serrated arm constitutes the first ray of its pectoral fin.[3] Using this as a kind

1 *Doras.* 2 *Bipes.*

3 Plate XII. Fig. 1. is a species of *Callicthys*, a fish of the same habits with the *Doras*. Fig. 2. is the pectoral ray of another Siluridan, which was dug up in a village near Barham, but which is not a fossil bone

of foot, it should seem, they push themselves forwards, by means of their elastic tail, moving nearly as fast as a man will leisurely walk. The strong plates which envelope their body, probably, facilitate their progress, in the same manner as those under the body of serpents, which in some degree perform the office of feet. It is affirmed by the Indians, that they are furnished with an internal supply of water sufficient for their journey, which seems confirmed by the circumstance that their bodies when taken out of the water, even if wiped dry with a cloth, become instantly moist again. Mr Campbell, a friend of Dr Hancock's, resident in Essequibo, once fell in with a drove of these animals, which were so numerous, that the Indians filled several baskets with them.

Another migrating fish was found by thousands in the ponds and all the fresh waters of Carolina, by Bosc; and as these pools are subject to be dry in summer, the Creator has furnished this fish, as well as one of the flying ones,[1] by means of a membrane which closes its mouth, with the faculty of living out of water, and of travelling by leaps, to discover other pools. Bosc often amused himself with their motions when he had placed them on the ground, and he found that they always direct themselves towards the nearest water, which they could not possibly see, and which they must have discovered by some internal index; during their migrations they furnish food to numerous birds and reptiles. They belong to a genus of abdominal fishes,[2] and are called swampines. It is evident from this statement that these fishes are both fitted by their Creator, not only to exist, but also move along out of the water, and are directed by the instinct implanted by him, to seek the nearest pool that contains that element; thus furnishing a strong proof of what are called compensating contrivances; neither of these fishes have legs, yet the one can walk and the other leap without them, by other means with which the Supreme Intelligence has endowed it. I may here observe that the serrated bone, or first ray of the pectoral fin, by the assistance of which the flat-head appears to move, is found in other Siluridans, which leads to a conjecture that these may sometimes also move upon land.

Another fish,[3] found by Daldorff, in Tranquebar, not only creeps upon the shore, but even climbs the Fan palm[4] in pursuit of certain Crustaceans which form its food. The structure of this fish peculiarly fits it for the exercise of this re-

1 *Exocœtus.*
2 *Hydrargyra.*
3 *Perca scandens.*
4 *Borassus flabelliformis.*

markable instinct. Its body is lubricated with slime which facilitates its progress over the bark, and amongst its chinks; its gill-covers are armed with numerous spines, by which, used as hands, it appears to suspend itself; turning its tail to the left, and standing, as it were, on the little spines of its anal fin, it endeavours to push itself upwards by the expansion of its body, closing at the same time its gill-covers, that they may not prevent its progress; then expanding them again it reaches a higher point; thus, and by bending the spiny rays of its dorsal fins to right and left, and fixing them in the bark, it continues its journey upwards. The dorsal and anal fins can be folded up and received into a cavity of the body.

How exactly does this structure fit it for this extraordinary instinct. These fins assist it in certain parts of its route, and, when not employed, can be packed up so as not to hinder its progress. The lobes of its gill-covers are so divided and armed as to be employed together, or separately, as hands, for the suspension of the animal, till, by fixing its dorsal and anal fins, it prepares itself to take another step; all showing the Supreme Intelligence and Almighty hand that planned and fabricated its structure, causing so many organs, each in its own way, to assist in promoting a common purpose. The fan palm, in which this animal was taken by Daldorff, grew near the pool inhabited by these fishes. He makes no mention, however, of their object in these terrestrial excursions; but Dr Virey observes that it is for the sake of small Crustaceans, on which they feed.

I shall name only one more animal that migrates for the great purpose of reproduction, and this is not the least interesting of them; and, though it does not furnish so large a supply of food to the countries it passes through, as the migratory fishes, still it is useful in that respect: the animal I allude to is the *land-crab*.

Several, indeed, of the crabs forsake the waters for a time, and return to them to cast their spawn; but the most celebrated of all is that known by the above appellation, and alluded to by Dr Paley, under the name of the violet crab, and which is called by French the tourlourou.[1] These crabs are natives of the West Indies and South America. In May and June, when the rainy season takes place, their instinct impels them to seek the sea, that they may fulfil the great law of their Creator, and cast their spawn.

They descend the mountains, which are their usual abode, in such numbers, that the roads and woods are covered with

1 *Gecarcinus carnifex.*

them. They feel an impulse so to steer their course, that they may travel by the easiest descent, and arrive most readily at the sea, the great object at which they aim. They resemble a vast army marching in battle array, without breaking their ranks, following always a right line; they scale the houses, and surmount every other obstacle that lies in their way. They sometimes even get into the houses, making a noise like that of rats, and when they enter the gardens they commit great devastations, destroying all their produce with their claws. They are said to halt twice every day, and to travel chiefly in the night. Arrived at the sea-shore, they are there reported to bathe three or four different times; when retiring to the neighbouring plains, or woods, they repose for some time, and then the females return to the water, and commit their eggs to the waves. This business dispatched, they endeavour to regain, in the same order, the country they had left, and by the same route, but only the most vigorous can reach the mountains. The greater part are so weak and lean, that they are forced to stop to recruit their strength in the first country they reach. When arrived again at their habitations, they have a new labour to undergo, for now is the time of their moult. They hide themselves in their subterranean retreats for this purpose, so that not a single one can be seen: they even stop up the mouth of their burrows. Some writers, however, affirm that they change their shells immediately after their oviposition.

The respiration of these land-crabs, for a long time, had puzzled comparative anatomists.—They could not explain how animals, breathing by gills, could subsist so long out of the water without these organs becoming useless. M. M. Audouin, however, and Milne Edwards, cleared up the mystery by the discovery of a kind of trough, formed by the folds which line and constitute the parietes of the branchial cavity, and destined to contain and preserve a certain quantity of water proper to moisten the gills. One species[1] has more than one pocket, or vesicle, filled with that fluid. This trough exists in the horsemen land-crabs,[2] but it is smaller, and a spongy mass furnishes the requisite moisture. The gills of the land-crabs, in other respects, do not differ from those of the tribe in general. God, when he formed these animals, would not separate them from their kind by a different mode of respiration, but by this compensating contrivance he fitted them for the circumstances in which he decreed to place them, and for a long sojourn out of the water.

1 *Gecarcinus Uca.* 2 *Ocypode.*

What is the great object of this law of the Creator, that impels them to seek, in many cases, a mountain retreat, at a distance from the ocean, which forms the liquid atmosphere fitted to the great body of the Crustaceans, has not hitherto, for want of sufficient and accurate details of their history, been made fully obvious. When insects leave the waters to become denizens of the earth and air, the object appears evidently an increase of food, not only for terrestrial animals, whether moving on the one or in the other, but to multiply even that of the inhabitants of the waters. When the day-flies[1] burst in such myriads from the banks of rivers which they inhabited in their first state, the fishes are all in motion, and often jump from the water to catch the living flakes that are every moment descending. When in the water, or under it, these animals and the may-flies are defended, or concealed from the fishes, and therefore are not so easy to come at; but now is their harvest, and when they drop their eggs, they fall towards the stream, and it is deemed a shower of manna.

The same object brings the several kinds of land-crabs at stated times to sea, to deposit their eggs where their young may reach a certain maturity, if not undergo a metamorphosis; probably at this period there is an assemblage of aquatic devourers of Crustaceans, to share in the expected harvest. And during the route of the myriads that thus migrate to the sea, beasts and birds, and man himself, all partake of the feast thus provided for them.

If we give this subject of the migration of animals due consideration, and reflect what would be the consequence if no animals ever changed their quarters, we shall find abundant reason for thankfulness to the Almighty Father of the universe, for the care he has taken of his whole family, and of his creature man in particular, consulting not only his sustentation and the gratification of his palate by multiplying and varying his food, but also that of his other senses, by the beauty, motions, and music of the animals that are his summer or winter visiters: did the nightingale forsake our groves, the swallow our houses and gardens, the cod-fish, mackarel, salmon, and herring our seas, and all the other animals that occasionally visit us their several haunts, how vast would be the abstraction from the pleasure and comfort of our lives.

By means of these migrations, the profits and enjoyments derivable from the animal creation are also more equally divided, at one season visiting the south, and enlivening their

1 *Ephemera.*

winter, and at another adding to the vernal and summer delights of the inhabitant of the less genial regions of the north, and making up to him for the privations of winter. Had the Creator so willed, all these animals might have been organized so as not to require a warmer or a colder climate for the breeding or rearing of their young: but his will was, that some of his best gifts should thus oscillate, as it were, between two points, that the benefit they conferred might be more widely distributed, and not become the sole property of the inhabitants of one climate: thus the swallow gladdens the sight both of the Briton and the African; and the herring visits the coasts, and the salmon the rivers of every region of the globe. What can more strongly mark design, and the intention of an all-powerful, all-wise, and beneficent Being, than that such a variety of animals should be so organized and circumstanced as to be directed annually, by some pressing want, to seek distant climates, and, after a certain period, to return again to their former quarters; and that this instinct should be productive of so much good to mankind, and, at the same time, be necessary, under its present circumstances, for the preservation or propagation of the species of these several animals.

There is another view that may be taken of this subject, equally showing the attention of the Almighty Father to the wants of every description of his creatures. The migrating tribes of almost every kind are attended by numerous bands of predaceous animals, which, as well as man, partake in the general harvest; the bears, wolves, foxes, dogs, and, in tropical countries, other beasts of prey, hang on the flanks of the bands of emigrators, and capture and devour the stragglers. The vultures, and other carnivorous birds, follow and share in the spoil: and the emigrating fishes are attended by whole tribes of predaceous birds and fishes, which thin their numbers before they are taken by the nets of the fisherman.

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I AM next to say something on the local distribution of animals. By their *local* distribution, I mean their station in any given country. Under this head they may be divided into terrestrial, amphibious, and aquatic.

The local distribution of *terrestrial* animals is very diversified. Some inhabit the loftiest mountains, here the eagle builds its aërie, and the condor[1] deposits its eggs on the bare rock; and

1 *Sarcorhamphus Gryphus.*

here the chamois[1] often laughs at the efforts of the hunter, astonishing him by the ease with which it scours over the rocks, or with which it ascends or descends the most inaccessible precipices.

Some animals, that in high latitudes are found in the plains, in a warmer atmosphere seek the mountains. Of this description is the beautiful Apollo butterfly,[2] which, in Sweden is very common in the country and gardens about Upsal, while in France it is found only on mountains between three and four thousand feet above the level of the sea. I received very fine specimens collected by a friend in the Pyrenees. The common viper[3] also, which in northern Europe is found in the plains, in southern is found only on Alpine or Subalpine mountains.

It has been observed by an ingenious and learned writer, that the terrestrial globe seems to be formed of two immense mountains, set base to base at the equator, and that upon each of these hemispheres the vegetables and animals are generally placed in parallel zones, according to the degree of heat or cold. The exceptions to this rule, he further observes, are easy to be appreciated, and confirms its truth, since the mountains, the various elevations and depressions of the country, which even under the same parallel modify the ordinary temperature, produce vegetables, and often animals, analogous to their several degrees of heat or cold. The lofty mountains in tropical countries, exhibit from their base to their snow-clad summits, the same gradation as these hemispheres present in going from the equator towards the poles.

The majority, however, of animals do not ascend such heights, but seek their subsistence in the plains, and less elevated regions; yet here a considerable difference obtains according to the nature of the soil and country. The vast sandy desarts of Africa and Asia, the Steppes of Tartary, the Llanos and Pampas of South America have their peculiar population; in the former the camel, and his master the Arab, whose great wealth he constitutes, are indigenous; in the latter the horse and the Tartar who rides and eats him; or the Hispano-American, and the herds of horses and oxen, returned to their wild and primitive type, who snares them with his lasso, and reduces them again to the yoke of man. Numerous also are the peculiar animal productions to which different soils afford subsistence. The sea-shore, sandy and barren wastes, woods and forests, arable lands, pasture, meadow and marsh, all are thus

1 *Antilope Rupicapra.* 2 *Parnassius Apollo.*
3 *Coluber berus.*

distinguished; every plant almost is inhabited by insects appropriated to it, every bird has its peculiar parasite or louse;[1] and not only are the living animals so infested, but their carcasses are bequeathed to a numerous and varied army of dissecters, who soon reduce them to a naked skeleton; nay, their very excrements become the habitation of the grubs of sundry kinds of beetles and flies.

But not only is the surface of the earth and its vegetable clothing, thickly peopled with animals, but many, even quadrupeds and reptiles, as well as insects and worms, are subterranean, and seek for concealment in dens, caves and caverns, or make for themselves burrows and tortuous paths at various depths under the soil, or seek for safety and shelter, by lurking under stones or clods, and all the dark places of the earth.

To other animals, in order to pass gradually from such as are purely terrestrial, to those that are aquatic, Providence has given the privilege to frequent both the *earth* and the *water*; some of which may be regarded as belonging to the former, and frequenting the latter, as water fowl of various kinds, the amphibious rat,[2] the architect beaver,[3] many reptiles, and some insects; others again as belonging to the latter, and frequenting the former; for instance, the sea-otter,[4] and the different kinds of seal[5] and morse,[6] the turtle,[7] the penguin,[8] several insects,[9] and the water-newts.[10] Other amphibious animals, if they may be so called, are aquatic at one period of their life, and terrestrial at another; this is particularly exemplified in some insects, thus the grubs of water-beetles,[11] those of dragon-flies,[12] may-flies,[13] ephemeral-flies,[14] water-moths,[15] gnats or mosquitos,[16] and several other two-winged flies, live in the water, while the perfect insect is either amphibious as the beetle, or terrestrial as the remainder.

But no part of this terraqueous globe is more fully peopled, and with a greater variety and diversity of beautiful, or strange, or monstrous forms, than the waters, from the infinite ocean to the most insignificant pool or puddle. Every part and portion of the supposed element of water; nay, almost every drop of that fluid teems with life. Thousands of aquatic species are

1 *Nirmus.*
2 *Lemmus amphibius.*
3 *Castor Fiber.*
4 *Enhydra marina.*
5 *Phoca.*
6 *Trichechus.*
7 *Chelonia Mydas.*
8 *Aptenodytes.*
9 *Dyticus, Gyrinus, Ranatra, &c.*
10 *Salamandræ aquaticæ.*
11 *Dyticidæ, Hydrophilidæ, Gyrinidæ.*
12 *Libellulina.*
13 *Trichoptera.*
14 *Ephemeridæ.*
15 *Hydrocampa.*
16 *Culex.*

known, but myriads of myriads never have been seen and never will be seen by the eye of man.

Amongst those that inhabit fluids, none are more wonderful than those that are termed Infusories ;[1] because they are usually found in infusions of various substances, &c. ; when dry, these animals lose all signs of life, but upon immersion, even after the lapse of years, they immediately awake from their torpor and begin to move briskly about. Even the air, according to Spallanzani, seems to contain the germs or eggs of these infinitesimals of creation, so that we swallow them when we breathe, as well as when we drink.

With respect to animals more entirely *aquatic*, some inhabit, as the majority of sea-fishes and animals, salt waters only, some salt at one time and fresh at another, as the species of the salmon genus, the sturgeon, &c.; and some frequent brackish waters, as some flat-fish, and shell-fish.

The bed of the mighty ocean is not only planted with a variety of herbs, which afford pasture to many of its animal inhabitants, but it has other productions which represent a forest of trees and shrubs, and are, strictly speaking, the first members of the zoological world, connecting it with the vegetable; these are denominated Zoophytes or animal plants, and Polypes (*Polypus*). This last name has been adopted from Aristotle ; with him however and the ancients, it is evidently used to designate the Argonaut[2] and Nautilus of the moderns, and also to include some terrestrial shells. The Zoophytes however are not confined to the ocean, every rivulet, and stagnant ditch or pool affords to some kinds, more commonly denominated Polypes, and also to some sponges, their destined habitation. An infinite army of shell-fish, whether multivalve, bivalve, or univalve, also cover the bed of the ocean, or move in its waters, and some dance gaily on its surface with expanded sails, or dashing oars when tempted by fair weather.

From this brief view of the local distribution of animals and their various haunts, we see the care of Divine Providence, that no place, however, at first sight, apparently unfit, might be without its animal as well as vegetable population : if the hard rock is clothed with a lichen, the lichen has its inhabitant: and that inhabitant, besides affording an appropriate food to the bird that alights upon the rock, or some parasite that has been hatched in or upon its own body, assists in forming a soil upon it. There is no place so horrible and fetid

1 *Infusoria, Acrita, Agastria, Amorpha, Microscopica.*
2 *Argonauta.*

from unclean and putrid substances, that is not cleansed and purified by some animals that are either its constant or nomadic inhabitants. Thus life, a life attended in most cases, if not all, with some enjoyment, swarms every where—in the air, in the earth, under the earth, in the waters—there is no place in which the will of an Almighty Creator is not executed by some being that hath animal life. What Power is manifested in the organization and structure of these infinite hosts of existences! what Wisdom in their adaptation to their several functions! and what Goodness and stupendous Love in that universal action upon all these different and often discordant creatures compelling them, while they are gratifying their own appetites or passions, and following the lead of their several instincts, to promote the good of the whole system, combining into harmony almost universal discord, and out of seeming death and destruction bringing forth life and health and universal joy! He who, as an ancient writer speaks, "Contains all things,"[1] can alone thus act upon all things, and direct them in all their ways to acknowledge him by the accomplishment of each wise and beneficient purpose of his will. Philo Judæus, in his book upon agriculture,[2] speaking of those words of the Psalmist, "*The Lord is my shepherd, therefore can I lack nothing*," has the following sublime idea, illustrative of this subject. "God, like a shepherd and king, leads, according to right and law, the earth, and the water, and the air, and the fire, and whatever plants or animals are therein, things mortal and things divine; the physical structure also of the heavens, and the circuit of the sun and moon; the revolutions and harmonious choirs of the other stars; placing over them his right Word the first born Son, who hath inherited the care of this Holy Flock, as the Viceroy of a mighty King."

1 *Hermas.* 2 Περι γεωργιας. 152. A. Ed. *Col. Allob.*

## CHAPTER III.

### *Functions and Instincts of Animals.*

Having, in the last chapter, stated how the dispersion and distribution of animals, under the Divine superintendence and direction, probably took place after the Deluge; and having likewise considered those temporary changes of place, either casual or periodical, which are still in operation, I shall next endeavour to give a general sketch of the animal kingdom, its classes and larger groups, and so much of their history, habits, and instincts, as may be necessary to indicate their several *functions* and *offices* in the general plan of creation, so as to illustrate more strikingly the Goodness that willed, the Wisdom that planned, and the Power that executed the wondrous whole; so that each in its place and station, by employing the faculties and organs, with which he has gifted it, in accomplishing his will, praises, though unconsciously, its Almighty and Beneficent Creator, thus loudly calling upon man, the rational head of the creation, to take up the strain and lead the general choir.

Before I descend to particulars, I must say a few words upon the general functions of the animal kingdom. These, like Janus, have a double aspect;—on one side they affect the vegetable world, and on the other their own body.

There is a singular contrast and contrariety between the majority of animals and vegetables. The head of the animal and the root or base of the vegetable perform the same office, that of collecting and absorbing the nutriment of each. The animal derives this nutriment from *organic* matter, the vegetable from *inorganic*. The plant gives oxygen to the heaven, and falling leaves and other matters to the earth. The animal gives nitrogen to the former, and the rejectamenta of its food to the latter. The most beautiful and admired, and odorous and elevated parts of the plant are its reproductive organs and their appendages, while in the animal they are the very reverse of this.

But, in all this, we see the wisdom and forethought of the Creator. We see how exactly, by this mutual inversion, each

class of beings is fitted for its station and functions. The plant to take root in, invest and ornament the earth, and keep the atmosphere pure by a constant supply of vital air; the animal to browse and trim the vegetable, and by checking its luxuriance promote its welfare, to furnish it with a product calculated for its health and necessary to its existence; and by the manure, various in kind as the animals themselves, which it produces, supplying to the earth fresh pabulum for its vegetable tribes, and making good what it lost by the exhaustion, occasioned by the infinite myriads that, investing it on all sides like a garment, derive their nutriment from it, some plunging deep, and others, as it were, skimming the surface: if we contrast this with the returns they make, we shall be convinced that, in this case, the expenditure would vastly exceed the income, and that a class of beings was essentially necessary as a counterpoise, which, by taking little or nothing immediately from the soil, at the same time that they added to it, some in a greater and some in a less degree, might afford a sufficient supply of those principles which are indispensably requisite for the due nutriment and development of the various members of the vegetable kingdom, and thus maintain an equilibrium, and make good the deficiency just stated.

There is another function which is devolved upon animals with respect to the vegetable kingdom; to keep the members of it within due limits, and to hinder them from encroaching too much upon each other. All organized beings have a natural tendency to increase and multiply; and while there is space this tendency is beneficial; but when plants or animals exceed certain limits, they stand in each other's way, and prevent all further growth or healthy progress. The herbivorous animals, in various ways, serve as a countercheck to this tendency, and keep the vegetable tribes from encroaching too much upon each other. As I have detailed the effects of this when I spoke of the ravages of the locusts, and shall have occasion again to notice it, I shall not now enlarge further upon it.

I am next to consider another general function of animals, or the effects they produce upon their own body: and here the reason just alluded to, their constant tendency to multiply so as to be injurious to each other, and also to vegetable productions, especially those that are important to man or beast, which in the present state of things is so constantly recurring, renders it necessary that some bounds should be set to their increase, which Providence effects by letting them loose against each other. The great object of the Creator is the maintenance of the whole system of creation in order and beauty, and

this he is pleased to accomplish, not always by the *concord* but by the seeming *discord* of the agents he employs.

When we take a first view of nature we are struck by a scene which seems to be one of universal conflict, for the very heavens appear not clear from the charge: the philosopher who studies them tells us of antagonist powers, that are perpetually striving with each other, the one to absorb all things in a common centre, the other to dissever them, and scatter them in illimitable space, and when we turn to the earth, what a scene of destruction is before us! The king of the terrestrial globe, man, constantly engaged in a struggle with his fellow man, often laying waste the earth, slaughtering its inhabitants, and deforming its productions—his subjects of the animal kingdom following the example of their master, and pitilessly destroying each other—the strong oppressing the weak, and most seeming bent to annihilate the races to which they are opposed; so that, humanly speaking, in the lapse of ages, we might expect that one species of animals would be annihilated after another, till the whole were obliterated from the face of creation, and the sublime language of the prophet literally verified; "*I beheld the earth, and, lo, it was without form and void; and the heavens, and they had no light. I beheld the mountains, and, lo, they trembled, and all the hills moved lightly. I beheld, and, lo, there was no man, and all the birds of the air were fled.*"

But if, with our spirits depressed, by the prospect of so universal a scene of mutual struggles and destruction, we listen again to the philosopher, he will tell us that the ceaseless struggle of the antagonist powers of the heavens prevents, instead of causing disorder and confusion, that by the powerful and mutual counteraction of these mighty opponents, all the heavenly bodies of our system are prevented from rushing to the centre, or being driven, dispersed into their atoms, beyond the *flammantia mœnia mundi;* that thus their annual and diurnal revolutions are maintained, that each observes its appointed course, keeps its assigned station, and ministers to the good and well-being of the whole system. If then we turn our view again to the earth, and take a nearer survey of things—if we consider the present tendency to multiply, beyond measure, of all things that have life, we shall soon be convinced that, unless this tendency was met by some check, the world of animated beings would be perpetually encroaching upon each other, and would finally perish for want of sufficient food; and that the partial evils inflicted by one individual or one class upon another, to borrow a term from the Political

Economist, proportions the demand to the supply; that thus both vegetables and animals are so accurately distributed, weighed so nicely against each other, as never to go a step beyond what God decrees, and what is most beneficial to the whole system; and that the actual number of every kind bears due relation to the work it has to do; and, upon closer inquiry, we find, that though since the creation, probably in consequence of the great change in the moral state of the world, superinducing physical changes also, some species no longer necessary may have perished, yet that, in general, they have maintained their ground from age to age, in spite of the attacks of the great army of destroyers. To maintain things in this state, thus to "*order all things in measure, number, and weight,*" as the wise man speaks, to cause all so to harmonize, and so out of death and destruction to bring forth life, indicates still more strongly the constant and wise superintendence, and powerful arm of a watchful Providence, and demonstrates irrefragably that there is a Great Being constantly at work, either mediately or immediately, to produce effects that, without his constant superintendence and intervention, could never take place. And thus, as sings the bard of Twickenham,

> "All nature is but art unknown to thee,
> All chance direction which thou canst not see,
> All discord harmony not understood,
> All partial evil, universal good."

## CHAPTER IV.

### *Functions and Instincts of the Infusory Animals.*

As at the original creation of the animal kingdom, it was the will of the Supreme Being to begin at the *foot* of the scale and to terminate with man, who was at its *summit*, thus making a gradual progress towards the most perfect being it was his will to create, and ending with him: so I think it will best manifest his power and perfections if I endeavour to trace out the footsteps of the Deity in the same direction as he proceeded; and instead of beginning, as is usually done by systematical writers, with the *highest* grade of animals, if I ascend upwards from the *lowest.*

Our first inquiry must be what are these lowest animals? And are there any organized bodies that partake of *two* natures, that are either animal at one period of their existence and vegetable at another, or else are partly animal and partly vegetable? These doubtful forms must be sought for amongst what have been denominated *first-plants*[1] and *first-animals*;[2] amongst the former is a certain genus or tribe[3] of plants, which are distinguished not only by their simple structure, but also by an oscillatory movement which seems to connect them, in some degree, with the animal kingdom. When collected in masses they resemble a piece of green velvet. Some cover considerable spots in moist places; others live in the water, either fixed to substances contained in it, or floating on the surface. They are generally based on a mucilaginous substance, the remains of those that, having fulfilled their functions, are become a caput mortuum. The filaments of which the living plant is composed continually oscillate from right to left, or from left to right, but very irregularly, some going in one direction, others in another; some remaining stationary while others continue in motion.

Professor Agardh inclines to the opinion that these oscillating plants owe their existence to different species of *animalcules*, which at first swim about as animals, and afterwards fix them-

1 *Protophyta.* 2 *Protozoa.* 3 *Oscillatoriæ.* Vauch.

selves as plants. This opinion has been adopted by others; and lately Mr Unger has stated that he has seen animated particles separate from the parent plant, in a few hours converted into globules of vegetable matter, which subsequently became plants perfectly similar to the individual from which they were produced.

But surely the motions of these seeds or germs, may be merely mechanical, and may be necessary to enable them properly to fix themselves, somewhat analogous to those mechanical contrivances by which the seeds of numerous plants, as those of the dandelion and cranesbill, are transported to a distance and enabled to enter the soil and fix themselves in it.

That any creature should begin life as an animal and end it as a plant seems to contradict the general analogy of creation, and requires much stronger proofs than appear to have been adduced in the present case, before it can be admitted. The motions of the oscillating plants are not very different from those of the stamina of some, and of the leaves of others, as the *Hedysarum gyrans;* yet Adanson has proved that the vibrations of the filaments are the same both in hot and cold weather, and that the aquatic species are equally sensible with the terrestrial, therefore the movement can scarcely be caused by the temperature. But as analogous motions were observed by Mr Brown in spherical and other molecules obtained from vegetables, it is evident that such motions do not necessarily indicate an animal, but only a kind of attraction and repulsion produced by an uncertain cause. Another argument proves their vegetable nature, these plants give out oxygen, whereas if they were animals they would absorb oxygen and give out azote.

Professor Agardh illustrates his opinion just stated by the following fanciful allusion. When thus fixed he considers these beings as no longer having any animal life, but as preserving the appearance of it, "Like those men of Plato," adds he, "agitated by eternal regret with which the remembrance of a happy life, the sweets of which they formerly tasted, inspires them; always oscillating, never tranquil, they seem aiming at the recovery of that happy life which they have lost." The locomotions, however, of the germes of these Hydrophytes, and their oscillatory movements when fixed, indicate at least a semblance of animality, and an approach to the confines of the animal kingdom.

Leaving, therefore, these doubtful forms, as having no just claim to be considered as animals, I shall now proceed to those whose right to that title is generally acknowledged. And here

two very different tribes start up and prefer their claim to be first considered; the *Infusories*, namely, and those which have been called *Polypes* and *Zoophytes*. But since the first of these two classes, by means of one of its tribes, as its great oracle, Ehrenberg, remarks, approaches the oscillating plants,—I shall consider it as the basis on which the Deity has built the animal kingdom. Indeed, though the Polypes at first sight appear most to resemble the higher *plants*, in their general configuration, the Infusories, as well as coming nearer to the lowest by some of their members, in others exhibit no slight analogy to *seeds*.

Of all the groups of animals those of the least consequence, one would think, must be those that for the most part escape the inquring eye unless aided by a microscope. The infusories, or as they have been also called *animalcules*, *microscopic animals*, *acrita* or indiscernibles, *amorpha* or without form, are of this description. These wonderful little creatures, though they are every where dispersed, remain like seeds, without apparent life or motion, perhaps after animation has been suspended for years, till they come in contact with some fluid, when they are immediately reanimated, move about in various directions, absorb their proper nutriment, and exercise their reproductive powers according to the law of their several natures. Yet these little animals, though in some respects they exhibit no slight analogy to vegetables, are not only distinguished from them by their irritability, but likewise by their organization, and powers of locomotion and voluntary action. Their mode of reproduction, however, is not far removed from that of some vegetables; they are spontaneously divisible, some longitudinally and others transversely, and these cuttings, if they may be so called, as in the Hydra or common Polype, become separate animals. They are also propagated by germs, and some appear to be viviparous. The species of *Vibrio* found in diseased wheat by M. Bauer is oviparous, as is evident from his observations and admirable figures. Lamarck indeed regards them as having no volition, as taking their food by absorption like plants; as being without any mouth, or internal organ; in a word, as transparent gelatinous masses, whose motions are determined not by their will, but by the action of the medium in which they move. That they have neither head, eyes, muscles, vessels, nerves, nor indeed any particular determinable organ, whether for respiration, generation, or even digestion. On account of these supposed negative characters, they were called by De Blainville, *Agastria*, or stomachless, as having no intestines; but Ehrenberg, who has

studied them in almost every climate, has discovered, by keeping them in coloured waters, that they are not the simple animals that Lamarck and others supposed, and that almost all have a mouth and digestive organs, and that numbers of them have many stomachs. Spallanzani, and other writers that preceded Lamarck, had observed that their motions evidently indicated *volition :* this appeared from their avoiding each other and obstacles in their way; from their changing their direction and going faster or slower as occasion required ; from their passing suddenly from a state of rest to motion without any external impulse; from their darting eagerly at particles of infused substances; from their incessantly revolving on themselves without a change of place ; from their course against the current ; and from their crowding to shallow places of the fluid in which they are: each species seems also to exhibit a peculiar kind of instinct. Lamarck thinks all this delusion proceeding from errors in judgment, and the result of prejudices inducing people readily to believe what accords with their persuasions. But to apply this remark to such observers as Spallanzani, &c., is drawing rather largely on the credulity of his readers, who might very justly change the tables and apply it to himself, who is certainly as much chained by system as any one can be. Admitting that the observations of Spallanzani just stated record facts, it appears clearly to follow from them that these animals *have* volition, and therefore cannot properly be denominated *apathetic*, or insensible. The fact that they almost all have a mouth and a digestive system ; many of them eyes, and some rudiments of a nervous one, implies a degree, more or less, of sensation in them all, and consequently that they have all, whether it be molecular and diffused in their substance, or confined to particular organs, I say that they have all a nervous influence and excitement sufficient for their several wants, corresponding with their several natures.

These minim animals may be said almost to be universally dispersed ; they inhabit the sea, the rivers, and other waters ; are supposed to float in the air ; they are found in the blood and urine ; in the tartar of the teeth ; in animal substances ; in vinegar ; in paste ; in vegetable substances ; in fruits, seeds, and grain ; in sand ; amongst tiles ; in wells ; on mountains, &c. Their numbers are infinite ; hundreds of thousands may be seen in a single drop of water; their minuteness is extreme, some being not more than $\frac{1}{2000}$ part of a line in length, and yet these atoms of animals have a mouth and several stomachs.

Let a man, says Dalyell, the translator of Spallanzani, conceive himself in a moment conveyed to a region where

the properties, and the figure and motions of every animal are unknown. The amazing varieties of these will first attract his attention. One is a long slender line; another an eel or serpent; some are circular, eliptical, or triangular; one is a thin flat plate; another like a number of reticulated seeds; several have a long tail, almost invisible; or their posterior part is terminated by two robust horns; one is like a funnel; another like a bell, or cannot be referred to any object familiar to our senses. Certain animalcules can change their figure at pleasure:[1] sometimes they are extended to immoderate length, then almost contracted to nothing; sometimes they are curved like a leech, or coiled like a snake; sometimes they are inflated, at others flaccid; some are opaque while others are scarcely visible from their extreme transparence. No less singular is the variety of their motions;—several swim with the velocity of an arrow, so that the eye can scarcely follow them; others appear to drag their body along with difficulty, and move like the leech; and others seem to exist in perpetual rest; one will revolve on its centre, or the anterior part of its head; others move by undulations, leaps, oscillations, or successive gyrations;—in short, there is no kind of animal motion, or other mode of progression, that is not practised by animalcules.

Their organs are equally various. Some appear to take their food by absorption, having no mouth, to this tribe belong what have been called vinegar eels; others have a mouth and several stomachs, but no orifice for the transmission of their excrements; others, again, have both a mouth and anal passage, and what is wonderful, in such minute creatures, sometimes as many as forty or fifty stomachs;[2] though many are without eyes, others are furnished with these useful organs, some having one, others two, others three, and others four; some have processes resembling legs. In the second Class of these animals, the *Rotatories*, to which the wheel-animalcules belong, the internal organization approaches to that of the higher classes, for they exhibit the rudiments of a nervous system; their alimentary canal is simple; they have a branching dorsal vessel, but without a systole and diastole; their pharynx is usually furnished with mandibles, which are sometimes armed with teeth. The mouth of the majority, especially amongst the rotatories, is fringed with ray-like bristles, which Cuvier thinks are connected with their respiration. This circumstance of a circle of rays surrounding the oral

1 Plate I. Fig. 3. 2 *Leucophrys*, *Enchelis*, &c.

orifice, is found in the polypes and several other animals of a higher grade. Their use in the present instance, I speak more particularly of the wheel-animalcules, is by their rotation to produce a current in the water to the mouth of the animal, bringing with it the still more minute beings which constitute its food.

These invisible inhabitants of the visible world created an early interest in inquisitive minds; Dr Henry Power, and after him the celebrated Hooke, about the middle of the seventeenth century, or earlier, noticed, what were called vinegar eels.[1] Sir E. King, in the *Philosophical Transactions*, described some experiments on the animalcules found in pepper water; and, subsequently, Mr Harris made observations upon a variety of these minute creatures. The subject was afterwards taken up by various writers, both here and on the continent. Amongst these none was more eminent than Spallanzani. O. F. Müller, who seems to have been the first who treated the subject systematically, embodied these animals in a Class by the name of *Infusories*.[2] He was followed by Bruguiere and Lamarck, who divided it into Orders and Sections. But the system of these zoologists has for the most part been set aside by Ehrenberg, a Prussian naturalist, before-mentioned, who devoted ten years of his life to the investigation of these animals, for which he was particularly qualified by his previous studies and employment, the anatomy of the Molluscans of the Red Sea, by which he had been accustomed to the use of microscopes and micrometers. His researches on the Infusories, during Baron de Humboldt's last journey, extend to more than fifty degrees of longitude, and fourteen degrees of latitude;—he went as far as Dongola in Africa, and the Altai mountains in Asia, and examined these animals in a great variety of situations. He found them on Mount Sinai; swarms of various species in the wells of the Oasis of Jupiter Ammon; and at a considerable depth in some Siberian mines, in places entirely deprived of light.

He considers them, it should seem, as forming a Sub-kingdom, which he denominates *Plant-animals*.[3] This sub-kingdom he divides into two Classes. The first, from the number of stomachs,[4] with which the genera belonging to it are furnished, he names, *Polygastrica*, or many-stomached, probably, to contrast with De Blainville's name before-mentioned. The second class he calls *Rotatories*,[5] consisting of the ciliated Polypes of

1 *Vibrio Anguilla.* 2 *Infusoria.* 3 *Phyto-zoa.*
4 Plate I. Fig. 1. 5 *Rotatoria.*

Lamarck;[1] each of these classes he subdivides into two parallel orders, the first containing those that are naked, and the second those that are loricated,[2] or covered with some kind of shell.

In the first of these classes, the *Polygastrics*, the animals recede further from the organization of the higher tribes, and approach nearer to that of vegetables; but in the second, as I before observed, rudiments of the organization of those tribes make their appearance. Many of the former are known to derive their nutriment from vegetable substances, but what the majority subsist upon is not certainly known; but the latter class, the Rotatories, are ascertained to be predaceous, as above stated. Their mode of drawing their corpuscular food within the vortex of their mouth is thus amusingly illustrated by Spallanzani. As a certain species of whale, says he (*sic magnis componere parva solebat*), after having driven shoals of herrings into a bay or strait, by a blow of its tail produces a whirlpool of vast extent and great rapidity, which draws the herrings into its vortex; the monster then presenting its open mouth, the herrings are precipitated into its throat, and it is soon satiated: so the carnivorous Infusories produce a vortex by their tentacles, and satisfy their appetite.

I have been more diffuse upon the history of the animals whose functions in nature I am next to consider, because to them in a more particular manner, applies Pliny's observation with regard to insects. *In his tam parvis, atque tam* nullis, *quæ ratio, quanta vis, quam inextricabilis perfectio!* In nothing is the power and wisdom of their Almighty Author more signally conspicuous. Organization so complex, and life, and spontaneous motion, and appetite, and means to satisfy it, and digestion, and nutrition, and powers of reproduction in animals of such infinite minuteness! Who can believe it? Yet so it is, and that each of these should be varied in the different tribes and genera—that these less than the least of all the creatures that present themselves to the observation of mankind, and which till within a century or two were not suspected to exist, should out-number beyond all statement of numbers, all the other animals together that people the whole globe, that they should probably enter into us and circulate in our blood, nestle between our teeth, be busy every where, and perceived no where, till the invention of the microscope drew aside the veil between us and these entities, and we saw how God had filled all things with life, and had based the animal kingdom upon living atoms, as well as formed the earth and the world of

1 Plate I. Fig. 2. 2 See Appendix, note 20.

inert ones. But to us the wondrous spectacle is seen and known, only in part; for those that still escape all our methods of assisting sight, and remain members of the invisible world, may probably far exceed those that we know.

We may conclude that this vast, or rather infinite, host of animalcules was not created merely to be born and die; was not sown, as it were, over every part of the earth's surface, lurking in seeds, and other vegetable and animal substances, till coming into contact with fluid matter of whatever description it starts into life, and swarming in the ocean, and its tributary streams; it was not thus dispersed every where, either alive, or in a state to revive and live, but for some great purpose, for which its organization, structure and station amongst animals, particularly adapt it.

With respect to its immediate action upon the vegetable and animal kingdoms, it has been ascertained, as to many species, that they ascend with the sap in vegetables,[1] and are found in the blood and excretions of animals,[2] who knows but they may act an important part in the animal frame; somewhat similar to what devolves upon the larves of certain insects, with regard to stagnant waters, they may be *depurators* where they are thus employed, and contribute to preserve a healthy action. It is true, as far as vegetables are concerned, especially grain, they appear to destroy, where they take up their residence, but when we discover the same or similar species, in sour paste or vinegar, they seem destined to consume substances that cease to be wholesome; and in fact, in all fluids, in which they usually so abound, they may be destined to fulfil a similar office, and it is a remarkable circumstance in their history confirmatory of this idea: that these animals, though animation in them is often suspended for a long time; when they swarm in infusions, having fulfilled their office, perish in a few days.

It is probable that in the waters of our globe an infinity of animal and vegetable molecules are suspended, that are too minute to form the food of even the lowest and most minute animals of the visible creation, and therefore an infinite host of invisibles was necessary to remove them as nuisances.

But the principal point, and that in which their utility most evidently appears, is their furnishing a principal portion of the food of innumerable animals of a higher order than themselves.

1 Mr Bauer found *Vibrio Tritiri*, in the stalk as well as in the ear and grain of plants of wheat, which were raised from seeds inoculated with it. *Phil. Trans.* 1823. 3.

2 See above, p. 81.

Those infinite armies and forests of locomotive and fixed Polypes, that give to the ocean one of the features that distinguish earth, have their mouths surrounded with tentacles, when expanded assuming the appearance of so many blossoms, with these they collect their food, which, amongst the more minute ones, consists often of our Infusories. A single stem of these compound animals, having often innumerable oscula or mouths, requires a vast supply of food; others equally compound, as the Ascidians or Alcyons, by alternately absorbing and expelling the sea water, draw in with it a supply of animal food, consisting, in part, of the creatures in question, which abound in the oceanic waters; some of these have a common organ for this purpose, and in others each individual of the system is fitted with one; the Molluscans and an infinity of the smaller inhabitants of the ocean, doubtless also derive a considerable portion of their nutriment from them, the minute Crustaceans probably do the same, and many insects, whose larvæ inhabit the waters, some by producing a vortex like the rotatories,[1] thus find an abundant supply to carry them to their intermediate state. But not only do these creatures furnish the more minute animals that inhabit the waters, with a considerable portion of their food, but, it should seem, even some of those that are of a higher grade, and larger stature. Whoever has been in the habit of keeping gold and silver fish,[2] in glass or other vessels, is aware that they require no other food than a fresh supply of water every second or third day. Their nutriment therefore must be derived from what they find in the water. In this may often be seen minute Branchiopods swimming here and there, sometimes with a bundle of eggs appended to each side: but these are not sufficiently numerous to form the whole of their food, the water must therefore contain other nutritive substances which may contribute to their subsistence, and as it is known that various infusory animalcules inhabit it, we may conclude that they are inserted in their bill of fare. It has been observed by an eminent writer, speaking of the gold fish, "The water, when care is taken to renew it frequently, appears sufficient for the nutriment of these fishes during many months; but it should be considered that though this water appears to us very pure, it always contains a multitude of animalcules and very minute plants, which the fishes are continually swallowing."

When Creative Wisdom covered the earth with plants, and peopled it with animals, he laid the foundations of the vege-

1 *Culex, Stratyomis*, &c. 2 *Cyprinus auratus.*

table and animal kingdoms with such as were most easily convertible into nutriment for the tribes immediately above them. The first plants and the first animals are scarcely more than animated molecules,[1] and appear analogues of each other; and those above them in each kingdom represent jointed fibrils.[2] It is singular and worthy of notice, that the Creator after the creation of inanimate matter, probably first imparted the living principle to bodies of the same form with the molecules and fibrils into which that matter is resolvable, thus uniting, by common characters, things essentially distinct, and preserving unbroken that wonderful chain which links together all created things.

Every body, who has eyes, is aware, that vegetation takes place upon almost every substance, upon the bark of trees, upon naked rocks, upon brick walls and tiled roofs, and even upon glass when not constantly cleaned. The first plants, that take on these their station, usually look like green or yellow powder, when they decay forming a little soil, in which others more conspicuous find sufficient nutriment, and so one succeeds another till a sufficient portion of soil covers the rock, &c. to afford the means of life and growth to more perfect plants, and often to arborescent ones. An analogous process takes place in the water. The *matière verte* of French authors makes its appearance, and other Hydrophytes, in conjunction with the Infusories, form as it were a first soil for the support and maintenance of animal life, both for those which derive their nutriment from vegetables, and those that feed on beings of their own class. Thus a maintenance is provided for higher forms, and, at last, for the highest; and a table is spread, both on the earth and in the waters, for every living thing, from that which the eye cannot discover, to man, the head and king of all.

How wonderful and adorable is that Almighty Being, who thus made all things dependant upon each other, and based the visible world, in the three great departments into which we see it divided, upon an invisible basis, and in which cohesion and life are maintained by those powers which God has placed as rulers in the physical world, and by which he still acts upon the universe of existences.

1 For instance, *Globulina* and *Monas*.

2 *Oscillatoria* and *Vibrio*. See Appendix, note 21.

## CHAPTER V.

### *Functions and Instincts. Polypes.*

THE tribe of animals to which we are next to direct our attention, though not invisible like the last, are almost equally concealed from our view by the medium that they inhabit; so that, with the exception of those that abound in fresh water, and are easily kept alive for examination, the great body of them inhabiting the ocean, can seldom be studied in a living state. All the polypes are aggregate animals, in which they differ from the majority of the preceding class. The most imperfect of them, as the sponges and some of the alcyons, seem to consist merely of a gelatinous mass, without any organs of prehension, which by its alternate contraction and dilatation, imbibes or sends out the water from which the animal derives its nutriment; but the great majority have a mouth furnished with arms or tentacles varying in number. These are described as tubes, filled with fluid, expanding at the base into a small cavity, which when contracted necessarily propels the fluid into the tentacles, and thus extends them; but when the tube contracts, the fluid flows back into the cavity, and the points of the tentacles converge over the mouth.

These parts are not only organs of sense, but also serve many other purposes, particularly those of prehension and motion; and they very probably assist in respiration, which appears evidently connected with the alternate contraction and expansion of these animals. They are also so constructed as to lay hold of every substance that floats within their reach, whether by means of any gummy excretion like bird-lime, as some suppose, or whether they are furnished with very minute suckers by which they can adhere to any substance, has not been ascertained. Trembley observed, that when the common polype of fresh water touched any little animal with one of its long tentacular arms, it was immediately arrested, and in spite of the most violent efforts to liberate itself, which he compares to those of a fish that had been hooked, was held fast, and carried to the mouth of the polype and swallowed.

The body of polypes is formed of a kind of inspissated mucus,

with confusedly agglomerated, and probably nervous, molecules equally distributed; it is covered by no skin, is extremely contractile, and forms an alimentary sac open at one end, serving both for mouth and anal passage. The equal distribution of nervous molecules through the whole substance of these animals, will account for their extreme tenacity of life. In fact, this uniform gelatinous mass, which is without any organized structure, may be regarded as a kind of primary substance, which possesses characters, in some respects, common to both animal and vegetable matter.

This substance without any nervous centre—though nervous influence, one would think must be in most force round the orifice where the tentacles are in action,—yet full of cerebral matter, sensible to the light without any organ of sight; extremely irritable; alternately contracting and expanding, and thus moving without any apparatus of muscles; with no trace of organization but the tubular rays that surround its mouth, which appear to perform the office of eyes, hands, feet, and lungs; this singular substance lends a clue to form the class into *Orders* according to the circumstances in which it is placed.

1. In the common *Polypes*[1] of our ditches and stagnant waters, it is a naked branching elementary sac or canal, without any internal support, and endued with powers of locomotion.

2. In the *Madrepores* and others,[2] its Maker for mighty purposes has enabled the animal to form for itself a fixed calcareous house or polypary as it is called, consisting often of innumerable cells, each containing a separate individual with its mouth and tentacles, united to the general body at its other extremity, and each with an external aperture, by which they are protruded, and expand like a flower.

3. In the *Coral* and affinities,[3] it forms an internal calcareous axis, which it envelopes as the bark does the tree: it is fixed by its base like the preceding tribe; and from this crust, or bark, the tentaculiferous mouths of the polypes emerge. In some the axis appears articulated.

N.B. In these two last the base by which the compound animal is fixed to rocks, or other substances, expands like the base or root of a tree; and by their ramifications these polypes, whether the polypary is external or internal, resemble its branching stem.

4. The *Sponges*[4] and *Alcyons*[5] have been generally arranged with the last Order, but, from M. Savigny's observations, it

1 *Hydra viridis, fusca*, &c. 2 *Lamellifera*, Lam.
3 *Corticifera*, Lam. 4 *Spongia*. 5 *Alcyonium*.

appears that certain of these animals have neither stomach, mouth, nor tentacles, the animal life of which he thinks might be disputed; but Mr Bell has discovered that they alternately imbibe and expel that fluid, which seems to prove their animal nature. Perhaps they ought to be considered as nearer to vegetable matter than the other polypes.

5. Other *Alcyons*[1] seem to have a more complex organization than any of the preceding polypes; they are stated to have eight parrallel stomachs. Only four genera belonging to this Order have been described, and its proper station seems doubtful.

6. In the *Sea-Pen*, and others,[2] the animal envelopes an axis, as in the third Order, and has a tentacular mouth, but it is not fixed by its base. The greater part of these animals float in the waters, but others remain at the bottom, either upon the surface or partly plunged in the sand.

Polypes are invariably aquatic animals, some inhabiting fresh water, but the great body are marine, and most numerous in tropical seas. In very high latitudes, only cellarians,[3] sertularians,[4] alcyons, and some sponges occur, and in the vicinity of volcanic islands in the Polar seas, corallines and gorgonians. These multiply a little from 6° to 9° N. L.: then, as they approach the tropics, the coral reddens, and the madrepores whiten, and at 33° they attain their full powers of growth and multiplication. Some frequent the mouths of rivers, where there is a conflux of fresh and salt water. Some love atmospheric influence, while others avoid it. The marine ones frequently plant themselves on rocks, in different aspects, often regulated by the climate. They rarely expose themselves to violent currents, or the direct shock of the waves. They are often found in the hollows of rocks or submarine grottoes, and in gulfs where the water is less agitated.

It was observed above that the Infusories present some analogy to the seeds of vegetables; the polypes go further, and represent, often most exactly, the developed plant from the tree, by almost all the intermediate stages, to the fungus,[5] at least the fixed polypes: these appear, as it were, to take root, to send forth branches which produce seeming blossoms, composed of what appear to be petals arising from a calyx, arranged sometimes in a single and at others in a double circle, and in some including the semblance of stamina; they are also very sensible to the light, and turn to its source, and like plants

1 *Polypi tubiferi*, Lam. 2 *Polypi natantes*, Lam. 3 *Cellaria*.
4 *Sertularia*. 5 Plate II.

are readily propagated by cuttings and buds; so that all the older naturalists regarded them as real plants, without apparently suspecting their animal nature. Ancient naturalists were very apt to mistake analogical resemblances for proofs of affinity, but in the progress of science, when natural objects were submitted to a stricter examination, more correct ideas were substituted for these mistaken ones, and the zoophytes, or polypes, were generally admitted to be real animals, though some, after Linné, still regarded them as something between animal and vegetable. Trembley was one of the first who ascertained their animal nature; he saw the fresh-water polypes,[1] by means of their long tentacles, seize and swallow certain grubs, and also many minute *Entomostracans*, common in stagnant water. These polypes so used their tentacles as evidently to indicate a degree of volition, sometimes using one and sometimes many, as circumstances required. When they had secured their prey, they contracted and gave a curve to these organs, so as to bring it near the orifice, or mouth, at their anterior extremity, which then began to open, and the animal they had caught was gradually absorbed. He has seen them attack small fishes, also worms, larvæ, and pupæ of gnats, parts of slugs, entrails, and even pieces of meat.

The marine polypes are equally ravenous with the river ones, feeding upon whatever they can lay hold of, sometimes, like the wheel-animals, or rotatories, producing a vortex in the water, and thus causing a flow to their mouth of the infusory, and other animalcules contained in that element. It is to be observed that these inhabit a common house, from which they cannot separate themselves; their sole character is that of being attached to an animated mass, so that each individual partakes of the life common to the whole, and also of a separate life, independent of that of the others. Yet the nutriment that one of these individuals takes, extends its influence to parts the most distant from the place it occupies.

Having made these general remarks, I shall next give a history of some of the best known and most interesting species.

1. The common polypes of stagnant waters, belonging to the *first* Order, have met with an admirable historian in M. Trembley, and what I have to communicate with respect to them will be chiefly derived from him. With regard to their *reproduction*, it is by germs and cuttings. The former issue gradually from the body of the parent polype, as the trunk of a tree sends forth a branch. The bud that forms the commencement

1 *Monoculi.*

of a young one, is a continuation of her skin, and its stomach of her stomach. When she takes her food, the bodies of her young are seen also to inflate themselves as if they had taken it with their own mouths, and the food may be seen passing from one to the other. After they have grown thus as branches for some time, and even have pushed forth germs themselves, they detach themselves from the parent stem, and become separate animals.

It is stated that, by this mode of generation, in the space of a month a single polype may be the parent of a million of descendants. Trembley observed some long branches of trees that had fallen into the water, which he describes as being as full of polypes as a peruke of hairs; and that though their innumerable arms were at work, there was no confusion amongst them.

But these animals, as is well known, do not multiply solely by germs, but also by cuttings, as they may be called; their substance is so instinct with life, that nothing appears able to destroy it—a circumstance, perhaps, arising from the nervous molecules of which it seems almost to consist. If divided transversely, each segment will become a distinct animal, send forth tentacles round its upper aperture, and close the lower one; if it is divided longitudinally, each half will form a separate tube in an hour, and begin to ply its tentacles in a day; even if divided into longitudinal strips, instead of the sides turning in, as in the former case, each strip becomes inflated, and a tube is formed within it: and what is still more wonderful, and seems next to a miracle, these animals may be turned inside out, like the finger of a glove, without destroying either their vitality, their power of producing germs, and of catching, swallowing, or digesting their food: so that they have, properly speaking, neither a *within* nor *without*, both surfaces of their alimentary canal being equally fitted for digestion. This, however, is not so entirely anomalous as it may at first sight appear; for cuttings of some vegetables, if planted inversely, will take root, the top bearing the root, and the bottom the branches and inflorescence.

The fresh-water polype usually remains fixed by its closed extremity to one spot, from which it seldom moves, exhibiting no other trace of an animated being than the motions of its arms; but when the want of light or heat causes it to shift its quarters, it moves slowly by fixing alternately, like a leech, its head and tail to what it is moving upon.

The majority of the *marine polypes* are attached, in some way, to a calcareous support formed by themselves, which is

called by Amoureux, Lamarck, and other continental writers, their *Polypary*;[1] and they are none of them locomotive except the last order.

4. The Polypes of the *second* Order, the sheathed polypes of Lamarck,[2] as the most important and interesting of this class of the animal kingdom, I wish to leave last upon the reader's memory. I shall, therefore, next make a few brief observations upon those sponges and alcyons that have no tentacles, and form the *fourth* Order. These are included by Lamarck amongst those just mentioned, but they appear not properly to belong to them, and to have a still more simple organization. In this tribe, as was before observed, nutrition seems carried on by a kind of systole and diastole, the sea water being alternately absorbed and rejected by the tubes composing the substance of the sponge, they having no organs to collect their food in any other way.

Many of these productions are remarkable for being hollowed internally, and in their external shape resembling cups, bowls, and vases: several gigantic specimens of this kind were collected in India by the late lamented Sir Stamford Raffles, to whose indefatigable exertions, judicious arrangements, and uncommon ardour in her cause, science is so deeply indebted, and presented by him, with the rest of his valuable collections, to the Museum of the Zoological Society, where they are now to be seen. Their general structure also, as well as form, fits them for receiving a large quantity of water, as well as for parting with it, in proportion to the pressure, when received: in the living animal, this pressure is produced by its expansion.

What particular function, or office, has been devolved by the All-wise Creator upon these zoophytes, which are produced so rapidly, and in such numbers, on the bed of the ocean and its rocks, has not been ascertained. As in the case of a vast variety of other marine animals, they probably derive their nutriment from the contents of the water absorbed by their tubes; they may contribute their part to the depuration of the oceanic waters, and to the maintenance of the equilibrium amongst their inhabitants, however minute, which is necessary to the general welfare. Doubtless, in their creation, He, who inhabiteth Eternity, to whose view all time as well as all space is present, had in view the benefit of his creature man, to whom they form a very useful present, and which he has long applied to his purposes. Sponges were in use as early as Aristotle's time, when the people that employed themselves in col-

1 Fr. *Polypier*.

2 *Polypi vaginati*.

lecting them observed, that when they attempted to pluck them up they appeared to resist, whence they concluded they had some sensation.[1] They now form a very considerable article of commerce. The fishery for them is chiefly carried on in the Mediterranean, particularly in the Grecian Archipelago. The collection of them is attended with danger, as they are fixed to the rocks at the depth of several fathoms, so that the sponge-fishers must be excellent divers. Tournefort says, that no youth in these islands is allowed to marry, till he has given proofs of his capacity in this respect. Amongst plants, as Mr W. S. Mac Leay has, I think, remarked, sponges present some analogy to the puff-balls.[2]

5. A *fifth* Order of polypes, worthy of attention, is that to which the *red coral* belongs, in these the animal instead of being covered, or in any way sheltered by its polypary, invests it completely, so as to form a kind of bark over every part of it; on this account the name has been changed by writers on these animals, and it is denominated their *axis*, since upon it they are, as it were, suspended, and run their prescribed race. This axis consists of a much more rigid, solid and lapidose substance, than the polypary of the really *sheathed* polypes, presenting when polished the smooth substance and lustre of marble, without any appearance of pores or other orifices—when broken it exhibits the same kind of fracture as a stick of red sealing-wax; this description refers particularly to the red coral,[3] for in some other genera belonging to the Order the axis is jointed,[4] and in others, very flexible.[5] The sheathed corallines appear in some sort, to be analogues of those animnls whose bodies are covered and defended by an external crust or shell, like the Testaceous Molluscans, the Crustaceans and the Insects; while the tribe in question, especially those having a jointed axis, present some analogy to the vertebrated animals, in which the muscles cover the bones. It should seem, from the solid and compact substance generated by them, that these Polypes absorb from the sea-water a greater quantity of the matter which is converted into carbonite of lime than the rest of the class, so as to enable them to condense it into the smallest compass, and therefore Providence has gifted them with the faculty of making up in *virtue*, so to speak, what they may want in *volume*. A single-stemmed species, however, belonging to the flexible genus *Antipathes*, found by Professoı Esch-

1 Aristot. *Hist. Anim.* B. i. c. 1, comp. B. v. c. 16.
2 *Lycoperdon.*
3 *Corallium.*
4 *Isis*, &c.
5 *Antipathes, Gorgonia*

scholtz, on the north-west coast of America, was ten feet long. The foot, or base by which the common coral is attached to the rocks, as indeed is the case with the whole section to which it belongs, is remarkably expanded; it rises at first with a single stem of varying magnitude, which soon divides into a small number of branches, in their turn dividing and subdividing irregularly into a great number of others, so as to resemble a leafless shrub, rising to the height of about eighteen inches. After pearls, this is the most precious production of the ocean, and has always been a valuable article of commerce. As well as the common sponge, it is principally the produce of the Mediterranean, and is formed with such rapidity, that a place which has been quite exhausted by the coral fishermen, in the course of a very few years, is again replenished with it. It is probably enabled, by its broad well fixed base and rigid axis, to withstand the violent action of the strong currents of the sea just mentioned.

6. The *Floating Polypes*, which form Lamarck's last order, chiefly differ from the coral in being locomotive, and sometimes swimming freely about in the sea, though some usually remain stationary, but never fixed. Their oviform germs, like those of many other marine polypes, are ejected by the mouth. The most noted species, from its singular resemblance to a quill with its plumes, is called the sea-pen.[1] It is a phosphoric animal, and emits a light so brilliant that by it the fishermen can see the fishes swimming near it, so as to be able to cast their nets.

The vast number of marine animals that are endued with the remarkable faculty of emitting light, indicate that it answers some important purpose in their economy. A fact observed by the celebrated Navigator Peron, renders it probable that its object is defence; he remarked that when the Atlantic Pyrosome[2] was irritated, as well as when it was contracted, its phosphorescence was augmented. A variety of hypotheses with respect to the phosphorescence of the ocean have been started; at first it was attributed to the revolutions of the earth, to electricity, &c.; then to putrescent marine animals, which certainly do emit light; but it is now generally known to be the property of a variety of the more frail inhabitants of the deep, and the above remark renders it extremely probable that it was given them by their Creator, to defend them from the attack of their enemies, whom a sudden augmentation of the intensity of their light may frighten from their purpose.

1 *Pennatula argentea.* 2 *Pyrosoma atlanticum.*

2. But the most celebrated polypes, and those which produce the most wonderful effects in some parts of the globe that we inhabit, belong to the section in which the polypary is lamelliferous, or having the star-shaped oscula, or mouth, from which the polype exerts its tentacles, lamellated or divided into various channels, separated from each other by elevated processes, resembling the gills of a mushroom: these, with several others related to them, Linné regarded as belonging to *one* genus which he denominated *Madrepora*, but which Lamarck has divided into *eighteen!* It is amongst the species of this genus, even as circumscribed by the author just mentioned, that we are to look for the polype, which is instructed by its Creator, not only to erect rocky reefs of vast extent and wonderful solidity—which often arrest and perplex the course of the navigator, and greatly increase the perils of navigation—and submarine mountains that keep gradually diminishing the mass of waters, but also islands, which emerging from the ocean, in process of time are covered with vegetation, and fitted to receive and maintain an animal population with man at their head. The species principally engaged in this great work is the coral, called by Linné the *muricated Madrepore*,[1] and generally known by the name of *white coral;* but Lamarck seems not to have been satisfied as to this species, since it is excluded from his list of madrepores, though he refers to four, if not five, varieties of it as distinct species. Its polype, though so celebrated for its wonderful works, seems to be unknown. Rumphius however has described that of the *fungus Madrepore*, and recently an Italian, Vincent Rosa, whose description I shall copy, another species.

"From every cell," says he, "issues a cylindrical animal, resembling an intestine, transversely wrinkled, about half an inch long and two lines in diameter, and of which the upper extremity or mouth is surrounded by about twenty-two very short tentacles. These animals, which are pendent, because this madrepore is always fixed under the projections of the rocks, and vibrates at the will of the waves, are always of a lively orange colour, they contract as soon as they are touched, and they die upon being taken out of the water." Whoever examines a fragment of the polypary of any of the varieties of white coral, will find it to consist of innumerable radiating tubes, variously intercepted, all of which appear to issue from a common base; these are the receptacles of the general body of polype, while the connected individuals with their blossoms

1 *Madrepora muricata.* PLATE II. FIG. 1.

inhabit an infinity of cells opening externally, from which the tentacles issue to collect their food.

The seemingly insignificant creatures here described, and which seem as little animalized as any animal can be to retain a right to the name, all whose means of action are confined to their tentacles, and whose sole employment appears to be the collection and absorption of the beings that form their food, are employed by their Creator, to construct and rear mighty fabrics in the bosom of the deep. He has so organized them, that from their food and the waters of the ocean, which by a constant expansion and contraction they absorb and expel, they are enabled to separate, or elaborate, calcareous particles with which they build up, and are continually enlarging, their structures; forming them into innumerable cells, each inhabited by an individual animal, which however is not insulated and separated from the parent body, but forms a part of a many headed and many mouthed monster, which, at every oral orifice, is collecting the means of still increasing its coral palace, and thus it goes on till it has formed a habitation, not for itself, but, as I said, for man, in the midst of the world of waters.

One of their most celebrated historians, Amoureux, thus expresses himself upon this part of their history. "Some, by their union or aggregation, form a long narrow ridge or reef, which extends uninterruptedly several degrees, opposing an immovable rampart to the great currents of the sea, which it often traverses, the solidity and magnitude of which increases daily. Sometimes this line of madreporic rocks assumes a circular form; the polypes that inhabit it gradually elevate their rocky dwelling to the surface of the sea, working then in a sheltered basin, they little by little fill up its voids, taking the precaution, however, to leave in the upper part of this impenetrable wall openings by which the water can enter and retire, so as to renew itself, and furnish them with a constant supply of their aliment, and of the material with which they erect their habitation."

They do not always elevate their polyparies from the depths of the waters to their surface, some extend themselves horizontally upon the bottom of the sea, following its curvatures, declivities, and anfractuosities, and cover the soil of old ocean with an enamelled carpet of various and brilliant colours, sometimes of a single colour as dazzling as the purple of the ancients. Many of these beings are like a tree which winter has stripped of its leaves, but which the spring adorns with new flowers, and they strike the beholder by the eclat of petal-like

animals, with which their branches are covered from the base to the extremity.

Captain Beechey has given a most interesting account of the proceeding and progress of these animals in erecting these mighty works, and of the manner in which the sea forms ridges, when the animals have carried their work as high as they can: upon these at length a soil is formed beyond the reach of its waves; a vegetation next commences, in time plants and trees spring up, animals arrive, and man himself finds it a convenient residence. His account is too long to copy, I must therefore refer the reader to it, but I must give here his statement of some proceedings of these animals, which have a bearing upon the principal design of the present work, and seem to indicate an instinctive sagacity in the polypes far above their rank in the animal kingdom, and quite inconsistent with their organization.

Speaking of Ducies Island, a formation of the coral animals, he describes it as taking the shape of a truncated cone with the face downwards, the form best calculated to resist the action of the ocean, and then proceeds to say, "The north-eastern and south-western extremities are furnished with points which project under water with less inclination than the sides of the island, and break the sea before it can reach the barrier to the little lagoon formed within it. It is singular that these buttresses are opposed to the only two quarters whence their structure has to apprehend danger, that on the north-east, from the constant action of the trade wind, and that on the other extremity, from the long rolling swell from the south-west so prevalent in these latitudes; and it is worthy of observation, that this barrier, which has the most powerful enemy to oppose, is carried out much further and with less abrubtness than the other." We should feel some surprise if a bee, in the construction of its comb, should strengthen the points most exposed to injury; but that an animal apparently gifted with the lowest degree of sensation, and no intellect, should know where to erect buttresses so as best to provide for the security of its structure indicates in a striking degree the superintendence of Providence directing its blind efforts and unconscious operations.

After considering all the wonderful facts here stated with regard to the proceeding and progress of these seemingly insignificant animals, a speculative imagination may not only picture to itself, with respect to any group of coral islands, its conversion into one vast plain, yielding forests of bread-fruit

and other trees, and ultimately sustenance to a numerous population, and a variety of animals subservient to their use, but taking a wider range and still further enlarging its view, might behold the tropical portion of the vast Pacific, not only studded with these islands, but exhibiting them in such frequent clusters and so large, as almost to form a kind of bridge of communication between Asia and America. Indeed, at present, we know not how far these founders of islands may have been concerned in rearing a considerable portion of those continents that form the old world. Calcareous strata and ridges occur every where, and though other causes may have contributed to their formation,[1] yet it is not improbable, that at the time when our northern climates were inhabited by tropical animals, our seas also might abound in madrepores, &c. which might bear their part in the erection of some of our islands.

Professor Buckland, in the appendix to Captain Beechey's Voyage, states that even within the arctic circle there are spots that can be shown to have been once the site of extensive coral reefs. The old coral reefs that existed previously to the deluge, by that great catastrophe, in many cases, might be formed into chalk ridges. This indeed seems proved by the remains of marine animals, especially sea-urchins, which from this circumstance the common people know by the name of *chalk-eggs*, and which, we learn from Captain Beechey, abound on the submerged ledges of some coral Islands; and at the same period, it is surely no improbable supposition, under the directing hand of Him who willed to destroy the earth by the waters of a flood, and at the same time determined, according to the good pleasure of his will, the precise mode of its renovation, that in the course of the rise, prevalence, or subsidence of the mighty waters, which, for the principal part of a year, acted with irresistible force upon the earth, considerable additions might be made from the debris of the earth's disrupted crust, to the reefs of coral that were left unsubverted, and so many islands be formed or enlarged.

When the Creator formed the coral animals, what foresight, as well as power and wisdom did he manifest! That a minute pouch of animated matter, with no other organs than a few tentacles surrounding its mouth, should be fitted to secrete calcareous particles from food collected by it, to transpire or regurgitate them so as to construct for itself a limestone house, that it should be empowered perpetually to send forth germs that could also act the same part; and thus in process of time,

1 See Lyell's *Geol.* 1. 130. 210.

by their combined efforts, build up in the midst of the fluctuating ocean, not merely insignificant islets, but whole groups of islands, which in due time are rendered fit for the habitation of man himself, and do in fact become his permanent abode —but not only this, but should so order all other circumstances connected with this procedure, as, for instance, the action of the waves and winds upon this nascent little world, that when the animal has built up to that point, which its nature, for it cannot exist when removed from the influence of its native element, enables it to attain, should take up the wonderful work and complete the design of the Great Creator, and give the structure its due elevation and consolidation, should furnish it with fountains and streams of water; should cover it with a soil capable of affording sufficient nutriment to trees and plants, which should in their turn afford food for some part of the animal kingdom, and finally for man himself. How evidently does all this show the adaptation of means to an end. What a number of calculations must be made, what a number of circumstances taken into consideration, what a number of contingences provided against, what a number of conflicting elements made to harmonize and subserve to the promotion of a common purpose, which it is impossible could have been effected but by the intervention and constant guidance of an unseen Being, causing all things so to concur, as to bring about and establish what he designs! And, when we further consider the multiplicity of aspects in which the subject must be viewed, in order to get a clear and correct idea of the co-operation of so many causes, seeming often at variance with each other; we may further affirm, without fear of contradiction, that the whole must be the plan and the work, as the primary and only intelligent cause, of a Being infinite in power, wisdom, and goodness.

There are two circumstances in the above account of the proceedings of these animals, that more particularly demonstrate Divine interposition. One is the precaution to which they have recourse when they build a circular reef in the sea, that they leave an opening in this part for the entrance of the tide and its reflux, so that a constant renovation of the waters takes place, without which they could not proceed in their operations, for want of their necessary aliment.

The other is, not only that they erect their buildings in the form best calculated to resist the action of the ocean, but also erect break-waters to strengthen the weakest points, and those from which the greatest danger is to be apprehended.

It is clear that beings so little organized, with scarcely any

sense or feeling, are not sufficient of themselves to take these precautions, they must be directed and impelled by some power acting upon them; which, foreseeing the want, provides for it; this can be no physical power, for that is equally without intelligence, and acts necessarily, but it must be the result of the will and original action of Supreme Intelligence, who either so organized the animal as to direct it to certain acts, when placed in certain circumstances, by the agency of physical powers; or by his own immediate employment of these powers, influenced its action, as the occasion required.

I cannot conclude this history of the Polypes without adverting to another circumstance which proves in a very striking manner the intervention of the Deity: and that they could not have assumed the various forms under which we behold them, from peculiar circumstances, to the influence of which, in the lapse of ages they were exposed. When we see animals, buried in the bosom of the ocean, symbolize the whole vegetable world from the tree to the moss and lichens that vegetate on its trunk, and the agaric or other funguses that spring up beneath it, we are naturally led to inquire into the reason of this system of representation, exhibited by beings that have no affinity, nor are even contrasted with each other by juxtaposition.

One of the general objects of the vegetable kingdom was to ornament the dry land with what was *fair to look upon*, as well as with what *was good for food.* But the depths of ocean, though planted with various vegetables, seem unapt to exhibit in beauty the frail blossoms of the plant, which though they can bear the fluctuations of their own atmosphere, must often be destroyed by the greater weight and more irresistible agitations of a denser element. To ornament the bosom of the deep, therefore, more solid forms, sending forth blossoms capable of sustaining the action of such an element, were requisite: and therefore God, who gifted his creature man with an inquiring spirit, and with an appetite for knowledge of the works of creation, to furnish him with objects for inquiry, and to gratify that appetite to the utmost, not only placed before his eyes upon the earth an innumerable host of creatures, of which he could gain a notion by only opening his eyes and by observing their beauties, and experiencing their utility, might praise his Maker for them; but also filled the deep with inhabitants, and ornamented it with animals that appeared to vegetate and blossom like plants, that his curiosity being excited, he might also study the inhabitants of the water, and glorify his Maker for the creation of them also.

But we may derive another use from the consideration of these plant-like animals, if the sceptic endeavours to persuade us, from the gradual progress, observable in natural objects from low to high, and from the narrow interval that often separates those in the same series from each other, that by the action of certain physical causes, consequent upon certain established laws and a fixed order of things, and by the stimulus of certain appetencies in themselves, animals gradually changed their forms and organization, and thus, by slow degrees, kept improving in all respects, till at last the monkey became the man, if the sceptic thus attempts to pervert us, we may turn round upon him, and ask him, how it was that the zoophyte, buried in the depths of the ocean, should imitate the plant? can a studied imitation every where denoting purpose and design, a mighty structure including innumerable forms and parts connected with each other and formed evidently according to a preconceived plan, be the result of the operation of blind, *unguided* physical agents, acting by the appetencies of these organized beings? How indeed could they have any appetency to put on the appearance of a set of objects they never saw? The thing is morally impossible. In fact, when we survey the whole series of natural objects, and find throughout a system of representation, as well as a chain of affinities, it is as clear as the light of day, that an infinite Intelligence must first have planned, an Almighty hand then executed, and that infinite Love still sustains the whole.

## CHAPTER VI.

### *Functions and Instincts. Radiaries.*

It happens not seldom to the student of the works of creation, when he is endeavouring to thread the labyrinth of forms in any of the three kingdoms of nature, and has arrived at any given point, to feel doubtful which course to pursue. The road divides, perhaps, into two branches, which both promise to lead him right. At the very outset of the animal kingdom, as we have seen, there was some uncertainty, whether we should begin by the Infusories or Polypes, and now the Tunicaries, or Ascidians as some call them, at the first blush seem more closely connected with the Polypes, than the Radiaries, which Lamarck has placed next to them; but when we consider that the organization is much more advanced in the former than in the latter, not only in the organs of digestion, but in those of sensation, respiration, and circulation, we feel satisfied that the latter, where the object is to ascend, should first be considered. I shall, therefore, now give some account of the *Radiaries.*

The animals forming this class receive this appellation, because they exhibit a disposition to form *rays*, both in their internal and external parts, a disposition which begins to show itself, as we have seen, both in the polypes and the infusories[1] with respect to their oral appendages, and is found also in the tunicaries and cephalopods, or cuttle-fish. And this tendency in the works of the Creator to produce or imitate radiation, does not begin in the animal kingdom; the Geologist detects it in the mineral, and the Botanist in the vegetable, for Actinolites, Pyrites, and other substances exhibit it in the former, and a great variety of the blossoms of plants in the latter. We may ascend higher, and say that irradiation is the beginning of all life, from the seed in the earth and the *punctum saliens* in the egg, to the fœtus in the womb; and still higher in the physical world, sound radiates, light radiates, heat radiates. If we further survey the whole universe, what do we behold but

1 See above, p. 82, 89, &c.

radiating bodies dispersed in every direction. Suns of innumerable systems, shedding their rays upon their attendant planets; and the Great Spiritual Sun of the universe, even God himself, is described in Holy Scripture as that awful Being, "*Whose goings forth have been from of old, from everlasting.*"

Cuvier, and after him several other modern Zoologists, have considered Lamarck's Class of Radiaries as forming a group or class of the zoophytes; but when we recollect that they cannot, like the infusories and polypes, be propagated by cuttings and offsetts, this seems to indicate an animal substance in which the nervous molecules are less dispersed, and that some tendency to nervous centres has been established. In the upper classes of invertebrated animals, indeed, many will reproduce an organ when mutilated, and some even a head, but none but the polypes and infusories multiply themselves in the way above stated. It seems, therefore, most advisable to adhere to Lamarck's system, by considering the animals in question, as forming a group by themselves, and to adopt his name of *Radiaries.*

These are distinguished from the class immediately preceding the polypes, by being limited as to their growth to a certain standard, as to their form by the general appearance of radiation they usually present, being either divided into rays, as in the star-fish; or having rays exhibited by their crust as in the sea-urchins; or embedded in their substance, forming appendages to their viscera, as in the sea-nettle or jelly-fish. They have not, like the polypes, a terminal mouth or orifice surrounded by food-collecting tentacles; but one placed, most commonly, underneath their body. Their digestive organs are distinct and more complex. They are never fixed, and are to be met with only in the sea and its estuaries. Lamarck has divided this class into two orders, the *Gelatines*[1] and the *Echinoderms.*[2]

1. The *Gelatines*, which some consider as a distinct class under the name of *Acalephes*,[3] are distinguished by a gelatinous body, and a soft and transparent skin; they have no retractile tubes issuing from the body; no anal passage; no hard parts in the mouth; and they have no interior cavity, their viscera being imbedded in their gelatinous substance.

Some genera[4] in this Order, like the fishes, are remarkable for an air-vessel which they can fill or empty, and so rise to the surface, or sink to the bottom at their pleasure, but it dif-

1 *Radiaires molasses.*
2 *R. Echinodermes.*
3 *Acalepha.*
4 *Physsophora*, &c.

fers from that of the fishes in being external; others are distinguished by a dorsal crest, which they erect and use as a sail.[1]

2. The *Echinoderms* have an opaque, leathery, or crustaceous skin, mostly covered with tubercles, or even movable spines, and generally pierced with holes, disposed in rows; retractile tubes which respire the water, and are used also for locomotion and prehension, emerge from these holes; a mouth generally situated below, and armed with hard parts; and a cavity simple or divided.

To begin with the *Gelatines*—in walking upon the sea-shore, I have occasionally remarked an animal of this tribe left by the waves, not much larger than a nutmeg, of a spherical form, with several longitudinal ridges, and nearly as transparent as the purest crystal. If at all injured by the touch, it immediately dissolved. Such delicate creatures has the Creator exposed to the action of the oceanic waves, and they sail gaily on, by means of their ciliated tails, receiving no injury, frail as they are, except in being sometimes cast upon the shore. These lucid gems of the waters,[2] which abound equally within the polar circle and near the equator, are eminently phosphoric. Bosc says, he has seen millions, which he could scarcely distinguish during the day from the water in which they lived, but which in warm and calm nights afforded the most brilliant spectacle. From their rotatory motion, they seemed then globes of fire which rolled upon the surface of the water. The more rapid their motion, the more intense the light, and their tails always emitted more than their body. They doubtless absorb animalcules with the water that they inspire, and they swim by a motion combining rotation with contraction and dilatation. They are found from a line to six inches in diameter. Providence has destined them to be the food of a vast number of fishes, even the whale does not disdain them; and we may conjecture the havoc that one of these giants of the ocean would make in their ranks. The manner in which they are propagated has not been ascertained, but from their infinite numbers in every sea, their progeny must be inconceivable.

Another phosphoric animal of the present tribe is distinguished by a dorsal crest, resembling a vesicle full of air, and which it is said to use as a sail, like many of the Molluscans, to conduct it over the surface of the waves. It is connected

1 *Vellela.* 2 *Beroe.*

with the body only by its middle, its extremities being at liberty, which enables the animal to steer its course in any direction.

I shall mention one more of these gelatines, which falls under the observation of every one who is fond of sailing, or rowing, in a boat on the ocean or in its estuaries. If he cast his eye upon the water in fair weather, he will see numbers of animals, in shape resembling an expanded umbrella, with some flesh-coloured organs round the summit or centre, carried with the rising or falling tide, and dancing along with a seemingly undulating motion: these belong to what are vulgarly called the jelly-fish, or *sea-nettles*.[1] Though the body of the animals of this tribe is gelatinous and easily melts, yet its weight is considerable, and it is said that they can render themselves heavy or light at pleasure, which some effect by means of a natatory vesicle, but the means in all has not been ascertained; unless they were thus gifted, as their specific gravity exceeds that of the water, they could not raise themselves to the surface, where they are seen swimming very gracefully; as it were, by an alternate systole and diastole, admitting and rejecting the sea-water. Several of them,[2] for it is not common to them all, when touched, cause a sensation similar to that produced by the sting of a nettle:[3] it is supposed by some that this is done by their tentacles, which are conjectured to have little suckers, as indeed is very probable, which adhere to the skin. This faculty, which is supposed to be the lowest degree of the electric power peculiar to several fishes, is found in other genera of this tribe; for instance, the Jamaica sea-nettle,[4] is said to affect the hands, when touched, still more severely. Probably this faculty was given to them by Providence, either for the defence of their frail forms against their assailants, or to enable them to secure their prey, this being the general use of their numerous tentacles and other organs. Lamarck observes, that some of these animals are so large as to be more than a foot in diameter, and that some weigh as much as sixty pounds. Their multitudes are prodigious, and, as well as the *beroe*, they are said to form part of the food of the whale: they are even devoured by some of their own class. The mode by which these creatures are produced in such infinite profusion is at present unknown. They do not reproduce mutilated parts; therefore it cannot be, as in the polypes, by the division of their bodies.

1 Plate III. Fig. 1.

2 *Rhizostoma*. Cuv. *Cepheæ Rhizostomæ*, Lam.

3 See Appendix, note 22.

4 *Physalis pelagica*

When we consider the extreme fragility and deliquescent nature of the animals constituting this order of the Radiaries, that a touch almost disorganizes their structure, and moreover that they form part of the food of the most gigantic animals in creation, we should be led to think it impossible that they could withstand all these combined actions upon them, and that however numerous and prolific, they must at length be utterly annihilated. Nothing less, indeed, than Almighty Power, and Infinite Wisdom and prescience, and a Goodness that is interested in the welfare of the meanest as well as the mightiest of the animals he has brought into being, could have preserved them from such a fate. He who made all things decreed their mutual relations, limited their numbers by certain laws, and appointed the means by which those laws should be executed. We may say, that in some sense the whales were created for the gelatinous radiaries and numberless other animals with which the seas frequented by these monsters abound, and that these gelatinous radiaries were created for the whales. The enormous mouth of the last-named animals is not armed with tusks or grinders, but fitted instead with vast numbers of oblique laminæ of a softer substance, usually denominated whalebone, which is adapted only for the crushing and masticating of soft bodies ; therefore instead of a prey more proportioned to their bulk, they contentedly make their meal off these small but innumerable gelatines, which, by their number, make up for their want of magnitude, and are exactly suited to the masticating organs of their devourer ; and though the waste of animal life seems almost infinite, yet was it not for this check, so great appear to be the powers of multiplication of the smaller creatures that swarm under the ice of the Arctic seas, there would be more than could be maintained consistently with the general welfare.

The object of Providence throughout our globe, as has been before observed, is so to balance the respective numbers of the different kinds of animals, from the invisible monad to the gigantic whale, that a certain proportion may be preserved, with regard to their numbers, between them, so that each may be in sufficient force to accomplish the end for which it was created. We may observe that though the whale devours myriads of millions, yet the quantum of suffering is less than if he were enabled to make his meal off larger animals, and his jaws, like the shark's, were fitted with laniary teeth. In fact the gelatines are incapable of suffering pain, having no digested nervous system, and when cast upon the shore they dissolve into a fluid exactly resembling sea water.

The *Echinoderms*[1] form the second order of the Radiaries. This name was first given by Bruguières to a class formed solely of Linné's genera *Echinus* and *Asterias*, but Lamarck has added others to it. He has divided it into three sections, the *Stelleridans*, *Echinidans*, and *Fistulidans*; in all these the outward envelope is of a much harder substance than in the gelatines, in the first and last of these sections resembling leather, and in the other, consisting of the sea-urchins,[2] it is a crust in some degree like that of crabs and lobsters. The animals of this Order, though their nervous system is obscure, have a high degree of muscular motion and are fitted with motive organs.

To look at a *star-fish* one would wonder, at first, how it could move progressively, its rays seeming not at all calculated for that purpose, this however is wisely provided for. Those of one family send forth a number of tentacles, from a furrow in the underside of the rays into which their body is divided, each terminating in a cup-shaped sucker, which they can lengthen or shorten, and fix to hard bodies. These tentacles, or legs, as Cuvier calls them, are similar in structure in all the Echinoderms. They are separately retractile, their form is nearly that of a long ampullaceous tube, filled with a subtle fluid; the elongated tubular part is that which appears without the shell; the spherical portion remaining within the body: by means of the above fluid, as in the Polypes,[3] the tube is darted forth, or retracted. Belon counted 5000 of these suckers in one species. In the sea-urchin star-fish[4] there are twenty rays, and the suckers are so thick as to touch each other. They may probably be of use to them also as organs of prehension to seize their prey. Those of the family to which the Medusa star-fish belongs, move in a different way. The diverging rays are firm and hard, have few spines, and no channel with suckers; they are used by the animal as legs, and as they are regularly placed it can move in any direction that suits it. To go towards any particular spot, it uses the two rays that are nearest to it, and another that is most distant from it; the two first curve at their extremity so as to form two hooks, which being applied to the sand drag the body forwards, while the posterior is curved vertically, and performs the part of a repelling leaver. The suckers, which in this genus issue from the sides of the rays, at the junction of the upper and lower surfaces, appear short, but being retractile, they can be lengthened, and doubtless are used to seize the

1 *Echinodermata.*
2 *Echinus.*
3 See above, p. 88.
4 *Asterias echinites.*

animals that come in their way. What can more strikingly indicate the contrivance and design of an Intelligent Being than the structure of these stellated animals by which they are enabled to move in different directions, and to secure their prey?

The exterior envelope of the *sea-urchins* is formed by two membranes, the one external and thicker, and the other a very thin pellicle. Between the membranes is a thick, solid, calcareous shell composed of a great number of polygonal pieces of a fibrous tissue, evidently immovable, but not soldered during the growth of the animal. The shell of the common species[1] if closely examined, when denuded of its spines and other organs, will be found to be divided into twenty longitudinal portions, ten of which are covered with breast-shaped protuberances,[2] varying in size, which bear the spines, and ten narrow ones perforated with a number of small orifices, from which the tentacular suckers emerge, which last Linné named *alleys;*[3] I shall therefore call the spine-bearing ones *groves.* These last are alternately wide and narrow, and of a lanceolate form; the wide ones having six rows of the larger tubercles, and the narrow ones only two; between each of these groves is an alley containing nearly thirty oblique double rows of orifices, eight or ten in each row. These alleys terminate in a point at the upper aperture of the shell and are truncated at the lower. Each of the larger groves, if examined internally, will be found to consist of about twenty parallelograms arranged transversely and united by an harmonic suture, in which the edges are merely applied to each other without any inequalities. These larger groves have a central longitudinal ridge, at which it readily divides and discovers a beautifully dentated suture, resembling the dog's tooth of a gothic arch;[4] on the side next the alleys the dentitions of the suture are much less prominent and conspicuous. The smaller groves have the same ridge and divide in the same way, and seem to form one piece with the alleys on each side of it: so that one of the narrow groves with its two alleys forms the support of one of the frames of the jaws.[5] These narrow groves consist of about sixty transverse pieces, and when divided of double that number: thus wonderfully is the house in which these animals reside, formed by its Divine Builder. The sutures of the human skull, as anatomists observe, admit of its more easy formation into a spherical box:

1 *Echinus edulis.* L.
2 Plate III. Fig. 2, *a.*
3 *Ambulacra. Ibid. b.*
4 Plate III. Fig. 3, *a.*
5 *Ibid.* Fig. 3, *d.*

the shell of the sea-urchin is adapted with equal skill and wisdom, the longitudinal sutures favouring the proper flexure one way, and the transverse ones allowing a curvature in a contrary direction: and besides, by this structure, as Mr Gray has observed and De Blainville intimates, the gradual increment of the shell, by the deposition of fresh matter in all these parts, is rendered easy.

But the spines and suckers of these animals are equally worthy of our notice and investigation; the former as instruments of defence and locomotion, and the latter as instruments of locomotion, prehension, and respiration. I mentioned the protuberances, large and small, the latter usually planted round the former, shaped like a breast with a central elevation resembling the nipple, these afford a basis with which the spines articulate, being united to it by a membranous ligature or sac, so as to form a kind of ball-and-socket articulation, working upon these protuberances by means of the membrane, the spines can assume every inclination between vertical and horizontal, and may be used both as motive and defensive organs. The great zoological and physiological luminary of Greece, Aristotle, observed of these animals that they use their spines as legs for change of place,[1] and Reaumur, who paid particular attention to their motions, found, that whether they moved in a horizontal position, as they usually do, or in a reversed one, or upon their sides, they principally used their spines. As they can move in any direction, some are used as legs for progressive movement, others as points of support to prevent a retrogressive one. It is by means of their spines, also, some performing one office and some another, that they bury themselves in the moist sand on the sea shore.[2]

It is not easy to conceive by what mechanism the spines are moved; the protuberances on which they move are fixed, and there appears to be no communication between the interior of the shell and the membranous sac by which they are attached to them. "It is very difficult," says Cuvier, "to see the fibres that move these spines at the will of the animal, for nothing is observable in their articulation but a very solid ligamentous substance, which it is very difficult to cut. I have examined, with a lens of considerable power, the shell both within and without, and have been able to discover no pores on either side, round the base of the protuberances or elsewhere; so that it seems impossible for any muscular threads, however fine, to pass from the body of the animal to the connecting ligament by

1 Hist. Anim. B. IV. c. 5, ad fin. 2 Osler in *Philos. Tr.* 1826.

which it could move it and so give the spine its different inclinations. Yet as the spines are employed by the sea-urchin to effect its motions, there must be some intermediate agent, hitherto undiscovered, which it has at its command, by which it can act upon them. Dr Carus's remarks on the zoophytes in general are very applicable in the present instance—"When we find," says he, "that there can be respiration without lungs; that nutrition, growth, and secretion may exist without a circulation of fluids; and that generation may take place without distinct sexes, &c. why should we doubt that sensitive life may exist without nerves, or motion without muscular fibres?" It is important to be observed here, that these spines, however strongly attached they may appear in the living animal, in the dead one fall off upon the slightest touch, which proves that the cause of their adhesion is connected with its life.

But though it is difficult to detect the muscular fibres that move the spines of the *common* sea-urchin, I had an opportunity, when correcting the proof containing the preceding paragraph, through the kindness of my friend Mr Owen, of the Hunterian Museum, well known for his admirable anatomical description of the animal of the pearly Nautilus,[1] of examining a preparation of the large spines, with their sacs, of the mammillary Sea-urchin,[2] in which the muscular fibres were distinctly visible, enveloping the base of the spine, when the sac was removed; so that, reasoning from analogy, it may be concluded that the spines of the common species have a similar muscular apparatus.

The spines vary much in their form and sculpture. In the species last named they seem to be of a horny substance, varying in magnitude and length, the larger ones tapering from the base and being blunt at the tip, they are beautifully fluted like the shaft of a Corinthian pillar.[3] The part enveloped by the membrane before mentioned, is thicker than the rest of the shaft, perfectly smooth, but terminates in a bead: they are tinted with violet, but the base and tip, or the pedestal and capital of the pillar are white. The base is concave so as to play upon the levigated centre of the above protuberance. Besides these larger spines, there are some bristled-shaped ones terminating in a subovate knob, which when unfolded appears to resemble a tripetalous flower with acuminated petals, and

1 *Nautilus Pompilius.*

2 *Cidaris mamillatus*, Plate III. Fig. 4.

3 *Cidaris mamillatus*, Plate III. Fig. 14.

which are supposed to be polypes.[1] Those parts void of spines, called the alleys, distinguished by rows of orifices disposed in pairs, are furnished with a quite different kind of organ, I mean the suckers[2] before alluded to and described, by which the animal can also move or fix itself to any substance; it is thought also, as they are perforated, that it uses them to absorb the water for respiration. The length of these suckers or tentacles, for so they may be also called, when they are fully extended, is always greater than that of the spines, so that they may serve as so many anchors to fix the animal and enable it to resist the mass of waters that press upon it. They are stated to be more numerous near the mouth than in other parts, by which arrangement Divine Wisdom has fitted them to maintain a horizontal position, which is their natural one. These suckers fix the animal so firmly to the rocks, that it is with the greatest difficulty, and seldom without crushing the shell, that they can be separated.

The most powerful and complex organs with which the Creator has gifted the Echinidans are their jaws and teeth. Their mouth has adapted to it a remarkable frame-work, consisting of five pieces, corresponding with five segments, into which the shell may be divded; each of these pieces forms an arch,[3] and the whole a pyramidal frame, which was compared by Aristotle to a lanthorn without a skin. To these are attached the movable part of the apparatus, consisting of five jaws, each containing a long tooth,[4] the teeth converging in the centre close the mouth.[5] Altogether this complex machine consists of twenty-five pieces moved by thirty-five muscles. The disposition of these pieces, Lamarck observes, and of their moving muscles, indicate that the parts of this machine can have only a common movement, and no one of them an individual or separate one; but it appears from Cuvier's elaborate description of this wonderful and complex machinery, if I understand him right, that the action of certain muscles will give to any one of the teeth that form the pyramids an independent motion. This powerful apparatus, which the animal can incline in different directions, indicates a kind of food, less easy to bruise and masticate than what we have seen satisfies the whale, and these organs afford a singular contrast to those by which that enormous monster masticates its food.

The Echinidans, whose station appears to be often near the

1 *Pedicellariæ*, *Ibid.* Fig. 12, 13.
2 *Ibid.* Fig. 14.
3 Plate III. Fig. 3, *d.*
4 *Ibid.* Fig 10, 11.
5 Plate III. Fig. 9.

shore upon submerged ledges of rock, feed upon whatever animal they can seize. We have seen that they sometimes turn upon their back and sides, as well as move horizontally, this enables them more readily to secure their food, with the aid of the numerous suckers in the vicinity of their mouth, which when once they are fixed, never let go their hold till the animal is brought within the action of their powerful jaws. Lamarck thinks they do not masticate but only lacerate their food; but as two faces of each of their pyramidal organs answer those of the two adjoining ones, and these faces are finely and transversely furrowed,[1] this looks like masticating surfaces. Bosc, who appears to have seen them take their food, says it consists principally of young shell-fish, and small crustaecous animals; as the latter are very alert in their motions, it is difficult for the sea-urchins to lay hold of them: but when once one of these animals suffers itself to be touched by one or two of the tentacles of its enemy, it is soon seized by a great number of others, and immediately carried towards the mouth, the apparatus of which developing itself, soon reduces it to a pulp.

Who can say that the All-wise Creator did not foresee all the situations into which this animal would be thrown, so as to provide it with every thing that its station and functions require? Considering its internal organization and the nature of the animal itself, and that it holds a middle station between the polype and the Molluscans, in the former of which the development of muscle is very obscure, and in the latter very conspicuous, and that it cannot, like the former, fix itself by its base, and so support a polypary, or if endued with locomotive powers carry with it a heavy shell; these things considered, and the nature of its food, and the force necessary to prepare it for digestion, it was evidently requisite that it should be defended by a crust sufficient to afford a support, and give effect to its powerful oral apparatus, and yet light enough to yield to the efforts of its motive powers; but as this crust, from its composition and nature, was liable to be crushed by a very slight pressure, it required further means of defence, and with these its Almighty and Beneficient Creator has amply provided it, by covering it, like a hedge-hog, with innumerable spines, varying in length, and capable of various movements. The long ones, when erected, defend it on all sides, both from the attack of enemies and from the effects of accidental pressure, and we may conjecture that when the longer ones are couched to answer any particular purpose, the short ones may come into

1 Plate III. Fig. 11.

play, and assist in keeping any pressure from the crust. Perhaps, as in the hedge-hog, the ordinary posture of the longer spines is couchant, and they are only erected when the animal is in motion or under alarm.

The wonderful apparatus which closes the mouth of the common or *typical* sea-urchin,[1] is another and striking proof that Creative Wisdom employs diversified means to attain a common end, the nutrition of the animal. The mouth of this animal is under its body, a situation far from favourable, according to appearance, for the mastication or bruising of its food: if its jaws moved vertically, like ours or the mandibles of a bird; or if they moved horizontally like those of insects, it would have been attended with no small trouble to an animal whose mouth was underneath, but its five pyramidal jaws with the points of the teeth in the centre, admit an action more accordant with the situation of the mouth. By means of its numerous muscles it can impart a variety of action to the mass and individual pieces that form its oral apparatus, so as to accommodate it to circumstances, a power not possessed by the higher animals. In those Echinidans, whose mouth is in the margin of the anterior part of the shell,[2] no such powerful apparatus is observable, its situation being in front of the animal, it is not as it were under restraint, it has less occasion for the aid either of tentacles in its vicinity, or of a powerful apparatus of masticating organs.

By furnishing these animals with a set of peculiar organs to act the part of hands as well as feet, we have another instance of the care of Divine Providence to adapt every creature to the situation and circumstances in which it is placed. The legs and arms of the higher animals would be rather an incumbrance to an Echinidan, as well as a deformity; it is therefore furnished with a set of organs better adapted to its peculiar station, wants, and functions, in a numerous set of retractile tubes[3] capable of the necessary extension, fitted at their extremity with a cup acting as a cupping-glass or sucker, and enabling the animal to adhere, with irresistible force, to any substance to which it applies them, and discharging at the same time the functions of hands to lay hold of their prey and convey it to their mouth, of legs and feet to stay themselves upon, and of lungs to assist in their respiration.

The workmanship also in these animal structures is as beautiful and striking as the contrivance manifested in them is

1 *Echinus edulis.*

2 *Ananchites, Spatangus, &c.*

3 PLATE III. FIG. 5

wonderful. Their protuberances, especially in the mammillary sea-urchin, their variously sculptured spines, their tentacular suckers, all by their perfect finish and admirable forms declare —The hand that made us is divine—since they exceed in all these respects the most elaborate human works.

The *third* and last section of the Echinoderms, or spiny-skinned Radiaries, are the *Fistulidans.*[1] Amongst these we may notice the *Sea-anemonies,*[2] marine animals, fixing themselves to the rocks, but having the power of locomotion, which from a common base send forth what appear to be a number of stalks terminating each in what seems a many-petaled flower of various hues, so that those who have an opportunity of observing them from a diving bell, may see the sub-merged rocks covered with beautiful blossoms of various colours, and vieing with the parterres of the gayest gardens. Ellis, who was the first Englishman who opened his eyes to the beauties and singularities that adorn the garden which God has planted in the bosom of the ocean, has named many of these from flowers they seem to represent, as the daisy, the cereus, the pink, the aster, the sunflower, &c.

These animals, at first, appear to come very near the polypes, especially the fresh-water ones,[3] bearing a number of individuals, springing, as it were, from the same root, each sending forth from its mouth a number of tentacles, which are stated to terminate in a sucker, and by which also, like the other Echinoderms, they respire and reject the water; they also reproduce their tentacles when cut off. Portions of the base when divided are reproductive, but they do not separate from the parent till their tentacles are completely formed. Their internal organization, however, is much more advanced than that of the polypes. They have a separate alimentary sac or tube, surrounded by longitudinal muscles, and even nervous nodules or ganglions, and also several ovaries.

In mild calm weather, when the sun shines, they may be seen in places, where the water is not very deep, expanding their many-coloured flowers at the surface of the waters—but upon the slightest indication of danger, the flowers suddenly disappear, the animal contracts itself and wears the aspect of a mass of flesh. They as it were, vomit up their young, or the germs formed in the ovaries: but they sometimes force their way out from other parts. When inclined to change their station they glide upon their base, or completely detaching themselves, commit themselves to the guidance of the waves.

1 *Fistulides*, Lam. 2 *Actinia.* 3 *Hydra.*

Reaumur observed them use their tentacles like the Cephalopods, for locomotion. They fix themselves with so much force, that they cannot be detached without crushing them.

It is not wonderful that so many of the lower aquatic animals should have been mistaken for plants, when they so exactly represent their forms, their roots, their branches and twigs, their leaves and their flowers—but besides the irritability of the animal substance, which however is partially exhibited by some plants; there is another character which seems, as a strong line of demarcation, to be drawn between them, and to which I have before adverted;[1] animals take their food by a mouth at one extremity of the body, plants by roots diverging from the other. The reproductive organs in the latter occupy the place and ornature of the nutritive ones in the former. The gay and varied colours of the blossoms, the infinite diversity of their forms, the delicious scent so many of them exhale, all are calculated to draw the attention and excite the admiration of the beholder, while the organs of nutrition are usually hid in the earth. Not so in the animal kingdom; the nutritive organs, or rather those that prepare the nutriment, are placed in the most eminent and conspicuous part of the body, in the vicinity of all the noblest avenues of the senses, while those of reproduction are placed in the most ignoble station, and are usually found closely united with those passages by which the excretions of the body pass off. In the *Tunicaries* indeed the mouth and the anal passage[2] are usually very near to each other, and in the polypes the same mouth that receives the food rejects the feces, and it even sometimes appears to happen that an animal has been swallowed, and after performing the ordinary revolution in the stomach, has been ejected again in a living state.

1 See above, p. 74.

2 Plate IV. Fig. 1.

## CHAPTER VII.

### *Functions and Instincts. Tunicaries.*

THE animals we have hitherto been considering were all regarded by Cuvier as belonging to his first class, the *Zoophytes*, and are continued therein by Carus; the latter, however, allows that the *Echinoderms* are somewhat removed from the class by the commencement of a nervous system. Lamarck's next class, the *Tunicaries*,[1] which we are now to enter upon, form part of the headless Molluscans[2] of Cuvier, and belong to that section of them that have no shells. My learned friend, Savigny, in his elaborate and admirable work on *The Invertebrate Animals*, who also considers them as a separate class, denominates them *Ascidians*,[3] dividing them into two Orders, *Tethydans* and *Thalidans*.[4] Many alcyons of Linné and others, are now referred to the Class we are treating of.

The characters of the class may be thus stated: ANIMAL, either gelatinous or leathery, covered by a double *tunic*, or envelope. The external one, analogous to the shell of Molluscans, distinctly organized, provided with two apertures, the one *oral*, for respiration and nutrition, the other *anal;* the interior envelope, analogous to their mantle, provided also with two apertures adhering to those of the outer one. *Body* oblong, irregular, divided interiorly into many cavities, without a head; *gills* occupying, entirely or in part, the surface of a cavity within the mantle; *mouth* placed towards the bottom of the respiratory cavity between the gills; *alimentary tube*, open at both ends; a *ganglion*, sending nerves to the mouth and anus.

These animals are either simple or aggregate; fixed or floating: the simple ones are sometimes sessile,[5] and sometimes sit upon a footstalk.[6] The aggregate ones possess many characters in common with the polypes, inhabiting, as it were, a common body, somewhat analogous to the polypary, except that it

1 *Tunicata.*
2 *Mollusca Acephala.*
3 *Ascidiæ.*
4 *Tethydes, Thalides.*
5 *Cynthia.*
6 *Clavelina.*

is more intimately connected with the animal that inhabits it: the *mouth* of all is surrounded with rays or tentacles, as is also, in many, the anal orifice; but in their organization they differ very widely, exhibiting traces of a nervous system, and even, in some, of one of circulation. The fixed ones are commonly attached to rocks or other inorganized substances, but sometimes they are parasitic; thus a species of botrylle[1] envelopes, like a cloak, certain ascidians, and another of the Tunicaries[2] envelopes the madrepores, more or less, with a milk white crust.

The Creator, when he filled the waters of the great deep with that infinite variety of animals of which every day brings genera and species, before unknown, to light, willed that many of them should, as it were, form a body politic, consisting of many individuals, separate and distinct as inhabiting different cells, but still possessing a body in common, and many of them receiving benefit from the systole and diastole of a common organ: thus, by a material union, is symbolized, what in terrestrial animal communities results from numerous wills uniting to effect a common object. The land, as far as I can recollect, exhibits no instance of an aggregate animal; nor the ocean of one, which, like the beaver, lemming, bee, wasp, ant, white ant, and many others, forms associations to build and inhabit a common house, and rear a common family.—Probably the nature of the different mediums these several animals inhabit is the cause of this diversity; and Providence, when it willed the peopling of the waters, as well as of the earth and air, into which the effluxes of light and heat from the central orb could not so penetrate and be diffused as to act with the same power and energy as upon the earth's surface, and in its atmosphere, so formed them as to suit the circumstances in which they were to be placed. Instead of sending the social aquatic animals forth by myriads to collect food and materials for their several buildings, he took the vegetable creation for the type of their general structure, in many cases fixed them to the rock or stone, united them all into one body, which, under a common envelope, contained often innumerable cells from which were sent forth by the occupant of each a circle of organs to collect food, from which, by some chemical operation, they could elaborate materials for the enlargement of their common house; and often cause that influx and reflux, to compare small things with great, resembling the oceanic tides, and by which the sea-water is alternately ab-

1 *Botryllus polycyclus.* 2 *Didemnum candidum*, Sav.

sorbed and rejected by these animals: but this function, in the case of some of the Tunicaries, the animals with which we are now concerned, seems to be affected by a central organ or pump common to the whole fraternity.

But although none of the marine associated animals are employed, like the terrestrial ones, in labours that require locomotion and the collection, from different and often distant parts, of materials for the erection of their several fabrics, and of food to store up for the maintenance of the various members of their community, yet there are some that are instructed to form associations, which yet are not united by any material tie or common body, so as to be *physically* inseparable. Of this description are the *Salpes*,[1] or biphores, as the French call them. These are phosphoric animals, so transparent that all their internal organs and all their movements, and even all the contents of their intestines, may be distinctly seen. They are gelatinous like the medusas and beroes, and like them dissolve into water. Their organization, however, proves them to be *Tunicaries*. Certain species of these animals, in this repect unlike every other genus of the animal kingdom, have the property of uniting themselves together, not fortuitously and irregularly, but from their birth and in a certain undeviating order. Bosc observed the reunion of the *confederate Salpe*,[2] which he thus describes: "Every individual is attached by its sides to two others, the mouth of which is turned to the same side; and by the back also to two others, when it is turned to the opposite side." In this circumstance it presents an analogy to the combs of the hive bee, in which each comb consists of a double set of cells placed base to base, with the mouths of each set looking opposite ways, and the cells so placed that a third of the base of three cells occupies the whole of one base in the opposite set.[3] This reunion, in the salpes, is effected by means of eight pedicles, of a nature exactly similar to that of the body. It is perfectly regular, that is to say—all the individuals are at the same distance and height, all the heads in one row are turned to the same side, and those of another to the opposite. These rows usually consist of from forty to fifty individuals, and are carried by the waves sometimes in a straight, sometimes in a curved, and sometimes in a spiral line. In the sea, during the day, they appear like white ribands, and during the night like ribands of fire, which alternately roll up and unroll, wholly or partially, either from the motion of the

1 *Salpa.*

2 *Salpa confœderata.*

3 Plate XI. Fig. 3.

water, or from the will of the animals that compose them. They are found in the ocean only at a great distance from land. Professor Eschscholz mentions one,[1] intermediate between the *Salpes* and *Pyrosomes*—and a similar one is now in the Hunterian Museum[2]—which by means of a pedicle appeared to be attached to some *common* body, all of them arranged in rows with the head turned to the same side; Savigny, whose eye nothing escaped, and the acumen of whose intellect equalled that of his sight, alas now dark, further informs us, that the Salpes adhere to each other only by certain gelatinous protuberances, or as Lamarck suspects, certain lateral suckers, disposed so as not to impede the motions of the muscles; but their union is only temporary. At a certain age, M. Peron observes, these animals separate, all the large individuals being solitary. The same traveller is of opinion that the concatenation of the Salpes is coeval with their birth.

The object of Divine Providence in endowing these animals with an instinct so singular can only be conjectured. They are of so very frail a nature, that perhaps when first produced, the fluctuations of the mass of waters, to the surface of which they appear to rise, might be sufficient to destroy them, or to carry them to the shore, where they would inevitably perish; but by being united in bands, they may be better able to resist their force, and perhaps the more vivid light they thus produce, may be designed for defence,[3] or to answer some other important purpose. When they have attained maturity of size and strength they may be better able to direct their course and avoid these injuries. The young of terrestrial animals generally are associated, under the guidance and protection indeed of the mother, till they are of age to take care of themselves. The object of Providence in both cases is the same, though the modes of its accomplishment vary according to the situation and circumstances of individuals. When we see such paternal care manifested for the welfare and maintenance in in existence, of beings so frail, that a mere touch would dissipate them, we cannot but assent to the observation of the Psalmist, that "*His tender mercies are over all his works*," the least and most insignificant as well as those that appear to occupy the most elevated place in the animal kingdom: and we may feel a comfortable assurance, built on this ground, that the eye which regards even these seemingly insignificant crea-

1 *Anchinia* 2 Plate IV. Fig. 2. 3 See above, p. 95.

tures, will, if we cast not off our confidence, never overlook *us*, or be indifferent to *our* welfare.

The last and highest tribe, belonging to the present class, are those which are never united to each other, but are solitary in all stages of their existence. These, as well as the preceding ones, make a near approach to the real Molluscans, at least their external and internal envelope bears considerable analogy with that of bivalve shells, as Lamarck acknowledges, though they differ in having a distinct organization, the shells of bivalves having neither apparent vessels nor fluids, while, in these Tunicaries, the covering, both external and internal, in some species, exhibits vascular ramifications very conspicuously.

Though several of the animals belonging to the class of Tunicaries are interesting on account of their singularity and beauty, I shall only select two, one from the aggregated, and one from those that are simple, for description and further remarks, and then proceed to the great class of Molluscans. Who would think, asks Lamarck, that the *Pyrosome*, first observed by Peron and Le Sueur, was an assemblage of little aggregate animals; any one that looked at this animal, or at Savigny's figure of it,[1] would mistake it for a simple polype, with a number of leaf-like appendages growing from its skin: but a closer examination would give him a very different idea, and he would discover, with wonder, that it was a mass filled with animals, united by their base, exceeding the number of the above appendages. The common body that contains these creatures resembles a hollow cylinder closed at its upper extremity and open at the lower; this body or mass is gelatinous and transparent, a number of tubercles of a firmer substance than the tube, but at the same time transparent, polished, and shining, differing in size, cover the surface; some being very short, and others longer, and the longer ones terminated by a lance-shaped leaflet. At the summit of each tubercle is a circular aperture, without tentacles, opposite to which is another circular orifice which is toothed.

The pyrosomes are the largest of the phosphoric animals, the *Atlantic* species[2] being about five inches long, and the *Mediterranean*[3] sometimes attaining to the length of fourteen. Their power of emitting light is so great that in the night they cause the sea to appear on fire. Nothing can exceed the daz-

1 *Anim. sans. Vertèbr.* Pl. IV. Fig. 7. 2 *P. atlanticum.*
3 *P. giganteum.* Pl. IV. Fig. 3.

zling light and brilliant colours that these floating bodies exhibit—colours varying in a way truly admirable, passing rapidly every instant, from a dazzling red to saffron, to orange, to green, and azure, and thus reflecting every ray into which the prism divides the light, or which is exhibited by the heavenly bow. In the water their position is generally horizontal, and their locomotion very simple: they float, as they are carried by the waves or the currents; like the salpes, they can however contract and restore themselves individually, and have also a very slight general movement which causes the water to enter their common cavity, visit their gills for respiration, and convey to them the substances which constitute their food. M. Le Sueur observed that when the central cavity of the common tube was filled with water, it was immediately spirted forth in little jets from all the extremities of the tubercles with which the surface was covered, from whence it appears that the external aperture of the individual animal is really the anal aperture, and the opposite or internal one the mouth, which thus received the water and the food it conveyed from the common tube, and rejected it by the orifice of the tubercles.

The internal organization of the little tenants of the common tube is given with considerable detail by Savigny,[1] the general opening at the summit, or truncated end of the tube, has an annular diaphragm, from which it appears that they are arranged in circles round it, so that in this respect they form rays; in shape they somewhat resemble a florence-flask, and have alternately a long and short neck. The cavity below the neck is filled by the gills and various intestines, which it would be difficult to describe intelligibly, in a popular manner. There seems some analogy in these floating hives of luminous animals, both as to size and motion, with the sea-pens.[2]

No species of the genus appears to have been met with in our seas, we may therefore conjecture that a warmer climate is essential to them. Their general functions beyond that of illuminating the great theatre in which their Creator has placed them, and probably affording food to some of the inhabitants of the seas in which they are found, have not yet been ascertained. Neither of the orifices of these little animals is furnished with tentacles, but their branchial orifice is toothed, in this they appear to differ from the great majority of aggregate animals. We may conjecture that when the water passes into the tube the diaphragm is either dropped or elevated to admit it, and then resuming a horizontal position closes the

1 *Ubi. supr.* pl. xxii. xxiii.

2 See above, p. 95.

orifice so that the water is forced into the interior aperture of the individual animals and passes out, as above described, by the exterior one. Food-collecting tentacles, therefore, would in this case be unnecessary, as their food would enter their mouths with the water. Providence thus taking care to compensate by this contrivance for the want of the ordinary instruments.

Some of the Tunicaries are stated to have recourse to a singular mode of defence. When seized by the hand, contracting themselves forcibly, they ejaculate the water contained in their cavities, so as often suddenly to inundate the face of the fisherman, who in the astonishment of the moment suffers the animal to escape. If this be a correct statement it proves that these animals are not altogether without some degree of intelligence, they know when they are assailed and how to repel the assailant.

Having given some account of the most interesting of the *aggregate* Tunicaries, I am next to notice the *simple* ones.—In these the two orifices by which the sea-water is received and expelled are not at opposite extremities, but usually approximated, one being higher than the other and furnished with tentacular filaments. The animals are fixed to rocks, shells, and sometimes to sea-weeds, and are either sessile, or elevated on a footstalk: the sessile ones present a considerable analogy with the puff-balls, and the others with different funguses, as *Clavaria*, &c. They seem, especially *Boltenia*, which is covered with short stiff bristles, to approach the *Echinidans*. Nothing more is known of these animals, than that, like the others, they alternately absorb and expel the sea-water. The *Cynthia Momus*[1] is remarkable for its changes of colour, being sometimes white, sometimes orange, and sometimes of a flesh-colour. As all this tribe are fixed, their history furnishes no other interesting traits.

Nothing is more striking than the infinitely diversified forms into which Creative Power has moulded the little frail animals, in this as well as the preceding classes, that are destined to inhabit, and numbers of them to illuminate, the wide expanse of waters occupying so large a portion of the globe we inhabit. When we survey, with curious and delighted eyes, the varied tribes that cover the soils of every aspect and elevation of that part of it that emerges from the fluctuating surface of the great deep, and which, instead of deriving their nutriment and means

1 Plate IV. Fig. 1.

of life and breath from the waters, saline or fresh, live, and breathe, and are fed, by principles and elements communicated, either mediately or immediately, from the atmospheric ocean, an expanse that envelopes uninterruptedly the whole of our globe, and which itself is fed and renovated by the constant effluxes of the great centre of irradiation; which also in its turn, as well as all the other orbs that burn and are radiant, and those that revolve around them and reflect their light, receive their all from *Him*, that GREAT AND INEFFABLE BEING, who gives to all and receives from none. But I lose myself, in infinite amazement; I shrink into very nothingness, when I reflect that such a miserable worm as I am, so fallen and corrupted, should presume to lift its thought so high, and lose itself in the depths of the unfathomable ocean of Deity. He has, however, commanded us to seek him, and assured us we shall find him if we seek him humbly and sincerely—he hath set before us his *works* and his *word*, in both of which he has revealed himself to us: and if our great object be to glorify him rather than ourselves, we shall collect the TRUTH from each, and shall find that they deliver, though each in a different language and style, the same mysteries; for they are the work and the word of the same Almighty Author, and must, therefore, if rightly interpreted, deliver the same truths, since they can no more contradict each other than he can contradict himself.

But let me endeavour to emerge from this ocean in which I seem to have lost myself, and, recovering my station upon *terra firma*, direct the attention of the reader to the lovely tribes that adorn every part and portion of this our destined but brief abode, I mean to the vegetable kingdom; we see how they cover earth, that not a spot can be found, of which in time they do not possess themselves, and that the more we extend our inquires the more numerous are the individual species with which we become acquainted. This being the case upon earth, reasoning from analogy, we may conclude that something similar takes place in the ocean; that could our discoveries be extended under the sea as easily as they are upon land; could we traverse the bed and waters of the great deep with the same facility that we do the surface of the earth, we should find the numbers of vegetables that respire, in some sense, the air, fall short perhaps of those plant-like animals that respire the water. And could we examine the individual species of which this infinite host consists, and compare their organizations, we should find as great a difference in the instruments and organs

by which their life is supported and their kind continued, as in the animals themselves; and yet in all this diversity should trace a harmony and concatenation that would evidently prove the Wisdom that contrived, the Power that formed, and the Goodness that gave a living principle and breath of life to all these creatures, were each of them the attributes of an INFINITE BEING.

## CHAPTER VIII.

### *Functions and Instincts. Bivalve Molluscans.*

HITHERTO in our progress from the lowest animals upwards, the mind has been perpetually submerged; not only every group, but every individual that we have had occasion to consider, has been an inhabitant of the waters, and to the great body of which a fluid medium is as necessary to life and action as an aërial one is to a land animal, but now we shall be permitted to emerge occasionally, for although the largest proportion of the animals forming the great class we are now to advert to, the *Molluscans*, are also aquatic, yet still a very considerable number of them are terrestrial, as a stroll abroad will soon convince us, when after a shower we find we can scarcely set a step without crushing a snail or a slug.

The term *Molluscan*[1] was employed by Linné to designate his second class of worms,[2] which excluded all the shell-fish, and amongst real Molluscans included both Radiaries, Tunicaries, and Worms; it literally signifies a nut or walnut, and therefore seems more properly applied to shell-fish, than to animals which are defined as simple and naked. As now understood, it still comprehends a very wide range of animal forms, and it seems difficult to describe them by any character common to them all. Their Almighty Author, in the progress of his work of creation, linked form to form in various ways; he not only made an animal of a lower grade a stepping-stone towards one of a higher, and which formed a part of the ascent to man, the highest of all; but as the mighty work proceeded, he threw out on each side collateral forms that ascend by a different route, or begin one to a different order of beings. And this circumstance it is that has opened the door for so many systems and that diversity of sentiment with respect to the grouping of animals, which we meet with in the writings of the most eminent naturalists. Some proceed by one path and some by another, though the object of all is the same,

1 *Mollusca.* 2 *Vermes.*

unless some bias from a favourite hypothesis interferes and diverts them from a right judgment.

The organization of the animals of the Class we have just left, as we have seen, appears of a higher character than that of any of the preceding ones; traces of a heart appear; a nervous ganglion is detected between the mouth and anus, sending nerves to each; a regular respiratory system by means of gills becomes evident; but still the animal is furnished with no head, no eyes, and in numerous cases has no separate existence, but forms a branch of the general body—thus resembling a plant—from which it cannot dissociate itself and become an independent individual.

Indeed when we enter the Class of Molluscans, we find that the nearest affinities of the Tunicaries have likewise no head, and this circumstance appears to have induced Lamarck not only to separate them from the class as arranged by Cuvier, but also his whole family of headless Molluscans,[1] of which he forms his two Classes of *Cirripedes*[2] and *Conchifers*.[3] The absence of a head from the animals of the bivalve and multivalve shells, is certainly a circumstance which, at the first blush, appears to justify their separation *classically* from the other Molluscans, but when we compare other characters, we shall find many that are common to both, particularly their nervous system, which is the same both in the Conchifers and Molluscans of Lamarck; for neither of these exhibit a medullary ganglionic chord, but only dispersed ganglions which send forth the requisite nerves; both have a double or bilobed mantle, gills on each side, and a heart and circulation. The *Cirripedes* indeed seem to be of a higher grade, at least their nervous system is more perfect—since they have a longitudinal spinal marrow with ganglions, a mouth furnished with toothed jaws disposed by pairs, and *jointed* tendril-like organs about the mouth—and approaches near to that of the Annulose animals,[4] the *Condylopes* of Latreille. These, therefore, may be considered as properly entitled to the denomination of a Class; but should not be placed at a distance from the Crustaceans, to which Lamarck, with reason, thinks they make a near approach, as they are by Cuvier and Carus. In fact, they seem to have little to do with the bivalve Molluscans, except in being defended by more than one shell, and having no head.

I shall now mention the most prominent characters of those

1 *Mollusca acephala.*
2 *Cirripeda.*
3 *Conchifera.*
4 *Annulosa.*

shell-fish, that I regard as strictly entitled to the denomination of *Molluscans*.

ANIMAL soft, without articulations. *Mantle* bilobed, enveloping more or less the animal. *Gills* varying. A *heart* and circulation. No *medullary chord* with *ganglions*, but a few scattered ganglions from which issue *nerves* to various parts. *Body* commonly defended by a calcareous *shell*, to which it adheres only by one or two points, but in some instances it is externally naked, and has an internal bone.

The Molluscans may be divided into several families, and those of Cuvier are mostly natural, but as my plan has been to ascend from the lowest grade of animals towards the highest, I shall reverse this order, and begin my observations with the last of his families, or more properly speaking *Orders*, excluding for the present the *Cirripedes* of Lamarck, or most of the multivalves of Linné, as leading off laterally towards the Crustaceans.

His first order he calls *Acephales*, or headless Molluscans, it includes all the bivalve shells of Linné, with the addition of the Pholads or stone-borers.[1] Lamarck has divided it into two sections, which, regarding it as a Class, are with him *Orders;* the first is *Bimuscular*,[2] having *two* attaching muscles, and *two* muscular impressions; and the second is *Unimuscular*,[3] having only *one* such muscle with *one* impression. With regard to their habits and economy, the bivalve Molluscans may also be divided into *two* sections, the *first* of which may consist of those that inclose themselves either in a cell or burrow, or live in the mud, &c.; and the *second* of those that fix themselves to the rocks, stones, and other substances, by means of a *Byssus*, which they have the faculty of spinning from their foot or other part, or by a *tendinous ligament* which they protrude through an orifice in their shell.

The general habit of the *first* family, including a vast variety of forms, seems to be that of *boring* and *burrowing*, many piercing wood, and even rock, and others burrowing in the sand, sometimes to a great depth. Thus they are instructed by their instinct to form a convenient cell or other habitation, either constantly submerged, or only when the tide visits them, in which they are enabled to procure their destined food, of what nature does not appear to have been clearly ascertained, although probably animalcules, introduced when they inspire

1 *Pholas.*
2 *Conchifères dimyaires*
3 *C. monomyaires*

the water for respiration, may form a principal portion of it, as the majority having no teeth for mastication, require a kind of nutriment for which it is not necessary: comparing this tribe of aquatic animals with those of the antecedent classes, we see the same object effected by different means. The *sheathed* polype[1] builds a house of matter elaborated in its own stomach, while the ship-borer[2] pierces wood, and the stone-borer the rocks, and the razor-shell[3] burrows deep in the sand with the same view; and thus each is instructed by its Omniscient Creator, and fitted by its structure and organization, to accomplish the intended purpose, but by different means and instruments.

While each of these creatures has a particular and individual end in view, in its several proceedings, its own accommodation and appropriate nutriment and defence; the Creator, who has gifted them accordingly, makes use of them as instruments, which by their combined agency, though each, as it were, by a different process, accomplish, usually by slow degrees, His general purposes. This object, in the present instance, as well as in numerous others, seems to be to remove obstacles that stand in the way, and prevent certain changes willed by Providence, in the sea-line of any country, from taking place. Rocks may be regarded as so many munitions of a coast, which prevent the encroachment of the ocean, but nothing can more effectually prepare the way for the removal of this safeguard, than its being, as it were, honey-combed by numberless stone-borers, that make it their habitation, thus it must be gradually rendered weaker; till it is no longer able to resist the impetus of the waves; the process is very slow, but it is sure; and it is worthy of remark, by what a seemingly weak organ most of these animals are enabled to effect this purpose, a fleshy foot, strengthened by no internal bone or gristle, but upon which they can turn as upon a pivot, and so in due time effect their destined purpose.

I shall now proceed to furnish some examples of the manner in which this is effected: and give an account of some of each of these tribes, beginning with those, and they are numerous, that make the burrows in the *sand* to a considerable depth, so that it presents a less solid mass to the action of the waves.

I shall first call the reader's attention to the proceeding of one usually denominated the *razor-shell*, from the supposed resemblance of some of the species to that instrument; in substance and colour they are often like the human nail, and as

1 See above, p. 89. n. 2. 2 *Teredo*. 3 *Solen*.

they, as well as the stone-borers, are stated to emit a phosphoric light, and also are eaten, it seems to me most probable that they are the animals and not the pholad as is usually supposed, which the Roman naturalist describes under the name *Dactyle.*[1] These animals burrow in the sand, sometimes to the depth of two or three feet, and never quit the burrow unless by force. Poli says the collectors of them are accustomed to pour oil upon the water, which renders it quite transparent so that they can discern the razor-fish in its burrow by its tubes which are exerted. So powerful are its struggles, that, though they wind linen about their feet, they are often severely wounded by the sharp edges of their shells. The animal descends to the bottom of its burrow when the tide retires, and there remains till its return when it rises again. In order to take it, the fishermen are accustomed to cast into its retreat—which always remains open for respiration, and which is indicated by a little jet of water—a very little salt, this probably deceives the razor-fish and causes it to ascend, thinking the tide returned. They bury themselves with wonderful celerity by the rapid action of their foot, and mount again by the combined action of that part and their smooth valves. The former is cylindrical and ends in a spherical summit of larger diameter than the rest of the foot.[2]

The *common cockle*[3] is also a borer. Mr Osler, in a very interesting paper in the *Philosophical Transactions* for 1826, has described the way in which they bury themselves. The foot of the cockle, he observes, is very strong and stiff, and is the instrument by which they principally perform this operation; but to look at it when unemployed, we cannot readily conceive how it can make a burrow capacious enough for so large a shell. Its point, indeed, is solid, and a viscid secretion from its surface enables it to fix itself more firmly in the sand, but this alone is not sufficient to accomplish this purpose, it is therefore further gifted with the power of distending it to a size, nearly equalling that of its shell—but how is this effected? It has a tube, opening just within the mouth, which conveys to the foot the water by which the animal is enabled to distend it—thus the size of the boring auger becomes so nearly equal to that of the shells, that the solid point or bit first entering the sand, in time, by rotatory motions often repeated, works a burrow that receives the shell, and the animal is buried with only the extremity of its siphon emerging. How admirable is this contrivance

1 See Appendix, note 23.

2 Plate V. Fig. 1.

3 *Cardium edule.*

of Divine Wisdom to enable it to bury its shell, which it could scarcely otherwise accomplish.

We easily comprehend the use of terrestrial burrowing animals, by this habit they not only construct a habitation for themselves, but by the mould they throw out they help to fertilize and renew the soil; but with regard to the aquatic burrowers on the barren sands, which the tides submerge, we only see one end answered, the welfare of the individual who forms them: but they likewise doubtless answer some more general purpose connected with a plan of Providence which daily advances towards its completion, though we do not clearly comprehend what that end is. I was once conversing with a fisherman of a village on the N. E. coast of Norfolk on the subject of his trade, when amongst other matters he observed, that from some alteration in the sands of that coast the number of small shell fish had considerably diminished of late years, which being the principal food of soles and other flat fish had occasioned a great diminution of them also. An over abundance of burrowing bivalves may undermine the beach to that degree, that the sea in high tides and stormy weather may make such a breach upon it as may carry away, or bury too deep, a large porportion of these shell fish, which would cause the fishes to leave the coast for one better provided with food for them.

No animal has been more celebrated for the mischief it has occasioned as a *timber-borer* than that of which I shall next give some account. I am speaking of the *ship-worm.*[1] Though the animal of some of the land-shells, as the snails,[2] do him some injury in his garden, man seldom suffers very materially from their ravages, but the ship-worm, where it gets head, does him incalculable injury: destroying piles as far as they are under the water and every thing constructed of timber that is placed within their reach, to which they are as injurious as the boring wood-louse;[3] they even attack the stoutest vessels, and render them unfit for service. Their object however is not to devour the timber, but with the same view that the pholads bore into the rock, to make for themselves a cell in which they may be safe from their enemies; their food is probably conveyed to them in the sea water. These animals cannot exist in fresh water, they pierce the wood by means of what Carus calls boring shells moved by a double-bellied muscle. The valves of the shells of this animal are emarginate or bilobed, both lobes are beautifully scored at the margin, but in different directions, the furrows in one being much the finest

1 *Teredo navalis.* 2 *Helix.* 3 *Limnoria terebrans.*

and receiving those of the other. The mode in which these animals bore has not been ascertained, probably it is by the rotation of their valves. Sir E. Home describes them as protruding a kind of proboscis which has a vermicular motion, and which he supposes to act as a centre-bit while the creature is boring. The shells, by means of their ridges, probably act, like those of the pholads, as rasps. They bore in the direction of the grain of the timber, deviating only to avoid the track of others.

Various are the animals whose function it is to attack substances from which the vital principle is departed, nor are those, we see in the foregoing instance, which are submerged, always exempted from this law. Fortunately the aquatic animals, that prey upon timber, fall very far short of the terrestrial ones in their number and in the amount of the damage they occasion, and their aversion to fresh water is the safeguard of our bridges and other buildings that are erected upon piles—did an animal, with the boring powers of the ship-worm, enter our rivers and abound there, we should see the magnificent bridges that so much adorn our metropolis and are so indispensable to its inhabitants, gradually go to ruin—the vast stones with which they are built might become the habitation of pholads, and other rock-borers, and the communication between the two sides of the river greatly interrupted. But a merciful Providence has so limited the instincts of the different animals it has created, that they cannot overstep a certain boundary, nor extend their ravages beyond the territory assigned to them. The law laid down to the ship-worm is to hasten the decay of timber, that is out of its place, and may be denominated an unsightly encroachment upon the ocean—this is the law they must obey, and they make no distinction, whether it is disowned by all, or an important and valuable part of man's property. Their individual *object*, as has been stated above, is their own benefit, and they neither know that they obey a law of God, or injure man, but the Almighty by an irresistible agency impels them to it, and they fulfil the purposes of his Providence, at the same time that they provide for their own welfare.'

The history of none of the boring bivalves is more interesting than that of the *Pholads*, or stone-borers. These animals are defended by two very fragile shells strengthened indeed by supplementary pieces, and rough like a file, inhabited by a very soft animal which appears to be furnished with no organs adapted to boring so hard a substance as a rock. When the young are disclosed from the egg, being cast upon the rock in which their mother resides, they bore a hole in it which they

enlarge daily, and which they never leave, unless compelled by force. This hole always communicates with the water, and is the orifice through which the animal exerts its double siphons; one of these siphons is its mouth and the other its anal orifice. Reaumur made some observations upon their mode of boring, he says, that it is by the rotation of the two valves of their shell which form a rasp, and continually wear away the rock which surrounds them. The surface of the valves of the shell is ridged longitudinally and transversely, and rough with asperities at the intersections of the ridges which seems to fit it for such an office, but still it is usually so tender and friable, that one would not expect it could act upon a rock, nor could it be by this agency that they first make an entry when young, or bore through shells, madrepores, and wood as they are said to do. They are stated principally to select calcareous rocks and sometimes hardened clay, which seem better adapted to the nature of their shells. Poli says they use their foot as an auger in excavating their crypts, the shell revolving upon it as upon an axis.

Mr Osler, in the memoir before alluded to, states that the pholads can be observed to burrow only in the young state: and that they are found completely buried when so minute as to be almost invisible. The guiding hand of Providence excites them from their very birth to fix themselves by their pointed foot, to erect their shells, and giving them a partial rotatory motion which employs the valves alternately, thus to enlarge their habitation, and this almost constantly, since the rapidity of their growth, for the first few weeks, compels them to act perseveringly in effecting that object, for the raspings of its crypt would clog the animal if they were left in it. When the siphon is distended with water, the animal, closing the orifices of its tubes, suddenly retracts them: thus a jet of water is produced which is prolonged by the gradual shutting of the valves, and clears the shell and the crypt.

There is another family of bivalves which bores the rocks, the species of which are instructed by their Maker, to accomplish their object by a very different process. I allude to Lamarck's family of *Stone-eaters*.[1] This family contains only two genera, removed from *Venus*, which he denominates *Saxicave*,[2] and *Petricole*,[3] the habits of which appear to be the same. M. Fleurian-de-Bellevue has described the proceedings of a species found in great numbers in submarine calcareous rocks near Rochelle. It lives like the pholads in crypts within the

1 *Les Lithophages.* 2 *Saxicava.* 3 *Petricola.*

rock, but as the crypt is not circular, it is clear it cannot be produced by a revolution of the animal upon its foot; M. de Bellevue, therefore, concluded that it dissolved the stone by means of a phosphoric acid transuding from its body. Some have thought, that did the animal secrete such an acid, it must have destroyed its shell, but since the rock round the crypt is found to be differently coloured from the rest, for a little thickness, and the animal does not frequent the argillaceous, basaltic, and other rocks in the vicinity, but only the calcareous ones, M. Bellevue's opinion is rendered not improbable. It is surely very possible that the acid may be so mixed and tempered as to act upon the rock and not upon the shell. Mr Osler, in the memoir lately quoted, brings forward some very powerful additional arguments which confirm this opinion. The species which he observed was the rugose saxicave.[1] This animal fixes itself by a byssus from the foot, and therefore cannot perform a rotatory motion, and it appears to have no mechanical means of excavating its crypt—it can act solely upon the calcareous part of the rocks it perforates—for these and other reasons, Mr Osler is of the same opinion with M. de Bellevue.

Poli has described a stone-boring bivalve, belonging to the *muscle* genus, which perforates marble, each inhabiting a separate crypt, generally as large as the shell, and which he thinks they enlarge by fricton and rotatory motion. The pillars of the temple of Serapis at Puteoli were perforated by these animals at the height of forty-six feet above the sea, whence it is probable they were so perforated before they were carried there.[2]

When we compare the proceedings of these four kinds of boring or burrowing Molluscans, above described, with their forms, we shall find in them a particular adaptation of means to an end. In the ship-worm, whose province is to penetrate into submerged timber and there to take its abode, we find the anterior part of the body armed with two shelly valves, moved by strong muscles, which cut and rasp the substance upon which they act, so that it probably begins its labour as soon as it is born, introducing its narrow body, defended at the other extremity also by shell, into the timber softened by the water, and slowly increasing its crypt as its dimensions increase—in this case the most powerful action seems to be at the anterior end, though assisted, it may be, by some motion at the poste-

1 *Saxicava rugosa.* 2 Poli, ii. 215.

rior. This kind of action appears best suited to its slender body.

Let us next examine the pholads, all the genuine ones are rough like a rasp, strengthened near the base with accessory valves and a thick interior margin, indicating that here is the great action, and here it is that the foot revolves, thus maintaining a rotatory motion, causing the valves to act as files upon the walls of its crypt and thus to enlarge it when necessary; perhaps this action may also be connected with its respiration and nutriment; it is probably very slow and gradual, so as not to injure the frail apex of its shells.

In another rock-borer, of a form not suited to effect an excavation by a rotatory motion, the deficiency, we see, is compensated for, and it effects its purpose by employing chemical agency when its crypt becomes too small for it.

The sand-boring razor-shell above described, would be impeded by a rough shell, in excavating its deep burrow, its valves therefore are smooth and polished, and its body very narrow, and consequently meets with less resistance in its motion either upwards or downwards—while the cockles which do not bore to a great depth are differently constructed and proceed in a different manner.

We next come to those bivalves which fix themselves to the rocks, or in other secure stations, by means of a *Byssus*, which is usually formed of brown silken threads, intertwined like wool, spun from the foot of the animal, formed from a slimy fluid furnished by a gland situated under its base. Poli says, with respect to the byssus of muscles, which have all of them this faculty, that it is of the same structure with hair, and that, at the extremities, it is furnished with little cups or suckers, by which it adheres so firmly, that the muscles can only be drawn from the water in great bunches. Some species are entirely enveloped with this substance. These provisions evidently indicate design and Creative Wisdom.

The giant *Clamp-shells*[1] belonging to the bimuscular section, sometimes four feet in length and weighing more than five hundred pounds, suspend their vast bulk by means of a strong byssus: below the hinge is a large opening, through which the animal passes a bundle of tendinous fibres, by which it is suspended to the rocks however large and weighty its shells, and thus it is enabled to fix itself securely, wherever its instinct directs it.

1 *Tridacne Gigas.*

These animals are said to be taken by means of a long pole, which is introduced between the valves of their shells when open; they immediately close them, and will not quit their hold, till they are landed. They are a principal article of food in the Moluccas, especially the young ones, which may be kept alive a long time.

The *wing-shell*[1] belonging to the unimuscular section, has long been celebrated, on more than one account, from a very early period. They are called wing-shells, or fin-shells, because they are shaped somewhat like a wing or fin, their Latin name (*Pinna*) is supposed to have been given them because of their resemblance to the plumes which the Roman soldiers wore in their helmets. They are sometimes very large, some are said to measure three feet in length: their substance differs from that of most shells, being of a fibrous structure, and they appear to be formed of transverse imbricated laminæ, they are also semi-transparent and very thin. Their byssus has been long celebrated, for it is mentioned by Aristotle.[2] Its Creator has provided this animal, as we learn from Poli, with a pair of bifid muscles with which it spins this substance, which emerges from the shell opposite the hinge; like the thread of the muscle it terminates in a sucker, and with it the animal adheres to the rocks and other bodies which it meets with at the bottom of the sea, and thus they brave the agitation of the waters. They seldom change their station, but they can unfix their byssus, if any circumstance renders such change imperative. In Sicily and Calabria this byssus, which is very silky, is manufactured into stuffs, stockings, and gloves, which are very fine and warm, but it will take no dye: articles composed of it are very dear, and the manufacture is fast declining. Aristotle observed a little crustaceous animal within the valves of the wing-shell, which he thought was necessary to its existence. Pliny says it is always accompanied by a companion, the *Pinnotheres* or *Pinnophylax*, that when the Pinna opens its shell, a number of small fish boldly enter, and when it is full, the crab gives the blind animal notice by a slight bite, who immediately closes his shell, and assigns a portion of the prey to his little useful companion. Small Crustaceans indeed, both crabs and shrimps, certainly do find their way not only into the shells of the Pinna, but into those of muscles and whilks,[3] but their object is to defend themselves, especially when their crust is soft, and not to tell the Pinna when to close its doors

1 *Pinna.*
2 See Appendix, note 21.
3 *Buccinum.*

upon its prey; for its food is the sea water or the animalcules it contains.

Many other bivalves, which I need not particularize, spin a byssus with their foot. Singular it is that the same office should be assigned to organs so differently situated in different animals. The spinnerets of the silk-worm, and other spinning moths are in the *mouth*, those of the spider in its *tail*, and those of various shell-fish in their *foot;* in the first case, if we consider the various purposes to which caterpillars apply the faculty of spinning, we see the importance of its being under the direction of the eye of the animal: and even in the case of the spider, the eye directs the animal in its course to form its concentric circles, and the thread follows it; and the same is the case when it spins the rays that traverse its web; and when it dedescends from a height the same takes place. But the foot is the only organ that is so situated in bivalve shells, as to throw forth a thread that will go *out* of the shell, where it is wanted for use.

Of all this tribe of shells none are more beautiful, both as to their form, painting, and sculpture, than what are called *Escallop* shells, or *Comb* shells[1] from their resemblance, as to the scoring of the upper valve, to that instrument. These may be regarded as, in some degree, analogues of the butterflies amongst insects, and their flying as it were, on the surface of the water, as we shall soon see, increases the resemblance. There is, however, a difference between the Condylopes or annulose animals and the Molluscans, which must strike every examiner, the latter cannot be called symmetrical animals, while in the former the most perfect symmetry, both as to number of parts, and their structure, general form, sculpture and painting, prevails; in the latter this general symmetry seems not to obtain; in the *bimuscular* bivalves, indeed, the two shells are generally symmetrical both in form, size, and sculpture, but this does not invariably take place. In many of the *unimusculars* the upper shell differs from the under, either in size or other particulars; in the escallop shells it is much flatter and more ornamented as to colouring; and in the animal itself it is not a general principle that each part shall have its counterpart, or, if single, that the two sides shall exactly correspond. This furnishes some addition to the other proofs of the superiority of the Insect over the Molluscan tribes; symmetry, especially of the external organs and parts, distinguishes all the higher classes from man downwards; but is continued in the

1 *Pecten.*

invertebrate sub-kingdom no further than the Condylopes, when it is interrupted or altogether ceases. It must be observed, however, that in the animal of the univalves, a beginning of symmetrical organs appears in the tentacles, which are in pairs mutually corresponding, a circumstance not discoverable in the bivalves.

The escallop shells were considered by Linné as belonging to the same genus with the oyster, which he regarded as a kind of rustic tribe belonging to it; but they not only differ widely in their shells, but also in the animal they contain. The mantle of the former is stated to be composed of two large membranes surrounded with long white hairs, and with pedunculated eyes: whence Poli denominated the animal of this shell "*Argus;*" but these assuredly are not real *eyes*, but probably eye-like organs or tentacles, useful to the animal, perhaps, as organs of investigation and prehension, but not of vision. Lamarck, who does not, *in loco*, mention this formation of the animal of the escallop shells, observes that the *Spondyls*[1] have the margin of the mantle furnished with two rows of tentacular threads, a structure that seems to indicate some investigating office or prehensory function resident in that part, perhaps like the tentacles of the polypes they may seize animalcules. The animal of the oyster has nothing akin to this, a sufficient proof, added to their very different shells, that they belong to different genera.

The French call these shells pelerines or pilgrims, they are also in catholic countries, especially in Spain and Portugal, called shells of St James, because the pilgrims to the shrine of St James of Compostella, in Galicia, were accustomed to ornament their cloak and hat with them.

I shall next make some observations upon the bivalve just mentioned, the oyster, which of all shell-fish, though it is one of the rudest and least sightly, has from every age been most in request, as a favourite article of food. This gift of Providence is widely dispersed, being found on the coasts of Europe, Asia, and Africa; those that frequent our own are reckoned the best of all. They are not a roving animal, but when they leave the matrix, they fix themselves to rocks or any substance that falls in their way, which they seldom quit. Like other Molluscans, they are hermaphrodites, and are stated by Poli, the great luminary of conchology, to contain 1, 200,000 eggs, so that a single oyster might give birth to 12,000 barrels !! Providence has thus taken care that the demands made upon them to gratify the appetite of his creature man, shall

1 *Spondylus.*

not annihilate the race. These also are the only shell-fish that man has thought it worth his while to cultivate, by keeping them in certain pits formed for the purpose, called amongst us *beds*, and to which the salt water is admitted only at high tides: and in these the green oysters are said to be produced; marine plants of that colour, the growth of which is favoured by the tranquillity of the water in these tanks, generate a vast number of seminiform germs, which entering the shells of the oysters when they open them to take their food—so it is stated—stain them with their own hue.

They have other enemies besides man: whoever has observed their shells will often see them quite covered with a small kind of sea-acorns.[1] It is related also that certain crabs get into their shells, first introducing a piece of stone to hinder them from shutting, but this is probably fabulous; they may, however, when the oysters open their shells to receive the sea-water, enter them as they do those of the muscles and the wing-shell, either for protection or for the sake of food. It is observed that the oyster defends itself against intrusive enemies by squirting upon them with force water kept in reserve in their shells; they keep out those that attempt to pierce their shells to get at them, by thickening them in the part attacked.

I shall next give some account of a bivalve that has interested mankind from a very early period of history, on account of the valuable gem that it produces, and which is frequently mentioned in Holy Scripture. The Supreme Being, in his goodness and attention to the wants and tastes of his principal creature, has not neglected to furnish him with various articles for ornament as well as for use: and the most valuable of all possessions, the kingdom of grace in the heart, is symbolized by a *pearl* of great price; and though the apostle charges females not to adorn themselves *with gold or pearls, but with good works*, the meaning of the passage is, that the latter should have their *first* attention, not to forbid absolutely the use of the former—they are to adorn themselves not so much with gold or pearls as with good works—which ought to be the object of their most sedulous care.

The animal that produces pearls in the greatest abundance, of the purest nature, and of the highest value, was by Linné classed with the muscles,[2] but Lamarck has formed it into a distinct genus which he names *Meleagrina*. In this country it is usually called the pearl-oyster. It inhabits the Persian Gulf, the coasts of Ceylon, the sea of New Holland, the Gulf of

1 *Balanus*, &c.

2 *Mytilus margaritiferus*.

Mexico, and the coasts of Japan. It attains perfection no where but in the equatorial seas, but the pearl fishery in the island of Ceylon is the most celebrated and productive; it is on the west coast, off the bay of Condatchy, where the country is very sandy and nearly without inhabitants, but on these occasions a populous town, with many streets a mile long, appears to have suddenly started up. The oyster beds or banks extend over a space thirty miles long by twenty-four broad. The twentieth of February is generally the day of rendezvous for the fishermen. The fishery is commonly rented by a single individual, who is allowed to employ 150 boats for thirty days, there are about 6000 boatmen and attendants. The oysters vary in their qualities according to the nature of the ground to which they are attached; and also in their number, by the action of the tides and other circumstances: those at the greatest depth produce the largest pearls, which are situated in the fleshy part near the hinge. Pearls consist of concentric coats of the same substance as that which forms the mother-of-pearl of the shell; they are produced by the extravasation of a lapidifying fluid, secreted in the organs of the animal and filtered by its glands. For one pearl that is found perfectly round and detached between the membranes of the mantle, hundreds of irregular ones occur attached to the mother-of-pearl like so many warts: they are sometimes so numerous that the animal cannot shut its shell, and so perishes. The pearl is a formation forced upon the animal by some annoying substance in its shell, which it covers with mother-of-pearl, as the bees do intrusive wasps with wax, to fix it or hinder it from affecting them by putridity, &c. Sir E. Home is of opinion that the abortive eggs of the animal are the nucleus upon which the pearl is formed, and he has made it very probable that this is often or generally the case, but still the process just mentioned may take place when accidental substances are introduced, and produce the warty excrescences, and sometimes loose misshapen pearls.

The diving tackle consists of a large stone suspended by a rope with a strong loop above the stone to receive one foot of the diver, and having also a slip-knot, and a basket formed of a hoop and network which receives the other foot. When he has fixed himself in this tackle and is duly prepared, he holds his nostrils with one hand, and pulling the running-knot with the other, instantly descends—when he reaches the bottom he disengages his foot from the stone, which is immediately drawn up to be ready for the next diver. He at the bottom throws himself on his face and collects every thing he can lay hold of

into the basket—when ready to ascend he jerks the rope and is speedily hauled up, and working himself up the rope he arrives at the surface sooner than the laden basket. A minute and half or two minutes are the utmost any diver remains under water. The shark-charmers form a necessary part of the company, by their incantations they are supposed to possess the power of preventing these voracious fishes from attacking the divers, and they will not descend without their attendance; where the bed is rich the diver often collects 150 oysters at one dip, but sometimes not more than five.[1] It is said that a single diver will, in one day, often bring up from 1000 to 4000 oysters.

From the simple circumstance that Providence has instructed this animal, which cannot eject from its shell those substances, whether formed within itself, or that have accidentally entered, to encase them in the precious substance which it is empowered to secrete, what a vast fund of ornament to deck the most lovely part of the creation, and having no parallel in any gem that the earth produces, is provided. The pearls obtained from other shell-fish vary in colour—those from the wing-shell are brown, and those from the fresh-water muscles greenish, but sometimes they are yellow, pink, bluish, and some are even black; these last are very rare and dear.

Other bivalves fix themselves by a tendinous ligament to the rocks. In one genus,[2] in the upper valve near the hinge, is an aperture, closed by a kind of operculum formed at the dilated extremity of an internal muscle, it is by this operculum that the animal fixes itself. In another, related to the last,[3] the beak of the lower valve turns up, overhanging in some degree the upper valve; in this beak is a notch or aperture through which the fixing tendon passes; affording an admirable instance of variation in the means of attaining the same end, when circumstances require it. It was necessary that the valves should not be reversed, a tendon through the lower valve secures this in the first of these animals; but in the second, where the overhanging beak would interfere with this purpose, the tendon issues from the beak itself, so as to enable the animal still to fix itself with the proper valve downwards. In the *Anomia* the valve takes the form of the substance it is fixed to.

1 Malte-Brun, *Geogr.* iii. 225.
2 *Anomia*, Pl. V. Fig. 2, 3.
3 *Terebratula*, Pl. V. Fig. 4.

Who would think that these headless animals, unprovided with organs that indicate any of the higher senses, as sight, smell, and hearing, and apparently fitted with no other means of motion than those of opening and shutting the valves of their shells, or travelling very slowly for a few inches, should yet be able not only to leap and use other motions, but occasionally to sail gaily on the surface of the ocean; but, however improbable this may seem, it has been proved to be the case by the evidence of eye-witnesses of the fact.

The common cockle,[1] Poli says, can not only, by means of its foot turn round, or to either side, but even take a good leap. The Trigons,[2] nearly related to the cockle, are mostly fossils, but there is one recent species, found on the coast of New Holland, called originally, from the pearly lustre of the inside of its shells, the pearl trigon,[3] a name changed, without reason, by Lamarck. This, which was originally taken by Lesueur and since by Captain King, was more recently brought from thence by Mr Stutchbury, who told me, that they would leap over the gunwale of a boat in which he was, to the height of above four inches. The foot of this animal is bent at an acute angle, so, as upon pressure, to form a very elastic organ,[4] and that of the cockle is nearly the same.

Those elegant shells of the Pectens, or comb-shells, have long been celebrated for their motions. Pliny says, probably meaning these shells, that they leap and flutter out of the water, and dive. D'Argenville relates, that when they are on shore, they regain the water by opening the valves of their shells as wide as they can and then shutting them briskly, by which they acquire sufficient elasticity to rise three or four inches, and thus proceed till they accomplish their object. Most probably the foot assists in producing these leaps. Their progression in the water is described as very different; when they rise to the surface—but the means by which they do this has not been clearly explained—they support themselves half under water. They next open their shells, to which they communicate such a vibration, that they acquire a very brisk movement from right to left, which enables them, as it were, to run upon the water.

The tulip-shell,[5] when it walks, if I may so speak, opens and shuts its valves, and at the same time lengthens and shortens its foot, which seems to indicate a connexion, or action, between the former and the latter organs, similar to what

1 *Cardium edule.* 2 *Trigonia.* 3 *T. margaritacea.*
4 Plate V. Fig. 5. 5 *Tellina.*

has been observed to take place in insects, and perhaps points out some analogy between the valves of the shell and the upper wings, or elytra of insects, and the mantle and their under wings.

Bosc states, that the animals of the genus Venus, in calm weather, may be seen sailing on the surface of the waters, using one of their valves as a boat and the other as a sail. As these are usually rather heavy shells, they must be furnished with some means of rendering themselves lighter than the water. Pliny, of old, mentions shells dedicated to Venus, which sail and oppose their concave part to the wind.

Thus we see the Creator has given even to these apparently stupid and inactive creatures means of enjoyment, that every one is not aware of; and powers of locomotion, of which, at first sight, they seem incapable.

I might enlarge here on the admirable contrivance and variety observable in the hinge, as it is called, by means of which the animals are enabled to open and shut the valves of their shells; upon the sculpture and colours that distinguish many of them, particularly amongst the unimusculars, but this chapter is already too long, and enough has been said to prove that they have in no respect been neglected or overlooked by the Almighty Being who willed their existence, and who is ever watchful over the creatures of his hand, to provide them with all things necessary for their being, consistently with the ends he created them to serve.

## CHAPTER IX.

### *Functions and Instincts. Univalve Molluscans.*

THE *Univalve* shells of the Swedish naturalist, a term adopted from Aristotle's *Monothyra*, are next to be considered; these, with the multivalve *Chitons* form the *Gastropods*, or shell-fish using their belly for a leg, of Cuvier; and with the cuttle-fish and nautilus tribe constitute Lamarck's Class of *Molluscans*. The latter author divides his Class into five orders, four of which belong to the tribe I am considering.

1. *Pteropods* (wing-footed); furnished with organs only for swimming and sailing.[1]

2. *Gastropods* (belly-footed); body straight, never spirally convolved; a muscular foot for creeping under the belly.

3. *Trachelipods* (neck-footed); greatest part of the body spirally convolved, always inhabiting a spirivalve shell; foot free, attached to the neck, formed for creeping.

4. *Heteropods* (diverse-footed); no coronet of arms; no subventral, or subjugular foot; fins, one or more, not disposed in pairs.[2]

As the Cephalopods, forming Lamarck's fourth Order, may be regarded rather as constituting a larger division or Sub-class of the Molluscans, than an Order, I shall consider them in a separate chapter.

1. Proceeding from one of the above Orders to another, I shall select such individuals, belonging to it, as appear to exemplify the great attributes of their Creator, either in their structure, forms, habits, or instincts. The animals of the *first* Order, like the long celebrated Argonaut and Nautilus, enliven the surface of the ocean in fine weather, where they steer their little barks through, between, and over its fluctuating waves, and spread their membranous sails to the soft breathing of the zephyrs.

One of the most noted animals of the tribe is known by the appellation of the Boreal Clio, which, like the jelly-fish, has a gelatinous body, is defended by no shell, and affords food to

1 PLATE V. FIG. 6, 7. 2 FIG. 8

the whales and other fishes, as well as to the sea-birds. This animal is abundant in places that suit it, and appears only during the warmest hours of the day on the surface.

Other genera of this Order are covered by a shell or shells. Of this kind is the genus *Hyalœa*, so named from its semi-transparent shell, which wears the appearance of a bivalve with soldered valves, the upper one being the largest; this difference of size of the seeming valves causes an aperture through which the animal sends forth two large yellow and violet wings, or sails, rounded and divided at their summit into three lobes. The head in this genus is almost evanescent, so that both shell and head exhibit an easy transition from the acephalous or bivalve Molluscans to those which have a head. When its wings or sails are unfolded it moves with great velocity on the surface of the sea. The animals of this Order, both from the beautiful colouring of their filmy sails or wings, and from their number and symmetry, are better entitled to the appellation of the butterflies of the ocean, than the escallop shells which have sometimes been so called. The mantle of the bivalves becomes an organ of very different use in the *Pteropods;* for they, having no means of fixing themselves like most of the bivalves, float continually in the ocean; to compensate for this want, as in innumerable other instances, their Creator has given them the power of expanding this organ as a sail, both for motion and to give some direction to their course; it is attached to the mouth or neck, and is connected in some species with their respiration. Nothing certain is known with respect to their food: probably they absorb the animalcules swarming in the sea water.

2. The series of *Gastropods* begins with animals that have no shell, amongst which the most remarkable seem to be the *Scyllœa* and the *Tethys*, both known to Linné, and by him described. The former is an oblong gelatinous animal, laterally compressed, elevated above in the middle, where it has two pair of membranous wings or fins. Its inferior surface is hollowed out longitudinally, by means of which, and its tentacles, it can embrace the stems of the fuci or sea-wrack, the flowers of which it eats. It is described as moving very slowly in the water by bending its extremities. It swims on the surface when the weather is calm, but adheres to the floating fuci when the sea is agitated, so that the kindness and foresight of its Maker—by giving it wings, for independent motion, and means to adhere to the fuci, when support is necessary to it, or it takes its food—has thus provided amply for its enjoyment and sustenance. The great peculiarity of the latter, the

Tethys, is a mantle which extends above and beyond the head, like that of some marine goddess, concealing it entirely, and forming an ample veil, fringed or undulated at its margin. By the help of this veil they elevate themselves to the surface, and probably sail on the waters. This animal is nearly related to the *Laplysia*, a kind of sea-slug, like which it lives in muddy places, and ejects a black fluid; it is very fetid, and its flesh is poisonous. It only rises to the surface in the hot season.

I shall next notice a tribe of Gastropods, which at first sight, considering the number of pieces of which their shelly covering is composed, seems to belong to the multivalves, amongst which Linné has placed it. It will be readily perceived that I am speaking of the *Chiton*, or *coat-of-mail* shell, but when the animal that it covers is examined, it will be found that, notwithstanding its multivalve shell, it really belongs to the Gastropods.

These animals are generally found under stones, sometimes they adhere to the surface of rocks, and sometimes conceal themselves in their fissures: they often traverse vast tracts of ocean fixed to the keels of ships, like some of the limpets they fix themselves a good way out of the water, so as only to be wetted when the tide is up, and sometimes above high water mark. Poli says that when they resist any attempt to force them from their station, they expel the air and water on all sides and produce a vacuum, so that it is very difficult to overcome the pressure of the atmosphere; and Mr Frembly, who had an opportunity of studying their habits on the coast of Chili, states that when not apprehensive of danger their attachment is very slight, and by pushing them gently they will easily slide from the surface to which they are attached, but if a direct attempt is made to unfix them by force, they will part with a portion of their shells sooner than let go their hold.

When we consider that these animals are not only often exposed to the violent action of the waves, but also to the attack of countless enemies, we see abundant reason for the coat of mail with which their Creator has covered them. Even the fleshy or cartilaginous margin, or zone, as my lamented friend the Rev. Lansdown Guilding, in his admirable memoir on this tribe, denominated it, is defended sometimes by scales, spines, and bristles, at others rough with numerous little bony tubercles; it is also described as in general fringed, so that when the animal attaches itself to a rock or stone, it is altogether calculated, by the application of the prone part of its body, to produce a vacuum. The wing-shell and other bivalves that suspend themselves by a byssus, are sufficiently protected by

their shells from the attack of their enemies, without so complete an adhesion of the body as is necessary for the coat-of-mail shell. Mr Guilding, who had excellent opportunities of observation, informs us that these animals are night-feeders, remaining stationary as above, during the day; reasoning from analogy he suspects they feed on marine plants, the sea-wrack, &c. These creatures slide along very slowly, if accidentally reversed, they recover a prone position by the violent motions of the ligament or zone that surrounds them, and if alarmed they sometimes roll themselves up like woodlice.

Lamarck proceeds immediately from the Chitonidans to the *Patellidans* or Limpets,[1] which also fix themselves so firmly to the rock, that it requires considerable force to separate them, and sometimes in such numbers that their surface seems quite covered by them. The transition from the former tribe to this, with no intermediate links, seems at first sight violent, and their right to be associated in the same family rather problematical: probably intermediate species will come to light which will render this point more evident than the shell of these animals appears to indicate.

With regard to their functions and the part assigned to them in the great plan of creation, little is known; probably, from their numbers in some parts, they may help to soften the rocks, so that they may, at some destined hour, yield more readily to the force of the winds and waves; thus they may be enumerated amongst the instruments which the Creator employs to effect his purposes, and such changes in the coast of any country, as he wills shall take place.

They afford a beautiful instance of the gradual progress of Creative Wisdom from form to form. If the student of the tribe looks with inquiring eye at a collection of the Patellidans, or limpets, in the flattest and most depressed of them[2] he will find no small resemblance to one of the valves of a bivalve shell, he will soon, however, discover a prominence in it, the first tendency towards the spiral convolution, a little removed from its centre, which will prove to him that it belongs to a very different tribe; looking again at others that are more elevated and conical,[3] he will see the same prominence or beak forming a more striking feature, and ascertaining these shells to be univalves, he will find, upon a comparison of them with the nerit,[4] the snail,[5] or the periwinkle,[6] that this umbo or knob is analo-

1 *Patella.*
2 *Umbrella indica.*
3 *Patella vulgata.*
4 *Nerita, Neritina,* &c
5 *Helix.*
6 *Turbo.*

gous to the spiral part of those shells, as he will see upon examining one of the bonnet-limpets,[1] in which he will detect an incipient decurved spire; passing from this by one of the chambered-limpets,[2] it will lead him to the neritidans, or top-shells, from which the road is direct to the sea-ear;[3] and by another[4] he arrives almost immediately at the periwinkles and snails. If he chance to examine further between the limpets and the whelks,[5] he will find another open shell,[6] which forms the path to the latter genus. If once more his eye happens to observe a shell almost open[7] but with the sides a little turned in, he will see still another road leading by the dippers[8] to the elegant tribe of cowries.[9] It is by this road that Lamarck travels to them. Again, he may perhaps be shown, preserved in spirits, an animal whose respiratory orifice is covered by a round shield—this is the sea-slug,[10] an animal famous for Pliny's legend of its noxious qualities, whose head resembles a hare, which leads from the Patellidans towards the common slug of our gardens.[11] To the bivalves there seems to be also a road from this central group, by a Norwegian shell described by Müller as an anomalous species of limpet, but which by Lamarck is considered to be a bivalve.[12] The lower valve in this genus is so thin that Müller overlooked it; by it the animal adheres to marine bodies—the upper valve, like the *Patella*, is sub-conical with a prominent vertex, and the two valves are not connected by a hinge.

A due consideration of all these circumstances, of this radiation, as it were, from a typical form as a centre, by various roads towards different tribes, seems to prove, and the observation is confirmed by facts in other departments of nature, that the world of animals, as well as that of heavenly bodies, consists of numerous systems each, so to speak, with its central orb, and all concatenated, and revolving as it were wheel within wheel, and all tending towards or branching from a common centre. It seems, in the present instance, taking the group expressed by *Patella* of Linné as the common centre, that from thence, though by different and diverging routes, we may arrive at almost every molluscan group or tribe.

The Molluscans that we have hitherto been considering,

1 *Pileopsis ungarica*, &c.
2 *Crepidula.*
3 *Haliotis.*
4 *Calyptræa.*
5 *Buccinum.*
6 *Concholepas Peruviana.*
7 *Bullæa.*
8 *Bulla.*
9 *Cypræa.*
10 *Laplysia depilans.*
11 *Limax.*
12 *Orbicula Norwegica*

with the exception of the herbivorous chitons, derive their nutriment from the sea water itself, either from animalcules or other marine substances requiring only absorption, but the Gastropods that we are next to notice live upon more solid food, and such as cannot be digested without a more powerful action upon it. Of this description are the dippers[1] which are furnished with a singular organ or gizzard that proves their predaceous or carnivorous habits; the remaining genera are herbivorous, but as they exhibit no very interesting traits I shall proceed to the next Order.

The *Trachelipods*, constituting Lamarck's third Order of Molluscans, may be divided into those that are *herbivorous*, and those that are *carnivorous*, the first having no respiratory siphon, with which the others are furnished.

The herbivorous Trachelipods may be sub-divided into *terrestrial* and *aquatic*, and the latter into those that inhabit fresh water or salt. It is not known that any of the predaceous ones are terrestrial. The terrestrial ones not only devour the leaves and stems of plants, but some also attack their *roots*, one species, defended by an operculum or mouth-cover, devours those of the violet.[2] Others of this tribe are found on trees, under moss, or feeding on the lichens; the shells of some of these are what are called turrited[3] or long and slender, with spiral whirls, resembling, in miniature, a lofty tower with a spiral straircase winding round it. By this attenuated structure their motions, in their close retreats, are less impeded. As it is in this tribe of univalves that the organ just mentioned, the *operculum*, or mouth-piece, first makes its appearance, it will not be improper here to give some account of it.

If we survey the various tribes of shell-bearing animals we find them defended from the injuries or attacks, to which their situation exposes them by various expedients, all of them indicating Power and Wisdom in their contrivance and formation, and Goodness in their end. These animals themselves all have a soft body furnished with organs of different kinds, suited to their station and purposes. Those that are below them in the scale, especially the naked Polypes, and gelatinous Radiaries, are still more frail and evanescent, but their organization is so inferior, that it is probably less subject to derangement from external accidents, or injuries are sooner remedied, than in that of the shell-fish—which, unless they were clad in some kind of mail, would probably soon perish. Accordingly we

1 *Bulla.* 2 *Cyclostoma elegans.* 3 *Clausilia.*

find some protected by a multivalve tubular shell,[1] the inhabitant protruding its organs at the summit, which is defended by an operculum consisting of more than a single piece—in others, also, the shell is multivalve, but the animal protrudes itself at the sides, and has no operculum, as in the common barnacle.[2] Others, again, are protected by a shell consisting of two valves, open at one or two ends, and these seek further protection either by burying themselves in the sand or perforating the rocks, or by suspending themselves by a byssus; others, again, which only open their shells at certain times, as the oyster, fix themselves to any convenient substance. To these succeed others, whose shell is transversely divided into many pieces,[3] but yet, taken together, it forms a single valve protecting the back of a gastropod, or slug-like animal, which for further protection, when it is not moving, and to supply the place of a lower valve, fastens itself to a rock or other substance.

With the Patellidans begin the undivided univalve shells, which like the preceding animals protect their lower side by fixing themselves to the rocks; the sea-ears,[4] which are still more open, have recourse to a similar mode of protecting themselves, they preserve a communication with the atmosphere or water without elevating their shells, by means of a line of apertures, under the thickest margin near the apex; these apertures begin when the animal is young near the spire, and as it grows it stops up one and opens another, as its occasions require. I have a very large specimen, in which there are traces of eighteen apertures, and all but six are stopped up. If we turn our eyes from these to the Buccinidan or Whelk tribe, we are struck by an open Peruvian shell, which at first sight seems like a limpet,[5] but upon inquiry we find that it is defended by an operculum, the plan of protection being here changed, and, instead of an under-valve, or a rocky munition, it is closed by a broad plate, which some peculiarity in its structure and organization doubtless required; from this by *Purpura* and *Monoceros* to the true *Buccinum*, the mouth narrows and the operculum with it.

If we examine the common periwinkle, we find the mouth of its shell closed by a horny organ called the *patch*, which is attached to the foot or rather neck, by its convex or lower surface, sitting on a sub-triangular flat space spirally convoluted; this is the *operculum*, and if examined on either side will be found to be also spirally convoluted, proving that it is formed

1 *Balanus. Tubicinella.* 2 *Pentelasmis.* 3 *Chiton.*
4 *Haliotis.* 5 *Concholepas.*

by the part on which it sits. When the animal expands its foot for creeping, the operculum is retracted within the shell, so as to be quite out of the way. If we examine the opercula of other shells, we shall find that the majority of them have the same spiral configuration traced both on the upper and lower surface. In most that I have seen the intervals of the whirls increase in width, as the spires of the shells do from the base to the mouth. In the top-shell[1] the whirls are perfectly regular and nearly equidistant. They vary much in thickness; I have one three-fourths of an inch thick, while those of the top-shell and periwinkle are very thin. In some of the thick ones, on the under side the convolutions are very convex, and sometimes elevated into concentrical ridges. Some underneath have a forest of obtuse elevations, and many are rough with minute tubercles. As to substance some are horny, while others resemble the shell; others are horny externally and shelly internally. If these formations on the under side, as in the common periwinkle, represent the shape of the part of the neck to which they are attached, as they most probably do, it must act the part of a mould, upon which the operculum is formed from its mucus, and increased as the aperture enlarges.

Lamarck is of opinion that the shell of univalves is formed in a similar way upon the *neck* of the animal, which in the *Murices* or rock-shells, and other tribes distinguished by spines or tubercles, has certain fleshy processes which produce those spines, &c. and is withdrawn when they have acquired consistence enough not to bend when thus left to themselves. Other conchologists, particularly one of the most eminent of our times, Poli, think that the shells of univalves are organized bodies, and produce their spines as vegetables do their prickles, he says also that their shells contain cellular membranes almost like a *Rete mucosum.*

In the progress of a shell's growth, as new spines are formed old ones drop off, how this is effected seems not to be accounted for by either hypothesis—it is anologous, however, in a great degree, to what was mentioned above with regard to the holes in the shell of the sea-ear, only that with them an old hole is stopped up, when a new one is formed. All that can be said on the subject is that the animal, instructed by Providence, as new processes are formed and a new whirl of its shell completed, is enabled to throw off by a solvent, or some other means unascertained, those that are no longer wanted.

It is observable that the terrestrial univalves,[2] of this Order,

1 *Trochus.* 2 *Helix*, &c.

are never armed with spines, tubercles, or other elevations, but exhibit generally a levigated shell. As they move about usually amongst bushes, under moss, or in grass, the object of the Creator in this structure was probably that their motions might not be impeded by any roughness of their shell.

Mr E. W. Brayley, in a very ingenious memior, in the Zoological Journal, has contended, with considerable strength of argument, that the movable black points, in the upper tentacles of snails, though he allows they may be their analogues, are not real eyes; but the Rev. L. Guilding, in a subsequent part of the same Journal states, that the large strombs of the Caribbean sea have eyes furnished with iris and pupil, similar to those of birds and reptiles—that they have also a vitreous and aqueous humour, and a black pigment, which certainly prove them to be real eyes—their organ of hearing, he thought, was likewise distinct. The cowries also are said to have eyes exhibiting both iris and pupil, as have some volutes.[1]

Giving these facts their due weight, I think we may conclude that the, so called, eyes of snails, are real though imperfect visual organs. It appears to be the plan of the Creator,

. . . . . to ascend
From small beginnings to a glorious end.

An organ is, as it were, sketched out, in the lowest animal, as for instance, a nervous system, which keeps developing and improving till it is brought to its acme in the highest: first we find in the polypes no nervous centre, but molecules every where dispersed; then the next form is a nervous collar round the œsophagus; next dispersed ganglions; then a ganglionic chord; and so on till we arrive at a regular brain and spinal marrow incased in a vertebral column. We may with reason therefore conclude, that the organ of vision, when first planted, would be a mere rudiment, though sufficient for the animal's purposes, and possessing few of the characters it exhibits when arrived at its most perfect form; these it keeps acquiring, as it becomes more developed, or to avoid misconception from nibbling critics, the Creator keeps giving it more and more perfect sight till he brings it forth, in all its glory, in the highest animals.

The most common in this country of these herbivorous Trachelipods, is the garden-snail,[2] but the species whose history has been most copiously related, is that called in France the

1 *Voluta Ethiopica*, Plate VI. Fig. 1. *a*.

2 *Helix hortensis*.

*Escargot*,[1] which, though stated to have been originally imported into this country, now abounds in some parts of Surry and other southern counties. I shall begin by giving some account of their economical and then of their physical history.

On the continent, especially in France, this large snail, which is more than double the size of our garden one, is used as an article of food, and though said not to be easy of digestion, is very palatable. They are thought to be in best season in the winter, when they are hybernating, and covered with their temporary calcareous operculum, which falls off in the spring. The Romans appear to have fattened these snails, in places appropriated for that purpose. Pliny mentions several sorts that were kept separate, and amongst others white ones that were found in the neighbourhood of Rieti. The Illyrian snails he describes as the largest; the African as most prolific; others from Soletum, in the Neapolitan territory, as the noblest and best: he speaks of some as attaining to so enormous a size, that their shells would contain eighty pieces of money of the common currency.[2] Bruguières, to whom conchology is under very great obligations, is of opinion that, by cultivation, the several species of snails might be brought to a much greater size, and furnish an abundant, wholesome, and even delicate aliment. There is no reason why the species of this genus, which feed on vegetable substances, should not be as palatable as the oyster or periwinkle.

Snails, in general, are hermaphrodites, or unite both sexes in the same individual: this is the case with the great majority of Molluscans; the object of Providence, in this kind of organization, is evidently the greater multiplication of the species, but though hermaphrodites, in each individual possessing the organs of both sexes, they are not so as to sexual union; reproduction can only take place when different individuals impregnate each other; this union takes place at the beginning of the spring, sooner or later, according to the heat of the season. Their courtship is singular, and realizes the Pagan fable of Cupid's arrows, for, previous to their union, each snail throws a winged dart or arrow at its partner. About twenty days after coupling the snails lay, at different times, a great number of white eggs, varying at each laying from twenty-five to eighty, as large as little peas, enveloped in a membranous shell, which cracks when dried. They lay these eggs in shady and moist places, in hollows which they excavate with their foot, and afterwards cover with the same organ.

1 *H. Pomatia.* 2 *Quadrans.*

These eggs hatch, sooner or later, according to the temperature, producing little snails exactly resembling their parent, but so delicate that a sun-stroke destroys them, and animals feed upon them; so that few, comparatively speaking, reach the end of the first year, when they are sufficiently defended by the hardness of their shell. The animal, at its first exclusion, lives solely on the pellicle of the egg from which it was produced. Providence, which in oviparous and other animals, has provided for the first nutriment of the young in different ways, appropriating the milk of the mother to the young of quadrupeds; the yolk of the egg to those of birds, tortoises, and lizards; and the white of the egg to frogs and toads, has made this pellicle or coat the best nutriment of the young snail. In fact, this pellicle, consisting of carbonate of lime, united to animal substance, is necessary to produce the calcareous secretion of the mantle, and to consolidate the shell, as yet too soft for exposure. When this envelope is eaten, the little snail finds its nutriment, more or less, in the vegetable soil around it, and from which it continues to derive materials for the growth and consolidation of the shell. It remains thus concealed for more than a month, when it first issues forth into the world, and without respect of persons, attacks the vegetable productions around, returning often to an earthly aliment, probably still necessary, for the due growth and hardening of its portable house. These snails cease feeding when the first chills of autumn are felt, and associating, in considerable numbers, on hillocks, the banks of ditches, or in thickets and hedges, set about their preparations for their winter retreat. They first expel the contents of their intestines, and then concealing themselves under moss, grass, or dead leaves, each forms, by means of its foot, and the viscid mucus which it secretes, a cavity large enough to contain its shell. The mode in which it effects this is remarkable; collecting a considerable quantity of the mucus on the sole of its foot, a portion of earth and dead leaves adheres to it, which it shakes off on one side; a second portion is again thus selected and deposited, and so on till it has reared around itself a kind of wall of sufficient height to form a cavity that will contain its shell; by turning itself round it presses against the sides and renders them smooth and firm. The dome, or covering, is formed in the same way: earth is collected on the foot, which then is turned upwards, and throws it off by exuding fresh mucus; and this is repeated till a perfect roof is formed. Having now completed its winter house, it draws in its foot, covering it with the mantle, and opens its spiracle to draw in the air. On closing this, it forms

with its slime a fine membrane, interposed between the mantle and extraneous substances. Soon afterwards the mantle secretes a large portion of very white fluid over its whole surface, which instantly sets uniformly, and forms a kind of solid operculum like plaster of Paris, about half a line in thickness, which accurately closes the mouth. When this is become hard the animal separates the mantle from it. After a time, expelling a portion of the air it had inspired, and thus being reduced in bulk, it retreats a little further into the shell, and forms another leaf of mucus, and continues repeating this operation till there are sometimes five or six of these leaves forming cells filled with air between it and the operculum.

The membranous partitions are more numerous at the end than at the beginning of winter, and, in snails inhabiting the mountains, than in those on the plains. These animals hybernate at the proper period, at very different temperatures, varying from 37° to 77° Fahrenheit. Respiration ceases during the period of hybernation.

The mode in which these animals escape from their winter confinement is singular: the air they had expired on retiring into their shell further and further, remains between the different partitions of mucus membrane above mentioned, which forms so many cells hermetically sealed; this they again inspire, and thus acquiring fresh vigour, each separate partition, as they proceed, is broken by the pressure of the foot, projected in part through the mantle; when arrived at the operculum they burst it by a strong effort, and finally detaching it, then emerge, begin to walk and to break their long fast.[1]

In all these proceedings the superintending care and wise provisions of a Father Being are evident. This creature can neither foresee the degree of cold to which it may be exposed in its state of hybernation, nor know by what means it may secure itself from the fatal effects it would produce upon it, if not provided against. But at a destined period, often when the range of the thermometer is high, not stimulated by a cold atmosphere, except, perhaps, by the increasing length of the night, at the bidding of some secret power, it sets about erecting its winter dwelling, and employing its foot both as a shovel to make its mortar, as a hod to transport it, and a trowel to spread it duly and evenly, at length finishes and covers in its snug and warm retreat; and then still further, to secure itself from the action of the atmosphere, with the slimy secretion with which its Maker has gifted it, fixes partition after parti-

1 Gaspard and Bell, *Zool. Jour.* i. 93.—ii. 174.

tion, and fills each cell formed by it, with air, till it has retreated as far as it can from every closed orifice of its shell—and thus barricades itself against a frozen death. Again, in the spring, when the word is spoken—*awake, thou that sleepest*—it begins immediately to act with energy, it reinspires, as above related, the air stored in its cells, bursts all its cerements, returns to its summer haunts, and again lays waste our gardens.

We may observe here, with respect to this and all hybernating animals, a beautiful relation and correspondence between their habits and their functions. Their official duty is to remove superfluities and nuisances, to prevent vegetable substances from encroaching too much upon each other, to remove entirely those that are dead and putrescent. At the season of the year, therefore, when the former are in full vigour, forth issue from their various retreats the innumerable tribes that make them their food, but when they cease to grow and flourish these services are not wanted, and the animals who perform them disappear from the face of nature. Again, when dead animals, or the excrements of living ones, or the sweets issuing from innumerable flowers, would clog the air that we breathe with effluvia unfriendly to health and life—countless armies are every where upon the wing, or on the alert, to prey upon such substances, and prevent their miasmata from breeding a pestilence amongst us; but when the cold season returns, the flowers lose their leaves and blossoms, and exhale no longer their sweets, and the scents arising from putrescent and other fœtid substances become no longer annoying. Then the whole army employed in this department disappears, and the face of nature seems to lose the most busy part of its population, gone to a long repose.

It is worthy of remark, with respect to the terrestrial animals of the tribe we are considering, that they all delight in shady and moist places, and that during hot and dry weather they seldom make their appearance, but no sooner comes a shower, than they are all in motion. It is probable that their power of motion is impeded by a dry soil, and that the grains of earth and small stones, when quite dry, adhere to their slimy foot.

As many of the marine shells appear in some degree amphibious, for instance, the *Chitons* and the *Limpets*, so, perhaps, some of the terrestrial ones may occasionally enter fresh waters; indeed the amber shells,[1] at least one species,[2] is stated

1 *Succinea.* 2 *S. elongata.*

to swim occasionally on the surface of the water. From these circumstances it seems not improbable that the shell-fish, as well as the birds, so vast a proportion of them being marine animals, were all amongst the objects created on the fifth day, and produced by the waters.

There are very large and beautiful shells found in South America, belonging to the terrestrial herbivorous section and to different genera[1] divided from *Helix* of Linné, but we know nothing of their history or habits, I shall therefore now say something upon the marine herbivorous Trachelipods.

The violet snail,[2] which, according to the account of its manners given by Bosc, who paid particular attention to them in a voyage from France to America, exhibits several very remarkable peculiarities. When the sea is calm, these animals may be seen collected often in large bands, swimming over the surface by means of a floating apparatus consisting of aërial vesicles, produced by their foot; and attached to its posterior part, a little below the point to which the operculum is fixed in other genera, and to which Cuvier thinks it bears some analogy,[3] who also observes that it has a natatory membrane or fin on each side of its body. During this action their head is very prominent, and the foot is so extended that the float or line of vesicles forms an angle with the middle of the shell. When the sea is rough, the animal absorbs the air from its vesicles, changes the direction of its foot, contracts its body, and lets itself sink. It does the same when in danger from any enemy, and further, like the cuttle-fish and some others, colours the water by the emission of a blue fluid, which serves to conceal it. They are vividly phosphoric in the night. Birds carry them off with great dexterity.

If their floating apparatus is mutilated the foot can reproduce it. The latter is flat towards the head, this part of it is furnished with a transparent membrane, which extends far beyond its extremity, and is composed of a large number of vesicles of unequal size, those in the middle being the largest; these vesicles the animals fill with air at their pleasure. The violet-coloured shell of this little animal is remarkably thin, which facilitates its excursions on the surface. It is singular that under this fragile vesicular float a little line of pearly fibres may be perceived, to which are attached its eggs; in some species they are contained in little membranous bags or sacs. It is thought that the young animals, when liberated

1 For instance, *Achatina Bulimus*, &c.

2 *Ianthina*, Plate VI. Fig. 2.

3 Plate VI. Fig. 2. *a*.

from these bags or chambers, ascend their mother's float, and so are transported to the surface. Fishes are enabled to rise to the surface of the water by means of their air-bladders, and some radiaries by a vesicle which surmounts them,[1] but neither of them are more singular than these outriggers by which the vessel of the violet-snail is kept both buoyant and steady.

The foot of the Molluscans, when we first observe it, seems to us merely an organ of locomotion, nothing remarkable in its structure, and incapable of any multifarious action, but when we study the history of this and the preceding snail, we see that it is a most important organ, and which performs a greater variety of operations than almost any organ of any other animal. We have seen that it spins a fine silk and thread; that it secretes a fluid serviceable for several purposes; that it can form a float, as in the present instance; that it can be used as a hand in excavating and building, and various other manipulations, so that in giving them this instrument and endowing it with such variety of functions in the various tribes, their Creator gave them every thing they wanted.

Perhaps the followers of Lamarck may say that, in the present instance, the animal constructs its own float itself, at the impulse of its own wants. But uninstructed by its Creator, how could it learn that vesicles full of air would serve to float its little boat, and if not already organized to answer the impulse of an exciting cause, in vain would the will of the animal, if so instructed, endeavour to produce and inflate the vesicles, or, when it willed to sink, to empty them of air.

The shell-fish of the aquatic tribe best known in this country is the *periwinkle*, vulgarly called the pin-patch,[2] which, next to the oyster and the cockle, seems most in request as a relishing article of food. These animals, as I observed, not very long since at Cromer, in Norfolk, appear to make the bladder-kelp,[3] which, at low water, may be seen there in large patches, a kind of submarine pasture, for I found them in abundance upon it at low water. As the Creator willed that the waters, whether salt or fresh, should have their peculiar inhabitants, it was requisite that each should have its appropriate food. Did all feed upon the same substance there would be a universal struggle, unless indeed, the entire variety of the submarine botanical world was done away, and one homogeneous article provided, in such quantity as to be a sufficient supply for all. But further, doubtless, different organizations and forms could not be maintained upon the same pabulum, and therefore dif-

1 See above, p. 104. 2 *Turbo litoreus.* 3 *Fucus vesiculosus.*

ferent creatures required different articles of food, or different parts of the same article. Here was a mutual office—the numberless vegetable productions require to be kept within due limits, and therefore the functions of the aquatic animals is to maintain them in due relative proportions. Was the ocean and all its streams planted as now, and there were no animals of any description to keep in check its vegetable productions, they would all in time grow up and choke the rivers and gradually raise the bed of the ocean till there would be *no more sea.*

Having considered the plant-devouring Trachelipods, I shall say something next upon the *carnivorous* or predaceous ones, which form the great body of large marine shells, and those which most ornament our cabinets, for to this tribe belong the Cowries,[1] Cones,[2] Mitres,[3] Whelks,[4] Tuns,[5] Volutes,[6] Helmets,[7] Rock-shells,[8] Strombs,[9] and other conchs which exceed the general run of shells in beauty, form, and magnitude. But with regard to their habits and instincts we know little or nothing of any interest.

They are distinguished from the herbivorous ones by breathing the sea water, for they are all submarine, by means of a siphon or tube, instead of by an aperture in the neck; in the place of maxillæ, their mouth is furnished with a retractile proboscis, with which they pierce and suck other shell-fish. The aperture of the shell is also very different, the siphon being accompanied sometimes by a channel, and sometimes by a notch at the base of the aperture.

The tribe most celebrated from ancient times, on account of the vaunted purple dye which one species produced, is that constituted by the *Rock-shells*, or Linné's great genus, *Murex*, and Lamarck's canaliferous *Z*oophagans, called so from the long straight canal which terminates the mouth of their shells. The principal feature of this tribe, besides their long channelled beak, is the vast variety of spines, and other processes and ridges, with which their Creator has armed a great number of them; the beak and mouth of several give them no small resemblance to the heads of certain birds, thus one is called the thorny woodcock,[10] another the snipe,[11] &c.

At the first blush an inquirer into the use of these spines

1 *Cypræa.* 2 *Conus.* 3 *Mitra.*
4 *Buccinum.* 5 *Dolium.* 6 *Voluta.*
7 *Cassis.* 8 *Murex.* 9 *Strombus.*
10 *M. Tribulus.* 11 *M. Haustellum.*

and other arms of shell-fish, would imagine that their object is defence, yet when he is told that those which are most remarkable for them, are themselves predaceous animals; and that the herbivorous shell-fish are usually not distinguished by any thing of the kind, he seems to hesitate as to what conclusion he shall draw. It may be observed, however, that the tribe most distinguished for these arms, the rock-shells, are not so remarkable for their size as many others which live by prey, as the strombs, the helmet-shells, and the tritons, so that their armour may sometimes prevent one of these from boring their shells, and inserting its proboscis into them.

The tribe we are now considering, the rock-shells, were in high esteem from the earliest ages on account of the dye that some of them afforded, and cloths dyed with it bore a higher price than almost any other: more than one species, however, yielded anciently a dye; one, according to Bochart, a glaucous or azure colour, as he interprets it, and the other purple. But Tyrian purple is no longer in request. I could say much, observes the author just named, upon the finding, fishing, and method of dying of the purpura, about the price, formerly enormous, nearly equalling that of pearls, a single shell, according to Aristotle, selling for a mina or about 3*l.*, concerning the time at which it began gradually to grow out of fashion, and at length to be wholly neglected: so that now it is never used, and no one knows the method of preparing it. In fact, the cochineal seems to have supplanted it, but it would surely be an object of great interest to re-discover the Tyrian rock-shell, as well as that which yielded the azure colour, and ascertain how far they deserved, especially the former, the high encomiums bestowed upon them, and to deck imperial shoulders. The shells are probably still in existence on the coast of Palestine. It was the custom to crush the shell as soon as taken, for if kept the animal was wont to vomit its flower, as the purple dye was called by Aristotle. This great philosopher thought the purpura lived six years, as the adult animal had six whirls in its shell, and he supposed one to be formed annually. He gives a detailed history of these animals, of their congregating in the spring, and of their forming a kind of comb, like bees; he also mentions several kinds of them, that the small shells were bruised, and the animal extracted from the large ones; that the dye lies between the neck and what he denominates the poppy. It is found, by Cuvier, to be placed above the neck by the side of the stomach. Plumier relates that a shell-fish of this genus squirts out its fluid in a stream,

whenever molested, which renders it probable that its object is defence.

Aristotle mentions the operculum of the purple, and also the proboscis, or tongue as he calls it, which he describes as longer than the finger, and protruded from under the operculum, with this it feeds, and with it can pierce shells, and will attack even those of its own kind; this agrees with modern observations, adding that the tongue is terminated by a sucker armed with short tentacles. Aristotle also observes, an observation confirmed likewise by modern investigators, that these animals bury themselves in the sand like the pectens. This learned naturalist also states that shell-fish at certain seasons hide themselves, snails in the winter, and the purples and whelks for a month during the dog days.

The dye of the purple is mentioned in Scripture as well as that of the coccus, and was used as such in the time of Moses. It is said also to be used at this time in India and America to dye small pieces of stuff, but in no place is it an important object.

Having given so long an account of the rock-shells or purples, I shall not have occasion to dilate upon any of the remaining genera, but shall merely notice a few peculiarities that some of them exhibit.

The Cowries are a tribe long known and admired for their beauty and polish, and one species[1] forms the current coin in many parts of Africa, and many Asiatic Islands. Some remarkable facts distinguish their history; from the form of their shell and of its aperture, its increment could not take place in the usual way, these animals, therefore, are furnished by their Creator with a remarkably ample mantle, the wings of which cover half the shell, and thus it is gradually thickened, and changes and variations in the colour take place that have puzzled conchologists to distinguish a species from a variety. At certain times the animal is also stated to quit its shell, and form itself a new one more appropriate to its size, a circumstance related by Aristotle of the Buccinum.[2]

Volutes are another polished tribe of shells, which are probably formed by the mantle as in the Cowries—they are particularly distinguished by having no operculum. The jet volute is viviparous, and its young when excluded are said to have shells an inch long. These probably are more exposed to enemies than the young of other shell-fish. They form an important article of food to some African nations.

1 *Cypræa Moneta.*

2 Κηρυξ, Arist.

Before I close this account of these predaceous Molluscans, I must observe, that they have two distinct sexes, and consequently male and female shells. The genuine hermaphrodites are confined to the bivalves, for in the univalve hermaphrodites two individuals are necessary for reproduction, and therefore those form a distinct link between the true hermaphrodites that impregnate themselves, and those that have distinct sexes. So gradual are the steps by which the Creator passes from low to high. First, animals are reproduced without sexual intercourse, as in the polypes; then the two sexes are united in one body, and suffice for their own impregnation—next follow two sexes in the same body, which cannot impregnate themselves, bringing us at last two distinct sexes, or unisexual individuals.

4. Lamarck's fifth family, the *Heteropods*, I introduce here because, being univalves, they appear to connect that tribe with the Cephalopods forming his fourth order, but which from the discovery of the animal of *Nautilus Pompilius*, so admirably described by Mr Owen, being further removed from the other Molluscans, and the animal of the Heteropods having a proboscis and only two tentacles, seems intermediate between the Zoophagan Trachelipods and the Cephalopods. They have four swimming organs. There seems a considerable affinity between this tribe and the Pteropods in these organs, which indicates a circular arrangement in the univalve Molluscans. The *Carinaria vitrea* is one of the rarest shells that is known, arising probably from its extremely fragile conch, which is nearly as transparent as glass. A model of it in wax may be seen in the British Museum. The animal is a sailor like the Argonaut, to which it comes near. It is found in the South Seas. There are two other species known, one of which frequents the Mediterranean. Some genera without shells are placed in this order by Lamarck. They swim horizontally like fishes, which circumstance, in conjunction with their fins or swimming organs, induced him to place them at the end of the Molluscans as near the fishes; several authors consider them as belonging to the *Pteropods*, to which they are certainly related.

## CHAPTER X.

### *Functions and Instincts. Cephalopods.*

We have now taken leave of what may be called the *proper* Molluscans, including the Bivalves, and Univalves[1] of Aristotle and Linné, or the Conchifers and Molluscans of Lamarck, and are arrived at a Class remarkable, not only for their organization, form and habits, but also for their position in the animal kingdom; for in their composition they seem to include elements from both the great divisions of that kingdom: from the Vertebrates—the beak, the eye, the tongue, an organ for hearing, the crop, the gizzard, and an analogue of the spine, with several other parts enumerated by Cuvier; and from their own sub-kingdom, many of their remaining organs. We may descend to the very basis of the animal kingdom for the first draught of their nervous system, for it is discoverable in the wheel-animals in which Ehrenberg detected pharyngal ganglions and a nuchal nervous collar;[2] the sucker-bearing arms seem to have their first outline in the fresh water polypes;[3] indeed if the mouth of the cuttle-fish with its suckers, be separated from the head, leaving behind the long arms, we see immediately an analogue of a radiary, particularly of a star-fish, with its rays bearing suckers below, and its central mouth. The lamellated tentacles observed by Mr Owen in his work, before quoted, on the animal of the Pearly Nautilus,[4] above and below the eyes, seem to lead to the antennæ of Crustaceans and Insects, and numerous Molluscan characters are obvious to every one. From these circumstances it seems evident that the Creator has placed this tribe in a station which leads to very different and distant points in the animal kingdom, and that there is scarcely any but what may recognize in it one or more of its own peculiar features—yet at the same time it exhibits many characters, both in its most extraordinary outward form and in its internal organization, that are quite

1 Διθυρα. Μονοθυρα.

2 *Ganglia nervea pharyngea. Annulus nerveus nuchalis.* Ehren.

3 *Hydra.*

4 *Nautilus Pompilius.*

peculiar and *sui generis*, of which no animal at present known exhibits the slightest traces. To mention only its muscular apparatus adapted to its unparalleled form ; its system of circulation, carried on in the first Order by three distinct organs instead of one heart ; and the wonderful complication of their tentacles, of the nerves that move them, and the vascular system that animates them.

This singular Class, which Cuvier denominated *Cephalopods*, or having their feet attached to their head, appears to follow very naturally the Trachelipods and Heteropods, lately described, which have not only eyes furnished with iris and pupil, but also distinct sexes, and are of predaceous habits, all characters which they possess in common with the Cephalopods or Cuttle-fish. There is, however, an animal amongst the naked Gastropods—called by the ancients, from its tentacles representing the ears of a hare, the sea-hare,[1] a name it still bears in Italy, which Linné named *Laplysia*, in which he was followed by Lamarck, but modern writers after Gmelin have called it *Aplysia*, a name used by Aristotle for a very different animal, a kind of sponge,[2] and, therefore, improperly applied—this animal has many characters that are found in some of the Cephalopods, particularly in its circulating and nervous systems; in having internal solid parts, and in discolouring the water with an inky fluid, so that there seems also a connection between this genus and the Cephalopods amounting to something more than a mere analogical resemblance.

Mr Owen has divided this Class into two Orders, from the composition of their respiratory organs, namely, those that have two branchiæ,[3] or gills, and those that have four.[4] The first includes those that have no shell, and the second those that have one. The last is further divisible into those whose shell has many chambers, as the *Nautilus*, and those where it has only one, as the *Argonaut*, or paper nautilus.

To the first of these Orders belongs the *cuttle-fish*,[5] one of the most wonderful works of the Creator. Its mouth is surrounded by eight long fleshy arms, or rather legs, somewhat conical in shape, and acute at the end, moved by innumerable nerves, furnished from numerous ganglions: these legs can bend in every direction with the utmost vigour and activity, their surface is furnished with many suckers, by which they can fix themselves strongly to any thing they wish to lay hold

1 *Lepus marinus*, Plin. 2 *Hist. An.* l. v. c. 16.
3 *Dibranchiata*. 4 *Tetrabranchiata*. 5 *Sepia*.

of, and by means of which, like the star-fish,[1] they can move from place to place. When this animal walks, in this resembling also the star-fish and sea-urchin,[2] it moves with its head and mouth downwards and its body elevated. It swims also and seizes its prey by means of these organs: besides these arms or legs, for they perform the functions of both, there is a pair of long organs, one on each side, having their origin between the first and second pair of legs, which are incrassated at the end, where, also, they are furnished with many suckers. Cuvier supposes they use these as anchors to maintain them in their station during tempests, and as prehensile instruments, by which they can seize their prey at a distance. In the centre of the legs is the mouth, surrounded by a tubular membranous lip, including a beak, consisting of two mandibles, like that of a paroquet; these mandibles or jaws are crooked, and the upper one fits into the lower as a sliding lid into a box. With these redoubtable jaws the cuttle-fish devours fishes, crustaceans and even shell-fish, which receive a further trituration in its muscular crop and its gizzard. By means of the suckers on their legs and arms, they lay such fast hold of their prey as to deprive them of all power of motion; thus they master individuals much larger than themselves. The hard and often spinose crust of crabs or lobsters cannot withstand the action of their trenchant jaws, aud they do not fear the gripe of their claws. Their large eyes, which resemble those of vertebrated animals, by their look of ferocity, are enough to create an alarm in the animals they pursue, and are said to see in the night as well as the day. So that although they are not like Pontoppidans Kraken—the notion of which is thought to have been taken from a large cuttle-fish—half a league in circumference, so as to be mistaken for floating islands, yet they are really as tremendous animals, their size considered, as any that Providence has commissioned to keep within due limits the populace of the waters.

One of their most remarkable and unique features, is the manner in which circulation takes place in them. They have *three* hearts; the principal one, seated in the middle, sends the blood through the arteries: the blood returns by a *vena cava*, which dividing into two branches, carries it to the two lateral hearts, each of which sends it to the gills for oxygenation, whence it returns again by the intermediate heart.

The *Octopus*, called by the French writers the *Poulpe*, probably a contraction of polype, differs from the common cuttle-

1 See above, p. 108. 2 Ibid. p. 114.

fish, having neither the arms nor long tentacles of that animal, and instead of the large heavy bone has only two small cartilages. This different structure is rendered necessary by the difference in their habits. The body of the octopus is small, and it has legs sometimes a foot and a half in length, with about two hundred and forty suckers on each leg, arranged, except near the mouth, in a double series; so that it walks with ease. They are often out of the water, and frequent rough places, are excellent swimmers, and move rapidly in the water with their head behind. The cuttle-fish, whose legs are short and body heavy, prefer the bottom, and do not attempt to swim, for which they are not well fitted. Providence has, therefore, given them their long arms to compensate for the shortness of their legs.

A remarkable peculiarity distinguishes these animals. They are furnished with an organ which secretes a black fluid, with which they can produce an obscurity in the water that surrounds them, on any appearance of danger, or to conceal themselves from their prey. The Chinese are said to use it in making the ink that bears the name of their country; something similar, but not so black, is prepared from it in Italy; and Cuvier used it to colour the plates for his memoir on these animals.

The second order of cephalopods, or at least the pearly nautilus, differs in several respects from those which constitute the first, and which I have just described, approaching much nearer to the Molluscans. The most striking approximation, and which first catches the eye of the examiner is its shell, which, though its spiral convolutions are not externally visible, exhibits a general resemblance to a univalve shell. To a person who had the opportunity of witnessing the motions of the animal that inhabits it, the first thing that would strike him, would be the means by which it progressed upon the bed of the sea, he would see no motion produced by the action of tentacular legs furnished with suckers, like those of the cuttle-fish, but instead of it, by a single expansive organ, exhibiting considerable resemblance to the foot of a snail. This organ, Mr. Owen, led by the nervous system, regards as surmounting the head and as its principal instrument for locomotion. The oral organs of this animal are much more numerous and complicated than those of the cuttle-fish, and are furnished with no suckers. Its tentacles are retractile within four processes, each pierced by twelve canals protruding an equal number of these organs, so that in all there are forty-eight. In fact, the whole oral apparatus, for the full description of which I must

refer the reader to Mr. Owen's excellent tract, except the mandibles and the lip, is formed upon a plan different from that of the cuttle-fish, as likewise from that of the carnivorous trachelipod Molluscans, and indicates very different modes of entrapping and catching their prey.

The eye, also, Mr. Owen states to be reduced to the simplest condition that the organ of vision can assume, without departing altogether from the type of the higher classes, so that it seems not far removed from that of the proper Molluscans. In this animal there is only a single heart, the branchial ones being wanting.

There is one circumstance which proves this cephalopod to belong to this shell, and not to be a parasitic animal as that of the argonaut has been supposed to be—it is this, though the whole body appears to reside in the last and largest concameration of the shell, yet there is a small tubular tail-like process which enters the siphon, but which unfortunately was mutilated, only a small piece being left, but enough to show that the animal had power over the whole shell by means of this organ, hence it follows that a Cephalopod is the animal that forms the shell of the nautilus, and its natural inhabitant, which goes a great way towards settling the controversy concerning the real animal of the argonaut, and amounts almost to a demonstration that the celebrated sailor that uses it as a boat, and scuds gaily in it over the ocean, is no pirate that has murdered its natural owner, but sails in a skiff of his own building.

The only circumstance that now leaves any doubt in the mind of the inquirer, is the very different nature of the cephalopod of the argonaut and the nautilus, the former appearing to be nearly related to the octopus or poulpe, and belonging to the genus *Ocythöe* of Rafinesque. In this genus the tentacular legs or arms are similar to those of the poulpes, planted on the inner side with a double series of sessile suckers, the second pair having a membranous dilatation at their apex,[1] which the animal is supposed to use as a sail when it moves on the surface of the sea. Some naturalists deny that this animal ever uses these organs for sailing or rowing, but Bosc expressly asserts, and I am not aware that there is any reason to doubt his veracity, that he has seen hundreds of the argonauts rowing over the surface of the sea, in calm days, at so small a distance from the vessel in which he was sailing, that though he could not catch one, he could observe all their manœuvres;

1 See *Zool. Journ.* n. xiii. t. iii.

he further says, that they employ their dilated tentacle sometimes as a sail and sometimes as an oar.

When we consider how many instances are upon record of Molluscans being fitted with organs that enable them to catch the wind and sail on the surface of the sea,[1] there is nothing contradictory either to analogy or probability that the argonaut should do the same, especially when we consider how universally this idea has prevailed, from the time, at least, of Pliny and Oppian, both of whom describe its sails with sufficient accuracy. Aristotle also speaks of his polype, which is evidently a cephalopod, as a sailor by nature—he says, that when it rises from the deep it is in a subverted shell, rendering that action more easy and keeping the shell empty, but that when arrived at the surface it reverses it; that it spreads its sail to the wind, and when that blows, letting down its two cirri, one on each side, uses them to steer with.

Upon comparing the animal of the nautilus with that of the argonaut, it appears evident, though the gills of the latter seem not to have been examined, that they belong to different Orders, at least, every probability rests on that side; yet every thing speaks the relationship of the latter to the octopus, and therefore they would properly form a section of the *dibranchiata* of Mr Owen. In fact, the oral organs of the former are so widely different from those of the Order just mentioned, that one would almost expect another to connect them. This probably lies dormant amongst the fossil ammonites, the shells of many of which, though consisting of many chambers, are evidently intermediate between the nautilus and argonaut.

We must next inquire what was the object of Him, who does nothing but with a view to some useful, though not always evident, end, in producing these miniature monsters of the deep, so wonderfully organized and so unlike every other tribe of animals, in his creation, and yet containing in them, as we have seen, as it were, the elements, whether we ascend or descend, of all the rest. It appears from the united testimony of almost every writer that has noticed them, that they have it in charge to keep within due limits, a tribe of animals, almost equally destructive with themselves, and which are armed also with weapons of offence, apparently equally terrific to their prey. It will be readily perceived that I am speaking of the *Crustaceans*, and of the formidable pincers with which they seize their prey. It must be a curious spectacle to see one of the larger poulpes attack a lobster; at first sight, we should

1 See above, p. 142.

think the latter most likely to master his assailant, covered as he is with a hard crust, and using adroitly his powerful forceps, we should feel sure that the cuttle-fish, with his soft body and oral organs equally soft, stood no chance against such an antagonist. But He who gave him his commission, has fitted him for the execution of it, his soft tentacular organs will bend in every direction, and the numerous suckers wherewith they are planted, by pumping out the medium that forms the atmosphere of marine animals, produce such a pressure wherever they are fixed, that, struggle as it may, it cannot disengage itself from the grasp of its assailant; and, by their flexibility, these organs can imitate the fishermen, and tie together the two pieces of the forceps, so that it cannot bite; thus, at last, it is brought within the action of the powerful beak of the cuttle-fish, which soon makes its way through its crust, and devours it shell and all. Even when at a distance, by means of its long arms, the cuttle-fish can lay hold of it and drag it towards it; and the poulpe, which has not these arms, makes up for it by having longer legs.

The argonaut probably uses similar means to master its prey, and finds some defence in its shell, but the nautilus has a still stronger castle, which it may be supposed defies the bite of the Crustacean; its oral organs are calculated for closer combat, but the tentacles appear less adapted for holding fast their prey, not being visibly furnished with suckers, but what they want in power is made up in numbers, since in lieu of eight or ten tentacular organs, they have nearly a hundred. So diversified are the ways and instruments by which infinite WISDOM, POWER, and GOODNESS enables its creatures to fulfil the ends for which he created them: and so an equilibrium is maintained in every part of creation.

The fossil species are mostly called by one name, *Ammonites*, as if they were the horns of the Egyptian Jupiter, and which, if any of them are now in existence, probably frequent the depths of ocean, and do not, like the argonaut or nautilus, visit its surface, to tell an admiring world, that God has created such wonderful beings. Specimens have been found of the enormous diameter of six feet. Though the sculpture of many of these great cephalopods gives reason to think that they may be intermediate between the argonaut and nautilus, yet the convolutions and external form of their conchs gives them no small resemblances to a genus of snails,[1] the species of which are often found in fresh waters, except that in this the

1 *Planorbis.*

shell is more concave on one side than the other. The genus *Spirula*, the animal of which appears also to be a Cephalopod,[1] seems to exhibit the first tendency to this form.

Amidst all this variety of Molluscous animals, exhibiting such diversity in their structure and organization, in their habits, food, modes of life, and stations, one great object seems attained by their creation especially, the production of calcareous matter. Even the shells of terrestrial testaceans, if we consider the vast numbers that every year perish, must add in no trifling degree to the quantity of that matter on the earth, and probably make up for the continual waste or employment of it, so as to maintain the necessary equilibrium; but in the ocean, the quantity added to that produced by corallines, must be exceedingly great, even in lakes beds are formed of the deposits of the shell-fish inhabiting them, how much more gigantic must they be in the ocean, this will be evident from the superior number and size of the oceanic shells compared with the minute species, the *Limnea*, *Planorbis*, &c. that inhabit our lakes and pools. Thus, as reefs and islands are formed by the coral animals, the bed of the ocean may be elevated by the shells of dead testaceous ones. That eye which is never closed, that thought which is never intermitted, that power which never rests, but, engaged in incessant action, and employing infinite hosts of under-agents to effect his purposes, sees and provides for the wants of the whole creation: the plant absorbs from the soil, the animal after devouring the plant, or the plant-fed creature, returns to the earth what the plant had absorbed, and so maintains the proper equilibrium; He who numbers the hairs of our head, numbers the workmen that he employs, employing them only in such proportions so distributed, as may best accomplish His purposes.

1 Plate VII. Fig. 2.

## CHAPTER XI.

### *Functions and Instincts. Worms.*

We are now at length, after long wanderings, arrived, if I may so speak, at the limits of the Molluscan territory, and, having visited the capital, seem now to be upon the confines of the higher hemisphere of the animal kingdom, the inhabitants of which are distinguished by having their whole frame built upon a vertebral column, inclosing a medullary chord, and terminating, at its upper extremity, in a skull containing a developed brain.

But though we seem arrived at the confines of this higher order of animals, there are still many, and some superior to the most perfect of the Molluscans, in the entirety of their nervous system, and the habits and instincts which they manifest, to which we have not yet paid the attention that they merit. These animals are particularly distinguished from the preceding Classes, by the *appearance*, or *actual existence* of *segments* or joints in their bodies, especially in their legs, of what may be called an annular structure. They are divided into two great tribes, which, from this circumstance, have been called *Annelidans*, and *Annulosans*, and the last, with more propriety, *Condylopes*.

There is one tribe, however, amongst the Radiaries, as we have seen, that shows some slight traces of insection, I allude to the star-fish and sea-urchins, forming the main body of Lamarck's Order of Echinoderms. If we examine the former, we find them marked out into areas, and in the latter, as I have before stated at large, the whole shell consists of numerous pieces united by different kinds of sutures.

Before I call the reader's attention to the two tribes lately mentioned, exhibiting the appearance or reality of insection, I must notice an anomalous tribe of animals, whose real station has not been satisfactorily made out. I am speaking of the *Entozoa* or Intestinal Worms. This Class, as Mr W. S. Mac Leay has remarked, consists of animals differing widely in their organization, some having a regular nervous system formed by a medullary collar sending forth two threads, while others have no distinct organs of sense.

Lamarck places this Class between the *Tunicaries* and *Insects*, and Cuvier, amongst his *Zoophytes*, between the *Gelatines* and *Echinoderms*. Mr Mac Leay has divided it into two classes, placing one, consisting of the Parenchymatous intestinal worms of Cuvier, between the *Infusories* and *Polypes*, and the *Cavitaries* of that author, amongst the *Annulosans* or *Condylopes*. Dr Von Baer is of opinion that these Entozoa, or worms, reducible to no common type of organization, inhabiting various animals in various parts of their body, together with the Infusories—and others might be added—should be banished from a natural arrangement of animals. He seems also to think, in which I feel disposed to agree with him, that the leading types of animal organization are to be found in its lowest grades.[1] As I formerly observed with respect to the Infusories[2]—these appear to be the basis on which God has built the animal kingdom. As some of the species appear connected with the *Annelidans*, I have introduced the Class here, but not as having formed any settled opinion as to its proper division and legitimate station.

The majority of this Class are, what their name imparts, *intestinal worms*, or parasites, that have their station *within* the body of other animals. Some of them, however, do not answer this description, as they are found only amongst aquatic vegetables; of this kind is a little tribe, which Linné arranged with the leeches,[3] to which they approach by the flukes.[4] The *Planaria*, in some respects, partakes more of the nature of a polype than of any other animal. Draparnaud, who paid particular attention to them, says that when young they have only two eyes, and acquire two more when adult. The head has no mouth; beyond the middle of the body, and on its under side, is a single orifice which serves for mouth, anus, and nostrils. This orifice answers to a long sac, which is the intestinal tube; from it sometimes issues a white tubublar organ, which he regards as respiratory; this organ is doubtless the same with the retractile trumpet-shaped proboscis, issuing from a circular aperture in the middle of the abdomen, mentioned by Dr Johnson in his interesting paper on these animals in the Philosophical Transactions, which he supposes to be a kind of mouth, when extended, equalling in length the animal itself.[5] This remarkable organ was also noticed by Müller and Mr Dalyell. The circumstance of its receiving and extruding its aliment and respiring at the same orifice, is a clear approximation to the

1 See *Zool. Journ.* July—October, 1828, 260.
2 See above, p. 80.
3 *Hirudo.*
4 *Fasciola. Distoma.*
5 Philos. Trans. 1825. i. 254. *t.* xvi. *f.* 10.

polype. A further confirmation of this is the power this animal possesses of spontaneously dividing itself for the purpose of reproduction. M. Draparnaud—after remarking that the species he described, which he calls *P. tentaculata*, and which is probably synonymous with that particularly noticed by Dr Johnson under the name of *P. cornuta*, is oviparous in the spring and gemmiparous in the autumn—observes, that, in the latter season, it divides itself spontaneously and transversely into two parts above the abdominal orifice, and at the end of ten days each of these parts has acquired the head or the tail that it wanted. He has divided individuals into many transverse pieces and two longitudinal ones, and every piece, in due time, completed itself. It formed eyes, an intestinal tube, and other necessary organs.

Mr Dalyell and Dr Johnson subsequently made similar observations, and by dividing the head had succeeded in producing an animal with two heads; the latter, from the result of several observations, found that each individual, upon an average, might, by spontaneous self-division, produce ten, and this when under constraint; if at liberty, and in their natural situation, we may conjecture that their reproductive powers might be carried much higher. Dr Johnson divided one into three equal portions, when the head speedily acquired a new body and tail; the tail, a new body and head; and the middle piece a new head and tail.

From this whole statement it is evident that these pseudo-leeches, to say the least, their substance considered, tend towards the polypes, and possess the same reviviscent powers. In several characters, which I shall notice hereafter, they also agree with the Annelidans. Draparnaud, from the approximation of the points on the head of *P. cornuta*, to the tentacles of *Lymnea*, thinks that they form a link between the Molluscans and the Worms. Reproductive powers have certainly been observed in the former, but only in the reproduction of mutilated organs, for a snail or slug cut in pieces, would not form so many individual animals. Bonnet has given an account of reproductive powers in one of the *Hispid Worms* of Lamarck, supposed by Gmelin to be the *Nais barbata* of Müller, and in a species of fresh water worm belonging to the Annelidans, which, if I may so speak, grows from cuttings, and like the *Planariæ*, can produce two heads. These last are probably not far removed from the flukes,[2] though their station is so different. Whether they live on animal or vegetable matter is

1 *Vers hispides.* 2 *Fasciola.*

not certainly ascertained; to look at their proboscis it seems rather calculated to fix them as a sucker, to some animal, and so to derive their nutriment from it, like their analogue, the leech, especially as the marine species are supposed to be carnivorous.

Their wonderful reproductive powers appear to be given them by a kind Providence to prevent their total annihilation; at least, it is stated, that at certain periods of the year, their numbers are so reduced, that where thousands were seen in summer, in spring scarcely one has survived. Their substance is so soft and gelatinous, that they are easily destroyed; to compensate this, they are gifted with the extraordinary powers of reproduction above described. God hath so tempered his sentient works, that seeming defects, in one respect, are compensated by redundance in another.

Having made these observations upon animals of this class, that do *not* infest man or beast internally, I next turn to those whose office is, in spite of all his care, to make the Lord of the Creation, as well as the whole animal kingdom, not only their constant abode, but also their food. More than *twenty* of these pestiferous creatures, that attack man, have been enumerated; some penetrate into the very seat of thought;[1] others disturb his bile;[2] others circulate with the blood in his veins;[3] others, again, are seated in his kidneys;[4] others in his muscles;[5] the guinea worm[6] in his cellular tissue: the ovaries of females are infested by another;[7] the tape-worms extend themselves, joint by joint, to an enormous length in his intestines;[8] some select the large intestine;[9] and others the small ones;[10] some even attack infants, and them only.[11] Such are the ills that flesh is heir to from these our internal assailants and devourers.—The recital is really enough to cause our hair to stand on end. No one can believe that all these instruments of punishment were at work in the first pair when they came from the hands of their Maker, and nothing, except *death*, can prove with a greater strength of evidence, that he is fallen from his original state of integrity and favour with God, than such

1 *Echinococcus Hominis.*
2 *Fasciola hepatica.*
3 *Linguatula Venarum.*
4 *Strongylus gigas.*
5 *Hydatigera cellulosa.*
6 *Filaria medinensis.*
7 *Linguatula pinguicula.*
8 *Tænia solium*, and *Botryocephalus Hominis.*
9 *Trichocephalus Hominis.*
10 *Ascaris lumbricoides.*
11 *Oxyurus Vermicularis.*

an army of scourges set in array against him. I shall enlarge a little upon a few of them, and then bid adieu to the disgusting subject.

There are few people, that have not heard of the *fluke*, or animal resembling a flat fish, and which really has been mistaken for one, often found in the liver of diseased sheep, and sometimes also in the human gall-bladder, and bile-vessels. The eyes of these animals are very prominent, and set in a cartilaginous ring, seeming to exhibit both iris and pupil; they are both planted in the upper side of the head, like those of the fish[1] they resemble. Like the leech, the fluke has two orifices—the first in a tubular prolongation of the head, and the other underneath in the abdomen, but distant from the tail. By these they fix themselves, living by suction; they sometimes produce fatal effects upon sheep. When only in small numbers, they, doubtless, as well as the rest of the Class, answer some good end; it is solely when they become too numerous that they occasion fatal diseases. Leeuwenhoek found 870 in one liver, and in others only ten or twelve. He says they occur in many kinds of quadrupeds, as stags, wild boars, and calves. He seems quite at a loss to account for their introduction into the livers of these animals, but concludes that, like the leech, their native element is water, and their eggs, swallowed by cattle when they drink, so find their way into the liver. This of course is all conjecture. Providence, who assigned to them their office, has also directed them to their station, but from whence or by what route we do not know certainly at present. A friend of mine who has kept a flock for many years, has observed that whenever they were turned into moist meadows in wet seasons, they suffered greatly from these animals; but that in the same situation, in a dry one, they were not affected.

The most celebrated of all the intestinal animals, are the Tape-worms, of which *five* species have been ascertained to inhabit man, besides whom quadrupeds, birds, reptiles and fishes are equally their victims. These are now divided into two genera, the common[2] and the grape-headed tape-worms.[3] The former is the most common in England,[4] but the latter[5] seems the most gigantic of any. Sir A. Carlisle, who has a most excellent paper upon the former, in the second volume of the Linnean Transactions, says that he has met with them from

1 Leeuwen: *Arcan. Nat.* E. Tr. *t. f.* H K. i. K.
2 *Tænia.*
3 *Botryocephalus.* PLATE I. B. FIG. 3.
4 *Tænia solium.*
5 *Botryocephalus latus.*

less than six feet long and consisting only of fifty joints, to thirty feet long with four hundred joints. But these are nothing compared with others of the latter observed by continental writers. Bonnet mentions them as sometimes extending to the length of thirty ells, probably meaning French ells, or one hundred and twenty-five feet, and Boerhaave, one that greatly exceeded that length.

These animals differ little from each other, but in the common tape-worm, the head which has a circular orifice or mouth at its extremity surrounded by a number of rays of a fibrous texture, and probably serving to fix the mouth, has on each side two small suckers which doubtless attach the head more strongly. The mouth, before spoken of, is continued by a short duct into two canals, which pass round every joint of the animal's body conveying its aliment, and sending a transverse canal along its bottom which connects the two lateral ones. Sir Anthony injected upwards of three feet of these canals by a single push with a small syringe, but he could not make it pass upwards beyond two joints which seemed to indicate the existence of valves opening only in one direction. He says there is no anal orifice, but other authors expressly mention one, and it is not easy to conceive, if the last has no orifice, how the joints can increase in number and remain concatenated. The body is composed of a vast number of joints, each having an organ whereby it attaches itself: those nearest the head are always small and they enlarge gradually as they recede from it. The extremity of the body terminates in a small semicircular piece.

Sir Anthony suspects that the several joints of the tape-worm are separate animals. This is an old opinion and has been adopted by several zoologists, but Bonnet seems to have proved, that however extended, the tape-worm is only a single animal. Whilst a living head remains attached to some joints, this creature maintains its station and keeps augmenting their number, but when any are broken off, they appear not to form new heads, as Sir Anthony supposes, but die and are expelled from the body. Their nutriment is probably derived from the gastric, pancreatic, and other juices which perpetually flow into the stomach and intestines of the animals they infest; and they employ the tentacular rays as a mean of irritation to determine a greater secretion of these fluids.

It would be an endless labour to expatiate in this vast field where the rest of the animal kingdom is concerned, amidst therefore the various and strange forms that are destined to this office, I shall select only a few, beginning with one that

affects one of the most valuable of our animal possessions, I mean the *Hydatids*,[1] which particularly and often fatally affect our flocks of sheep, not indeed that they are confined to them, for they are found also in swine, deer, and oxen, and even in man himself.

These animals resemble the tape-worm in their oral organs, but their body, especially posteriorly, is vesicular. The lymphatic vesicles are what medical men call hydatids; they are found usually in the brain and in the liver of these animals. Their size varies according to the species, some are as big as the fist, and one was shown to the School of Medicine in Paris as big a man's head. Their shape varies, but generally is somewhat spheroidal, their substance is composed of membranes one on another more or less thick, and formed of circular fibres visible only under a lens; they are half-filled with transparent lymph. They exhibit a peristaltic motion which is often very lively.

Three species more particularly annoy our sheep. The cerebral hydatid,[2] which finds its way into the brain of these poor animals and occasions the vertigo; and the vervecine[3] and ovine hydatids,[4] which penetrate into their lungs and liver and occasion the rot. It is usually discovered when a sheep is infested by the former of these pests by its turning often and briskly its head on one side; when it runs very quick, and suddenly stops without any apparent cause; in a word, when it appears almost deranged. Though the progress of the disease they produce is slow, it is generally fatal. Five hundred have been counted in the head of a single sheep. The ravages, however, produced by this hydatid are nothing to those occasioned by the other two, which attack the lungs and liver and cause the rot, by which, in some years, thousands perish.

Some worms are remarkable for their very singular forms or station. One that attaches itself to the gills of the bream, looks like a double animal,[5] and a kind of fluke,[6] in great numbers infests the ball of the eyes of the perch.[7]

Though at first view the animals of which I have in the present chapter given some account seem to be altogether punitive, and intended as scourges of sinful man both in his own person and in his property, and their great object is hasten-

1 *Hydatis.* 2 *H. cerebralis.*
3 *H. vervecina.* 4 *H. ovilla.*
5 *Diplozoon paradoxum.* PLATE I. B. FIG. 4.
6 *Diplostomum volvens.* Ibid. FIG. 5. 7 Ibid. FIG. 6.

ing the execution of the sublapsarian sentence of death, yet this evil is not unmixed with good. Though fearful and hurtful to individuals, yet it promotes the general welfare by helping to reduce within due limits the numbers of man and beast. Besides, with regard to the Lord of the Creation, these things are trials that exercise his patience and other virtues, or tend to produce his reformation, and finally to secure to him an entrance into an immutable and eternal state of felicity, when that of probation is at an end, so that the gates of Death may be to him the gates of PEACE and REST.

## CHAPTER XII.

### *Functions and Instincts. Annelidans.*

THE animals we have just been considering form an almost insulated group, so that it seems not easy to say to what tribe they are most nearly related, but the soft Pseudo-leeches, as was observed above, especially those that have rudimental tentacles, seem to tend somewhat towards the molluscan tribes; they exhibit considerable resemblance to the blood-suckers or true leeches, and like them have an instrument of suction, though employed, perhaps, in extracting the sap or the blood of plants, and at the same time, in many respects, as we have lately seen, they approach the polypes.

The Flukes, likewise, appear to have some characters in common with the leech,[1] so that a passage is open from the intestinal worms towards the *Annelidans*, some of which, as the earth-worm, occasionally become intestinal, and several are possessed of reproductive powers almost as great as those of the pseudo-leech, or the polype. I shall therefore next, in taking my departure from the worms, bend my steps to the animals just mentioned, which formerly bore the same general denomination.

They are called Annelidans, I suppose, because they appear to be divided into little rings, or else to have annular folds, and are soft vermiform animals, some naked, others inhabiting tubes, in some simply membranous, in others covered with agglutinated particles of sand, and in others formed, like those of the Molluscans, of shelly matter. Some have neither head, eyes, nor antennæ, while others are gifted with all these organs; instead of jointed legs, their locomotions are accomplished by means of fleshy bristle-bearing retractile protuberances or spurious legs disposed in lateral rows. Their mouth is terminal but not formed on one type; in some it is simple, orbicular or labiated; in others it consists of a proboscis often having maxillæ. They have a knotty spinal marrow, in this being superior to the Molluscans and approaching the Condy-

1 See above, p. 175.

lopes. They have red blood, and their circulation is by arteries and veins, but they have no special organ for the maintenance of the systole and diastole, their Creator not having given them a heart, but where the veins and the arteries meet, there is an enlargement, and the systole and diastole is more visible, as Cuvier remarks, than in the rest of the system, these enlargements therefore seem to represent a heart.

Savigny, in the third part of his *Systême des Animaux sans Vertèbres* divides them into five Orders, of which he gives only the characters of the four first, intending to publish, in a supplement, his account of the fifth; these Orders he arranges in two Divisions—the first including those that have bristles for locomotion, and the second those that have them not.

1. His *first* Order he denominates *Nereideans*,[1] and characterizes them as having legs provided with retractile subulate bristles, *without* claws; a distinct head with eyes and antennæ; a proboscis that can be protruded, generally armed with maxillæ.

2. The *second* he names *Serpuleans*, these add to the legs of the former retractile bristles, *with* claws; they have no head furnished with eyes and antennæ, and no proboscis.[2]

3. The *third* he names *Lumbricinans;* these have no projecting legs; but are furnished with bristles seldom retractile; they have no head with eyes and antennæ, and no maxillæ.

4. His *fourth* Order he names *Hirudineans.* They have a prehensile cavity, or sucker, at each extremity, and eyes.[3]

5. In his *fifth* Order he intends to comprehend those Annelidans that have neither bristles nor prehensile cavities, but his account of this has not been published.

He begins with the most perfect of the Annelidans, but viewing them in connection with the worms I must reverse the order, and instead of descending ascend, which will bring me ultimately into connection with the more distinctly jointed animals the Condylopes.

1. The Order of *Hirudineans* includes animals that are of the first importance, as well as some that are fearfully annoying, to mankind. The common leech[4] has long been so much in request with medical men, on account of the facility with which it can be applied to any part of the body where bleeding is required, that they are now become scarce in our own waters, and consequently dear, so that large numbers are imported from the Continent.

1 *Nereideæ.* 2 *Serpuleæ.* 3 *Lumbricinæ and Hirudineæ.*
4 *Hirudo medicinalis*, L. (*Sanguisuga*, Sav.)

Providence has gifted these animals with a sucker on the underside at each extremity of their body, by which their locomotions are performed, and by means of the anterior one they fix themselves to any animal that comes in their way. We see therefore in them, though on a larger scale, some approximation to the locomotive and prehensile organs of some of the Cephalopods, and prior to them, of the Stelleridans and Echinidans,[1] which likewise move and fix themselves by suckers. The mouth is situated in the cavity of the oral sucker, it is triangular and armed with three sharp teeth disposed longitudinally in a triangle, two being lateral and one intermediate, and higher up. These teeth are sharp enough to pierce not only the human skin, but even the hide of an ox, and have their edge armed with two rows of very minute teeth; at the bottom of the mouth is the organ of suction which imbibes the blood flowing from the wound made by the teeth. These animals inhabit fresh waters, in which they swim like eels with a vermicular motion. In moving on a solid body, they first fix themselves by their *anal* sucker, which is larger than the *oral*, and then by means of their annular structure, extend themselves forwards, when they fix their mouth, detach their anal sucker, and thus fixing themselves alternately by each proceed with considerable rapidity. They are hermaphrodites, and bring forth their young alive. When in their native waters they suck any animal that comes in their way, even those with white blood, as the larvæ of insects, worms, and the like.

Herodotus relates that the crocodile, in consequence of its frequenting the water so much, has the inside of its mouth infested by leeches, which a little bird, named the *trochilus*, enters and devours, without receiving any injury from the monster. Geoffroy St Hilaire asserts that no leeches are found in the Nile, and therefore supposes the *Bdellæ* of the father of history were not leeches but mosquitoes. But Savigny has described a leech under the name of *Bdella nilotica*[2] which he regards as synonymous with the leech of Herodotus. Bosc mentions one which was found in the stagnant waters in Egypt, when not inflated as small as a horse hair, which very much annoyed the French soldiers, attacking them in nearly the same way; when they drank, fastening itself to their *throat*, and occasioning hemorrhages and other serious accidents.

Mr Madox, in his *Excursions in the Holy Land, Egypt*, &c., states that he had frequently seen, on the banks of the Nile, a bird about the size of a dove, or rather larger, of handsome

1 See above, p. 164, 108, 110.

2 Plate VIII. Fig. 3.

plumage, and making a twittering noise when on the wing. It had a peculiar motion of the head, as if nodding to some one near it, at the same time turning itself to the right and left, and making its congé twice or thrice before its departure. This bird, he was told, was called *Sucksaque*, and that tradition had assigned to it the habit of entering the mouth of the crocodile, when basking in the sun, on a sand bank, for the purpose of picking what might be adhering to its teeth: which being done, upon a hint from the bird, the reptile opens his mouth and permits it to fly away.[1]

This seems evidently the *Trochilus* of Herodotus, above alluded to, as clearing the mouth of the crocodile from the leeches. Aristotle, in more than one place of his *History of Animals*, mentions such a bird, and a similar tradition concerning it, with that of Mr Madox. "The Trochilus flying into the yawning mouth of the crocodile cleanses his teeth, and thus is provided with food. The latter, sensible of the benefit, suffers it to depart uninjured."[2] In another place,[3] he seems to speak of it as an aquatic bird, yet afterwards he describes it as frequenting shrubberies and subterranean places.[4] Whether this animal really attends thus upon the crocodile has not been ascertained, but it would be singular that such a tradition should have maintained its ground so long without any foundation.

As a further proof that the *Bdella* of the father of history is a true *leech*, and not a mosquito,—as M. Geoffroy St Hilaire, from the meaning of its primitive,[5] would interpret the word,—it may be observed that Aristotle compares the Bdella to an earth-worm,[6] and describes its peculiar motion; and in Hesychius it is said to be a kind of *Scolex* or worm; Theocritus also alludes to its blood-sucking propensities.[7]

That leeches infest the aquatic Saurians is further evident from a letter received by Mr R. Taylor, and very kindly communicated by him to me, from a friend at Calcutta, Mr W. C. Hurry, who having observed that the fauces of the gigantic crane[8] were generally very full of leeches, determined to examine the crocodile; and upon a large alligator he found a small red species, of which he sent specimens. A friend of mine, Mr Martin, of Islington, observed also that the alligators

1 *Excursions*, &c. i. 408.
2 *Hist. An.* l. ix. c. 6.
3 *Ibid.* l. viii. c. 3.
4 *Ibid.* l. ix. c. 11.
5 Them. Βδέλλω, to suck.
6 *De incessu animal.* c. 9.
7 *Idyll.* ii. line 55, he calls it Αιμνατις Βδέλλα.
8 *Ciconia Argala?*

of Pulo Penang were infested, as he thought, by an animal of this kind, called by the natives its louse.

The Trochilus of Aristotle, Mr Stanley states to Mr Taylor, is the Egyptian Plover;[1] who further observes that the Green Tody[2] is also related to cleanse the mouths of the alligators in the West Indies, from the gnats and flies that stick, in great abundance, in the glutinous matter they contain.

But there is a terrestrial kind of leech found in the island of Ceylon, which appears to be a greater pest than any other species of the genus, and one of the greatest scourges of that fine island. They infest, in immense numbers, the mountains, woods, and swampy grounds, particularly in the rainy season. They are oftener seen on leaves and stones than in the waters. The largest are about half an inch long when at rest. Their colour varies from brown to light brown, with three longitudinal yellow lines. They are semi-transparent, and when fully extended are like a fine chord, sharp at the extremity, and easily thread any aperture, so that they can penetrate through the light clothing worn in that climate, rendering it impossible, at that season, to pass through the woods without being covered with blood, Dr Davy counted fifty on the same person; no sooner does any individual stop, than, as if they saw or scented him, they crowd towards him from all quarters. From their immense numbers, activity, and thirst of blood, they are the great pest of travellers in the interior. Percival says that the Dutch, in their march into the interior, at different times, lost several of their men from their attack. Other animals besides man suffer dreadfully from them, and horses in particular are rendered so restive, when they fasten upon them, as to be quite unmanageable and unsafe to ride. The only way to prevent their attack, is to cover the skin completely.

The office devolved upon the present tribe, is one which, within certain limits, is beneficial to the animals who are the objects of it—though those last mentioned would be inserted in a list of the destroyers of the animal kingdom—which contribute to maintain a just balance between the different members of it. The fly that bites the horse prevents it from overfeeding, and so the leeches may be of use to the larger aquatic animals, at the same time that the smaller ones, such as the grubs of insects, must generally perish from the insertion of their sharp jaws, and the suction of their proboscis.

Yet, as we see, this is one of the animals that man has taken into alliance with him, and this no doubt Providence intended

1 *Charadrius Ægyptius.* 2 *Todus viridis.*

he should, and probably directed him to it, I mean by causing certain circumstances to take place that attracted his attention and indicated its probable use. So that what at first put him to pain, and caused him alarm, he found, upon trial, might be rendered a very valuable addition to his means of cure when attacked by disease, or when he was suffering from a local injury.

The leech tribe, besides its utility in the exercise of its own function, may be useful as affording nutriment to some other animals, as fishes and birds.

The *earth-worms*[1] form a principal feature of the next Order, and afford a delicious morsel to birds of every wing. The fisherman also baits his hook with them, and the ground-beetles[2] often make a meal of them, so that had they no other use, still they would be a very important part of the creation. But their great function appears to be that of boring the earth in all directions, whereby they are useful to the farmer and grazier, giving a kind of under-tillage to pasture and other lands, and by the casts which they every where throw up, they help to manure the soil, and do the same for pastures, that the spade does for the garden and the plough for arable land, place the soil that laid below above. Their food being vegetable detritus, what passes from them must be very good manure.

The anatomy of these well-known animals is very singular and well worthy the attention of the physiologist and zootomist, the only circumstance relating to it that I shall here mention is that their long body is not only divided externally into rings, but internally into an equal number of cells separated from each other, if I may so speak, by a kind of dissepiment or diaphragm—there are more than a hundred of these cells in the common species, as appears by Mr Bauer's admirable figures in the *Philosophical Transactions* for 1823, to which I must refer the reader for further information on this subject, first observing that there seems some analogy between the cells of the earth-worm and the joints of the tape-worm.

The motion of these animals, and of many other Annelidans, is accomplished by means of the rings of their body and their lateral bristles; the latter the Creator has given to them, in the place of legs: pushing with the anterior portion of these against the plane of position, by contracting the rings, they bring up the posterior portion of their body, and then fixing

1 *Lumbricus* (*Enterion Sav.*) *terrestris*. L. &c. 2 *Carabus*. L.

that part, extend the anterior rings, and so proceed successively with a kind of undulating motion.

3. We are next to notice a tribe of Annelidans, many of which, in one respect, make some approach to the Testaceous Molluscans. Though truly annulated and furnished with a kind of false legs, they are defended by a shell resembling in its substance, that of the class just alluded to, but often by its irregular convolutions proving that it belongs to an Annelidan and not to a Molluscan; some indeed approach to the spiral convolutions of a Trachelipod shell; others form a membranous sac, and cover it with agglutinated particles of sand, as the common *Sabella;* others again, likewise inhabit a tube, but they fix it in the rocks. The testaceous animals of this class, particularly the worm-shells[1] inhabit a tortuous tube which they form, probably with more ease and celerity than the Molluscans form their shells—for they appear almost to do this as they move, since the shape of the shell imitates the sinuous windings of a worm, and that of the *Serpula* adheres to the substances on which it is formed. We see it often upon the shells of bivalves, to which it adheres by the lower surface, looking like a little worm creeping upon them;[2] and forming convolutions; I have a specimen on a valve of the cock's-crest oyster,[3] which is bound down by a process issuing apparently from the disk of the oyster-shell itself, how produced and thrown over the *Serpula* it seems not easy to conjecture. Different species of these worm-shells are often found, embracing each other with their convolutions, on the same shell; wherever the sea is or has been, they abound either in a recent or fossil state; they are found on rocks, and sea-weed as well as on marine shells, and those of lobsters. The Serpulidans, in general, imitate the spiral structure of the Trachelipod and other Molluscans, as is particularly evident in *Siliquaria* and *Vermetus*, if indeed the last genus is not itself a Molluscan, as Lamarck makes it.

Other species of this Order are taught to establish themselves in fissures of rocks, which serve them instead of a shell to protect the membranous tubes into which they retract their petaliform tentacles, which together represent a beautiful radiated

1 *Serpulidæ.* 2 *S. Triguetra.*

3 *Ostrea Crista-galli.* Since the above was written, in the collection of the late Peter Collinson, I have seen two specimens of this oyster, which had produced from the back of their shell a double series of processes, with which, as with so many fingers, they had taken firm hold of a piece of stick.

blossom, or the nectarium of a passion-flower. Of this kind is the *Magnificent Amphitrite*, figured in the *Linnean Transactions*.[1] It is found in the rocks of various parts of the coast of Jamaica. When alarmed, it retracts its tentacles within its tube, and the tube itself into the rock. How it excavates its rocky burrow has ~~not be~~en ascertained.

The *Sabellæ*, which pass under various names in different authors, inhabit the sandy parts of the shore, and like certain case-worms form a covering for their tube of selected grains of sand, mixing sometimes other substances that suit their purpose, which, by some secretion at their disposal, they glue pretty firmly together so as to form a neat case tapering towards the tail. The animal buries itself and case in the sand, with its head towards the surface, so, probably, as to enable it to protrude it and expand its tentacles to collect its food when covered by the water. The bristles of the legs in some species resemble burnished gold.

The functions of a large proportion of the animals of this order seem to correspond with those of the bivalve shell-fish; they undermine the sands and the rocks, bore into sponges and corallines, and other submarine substances, and some probably, into submerged wood: like them, also, they seem to feed on animalcules brought within their reach by the tide. The Serpulidans, whose food is similar, are directed by the will of their Creator to affix themselves externally to any submerged bodies that come in their way, whether mineral or animal. All they require seems to be something to attach themselves to, on which they can protrude their tentacular gills, and seize their prey. They must contribute largely, as well as the mining Annelidans of this order, to the production of calcareous matter. Mr Sowerly suspects that their proboscis may be instrumental in forming the shell, but it seems not properly a proboscis, but merely an operculum on a long footstalk, which was requisite that it might be protruded so far as not to interfere with the action of the gills.

The animals included in Mr Savigny's first Order, the *Nereïdeans* bring us very near to the Condylopes. They have a distinct head, jointed organs like antennæ, eyes, a proboscis armed with maxillæ, and spurious legs. They have also certain dorsal scales, which M. Savigny calls elytra, and deems analogous to the organs of flight in insects. These animals seem to afford the first example of the conversion of organs of

1 *Tubularia magnifica*. Shaw.

locomotion into others, employed for a different purpose. I do not mean by this, that, in the progress of the animal's growth, one organ is really converted into another, but that analogous organs, in different tribes or genera, are employed for different purposes. Thus, what in most Annelidans are locomotive organs, in *Lycoris*, *Phyllodoce*, and some other Nereïdeans[1] become a kind of tentacle. The marine *Scolopendra* of Aristotle most probably belonged to this Order, and many species make a near approach to the terrestrial ones.[2] Like them they are long and often flat, consisting of a great number of segments, some having between two and three hundred, furnished according to the species, with one, two, or three pairs of legs in each ; like them also they twist about in all directions when handled, they conceal themselves in close places where they lie in wait for their prey. In one respect some of them add the instinct of the spider to that of the centipede, for they line and sometimes cover the cavities of the rocks which they inhabit with a slight silken web, and thus concealed they watch the approach of some animal, and, suddenly thrusting out the anterior part of their body, seize and devour it.

My late indefatigable and talented friend, the Rev. L. Guilding once found a *land* species, in an ancient wood in the Island of St. Vincent's which from its soft body he regarded as a Molluscan, but from its figure, and annulose structure, its jointed antennæ, and seemingly jointed legs crowned with bristles, it[3] certainly belongs, as Mr Gray has remarked, to the present class. Though it has scarcely a distinct head, its resemblance to the cylindrical myriapods[4] is very striking. Other species of this Order resemble the Isopod Crustaceans, and some even roll themselves up like one tribe of them.[5]

These animals have their haunts sometimes in deep burrows and passages under the sea-weed or in the sea-sand. They are so fierce in their habits that some have been styled the tigers of the worms. Some fishes in their turn make them their prey. Many of them, as the sea-mouse,[6] are remarkable for the brilliancy of their metallic hues. Perhaps these dazzling splendours, as in the case of some insects,[7] may be of use to them in preventing the escape of their prey. Their forms and instruments of locomotion seem particularly adapted to the situation and circumstances in which they are placed ; their

1 Savigny, *Syst. des Annel.* 9, 12, 13.
2 Plate VIII. Fig. 4.
3 Plate VIII. Fig. 1. Mr G. calls it *Peripatus juliformis.*
4 *Julus.* L.
5 *Nereis Armadillo.*
6 *Aphrodita aculeata.*
7 *Introd. to Ent.* ii. 221.

legs, which approach the jointed legs of crustaceans and insects, fit them for moving on the surface of the bed of the sea, their oars for swimming in the water, and the long form of many for threading the sinuous paths and burrows in which they have their habitation and place of refuge. So exactly are they fitted by the skilful hand of the almighty and benevolent Architect of all animal forms to live and move in the place he has assigned to them.

## CHAPTER XIII.

*Functions and Instincts. Cirripedes and Crinoïdeans.*

### CIRRIPEDES.

THERE is a class of animals defended by multivalve shells, separated from the Molluscans not only by the more complex structure of their shells, but also by very material differences in the organization of the creatures that inhabit them. These Linné considered as forming a single genus, which he named *Lepas*, a word derived from the Greek lexicographers, and explained by Hesychius as meaning a kind of shell-fish that adheres to the rocks. In this country these animals are known by the general name of *Barnacles*. Lamarck, I believe, was the first who regarded them as entitled to the rank of a class, which he denominated *Cirrhipeda*, not conscious, that by the insertion of the aspirate, he made his term, like *Monoculus*, half Greek and half Latin: later writers who have adopted the class, to avoid this barbarism, have changed the term to *Cirrhopoda*, but as this gives a different meaning to the word, changing *fringed* or *tendril-legs*,[1] very happily expressing the most striking character of the animals intended, into *yellow-legs*,[2] which does not indicate any prominent feature, I shall, after Dr Leach and Mr W. S. Mac Leay, omitting the aspirate, call them *Cirripeda*, or Cirripedes.

These animals have a soft body, protected by a multivalve shell. They are without eyes, or any distinct head; have no powers of locomotion, but are fixed to various substances. Their body, which has no articulations, is enveloped in a kind of mantle, and has numerous tentacular arms, consisting of many joints, fringed on each side, and issuing by pairs from jointed pedicles: their mouth is armed with transverse toothed jaws in pairs, which, like the mandibles of the Crustaceans, are furnished with a feeler; they have a knotty longitudinal spinal chord; gills for respiration; and for circulation, a heart and vascular system.

1 Lat. *Cirri*. 2 Gr κιρρος.

This class is divided into two Orders.

1. The *first* consists of the *Lepadites*, or Goose-barnacles,[1] the species of which are distinguished by a tendinous, contractile, and often long tube, fixed by its base to some solid marine substance, supporting a compressed shell, consisting of valves united to each other by membrane, and by having six pairs of tentacular arms. They are usually found in places exposed to the fluctuations of the waves. One genus[2] appears to perforate rocks to form a habitation. These animals roll up and unroll their arms with great velocity, thus creating a little whirlpool, that brings to their mouth an abundant supply of animalcules, an action which Poli compares to fishermen casting a net. Some species, instead of shell, are covered by a membranous sac, having occasionally very minute shelly valves.[3]

2. The *second* Order of Cirripedes consists of the *Balanites*, or Acorn-barnacles, which are distinguished from the Lepadites by a shelly, instead of a tendinous tube, the mouth of which is closed by an operculum, usually consisting of four valves. The animals of this Order are commonly regarded as sessile; but, if Lamarck is right in considering the valves of the shell of the Lepadites as analogous to the operculum of the Balanites, as it seems to be, and their tendinous tube as really a part of the body of the animal—as its being organized, living, and muscular, seems to prove—then it must be analogous to the shelly tube of the latter, and both must be considered as elevated by a footstalk. This tube, in the Balanites, consists usually of six pieces, soldered, as it were, together; and in several species, as in the common sea-acorn,[4] of a triangular shape, and having their acute angle alternately at the base and at the mouth of the tube. The base of the tube generally takes the form of the bodies upon which it is fixed, and is sometimes composed of shell, sometimes of membrane, and sometimes it is incomplete. The animal, in this Order, has twenty-four tentacular arms, shorter than those of the Lepadites, consisting of two sorts, namely, six pairs of large similar ones, but unequal in size, placed above; and as many smaller pairs, dissimilar and unequal, and placed below. One pair of these is much larger than the others. In the water they keep these tentacles[5] in perpetual motion, and thus arrest, or, by producing a current

1 *Anatifa. Pentelasmis*, &c.
2 *Lithotrya.*
3 *Anatifa coriacea et leporina.*
4 *Balanus Tintinnabulum.*
5 These organs, though called tentacles, from their use, seem rather analogous to the *antennæ* and other *jointed* organs of *Condylopes*.

to their mouth, absorb the animalcules, which constitute their food. They not only fix themselves upon inanimate substances, such as rocks, stones, the hulls of ships, &c. but also upon various marine animals and plants. Thus some are found on Zoophytes, as sponges and madrepores; others attached closely to each other on shell-fish, especially bivalves, so closely that the point of a pin cannot be thrust between them. One species takes its station on the shell of the turtle;[1] others plant themselves in the flesh of the seal; and others bury their tube in the unctuous blubber of the whale.

If we compare the animals of the above Orders with each other, we shall find that they are fitted by their Creator to collect their food in different ways. The *Lepadites*, by means of their long contractile flexible tube, can rise or sink, and bend themselves in different directions, so as, in some sort, to pursue their prey; their tentacles, also, from their greater length, seem to further this end: these, according to Poli's metaphor above alluded to, they can throw out and draw in laden with fry, as a fisherman does his net. When their prey is in their mouth, it is subjected to the action of their toothed jaws, which seem more numerous and powerful than those of the Balanites; and as the valves forming the shell are more numerous and connected by membrane, and the whole shell more compressed than the operculum of the last named animals, we may suppose that they are capable of a more varied action, and one that may perhaps add to the momentum of the masticating organs. Hence we may conjecture that the animals destined to form their nutriment, may be larger, so as to require more exertion and force, both to take and to masticate.

In the other Order, the structure of the *Balanites* seems to indicate merely the protrusion and employment of their tentacles; and being usually attached to floating bodies, such as the hulls of ships, or parasitic upon locomotive animals, riding as they do upon the back of the turtle, the dolphin, and the whale, they may visit various seas in security, and feast all the while, with little trouble and exertion, upon animalcules of every description, the produce of artic, temperate, and tropical seas.

With respect to their place in nature, it seems not quite clear whether they should be regarded as leading from the Molluscans, with which Cuvier arranges them, towards the Crustaceans, and they certainly seem to have organs borrowed from both; their shells and mantle in some degree from one, and

1 *Coronula testudinaria.*

their palpigerous mandibles and jointed organs, proceeding in pairs from a common footstalk—like the interior antennæ of the lobster—and knotty spinal chord from the other: but with respect to their jointed organs, I must observe that they still more closely resemble those of some of the Encrinites,[1] like them being fringed on each side, though not with organs of that description. A learned naturalist, Mr W. S. Mac Leay, is of opinion that the Echinidans, or sea urchins, exhibit some approximation to the Balanites.[2] If, indeed, we compare the genus *Coronula* with an *Echinus*, we shall discover several points in which their structure agrees. We learn from Lamarck, that the pieces of the so called operculum, which close the mouth of the former shell, are affixed rather to the animal than to the shell. Thus the operculum, in some sort, represents the jaws of an Echinus, though consisting of fewer pieces, and the tube appears divided into alleys, like the crust of that animal. These circumstances seem to prove some affinity between the Cirripedes and Radiaries; they appear also to have some points in common with Savigny's Nerëideans, especially *Amphitrite*.[3] Weighing all these circumstances, I have thought it best to place the Cirripedes immediately before the Entomostracan Crustaceans.

But what if these Cirripedes should at last prove to be, not the guides to the great Crustacean host, but its legitimate progeny? This has been asserted, at least partially, by a modern zoologist, who has assigned his reasons for this singular and startling opinion. I will not say the thing is impossible—for with God all things are possible—but it certainly appears in the highest degree improbable. That a *Zoea* should become a crab is sufficiently extraordinary, and an opinion, as Latreille remarks, which, if it be not erroneous, has great need of support from experiment:[4] but that a locomotive animal, gifted with eyes and legs, should, by an extraordinary metamorphosis, in its perfect state, become a barnacle, without head, eyes, or locomotive organs, can never be admitted till confirmed by repeated experiments of the most able and practised zoologists, so as to place the matter beyond dispute. I by no means, however, mean to assert that Mr Thompson did not think he saw what he has stated, in both cases, to take place, but he was probably deceived by appearances in some such way as he states Slabber to have been.[5]

A single fact, observed by Poli, is sufficient to overturn this

1 Plate III. B. Fig. 1. 2 *Hor. Ent.* i. 312. 3 *Ibid.*
4 *Cours D'Entomologie*, i. 385. 5 *Zool. Research*, No. i. 7.

whole hypothesis. This illustrious conchologist relates that he had an opportunity of examining the immense fecundity of the sessile barnacles. "In the beginning of June he found innumerable aggregations of them, covering certain boats that had been long stationary, which, when closely examined, were so minute, that single shells were not bigger than the point of a needle; and that from that time they grew very rapidly, and arrived at their full size in October." These very minute ones must have been hatched from the egg, and not produced from larves.

With regard to the functions and instincts of these Cirripedes, very little has been observed. We see from the above account of them, that, like many other animals amongst the lowest grades of the animal kingdom, they are furnished with particular organs adapted to the capture of animalcules and other minor inhabitants of the deep, which they help to keep within due limits. Probably they act upon the substances to which they attach themselves, and promote the decomposition of shells, and other exuviæ of defunct animals, and also of the rocks and ligneous substances on which they take their station. Of this we are sure, that they work His work who gave them being, and assigned them their several stations in the world of waters.

## CRINOÏDEANS.

In the deepest abysses of the ocean, it is probable, lurks a tribe of plant-like animals, to judge from its numerous fossil remains, abounding in genera and species that are very rarely seen in a recent state, and which, from a supposed resemblance between the prehensory organs or arms, surrounding the head or mouth of several species belonging to the tribe, when their extremities converge, to the blossom of a liliaceous plant, have been denominated *Encrinites* and *Crinoïdeans*.[1] It was not my original intention, as little or nothing was known with respect to the habits and station of the few recent ones that have been met with—except that one has been taken in the seas of Europe, and three in the West Indies, namely, near Martinique, Barbados, and Nevis—to have introduced them into the present work, but having subsequently seen fragments of a specimen, taken either in the Atlantic or Pacific, I am not certain which, and upon examining it under the microscope, finding

1 From κρινον, a lily.

evident traces of suckers on the underside of its fingers, and of the tentacles that form its fringes,[1] a circumstance I found afterwards mentioned by Ellis, and which throws some light upon their economy, I felt that I ought not to pass them wholly without notice, and finding in the Hunterian Museum a very fine specimen which does not appear to have been figured, for the figure given by Ellis seems to have been taken from Dr Hunter's specimen, now at Glasgow, and Mr Miller's from a specimen of Mr Tobin's, now in the British Museum, by the kind permission of the Curators of the Museum in Lincoln's Inn Fields, I was allowed to have a figure of it taken by my artist, Mr C. M. Curtis.[2]

Lamarck has placed the Crinoïdeans, led probably by their plant-like aspect, in the same Order with his *Floating Polypes*,[3] not aware that the majority are evidently *fixed*, but Cuvier and most modern zoologists consider them, with more reason, as forming a family of the *Stelleridans*, from which the way to them is by the genus *Comatula*, remarkable for its jointed rays fringed on each side. The *Marsupites*, as Mr Mantell, after Mr Miller, has observed, form the link which connects the proper or pedunculated Crinoïdeans with the Stelleridans. If we compare them again with the class last described, the *Cirripedes*, especially the *Lepadites*, we shall find several points which they possess in common. In the first place both sit upon a footstalk, though of a different structure and substance; the animal in both, in its principal seat, is protected by shelly pieces or valves; the head or mouth in both, is surrounded by dichotomizing articulated organs, involuted, and often converging at the summit, and fringed on each side, in the Crinoïdeans, with a series of lesser digitations, and in the Cirripedes with a dense fringe of hairs. If the opinion of Mr W. S. Mac Leay, stated above, that some of the *Echinoderms* exhibit an approximation to some of the *Cirripedes*, is correct, as it seems to be, the *Crinoïdeans*, though still far removed, would form one of the links that concatenate them; or if their connection is thought merely analogical, the *Balanites* would be the analogues of the *Echinidans* and of the sessile Crinoïdeans, and the Lepadites of the pedunculated ones.

The following characters distinguish the *Pentacrinites*, to which Tribe all the known recent species belong.

*Animal*, consisting of an angular flexible column, composed of numerous joints, articulating by means of cartilage, and per-

1 Plate III. B. Fig. 2. 2 *Ibid.* Fig. 1.
3 *Polypi natantes.*

forated for the transmission of a siphon or intestinal canal, and sending forth at intervals, in whorls, several articulated cylindrical branches, curving into a hook at their summit; fixed at its base, and supporting at its free extremity a cup-like body, containing the mouth and larger viscera, consisting of several pieces, terminating above in five (or six) dichotomizing, articulated, semi-cylindrical arms, fringed with a double series of tentacular jointed digitations, furnished below on each side with a series of minute suckers: these arms, when expanded, resemble a star of five (or six) rays, and when they converge, a pentapetalous or hexapetalous liliaceous flower. The whole animal, when alive, is supposed to be invested with a gelatinous muscular integument.

In the specimen figured by Mr Ellis, and that in the Hunterian Museum, there appear to be *six* arms springing from the so-called pelvis, but the natural number appears to be *five*, corresponding with the pentagonal column. Mr Miller seems to be of opinion that the species described by M. Guettard, and that which he has himself figured, are the same species, and synonymous with the *Isis Asteria* of Linné and the *Encrinus Caput Medusæ* of Lamarck, but to judge from the figures of the first in Parkinson,[1] and of the other in Miller,[2] compared with that which is given in this work,[3] the last seems to differ from both, as well in the pelvis, as in the dichotomies, and length of the arms; its suckers likewise appear to be circular,[4] and not angular as they are described by Mr Miller under the name of plates.[5] If this observation turns out correct, I would distinguish the last species by the name of *Pentacrinus Asteria.*

The stem of the Crinoïdeans consists of numerous joints, united by cartilages, which exhibit several peculiarities; in the first place the upper and under side is beautifully sculptured, so as to represent a star of five rays, or a pentapetalous flower; the Creator's object in this structure appears to be the attachment of the cartilage that connects them, and, perhaps, to afford means for a degree of rotatory motion, as well as to prevent dislocations, and also to increase the flexure of the stem according to circumstances, and the will of the animal. For the transmission of the siphon, whether a spinal chord, or intestinal canal, or both, each joint of the column is perforated, the aperture being round in some, and floriform in others. The whole stem, with its whorls of branches, exhibits a striking

1 *Organic Remains*, ii. *t.* xix. *f.* 1.
2 *Crinoïdea*, 48. *t.* 1.
3 Plate III. B. Fig. 1.
4 *Ibid.* Fig. 2.
5 *Ubi supr.* 54. *t.* ii. *f.* 6.

resemblance to the branch of the common horse-tail.[1] The entire structure seems calculated to enable the animal to bend its stem, which appears very long, in any direction, like the Lepadites, and thus as it were to pursue its prey; we may suppose that the branching arms, fingers, and their lateral organs, when they are extended horizontally and all expanded, must form an ample net, far exceeding that of the Cirripedes, which, when they have their prey within its circumference, by converging their arms, and closing all their digitations, and employing their suckers, they can easily so manage as to prevent the escape of any animal included within the meshes of their net.

With regard to their functions, and what animals their Creator has given a charge to them to keep within due limits, little can be known by observation; as nothing like jaws has been discovered in them, in which they differ from the Cirripedes, it should seem that either their food must consist of animalcules that require no mastication, or, if they entrap larger animals, that they must suck their juices, which seems to be Mr Miller's opinion.[2] This idea is rendered not improbable by the vast number of suckers by which their fingers, and their lateral branches or tentacles as they are called, are furnished; by these they can lay fast hold of any animal too powerful to be detained in their net by any other means, and subject it to the action of their proboscis.

From the great rarity of recent species of these animals, it should seem that the metropolis of their race is in the deepest abysses of the world of waters. "It appears," says Bosc,[3] "that the species were extremely numerous in the ancient world, perhaps, those actually in existence are equally so, for I suspect that all inhabit the depths of the ocean, a place in which they may remain to eternity without being known to man."

Naturalists very often, too hastily, regard species as extinct, that are now found only in a fossil state, forgetting that there may be many stations fitted for animal or vegetable life, that are still, and, perhaps, always will be inaccessible to the investigator of the works of the Creator, where those mourned over as for ever lost, may be flourishing in health and vigour.

1 *Equisetum arvense.* 2 *Crinoïdea*, 54.
3 *N. D. D'Hist. Nat.* x. 224.

## CHAPTER XIV.

*Functions and Instincts. Entomostracan Condylopes.*

We are now arrived at a great branch of the animal kingdom, which, in its higher tribes, exhibits Divine Wisdom, acting, in and by the instincts of creatures, small indeed in bulk, but mighty in operation, in a way truly admirable, indicating, in a most striking manner, the source from which it proceeds.

Some modern zoologists do not regard this vast and interesting branch as forming a group by itself, but have associated with it, under a common name, several of the preceding classes. Carus, in his *Class of Articulated Animals*,[1] includes Lamarck's *Worms* and *Annelidans;* and Dr Grant, in his *Sub-kingdom*, bearing the same appellation, adds to these the *Wheel-animalcules*,[2] and *Cirripedes*.[3]

I cannot help thinking, however—taking the whole of their organization and structure into consideration, particularly their powers and means of locomotion and prehension—that it is best to regard those animals having *jointed legs*, and, mostly, *a body formed of two or more segments*, as constituting a separate Sub-kingdom. This is the view that my late illustrious and lamented friend, Latreille, has taken of this great group, named by him, from the above circumstance, *Condylopes*,[4] which term, since that of *Annulose animals*,[5] sometimes used, is synonymous with *Annelidans*, I shall adopt in the present work.

The distinctive characters of this great group, or Sub-kingdom, may be given in few words:

Animal, not fixed by its base, but locomotive.

*Body*, in the great majority, consisting of two or more segments.

*Legs*, jointed.

The first of these characters distinguishes the *Condylopes* from the last class, the *Cirripedes*, which are fixed by their base, whereas the present tribe are more free in their motions than most of the animals of the preceding groups; and the two last

1 *Articulata.* 2 *Rotifera.* 3 *Cirrhopoda.*
4 *Condylopa*, from κονδυλοι, joints, and πους, a foot. 5 *Annulosa.*

from the *Annelidans*, which, though annulated, are not insected, and have no jointed legs.

Cuvier, Latreille, and most other zoologists, consider this section of the animal kingdom as subdivided into *three* great Classes—*Crustaceans*, *Arachnidans*, and *Insects:* Dr Leach, taking the respiratory organs for his guide, also begins with three *primary* Sections, those, namely, which have *gills*, those which have *sacs*, and those which have *tracheæ*, for respiration; and out of these he forms *five* Classes, viz. *Crustaceans*, *Arachnoidans*, *Acarines*, *Myriapods*, and *Insects*. The first and last of these Classes he further subdivides, each into two Sub-classes: the Crustaceans into *Entomostracans* and *Malacostracans;* and Insects into *Ametabolians* and *Metabolians*, or those that do not undergo a metamorphosis, and those that do. So that according to his *primary* Section his system is *ternary;* according to his *secondary* it is *quinary;* and according to his *tertiary* it is *septenary*. I shall mostly follow him in each of these last subdivisions.

Having made these remarks upon the Condylopes in general, I must now proceed to one of the Classes above enumerated: but here, at first, it seems difficult to ascertain which ought to be regarded as forming the first step in an ascending series,—a difficulty, indeed, which often arrests the course of the student of the works of his Creator, for, when any one, in a philosophic spirit, after a careful survey, sits down to trace the paths by which Divine Wisdom seems to have passed in the creation, and the arrangement and connection of the various groups of organized beings, he is lost and bewildered in a most intricate and mazy labyrinth, in which paths intersect each other at every angle, and when he thinks he is travelling in a straight road he often comes to branches leading off from it, which render it uncertain in which direction he ought to proceed, in order best to attain the object he is pursuing.

Such indeed is the perplexity of animated nature, that it is impossible to see clearly the arrangement of the objects that constitute either the vegetable or the animal kingdom; and in order to get any tolerable notion of them, as God has placed them, when we have reached a certain station we are often obliged to retrograde, and begin a branch, from the point of its divergement, far removed from that to which we have arrived.

Latreille, in the last edition of the *Règne Animal*, divides his *Crustaceans* into *two* Sub-classes, the first of which, after Aristotle, he denominates *Malacostracans;*[1] and the second, after

1 *Malacostraca.*

Müller, *Entomostracans:*[1] these, on account of a connection which seems to exist between them and the *King-crab,*[2] he places immediately before the *Arachnidans.* I agree with this learned entomologist, in considering them as inferior to the proper Crustaceans, and shall therefore begin the Condylope group with some account of them. Like the infusory animalcules, they form a kind of centre, sending forth rays to different points, some inclosed in a bivalve shell, seeming to tend towards the *Molluscans*;[3] others assuming more of the *Crustacean* form;[4] a third looking to the *Arachnidans*;[5] and a fourth to the *Thysanuran,* or Sugar-louse tribe;[6] with other forms that might be enumerated, some of which are perfectly anomalous, so that it appears almost indifferent where they are placed. As there is, however, evidently some affinity between the Entomostracans and the Cirripedes, not only in both being furnished with jointed organs for their motions, but also in some of the former being inclosed in shells, and in others by the brisk agitation of their legs, producing a current in the water to their mouths, as De Geer states of the Water-flea:[7] this furnishes a further argument for placing them next to the latter tribe.

It is difficult, and next to impossible, to fix upon any characters that are common to the whole of this remarkable Class. Generally speaking, but not invariably, they are covered, not by a calcareous and solid, but by a horny and thin integument. They vary considerably in the number of their antennæ and legs, the former often branching, and used as oars, and the latter usually being connected with their respiration, evincing the analogy between these legs and the ciliæ of the Rotatories, and tentacles of the Polypes;[8] in the majority these organs are not calculated for prehension. One group of them lives by suction and is parasitic upon other aquatic animals: the great body, however, masticate their food, but without the aid of maxillary legs. Their eyes are generally sessile, and a considerable number of them have only one, or rather two eyes enveloped by a common cornea.[9]

Latreille, in his *Cours D'Entomologie,* divides this Class—regarded by Linné as forming one genus, which he named *Monoculus*—into *six* Orders; but it will be sufficient here to adopt his division of them in the *Règne Animal,* into *two,* which, as separating the fresh-water from the marine genera, is more

1 *Entomostraca.* 2 *Limulus Polyphemus.* 3 *Cypris, &c.*
4 *Branchipus.* 5 *Limulus.* 6 *Cyclops.*
7 *Daphnia Pulex. De Geer,* vii. 453.
8 See above, pp. 82, 88.
9 Roget, *B. T.* ii. 493.

simple, and better suited to my purpose. These Orders he names Branchiopods and Pœcilopods.

1. The *Branchiopods* are all very minute, and several of them microscopic animals. Their mouth consists of an upper lip, two mandibles, a tongue, and one or two pairs of maxillæ. Their legs are natatory, connected with their respiration—whence their name of *Branchiopods*, or gill-bearing legs—often branching, varying in number from six to more than a hundred.

2. The *Pœcilopods* differ from the preceding Order by the different structure and uses of their legs, which are not branching, and all of them in some, and part of them in others, are prehensory and ambulatory, in some part are also branchial and natatory. They differ likewise by not having the ordinary mandibles and maxillæ, which are sometimes replaced by the spiny hips of the six first pairs of legs, and, in one tribe, by a mouth and oral organs proper for suction.

There is a tribe of parasitic animals, which neither Cuvier nor Latreille have included amongst the Entomostracans, but which Audoin and Milne Edwards conjecture are of a *Crustacean* type. I am speaking of the *Lerneans* of the author first mentioned, which he has placed, but not without hesitation, in his first order,[1] of Intestinal Worms.[2] Dr Nordmann, however, has made it evident that they undergo a metamorphosis little differing from that of the first Order of the Entomostracans, the Branchiopods, especially *Cyclops ;* and he is of opinion, that, in a system, they would follow that genus. Their resemblance is indeed striking in their preparatory states, but in their last or perfect state, they differ, and like the Pœcilopods, are parasitic ; many of them are furnished with a very conspicuous organ, which I shall afterwards describe, for fixing themselves ; and their form is very different, their body consisting of two segments, like that of the Arachnidans,[3] though attached to their abdomen, like many of the Branchiopods, they have two egg-pouches.[4] In fact the Lerneans seem scarcely more anomalous amongst the Entomostracans, than the King-crab, and other Pœcilopods. All things considered, perhaps, they may be regarded as forming an osculant group between the two Orders.

The animals of the first Order mostly frequent stagnant waters, moving about with great rapidity. They are generally regarded as predaceous, and are stated to make the infusory animalcules their prey, but some are supposed to be herbivo-

1 *Intestinaux cavitaires.*
2 *Entozoa*, Rud.
3 Plate IX. Fig. 5.
4 *Ibid. f. f.*

rous, and they abound particularly in waters in which plants are vegetating. As the places that they frequent are very subject to be dried up in the summer-time, it seems probable that a kind Providence has fitted them for this event, by giving them, as well as the Infusories, powers of reviviscence. Latreille thinks that those of them, which, for the protection of their slender and frail branching antennæ and legs, are enclosed in shells, have the power, after drawing in all their organs, of hermetically sealing their shells till the return of moisture.

These little animals differ from the Molluscans, and the other preceding Classes, by the changes of their integument; they do not, like them, when their advance in growth requires it, add to their shells; but, fixing themselves to some substance at hand, they move their limbs, and the valves of their old shells, new ones being already formed underneath, and thus loosening their exuviæ, in a short time they cast those of the whole body; of all their limbs, hairs, plumes, even those that are invisible to the naked eye. Amongst these exuviæ may be detected, not merely the cast skin of the external parts, but that of the internal also. These moults follow each other at an interval of five or six days, and it is not till after the third that the animal has acquired the reproductive faculty.

In the antecedent classes of the animal kingdom, which were almost all inhabitants of the water, we have seen no instances of animals casting their skins, or undergoing any metamorphosis—either in the number or form of their parts—in their progress to their adult state. Some few shell-fish, indeed, are stated to cast their shells, and form others,[1] but a degree of doubt rests upon the fact. In the Branchiopods, however, a kind of metamorphosis, as well as the moult just described, has long been noticed and recorded.

The young ones of the *Cyclops*, the animal before mentioned as an analogue of the sugar-louse, when first hatched have only *four* legs, their body is nearly round, and has no tail, which led Müller to mistake them for species of a different genus;[2] soon afterwards another pair is acquired, which the same author regarded as a second genus,[3] and so it proceeds till it assumes the perfect form of its kind. Nordmann has given figures of a very remarkable Lernean parasite,[4] which infests the perch, representing its whole progress, from the egg

1 See above, p. 161.
2 *Amymone.*
3 *Nauplius.*
4 *Actheres Percarum.*

to the perfect insect,[1] which, like the Cyclops, does not acquire all its organs, except at its last metamorphosis.

Our progress upwards, as far as we have at present proceeded, has been a gradual advance, form after form appearing upon the stage of animal existence, each distinguished by characters indicating an elevation as to rank and station. But in the animals amongst which the law in question obtains, we see the same individual, at different periods of its existence, assuming a higher tone of character, and often endued with organs that fit it for a more extended range. Sometimes from being purely aquatic, it becomes a denizen of the earth and the air—or of earth, air, and water at once—and, with this change of character and organs, its Creator wills it to undertake a new charge in the general arrangement of functions and duties.

It will be recollected that a very considerable portion of the food of the higher creatures, especially the birds, is derived from animals that undergo a metamorphosis ; and, that the majority of these in their first state, are more bulky, and contain more nutritive substance than they do when arrived at their last, and, therefore, even in this view, circumstances important to the general welfare may arise from this disposition, and variety of food may also be produced, and more enjoyment to the various animals who are destined to live by the myriad forms of the insect world.

Whether the higher Orders of Crustaceans undergo a real metamorphosis has not been satisfactorily proved. They are known to change their shells annually, but it has not been observed that this moult is attended by any change of form, or by the acquisition of new locomotive or other organs. Insects, we know, after their last change do not increase in size ; the Crustaceans are found, however, to vary very much in this respect. Whether a different law obtains amongst them, from what takes place in insects, and they follow the Batrachian reptiles, which, after they have exchanged the tadpole for the frog, grow till they have arrived at the standard of their respective species, I cannot certainly affirm; but reasoning from analogy, it seems more probable that the crustaceans should follow the law of animals most nearly related to them, and belonging to the same primary group, than that they should copy the reptiles, animals far removed from them, and of a completely different organization.

There is another point in which this subject of animal meta-

1 Plate IX. *Egg*, Fig. 1, 2. *Larva*, Fig. 3. *Pupa*, Fig. 4. *Imago*, Fig. 5.

morphoses may be viewed. Do not these successive changes in the outward form, functions, and locomotions of so many animals preach a doctrine to the attentive and duly impressed student of animal forms, and their history—do they not symbolically declare to him, that the same individual may be clothed with different forms, in different states of existence, that he may be advanced, after certain preparatory changes, and an intermediate interval of rest and repose, to a much more exalted rank; with organs, whether sensiferous or locomotive, of a much wider range; with tastes more refined; with an intellect more developed, and employed upon higher objects; with affections more spiritualized, and further removed from gross matter?

The multiplication of these creatures, which, like the *Aphides*, are oviparous at one time, and viviparous at another, is sometimes prodigious, and only exceeded by that of the Infusories. A female *Cyclops*, the animal before alluded to, in the space of three months, after one fecundation which serves for several successive generations, lays her eggs ten times, and it has been calculated that from only eight of these ovipositions, allowing forty for each, she might be the progenitrix, incredible as it might seem, of four milliards and a half, or four thousand five hundred millions!![1] Another animal belonging to a genus of the present order,[2] was observed by Captain Kotzebue in such myriads that the sea exhibited a red stripe, a mile long, and a fathom broad, produced by a species, individually viewed, scarcely visible to the naked eye. How astonishing is the reflection, that in so short a space, in the case of the Cyclops, a single individual should be gifted by its Creator to fill the waters with myriads of animated beings, supposing a single impregnated female at first to have been the surviving inhabitant of any given pool or ditch. Conjecture is lost when we meditate upon the mysterious subject. How can life, as originally imparted, at the interval of a few months be so multiplied and subdivided, as, that such infinite shoals of beings shall each have a share in the wonderful bequest. But, when we reflect that an Omnipresent Deity is everywhere mighty in operation, working all in all, and that he guideth all the powers of nature, as the rider guideth the horse upon which he sitteth, to answer the purposes of his providence;[3] we may easily conceive, that under his superintendence the thing may

1 Latreille *Cours D'Entomologie*, i. 421. 2 *Calanus*.
3 1 Cor. xii. 6. Ps. lxviii. 4, 33.

be accomplished, though how it is accomplished, must always remain an unfathomable mystery.

These powers of multiplication are, however, given to these creatures for a wise and beneficent purpose. They themselves afford a supply of food to a variety of creatures—to numerous aquatic insects, even polypes and worms; and to many fishes and birds, by whom their numbers are hourly and greatly diminished. As the stagnant waters likewise, in which they abound, are apt to be dried up in the summer season, many of them probably perish; but, in some, animation may be suspended till the places they inhabit are again filled with water. I have found the little animal described by Dr Shaw, in the *Linnean Transactions*, as the *Cancer stagnalis* of Linné, in horse-hoof prints, in the spring, then filled with water, but which had been previously quite dry.

The finny tribes of the world of waters seem more particularly exposed to the invasion of parasitic foes; as far as they are known there is scarcely a fish that swims that is not infested by more than one of these enemies; even the mightiest monsters of the ocean, the gigantic whale, the sagacious dolphin, the terrific and all-devouring shark, cannot defend themselves from them. Where they abound they doubtless generate diseases, and are amongst the means employed by a watchful Providence to keep within proper limits the inhabitants of the waters; and probably there are other benefits which our imperfect knowlege of their history prevents us from duly appreciating, that are conferred, through these animals, upon the oceanic population. Their prevalence upon the predaceous fishes, as was before observed, may tend to dimish their ravages by lessening their activity; while to those of a milder character, within certain bounds and under certain circumstances, they may be beneficial rather than injurious.

Of this description is the tribe of *Lerneans*, above alluded to as intermediate between the Branchiopod and Pœcilopod Entomostracans; of which I cannot select a more interesting species to exemplify the adaptation of the structure to the instinct and functions, than one described and figured by Dr Nordmann, under the appropriate name of *Actheres Percarum*,[1] or *Pest of the Perch.*

This animal, like the Branchiopods, is found in fresh water, where it attaches itself to the common, and another species of the perch genus,[2] and takes its station usually within the mouth, fixing itself, by means of its sucker, in the cellular

1 Αχθηρης, *Annoying*. 2 *Perca fluviatilis* and *P. lucioperca*.

membrane, so deeply that it cannot disengage itself, or be extracted by external force, without rupturing the so called arms, that are attached to the sucker, and leaving it behind. The animal often fixes itself to the palate, and even to the tongue. The arms[1] take their rise at the base of the cephalothorax—as the part consisting of head and thorax, not separated by a suture, is called—where they are very robust and thick, but they taper towards the other extremity, a single sucker,[2] common to both, being, as it were, hooked to them. These arms are bent nearly into a circle, surrounding the cephalothorax, and the sucker is in front of the head: their substance is cartilaginous, and they repose in the same plane with the head; whence we may conjecture that the animal, when fixed and engaged in suction, lies close to the part where it has taken its station. When we consider that these predaceous fishes often gorge their prey, swallowing it entire, we see how necessary it was that our parasite should be thus fitted to fix itself firmly, and root itself, as it were, that it may be enabled to withstand the pressure and violent action of the bodies that pass over it, for the palate and tongue of a *Perch* must be a perilous station. This purpose seems further aided by a quantity of saliva, usually formed around it.

These pests of the perch are themselves subject to the incursions and annoyance of animals still more minute than themselves. A small species of mite[3] makes them its prey, and when the saliva just mentioned is removed, they are often found quite covered by a species of Infusory belonging to the genus *Vorticella.*

The next Order, including all the *marine* Entomostracans, will not detain us long. The first section consists of a single, but very remarkable, genus, the type of which is the *Monoculus Polyphemus* of Linné.[4] In the West Indies it is called, by way of eminence, the *King-crab*, and is found in the seas both of the East and West, from the equator to the 40th deg. of latitude. The species are few, and near to each other. They differ widely both in their characters and form from every other Crustacean tribe. Like the *Cirripedes*, they have no distinct head: their crust is divided into two portions, the anterior embracing the posterior, and being terminated, like the Rays, to which they present an analogy, by a long angular tail. They have both compound and simple eyes; the first are situ-

1 Plate IX. Fig. 5. *c, c.*
2 Ibid. Fig. 5. *d.*
3 *Gamasus scabriculus.*
4 *Limulus.*—Müll.

ated, one in the middle of each lateral ridge, usually under the spine on the outer side; the second, or simple eyes, are on each side of the intermediate ridge, where it begins: these last are very minute, and not easily discoverable. The under side of the shield, or anterior portion of the crust, is deeply hollowed for the reception of the body, and the cavity is marked out anteriorly by an emarginate ridge, which gives it something the appearance of the hooded serpent. Some of them attain to a large size, the species found near the Molucca Islands being sometimes two feet in length.

The head in them, as in the Arachnidans, seems suppressed, or to merge in the thorax, which also, as in that Class, bears the eyes, the outer pair corresponding with those of certain Crustaceans in which they are sessile, and the inner pair being like those of the Arachnidans, but they have neither the oral organs nor the legs of the Class just named. In fact, these animals seem to stand in much the same position amongst the Entomostracans, that the Cephalopods do amongst the Molluscans, and moreover as giants amongst pigmies. Time will probably throw more light upon these singular works of the Creator.

Their most remarkable organ is their *tail*, which is probably of considerable service to them in their locomotions. It is shaped like a stiletto, and is so extremly sharp at the extremity, that it will easily pierce the flesh, and may perhaps be used by the animal as a weapon, as it is said to be by the Indians; it is so articulated with the posterior piece of the crust as to move with more ease upwards and downwards than laterally. Comparing the small body with the vast volume and levity of the crust which covers and protects it, and considering that the animal, as M. Latreille has remarked, passes the night with its anterior half out of the water, we may conjecture that, by the depression of the tail, it may be elevated in part above the water, and remain stationary. By a slight inclination on either side it probably also helps to steer it, and as it is ciliated at the base, like the natatory legs of a *Dyticus*, it may be of some use in swimming. The legs are all armed with pincers, like those of a crab, from which it seems evident that it is predaceous, and, from their small size, that its prey must consist of minute animals.

The whole of its structure appears calculated to give the king-crab more than usual buoyancy, the reasons of which, when its history is better known, will be more fully understood; and the Power, Wisdom, and Goodness that everywhere flash upon us, when we consider animal structures and their adaptation to their habits and instincts, when fully investigated, will

be duly appreciated. It is said that this creature, amongst the ancient Japanese, was the symbol of the zodiacal sign *Cancer*.

The animals belonging to the *second* section of the Pœcilipods differ from all the rest, by the manner in which they take their food. They are parasitic upon Cetaceans, fishes, some reptiles, and Crustaceans, whose juices they imbibe by *suction*. They are often fixed to the gills of these animals, but nothing further interesting is known of their history. Some have two long jointed tails, like ephemeræ,[1] and others are distinguished by a remarkable lateral elongation of the thorax.[2] Some fix themselves to their prey by means of suckers, terminating their first pair of legs,[3] which the remainder have not.

The observation of Dr Von Baer, quoted in a former part of this work,[4] that the lowest grades of the animal kingdom exhibit the leading types of the various organizations it contains, for reasons before alluded to, would almost justify the zoologist in assigning to the Entomostracans a place amongst the Infusories. But the subject of *centres*, in that kingdom, sending forth, as it were, rays in different directions, and leading to various forms, requires very deep and minute investigation, and abundant proof, before it will be safe to adopt it as a principle.

1 *Caligus*.
2 *Nicothoe*.
3 *Argulus*.
4 Ante, p. 172.

## CHAPTER XV.

*Functions and Instincts. Crustacean Condylopes.*

We are now arrived at a Class of animals, in which the organs of locomotion assume a new and more perfect form, corresponding in some measure with those of many of the vertebrated animals. The advance, in structure, hitherto, from a mouth surrounded by organs like rays, serving various distinct purposes, and by different means contributing to the nutrition, respiration, and motions of the animal, has been, by certain inarticulate organs, more generally distributed over the body, but still in a radiating order; as for instance, the tentacular suckers of the Stelleridans and Echinidans, which they use in their locomotions, and for prehension, as well as the purposes just named. In the Entomostracans, as we have seen, the legs, though jointed, are very anomalous, assume various forms, and are applied to sundry uses: in the sole instance of the king-crab, they take the articulations of those of the Crustaceans, in which we may trace the general structure of the legs of the other Classes of Condylopes.

But as I shall have occasion, in a subsequent chapter, to give a concentrated account of the gradual development of the organs of locomotion and prehension, from their first rudiments in the lowest grades of the animal kingdom to their state of perfection in the highest, I shall not here, therefore, enlarge further upon the subject, than by observing, that, in most of the *Decapod* Crustaceans, the anterior legs are become strictly *arms*, terminating in a kind of didactyle hand, consisting of a large joint, incrassated usually at the base, and furnished on its inner side with a smaller movable one, constituting together a kind of finger and thumb, with which it is enabled to seize firmly and hold strongly any object that its inclinations or fears point out to it. This hand we called the *chela* or claw, or more properly pincers, of the lobster or crab. We find it also in the scorpion and book-crab,[1] which on shore are in some sort analogous to the long-tailed and short-tailed Crustaceans, or

1 *Chelifer.*

lobsters and crabs of the waters. This structure of the hand, in these creatures, is particularly fitted to their wants and situation. A hand like ours, consisting of a quadruple set of fingers and an opposite thumb, to be of sufficient power for their purposes, must be so disproportioned to their size, as to be an incumbrance rather than a useful instrument of prehension; but as now constructed, it has the requisite strength for the purposes of the animal, without being disproportioned to its size, and inconvenient for its use. Thus we see how nicely every thing is calculated and adjusted by Supreme Wisdom, to the nature and circumstances of every animal form.

But these great claws are by no means universal amongst the Crustaceans. In some the claws are very small, but the loss is often made up to these by an increase as to number, so that if they cannot lay hold of large animals, they can seize, at the same time, several small ones. We have seen that in the king-crab all the legs have these prehensory claws, and they vary in number in many of the smaller Crustaceans, as the shrimp,[1] prawn,[2] pandle,[3] &c. The foreleg of some of these has prehensory claws, that are formed like the mandibles or cheliceres of spiders and the arms of the *Mantis*—whence they are called mantis-crabs. Instead of a forceps, consisting of a finger and thumb, the claw that arms the extremity of the leg is folded down, and received into a channel of the shank, and kept from dislocation by a tooth, or spine, at the base: this structure may be seen in the shrimp.

There is another circumstance, distinguishing the decapod and stomapod Crustaceans, that is peculiar to them, their eyes are placed upon jointed footstalks, so that when they want to explore and examine what passes around them, they can immediately erect these organs, and so greatly enlarge their sphere of vision, but when they have retired to their retreats in the cavities of the rocks, or to burrows that they have formed, they can place them in repose, in a cavity provided for them by their Creator, in the head.

Any person, who casts an eye over these creatures, will be struck by repeated analogical forms, representing some terrestrial animals of the same Sub-kingdom. Thus a large number of those distinguished by the shortness of their tails, the *crabs*, present, both in their retrogressive and, lateral motions and general aspect, an astonishing resemblance to many Arachnidans; some imitating spiders, and others phalangians:[4] and,

1 *Crangon vulgaris.*
2 *Palæmon serratus.*
3 *Pandalus.*
4 *Macropodia Phalangium.*

amongst the long-tailed tribe the lobsters, one[1] very accurately represents a scorpion, and another a mantis.[2]

We have seen the same tendency in the *Annelidans* to approach or imitate terrestrial forms, as if the marine and aquatic animals were anxious to quit their fluid medium, and to become inhabitants of the dry land. The animal living on shore and in the woods at St Vincent, taken for a Molluscan by Mr Guilding,[3] appears almost like a creature that had succeeded in such an attempt.

All these resemblances and approximations show, that the great Creator embraced at one view all the forms to which he intended to give being, and created no individual without furnishing it with organs which give it some relation to others; or so moulding its outward form, as to cause it to represent some others to which it is clear it is not brought near by any characters, common to both, that indicate affinity. What can more evidently and strongly manifest *design*, and that of a mind comprehending simultaneously the whole world of created beings, than thus to concatenate all link to link and wheel within wheel, through all their intricate revolutions and ramifications connecting and connected, and all the while reflecting others of a higher or a lower grade with mimic features? this shows the hand, the art, the wisdom, the power, and the goodness of that unfathomable depth and immeasurable height of Deity, which comprehends all things and is comprehended by none; and to whom all things owe their being, and their form, and their organs, and their several places and functions.

The general characters of the present class are—

Body apterous, covered by a calcareous crust, divided into segments. *Legs* jointed, 10—16. *Mouth* composed of a *lip*, *tongue*, a pair of *mandibles*, often bearing a feeler, and two pairs of *maxillæ*, covered by maxillary *legs*. *Spinal chord* knotty, terminating anteriorly in a small *brain*. A *heart* and *vessels* for circulation. *Respiration* by gills.

These are divisible into five orders.

1. *Decapods*. *Gills* situated under the sides of the shell. *Ten* thoracic legs. *Eyes* on a jointed footstalk.
2. *Stomapods*. *Gills* attached to five pairs of appendages, or spurious legs, under the abdomen. *Eyes* as in the Decapods.
3. *Læmipods*. No abdominal *appendages*. *Eyes* sessile.

1 *Thalassina Scorpioides*. 2 *Squilla Mantis*.

3 See p. 187, Plate VIII. Fig. 1.

4. *Amphipods.* Head distinct. *Eyes* sessile.
5. *Isopods. Head* distinct. *Eyes* sessile. *Legs* simple, equal.

1. *Decapods.* This order naturally resolves itself into two sections, viz. The *short-tailed* Decapods or *Crabs,*[1] which have their abdomen folded under the trunk: and the *long-tailed* Decapods or *Lobsters, Cray-fish,* &c.[2] whose abdomen is always extended.

Writers on the Crustaceans usually begin with the short-tailed, and then proceed to the long-tailed Decapods, and this arrangement seems natural, when the transit is to those with sessile eyes, such as the locust-crab;[3] but yet when we consider how nearly related to the *spiders* the former animals are, and that in the latter, though the head is not formed by a distinct suture dividing it from the thorax, yet its contour is strongly marked out externally by an impression, and internally by a ridge, at least in the lobster and cray-fish,—it seems as if the two tribes should form two parallel lines, and proceed, side by side, towards the Arachnidans and Myriapods.

I shall, however, follow the usual plan, and give now some account of the *crabs.* Of these, none are more remarkable than what have been denominated *land-crabs,* from their usually living on shore, and making for the sea only at certain seasons. Of the most noted species of these I have already given a full account,[4] but I shall here notice some others, having the same habits, that will interest the reader. Aristotle, long ago, noticed a crab of this description, found in Phœnicia, under the name of the *Horseman,*[5] which he says runs so fast that it is not easy to overtake it.[6] Olivier found this account true of those he saw on the coast of Syria; and Bosc observed a species[7] in Carolina, which he had some trouble to overtake on horseback and shoot with a pistol. These horsemen crabs are found only in warm climates, where they inhabit sandy spots near the shore, or the mouths of rivers. They make burrows in the sand, to which they retreat when alarmed, and in which they pass the night.

Another kind of land-crab[8] is distinguished by the extraordinary disproportion of its claws; one of them, sometimes the left and sometimes the right, being enormously large, while

1 *Brachyuri.*
2 *Macrouri.*
3 *Orchesia litterea.*
4 See above, p. 66.
5 Ιππευς. Gr.
6 *Hist. Anim.* l. iv. c. 2.
7 *Ocypode Hippeus,* probably *Cancer Cursor.* L.
8 *Gelasimus vocans.*

the other is very small, and often concealed, so that the animal appears single-handed. This formation, however, is not without its use, for, when retired into its burrow, it employs this large claw to stop up the mouth of it, which secures it from intrusion, and this organ is in readiness to seize such animals as form its food and come within its reach. They have the habit of holding up the great one, as if they were beckoning some one; but this doubtless is an attitude of defence. These crabs live in moist places, near the shore. They attack, in crowds, any carrion, and dispute the possession of it with the vultures; they do not willingly enter the water, except when they lay and hatch their eggs, and it is conjectured that their young are for some time entirely aquatic. One kind of them,[1] which forms numerous burrows, remaining in them during three or four months in the winter, usually stops them up, so that the animals are obliged to reopen them when the warmth of the vernal sun bids them come forth again from their winter quarters. They are devoured by numerous animals,—otters, bears, birds, tortoises, and other reptiles, all prey upon them, but their multiplication is so excessive, that there seems no sensible diminution of their numbers.

The next tribe of Decapods are the *long-tailed ones*, which do not fold their abdomen under their body. This part is usually furnished at the extremity with several plates, which the animal expands so as to form a fan of five or six leaves; they are easily seen in the common lobster;[2] like the tail of birds, they are useful to the animal in its passage through an element that requires to be moved by organs of a firmer consistence than feathers. The lateral ones in the species just named, having a kind of articulation, so that they can be partially depressed, and push against the plane they are moving upon; they do not, like the crabs, quit the water, and are some of them, as the cray-fish,[3] fresh-water animals.

I shall begin with a tribe which, in some degree, connects the crab with the lobster, these are what are denominated *Hermit-crabs*,[4] whose abdomen being naked, and unprotected by any hard crust, their Creator has given them an instinct, which teaches them to compensate this seeming defect, by getting possession of some univalve shell, suited to their size, which becomes their habitation, and which they carry about with them as if they were its proper inhabitants. These crabs

1 *G. Pugillator.*
2 *Astacus Gammarus.*
3 *Astacus fluviatilis*
4 *Pagurus*, PLATE X. FIG. 2.

are particularly formed for the habit that distinguishes them. Their naked tail has a tendency to a spiral convolution, fitting them to inhabit spiral shells, which they usually select for their mansion, though, from recent observations, it has been found that any univalve will answer their purpose. Their tail is terminated by an apparatus of movable and hard pieces,[1] which appear intended to enable the animal to fix itself more firmly in the spire of the shell. Usually the right hand claw, which is disengaged from the shell, is double the size of the other which is not, and is that which is most employed; but in narrow-mouthed shells, such as the volute, in which Freycinet found one,[2] both claws are disengaged, and are of equal size. The reason of this formation is evident. The fourth and fifth pairs of legs[3] are much smaller and shorter, than the anterior ones, they have, below the claw, a piece resembling a rasp, which appears formed to assist them in moving in the shell, whether they wish to move outwards or inwards, and, on one side, they have a series of egg-bearing appendages.[4] This whole structure proves that they are formed with this particular view of inhabiting the shells of a very different tribe of animals. Some of these hermit-crabs, for there are several species of them, may be called *terrestrial*, while others are *aquatic*. In some of the Indian isles, the shores are covered with them. When the heat is most intense, they seek the shelter of the shrubs, and when the freshness of the evening breathes, they run about by thousands, rolling along their shells in the most grotesque manner, jostling each other, stumbling, and producing a noise by the shock of their encounters, which announces their approach before they appear. When they perceive any danger, they hastily conceal themselves in any ready made holes they meet with, or under the roots, or in the trunks of decayed trees, seldom making for the sea, how near soever they may be. At Guam, a very large species frequents forests more than a mile from the sea; and in Jamaica, another species, called there the soldier,[5] has been found in great quanitities on elevated ground, more than four leagues from it.

The common species[6] is aquatic, and usually inhabits the whelk; it is stated annually to leave its shell, at the time of its moult, and after this great crisis is over, to seek another suited to its increased magnitude. Aristotle, Belon, and others affirm that these animals quit their shell to seek their prey,

1 *Ibid.* 2. *a, a, a.*
2 *Pagurus clibanarius.* See PLATE X. FIG. 2.
3 *Ibid. b b, c c.*
4 *Ibid. d, d, d, d.*
5 *Pagurus Diogenes.*
6 *P. Bernhardus.*

and that when danger threatens them, they retreat to it backwards, but observations have not been made by modern authors which confirm this statement. Their sexual intercourse however, could not take place without their first leaving their mansion.

Why our, so called, hermits are gifted with this singular instinct, is not easy to conjecture. Many other creatures make use of houses that they had no hand in erecting, as the bees, the cuckoo, and sometimes the bear, &c.; but I do not recollect any that, as it were, clothe themselves with the cast garments of other animals. Providence, besides the defence of their otherwise unprotected bodies, has no doubt some object of importance in view in giving them this instinct. Perhaps they may accelerate the decomposition of the shells they inhabit, and cause them sooner to give way to the action of the atmosphere; and as all exuviæ may be termed nuisances and deformities, giving to these deserted mansions an appearance of renewed life and locomotion, removes them in some sort from the catalogue of blemishes. By this physical hypocrisy, of assuming the aspect of a different animal, which is known as not having powerful means of destruction, these creatures may deceive the unwary, and make them their prey, which if they wore the livery of their own tribe, would be on their guard and escape them.

Next to the Hermit-crabs, or rather Hermit-lobsters,[1] comes a very interesting genus, which might be denominated *Tree-lobsters*, from the singular circumstance of their quitting the sea, like the Climbing-perch,[2] and in the night ascending the cocoa-nut and other palm-trees, for the sake of their fruit. The species which manifests this remarkable instinct is gigantic, and must exhibit a striking spectacle when engaged in ascending the stem of a cocoa-tree; but Mr Cummings observed its proceedings in the Polynesian Islands, where he saw it ascending the palm-trees and devouring their fruit. I have, in a former chapter,[3] stated that the *Climbing perch* ascends the fan-palm in pursuit of certain Crustaceans, perhaps related to the *Birgus*, which frequent it. Freycinet observed these crabs, in the Marian Islands, and says that their claws have wonderful strength, for when the animal has seized a stick, an infant may be suspended from them. They are very fond of the fruit of the cocoa-palm, and may be fed with it for months without suffering from want of water. Whether, like the land-crab,

1 *Birgus Latro.* PLATE X. FIG. 1.
2 See p. 65.
3 See p. 65.

they have a reservoir capable of containing a sufficient quantity of that fluid to keep the gills moist, has not been ascertained: probably they have.

Amongst the larger species of the long-tailed Section, there is one of the most ferocious aspect, having its head, the base of its long antennæ, and its thorax, beset with sharp spines. This is called in the London market the *Thorny lobster*,[1] and is stated sometimes to be nearly a yard in length: it is also called the *Cray-fish*, and by the French, who esteem it highly, the *Langouste:* it is, however, far inferior to the common lobster, from which it is distinguished by having no pincers, its legs terminating in a strong simple claw, set with bunches of bristles, a circumstance indicating a different mode of taking its prey. From the amplitude of their fan-like tail, and from their natatory plates, these lobsters seem formed for rapid motion in the water.

The next species that I shall mention is of much more importance to us, and has been celebrated by epicures from ancient times. Instead of unarmed hands and legs, the *Lobster*,[2] as every one knows, has the *former* armed, often with an enormous pair of claws, which must be of vast power, and, besides, the two anterior pairs of their *legs* are furnished with small pincers. It is observable that the movable finger of the claw of the hands is on their inner side, while, in these two pairs of legs, that on the outside is movable. Aristotle's *Carabus*[3] is generally referred to the thorny lobster; but in one place he expressly mentions its using its pincers to catch and carry its food to its mouth, which could not apply to that animal, though it agrees well with the common lobster; yet in another place, under the same name, he appears to mean the other.[4] It is not known exactly to what use these smaller pincers are applied; it must be observed, however, that if the legs are regarded as naturally pointing towards the head, as in Dr Leach's figure of *Nephrops*, the movable thumb in all is on the same side. The antennæ in this genus are about the length of the body. The pincers of the hand are very powerful and tubercular; they are used by these animals both to seize their prey and for self defence, and they contain very powerful muscles. When in the water the lobster seizes any thing presented to it, and holds it so strongly that it is impossible to extricate it without breaking the claw.

All Crustaceans cast their crust annually. At first it seems

1 *Palinurus vulgaris*, Leach. *Malacostr. Podophth. t.* xxx.

2 *Astacus Gammarus.*

3 Gr. καραβος, *Hist. Anim.* l. viii. c. 2.

4 *Ibid.* l. ii. c. 2.

wonderful how this can be accomplished. With insects, in whom it takes place only in the larves, and whose form and substance are usually adapted to it, a longitudinal fissure of the skin of a soft caterpillar, or grub, when the animal grows too big for it, we can conceive to be no difficult task: but with animals covered with a hard crust, and in whom not only the covering of the head, trunk, and abdomen is to be cast, but also that of the legs and other organs, it seems an operation infinitely more arduous. But He who gave them this defence, instructs them also how to rid themselves of it when it grows too strait for them, and has moulded their structure accordingly.

These animals are not, like most insects, limited to an existence, terminated within the period of one revolution of the earth round the sun, but sometimes witness several; and some are said even to live *twenty* years, and keep growing during the greater part of their life. But this would be impossible, since it is incapable of extension, unless they could give room for the expansion of their body, by occasionally rejecting the case which encloses it. At a certain time of the year, about the end of the spring, when food is plentiful, they begin to feel themselves ill at ease: they then probably seek the clefts of the rocks, and other close places, in which they can undergo, in concealment and security, a change which exposes them, in a defenceless state, to danger.

But we should have known nothing of the manner in which this great work is effected, had not the illustrious French naturalist, Reaumur, adopted methods which enabled him to ascertain their mode of proceeding. In the spring, in boxes pierced with holes, which he placed both in the river, and in an apartment, he put the fresh-water cray-fish,[1] of the same genus with the lobster. He observed that when one of these was about to cast its crust, it rubbed its feet one against the other, and gave itself violent contortions. After these preparatory movements, it swelled out its body more than usual, and the first segment of its abdomen appeared more than commonly distant from the thorax. The membrane that united them now burst, and its new body appeared. After resting for some time, it recommenced agitating its legs and other parts, swelling to the utmost the parts covered by the thorax, which was thus elevated and separated from the base of the legs; the membrane which united it to the underside of the body burst

1 *Astacus fluviatilis.*

asunder, and it only remained attached towards the mouth. In a few minutes, from this time, the animal was entirely stripped except the legs. First the margin of the thorax was seen to separate from the first pair of legs; at that instant, drawing back its head, after reiterated efforts, it disengaged its eyes from their cases, and all the other organs of the anterior part of the head; it next uncased one of its fore legs, or all or part of the legs of one side, which operation is so difficult that young ones sometimes die under it. When the legs are disengaged, the animal casts off its thorax, extends its tail briskly, and pushes off its covering and that of its parts. After this last action, which requires the utmost exertion of its remaining vigour, it sinks into a state of great weakness. Its limbs are so soft that they bend like a piece of wet paper; but if the back is felt, its flesh appears unexpectedly firm, a circumstance arising, perhaps, from the convulsive state of the muscles. When the thorax is once disengaged, and the animal has begun to extricate its legs, nothing can stop its progress. Reaumur often took them out of the water with the intention of preserving them half uncased, but they finished, in spite of him, their moult in his hands. Upon examining the exuviæ of these animals, we find no external part wanting; every hair is a case which covers another hair. The lower articulations of the legs are divided longitudinally at a suture which separates during the operation, but which is not visible in the living animal.

When we consider this apparently arduous and complex operation, we see the most evident proofs of *design*, and that the Creator has so put together the different parts of the animal's structure, that there is no occasion to divide the crust itself in order to liberate it. Instead of a solid tube, he has inclosed the leg in joints that are furnished with the means of dividing longitudinally, upon sufficient expansion of the included limb, and so opening a way for its liberation. In the whole body all the segments and parts are so united by a membrane which can yield to the expansive efforts of the animal, that the entire liberation of it from the armour that encases it, is accomplished with infinitely more ease than we should expect, even after a careful investigation of it. Besides membranous ligaments, so arranged by the Wisdom of the Creator as to yield to the efforts of these creatures to liberate themselves from their too strait garment, he has also furnished them, as Reaumur remarks, with a slimy secretion, which moistens the interval between the old and new shell, and facilitates their separation.

The time requisite for hardening the newly acquired crust, according to its previous state, is from one to three days. Those animals that are ready to moult have always two stony substances called crabs'-eyes, placed in the stomach, which, from the experiments of Reaumur and others, appear destined to furnish the matter, or a portion of it, of which the shell is formed, for if the animal is opened the day after its moult, when the shell is only half hardened, these substances are found only half diminished, and if opened later they are proportionably smaller. Thus has Creative Wisdom provided means for the prompt consolidation of the crust of these creatures, so that it is soon rescued from the dangers to which, in its naked state, it is exposed. Reaumur measured several cray-fish, before, and after their moult, and found that their augmentation amounted to about one-fifth, this amount probably decreases as they approach nearer to their adult state. From a chemical analysis of the crust of the lobster it has been ascertained that it consists of gelatine united to calcareous earth; it differs from the shells of Molluscans in having a much greater proportion of gelatine, whereas in the latter the calcareous earth greatly predominates.

It is asserted that *birds*, and other animals in tropical countries, have *two* moults within the year, after the two rainy seasons are passed, and two broods; whether this is the case with Crustaceans has not been ascertained. Most other Condylopes do not survive the laying of their eggs, but the Crustaceans are evidently exempted from this law, and emulate the higher animals in the duration of their existence.

It may be observed that the moult of Crustaceans differs in one respect from that of birds, which only change their feathers, and that of quadrupeds who only change their fur, since they disengage themselves from their whole external skin with all its appendages, whether of fur, or any other substance. Their moult resembles rather that of trees, whose outer skin, under the form of bark, peels off annually, and is succeeded by another formed under it, as is particularly evident in the birch, plane, &c.

It is to the researches of the same learned, and patient, and penetrating experimenter and naturalist that we are indebted for what knowledge we possess of the means employed by nature for the reproduction of the mutilated organs of Crustaceans. Having cut off the legs of some crabs and lobsters, and placed them in covered boats, cummunicating with the water, and destined to keep fishes or Crustaceans alive, at the end of some months, he saw that the mutilated legs had been replaced by

new ones, perfectly resembling the old, and almost as large. The time necessary for this reproduction was not fixed, but depended upon the warmth of the season, and the supply of food furnished to the animal, and likewise upon the part in which the mutilation took place. The point of union of the second and third joints, is the part of the leg where a fracture is most easily made, and the reproduction is most rapid. At this point there are many sutures which appear distinct from articulations; it is in these sutures, particularly the intermediate one, that the separation usually occurs, and many Crustaceans, if they are wounded in some other part of their leg, cast the remainder off at this suture to facilitate the reparation of their loss. So much only is reproduced in each leg as is necessary to render it again complete

When a leg is mutilated in the summer, if examined a day or two after the experiment, the first circumstance observable is a kind of covering membrane of a reddish hue ; in five or six days more this membrane becomes convex ; next it is protruded into a conical shape, and keeps gradually lengthening as the germinating leg is developed ; at last the membrane is ruptured and the leg appears, at first soft, but in a few days it becomes as hard as the old one ; it now wants only size and length, and these it acquires in time ; for at every moult it augments in a more rapid proportion than the legs that have their proper size. The antennæ, maxillæ, &c., are reproduced in the same manner, but if the tail is mutilated, it is never reproduced, and the animal dies. When attacked, Crustaceans, as well as some of their analogues, the grasshoppers, often cast their legs as it were voluntarily.

When we reflect on this history, we cannot help admiring and adoring the goodness of the Creator, and his care over the creatures he has made, in giving to these animals, which, both from the multiplicity and exposure of their legs, and other organs, and their numerous enemies, are particularly liable to mutilations, a power that enables them, in a short period, to pursue the course directed by instinct, with undiminished or little diminished powers.

The *Stomapods*, or mouth-legged Crustaceans, so named because the maxillary legs do not differ materially from the thoracic ones, form the *second* Order of the Class, and the species belonging to it, on account of their general resemblance to the orthopterous tribe forming Linné's genus *Mantis*, are called *Sea-Mantises*. One of them,[1] in its anterior legs, accu-

1 *Squilla Mantis.*

rately represents that genus. But the most remarkable animals belonging to the Order are the *Phyllosomes*[1] of Dr Leach, which in some respects are analogues of the *Spectres*,[2] not having the raptorious fore leg of the Squillæ, but their thorax, which consists of two segments, the first very much dilated, approaches nearer to that of *Mantis strumaria*.[3] It has been taken in several tropical seas, and when living, it is said to be as transparent as crystal, except its eyes, which are sky-blue.

The subsequent Orders of the Crustaceans, called by the general name of *Malacostracans*, are distinguished from the preceding by having sessile eyes, imbedded in the substance of the head, and though they contain many singular creatures, we know little of their habits and history.

Many of the animals belonging to Latreille's *Lœmodipods*, or throat-footed Crustaceans, which begin the sessile-eyed tribes, have very slender bodies, and their legs are separated by a considerable interval, like those of geometric larves or loopers amongst insects, whose motions they also imitate. One remarkable creature is included in this Order, which is parasitic upon the whale,[4] and by its hooked claws is enabled to maintain its station amidst the fluctuations of the waves. This animal, like the king-crab, has both compound and simple eyes.

Next to these succeed the Order of *Amphipods*, including a number of genera, consisting usually of minute animals; many of them, like the grass-hoppers, and several other insects, are gifted by their Maker with the faculty of leaping. When one meets with a heap of sea-weeds upon the beach, recently left by the tide, if we turn it over we shall often see under it myriads of little animals belonging to this Order, jumping about in all directions, which are thus enabled, either to find shelter under another mass of moist sea-weed, or perhaps to reach their native waves in safety. Whether these Crustaceans, like their analogues on shore, feed on vegetable substances, has not been ascertained; they are generally found as above stated; and there may be *herbivorous* species amongst the Crustaceans, as well as in almost every other class of animals.

The last Crustacean Order is called by Latreille, *Isopods*, from their legs being usually of the same length; though a large proportion of these are *aquatic* animals, yet the Order terminates in those that are *terrestrial*. Several of the former are furnished with one or more pair of didactyle legs, but the terrestrial ones never have these prehensory organs.

1 Plate X. Fig. 3. *P. brevicorne?*
2 *Phasma*. 3 Stoll. *Spectr. t.* xl. *f.* 42. 4 *Cyamus Ceti*.

Amongst the Crustaceans, Latreille has included the *Trilobites*, a remarkable tribe of animals, at present found only in a fossil state, and like the chitons, certain wood-lice,[1] and the armadillo,[2] rolling themselves up in a ball. They may form part of a branch connecting the Crustaceans and Molluscans, but I leave the discussion of this point to abler hands.

Thus have we at length arrived at animals, the majority of which are *terrestrial*, at least in their perfect state, for many terrestrial Condylopes have aquatic larves and pupes, but few, or none, I believe, inhabit salt water, except perhaps some species of bugs.[3]

The great Crustacean host, of which probably we do not know half the species, is certainly a most valuable gift to mankind, as well as to the various inhabitants or frequenters of the waters, especially of the ocean, varying as they do in size, from the great thorny lobster to the minute tribes of Entomostracans; they probably become the prey of many sea animals, besides the Cephalopods, which are stated to make such havoc among them.[4] When we further consider their powers of infinite multiplication, we see that however great the consumption of them, there appears no diminution of their numbers, so that one kind of animals, by the will of Him who created all things, and who gave a law to each species, which regulated their numbers, and the momentum of their action, doing or suffering, is made to compensate for another, and the law of preservation to act as an equipoise to the law of destruction.

When we look, however, at these animals, especially the larger kinds, and survey their offensive organs and weapons, and the coat of mail that defends them, we feel convinced that they also are employed to keep down the numbers of other inhabitants of the ocean, more especially as the great body of them are evidently predaceous: and this, on such a survey, seems to us their primary function. God numbers and weighs them both with those they destroy and those that destroy them; his bridle is in their mouth, and they go as far as he permits them: and when he gives the word—Peace, be still—the mutual conflict relaxes, or, in some parts, is intermitted, till the general welfare calls for its revival.

It may be observed with regard to this constant scene of destruction, this never universally intermitted war of one part of the creation upon another, that the sacrifice of a part main-

1 *Armadillo vulgaris.*
2 *Dasypus.*
3 *Salda Zostaræ.* F. &c.
4 See above, p. 168.

tains the health and life of the whole; the great doctrine of *vicarious suffering* forms an article of physical science; and we discover, standing even upon this basis, that the sufferings and death of one being may be, in the Divine counsels, and consistently with what we know of the general operations of Providence, the cause and instrument of the spiritual life and final salvation of infinite hosts of others. Thus does the animal kingdom, in some sort, PREACH THE GOSPEL OF CHRIST.

## CHAPTER XVI.

*Functions and Instincts. Myriapod Condylopes.*

THERE are two Classes of Condylopes, extremly dissimilar in their external form and the number of their legs, and yet in some respects related to each other, at each of which we may be said now to have arrived; both are almost exclusively terrestrial, and both remarkable for their ferocious aspect; the one the analogue of the *crab*, and the other apparently related to the Isopod Crustaceans, the *oniscus* and *armadillo*. It will be easily seen that I am speaking of the *Arachnidans* and *Myriapods*.

Regarding, therefore, the long-tailed Decapod Crustaceans as leading, by the Order of Isopods which we last considered, towards the *Myriapods*, and the short-tailed ones or crabs, as tending towards the *Arachnidans*, I shall give a brief account of the former of these Classes in the present chapter, and I am the more induced to assign them precedency because of their evident connection with certain *Annelidans*, which indeed Aristotle, and other ancient Naturalists, thought was so close, that they considered them as belonging to the same genus,[1] and it is worthy of remark that, in the Class just named, the representatives, if they may be so called, of the Myriapods, are, like them, divided into two tribes, one with a *cylindrical* and the other with a *flat* body.[2]

The Myriapods exhibit the following general characters.

ANIMAL undergoing a metamorphosis by acquiring in its progress from the egg to the adult state several additional segments and legs. *Body* without wings, divided into numerous pedigerous segments, with no distinction of trunk and abdomen. *Head* with a pair of antennæ; two compound eyes; a pair of mandibles; under-lip connate with the maxillæ.

The class naturally divides itself into two *Orders*, distinguished both by their form and habits.

1 Aristot. *Hist. Animal.* l. ii. c. 14. Plin. *Hist. Nat.* l. ix. c. 43.
2 See p. 187, and PLATE VIII. FIG. 1. 4.

1. *Chilognathans.*[1] Body generally cylindrical; segments half membranaceous and half crustaceous, each half bearing a pair of legs; *antennæ* seven-jointed, filiform, often a little thicker towards the end. These are called Millipedes. *Julus L.*

2. *Chilopodans.*[2] *Body* depressed; segments covered by a coriaceous plate, bearing each only a single pair of legs; *antennæ* of fourteen or more joints, setaceous. These are called Centipedes. *Scolopendra L.*

1. Very little is known with respect to the habits and instincts of the animals belonging to either of these Orders, except that they frequent close and dark places, being usually found under stones, under bark, in moss, and the like.

Latreille names the three families into which he divides the *first* of them, *Onisciform*, *Anguiform*, and *Penicillate;* one[3] resembles a wood-louse, like the mammalian armadillo, the trilobites, and chitons, when alarmed, rolls itself up into a spherical ball; besides the ordinary dorsal and ventral segments, these have, on each side underneath, between the lateral margin and the legs, a series of rounded plates, which Latreille conjectures may be related to the organs of respiration, which seems to give them some further affinity to the Trilobites. They are found mostly under stones, and creep out before rain.

Another,[4] in its cylindrical body, gliding motion, and coiling itself up spirally, presents a striking resemblance to a snake. Some species[5] emit, through pores, that have been mistaken for spiracles, a strong and rather unpleasant odour.

The *penicillate* family, of which only a single species is known,[6] is remarkable for several pencils or tufts of long and short scales, which distinguish the sides of the body. These are found principally under the bark of trees.

The myriapods belonging to this order De Geer describes as very harmless animals. They appear to feed upon decaying vegetable or animal matter. The author just named thinks that the common *Julus*,[7] or Gallyworm, feeds upon earth; one that he kept devoured a considerable portion of the pupe of a fly; other species are stated to eat strawberries and endive; and Frisch fed one, that he kept a long time, upon sugar.

1 *Chilognatha*, so called because their *lip* is formed of the jaws, from Gr. χειλος, a lip, and γναθος, a jaw.

2 *Chilopoda*, so called because their *lip* is formed of the *foot*, from Gr. χειλος, a lip, and πους, a foot.

3 *Glomeris.*

4 *Julus*, &c.

5 *J. fœtidissimus.*

6 *Pollyxenus lagurus.*

7 *J. terrestris.*

2. The *Chilopodans* or Centipedes, which constitute the *second* order, Latreille divides into two families, which he denominates *Inæquipedes* and *Æquipedes*. The *Inæquipedes*, so called because the six last pairs of legs are suddenly longer than the rest, belong, as at present known, to a single genus,[1] which being less depressed than the other Centipedes, seems to connect the two Orders. They are not found in England, but in France they are stated to frequent houses and outbuildings, where they conceal themselves during the day, between the beams and joists, and sometimes under stones; but when night comes they may be seen running upon the walls, with great velocity, coursing their prey, which consists of insects, woodlice, and other minute creatures; these they puncture with their oral fangs, and the venom they instill acts very quickly, thus enabling them easily to secure their victim.

The *Æquipedes*, so called because all their legs, except the last pair, are nearly equal in length, are subdivided into several genera, the most remarkable of which is distinguished by the ancient name of *Scolopendra*. Some species of this genus grow to an enormous size; a specimen of the giant centipede[2] in the British Museum is more than a foot long. The arms of the animals of the present Order are more tremendous than those of the Millipedes, for their second pair of legs terminates in a strong claw,[3] which is pierced at the apex for the emission of poison; in this family the first or hip-joints of these legs are united and dilated so as to form a lip.[4] In warm climates, the centipedes are said to be very venomous.

As the anguiform *Chilognathans* represent the living and moving serpent, so the family I am now considering, the equipede *Chilopodans*, may be regarded as representing the skeleton of a dead one. The head, with its poison fangs, the depressed body, formed of segments representing vertebral joints, and the legs curving inwards, and resembling ribs, all concur to excite the above idea in the mind of the beholder.

Like the last family, these also frequent close places, and sometimes creep into beds; they devour insects, and similar small animals, which Latreille found the puncture of their envenomed fangs arrested, and killed instantaneously; and it is sometimes attended with serious inconveniences to man himself. One species,[5] in some parts of the West Indies, goes by the name of the *Mischievous*;[6] and the pain caused by the

1 *Cermatia*. Illig. Leach. *Scutigera*. Lam. Latr.
2 *Sc. Gigas*.
3 *Introd. to Ent. t.* vii. *f.* 13. *ä*.
4 *Introd. to Ent. Pl.* vii. *f.* 11. *d. b.*
5 *Scolopendra morsitans*.
6 *Malfaisante*.

bite of the Giant Centipede, though it is never mortal, is greater than that produced by the sting of the scorpion.

Some centipedes emit a phosphoric light; of this description is one distinguished by the name of the *phosphoric*,[1] which is stated by Linné to have fallen from the air upon Captain Ekeberg's vessel in the Indian Ocean, a hundred miles from land. But the light-giving centipede best known is the *electric*,[2] which is remarkable for emitting a vivid phosphoric light in the dark; this is produced by a viscid secretion, which, as I have observed, when adhering to the fingers, gives light independent of the animal. This species also frequents beds. Its object in this may, perhaps, be to search for bugs and other insects that annoy our species during repose.

The function which the Creator has devolved upon the Myriapods of the first Order, seems to be that of removing *putrescent* vegetable and animal matter from the spots that they frequent; and that of the second to keep within due limits the minor inhabitants, especially the insect, of the dark places of the earth. Viewed in this light, however disgusting they may seem to us in their general aspect, we may regard them as beneficial, and as contributing their efforts to maintain in order and beauty the globe we inhabit.

It is worthy of remark that the great Hebrew Legislator, amongst the unclean animals which it was unlawful for the Israelites to eat or to touch, enumerates those which *multiply feet*.[3] In the common version it is translated, *Hath more feet;* but the marginal reading is nearest to the Hebrew, and seems to allude to a circumstance upon which I shall hereafter enlarge, namely, that these animals increase the number of their legs with their growth. As a subject intimately connected with Zoology in general, and leading to a very profitable study of the animal kingdom in a moral point of view, it will not be foreign to the object of the present treatise if I add here a few remarks upon the distinction of animals into clean and unclean, observable in many parts of Holy Writ. This distinction was originally to indicate those which might or might not be offered up in sacrifice, and, afterwards, when animal food was permitted, to signify to the Jews those that might and those that might not be eaten. When Noah was commanded, *Of every* clean *beast thou shalt take to thee by sevens, the male and his female; and of beasts that are* not clean, *by two, the male and his*

1 *S. phosphorea.* 2 *Geophilus electricus.* 3 *Levit.* xi. 42.

*female*[1]—it is evident that the distinction was familiar to the Patriarch. The *unclean* animals, with respect to their habits and food, belonged to two great classes, namely *Zoophagous* animals, or those which attack and devour *living* animals; and *Necrophagous* animals, or those which devour *dead* ones, or any other putrescent substances. Of the first description are the *canine*[3] and *feline*[3] tribes amongst *quadrupeds;* the *eagles*[4] and *hawks*[5] amongst *birds;* the *crocodiles*[6] and *serpents*[7] amongst *reptiles;* the *sharks*[8] and *pikes*[9] amongst *fishes;* the *tiger-beetles*[10] and *ground-beetles*[11] amongst *insects;* and to name no more, the *centipedes* in the class we are treating of.

With regard to the *necrophagous* tribe, I do not recollect any *mammalians* that are exclusively of that description, for the *hyæna*[12] and *glutton*[13] are ferocious, and eagerly pursue their prey, they will, however, devour any *carcasses* they meet with, and even disinter them when buried; but the *vulture* amongst the *birds* will not attack the *living* when he can gorge himself with the *dead;* the *carrion crow* belongs also to this tribe; amongst *insects*, the *burying*,[14] *carrion*,[15] and *dissecting beetles*,[16] the *flesh-fly*, and many other *two-winged* flies, feed upon *putrescent flesh;* and numberless others satiate themselves with all unclean and putrid substances, whether animal or vegetable. In the present class, the *millipedes* belong to the necrophagous tribe.

A third description of animals, appearing to be intermediate between the clean and unclean, and partaking of the characters of both, was added to the list—for instance, those that are *ruminant* and do *not divide the hoof*, as the *camel*, which, though it has separate toes, they are included in an undivided skin; and those that *divide the hoof*, but are *not* ruminant, as the *swine.*

It appears clear from St Peter's vision, recorded in the Acts of the Apostles,[17] that these unclean animals were symbolical, and in that particular case represented the Gentile world with whom it was not lawful for the Jews to eat or associate,[18] doubtless, lest they should be corrupted in their morals or faith, and seduced into Idolatry, and its natural consequences, with regard to morality, by them. In other passages of Scripture,

1 *Genes.* vii. 2. 2 *Canis.* 3 *Felis.*
4 *Aquila.* 5 *Falco.* 6 *Sauria.*
7 *Ophidia.* 8 *Squalus.* 9 *Esox.*
10 *Cicindela.* 11 *Carabus, Harpalus, &c.*
12 *Canis Hyæna, L.* 13 *Necrophorus.* 14 *Silpha.*
15 *Dermestes.* 16 *Sarcophaga carnaria.*
17 *Acts*, x. 10—15. 18 *Ibid.* ver. 28.

unclean animals are employed to symbolize evil and unclean *spirits* as well as *men*, as the serpent, the dragon, or crocodile,[1] the lion,[2] and the scorpion.[3]

By way of corollary to the present short chapter, I shall devote a few pages to a very interesting subject, intimately connected with the animals whose history and habits I have just described, and which marks out the plan upon which the wisdom, power, and goodness of the Creator have been manifested in animal structures. I allude to what has been named the *conversion* of organs, by which term is meant, not only in particular instances, multiplying the functions of any given organ, as, for instance, when the *tail* of an animal is employed like a *hand*, to take hold of the branch of a tree, and to assist in locomotion, as in the chameleon, and certain monkeys;[4] and the tongue is also made to subserve to prehension, as in the case of the giraffe; but likewise when the organ is converted from one use to another, as when the anterior leg is taken from locomotion, and given to prehension, as the human hand; or as when all the ordinary organs of locomotion in one tribe are in another converted into oral organs, either to assist in mastication, or to discharge the office of a lip, as in the Crustaceans and centipedes. In the investigation of this curious and interesting subject, the class of Myriapods affords an example, if I may so speak, of the gradual conversion of locomotive organs into auxiliary oral ones. Something of this kind I have before stated,[5] is discoverable in certain Annelidans, either related to those animals or their analogues.

In the *Introduction to Entomology* it is observed, with respect to the larves of many *Hexapod* Condylopes, that their progress towards what is called their perfect state, is by *losing* their spurious *legs* or *prolegs*, and by *acquiring* organs of *flight;* whereas in the *Myriapods*, the reverse of this takes place; instead of losing legs and shortening their body, some of them when first hatched, have only *six* legs, representing the six legs of Hexapods, and all in their progress to their adult state acquire a large number of what may be denominated spurious legs, which support many additional segments.

As the *Chilognathans*, in their young state, come nearest to the insect or hexapod tribes, I shall begin by stating the changes they undergo. In the most common species,[6] according to De Geer's description and figure, the animal is divided into

1 *Revel.* xx. 2. 2 1 *Pet.* v. 8. 3 *Luke*, x. 19.
4 *Ateles.* 5 See above, p. 186.
6 *Julus terrestris.*

three principal parts, as in Hexapods; first, there is a *head* with antennæ, and the usual *oral* organs, though a little aberrant in their structure; next, there is a *trunk*, consisting of three segments, each bearing a pair of legs; and lastly, there is an *abdomen*, divided into five segments, without legs.[1] With regard to their oral organs, they correspond with those of Hexapods, both in number and kind, for in the mouth, above is a representative of the upper-lip; below this is a pair of mandibles or upper-jaws; next follows a lower-lip, consisting of three pieces united together, the two lateral ones analogous both to the lower-jaws of Hexapods, and the first pair of maxillæ of Crustaceans; and the intermediate one, resolvable into two pieces, representing the lip of the former and the second pair of maxillæ, according to Savigny, of the latter, from his figures,[2] the maxillary and labial feelers appear to have their representatives; yet though he has figured he does not notice them as feelers.[3]

The six original or natural legs of the Iulus are its first organs of locomotion, which when the animal is arrived at its complete development, as to number of legs and segments,—are said still to maintain their original function, although probably diminished in energy; the two first pairs are, however, as it were, applied to the mouth, the segments that bear them being very short. The sciatic joint or hip[4] of the first pair forms a single piece; those of the second are also united and more elevated; but those of the third are distinct: so that in this Order of the Myriapods we see the first tendency towards employing what in Hexapods wear the form and perform the functions of *legs* as auxiliaries of the *mouth*, and of the locomotive function being devolved upon organs which have no representative in Hexapods, except in their incipient state.

To proceed next to the *Chilopodans*—it has not yet been ascertained what changes they undergo in the progress of their growth, save that the number of legs and segments increases till they have arrived at their full size,[5] nor is it known how many they have when first hatched, but, from their structure, it seems evident that the analogues of the two first pair of legs of the Chilognathans, can never be employed in locomotion; and further, that not only is their first or hip-joint united with

1 De Geer, vii. 583. *t.* xxxvi. *f.* 20, 21.

2 *Anim. sans Vertébr.* Mem. ii. *t. f.* 1. o. 2. o.

3 He says that the pieces forming the labium are *Dénuées des palpes. Ibid.* p. 44.

4 *Coxæ.*

5 De Geer, vii. 562.

its fellow, so as to form a kind of auxiliary lip, but the other articulations are converted into prehensory organs, instead of a locomotive one, in the first pair armed at the end with a minute forceps, and in the second with a fang resembling the tooth of a serpent, having a pore at the extremity for the emission of poison, connected with an *Ioterium* or poison bag.

Here then, in these two Orders of the Myriapods, we have a regular *conversion* of organs: those that in the Millipedes are used for locomotion, in the Centipedes, exchange that function for that of prehension, both agreeing in being auxiliary, at their base, to mastication, but the latter with a greater momentum.

The reason of this change in the functions of these organs we shall readily see when we consider the habits and food of these respective Orders. The Chilognathans deriving in general their nutriment from *putrescent* substances whether animal or vegetable, have no resistance to overcome, and therefore require not the aid of additional prehensory organs to enable them to execute their offices; while the Chilopodans, having to contend with *living* animals, must put them *hors de combat*, either by killing them, or deadening their efforts, before they can devour them. In this last Order we find that though the two first pairs of legs have a new office, the third pair are still used for locomotion.

From the oral organs and their auxiliaries of the Myriapods to those of the *Crustaceans*, the interval is not very wide; and amongst the latter the *Isopods*, especially the terrestrial ones, as might be expected, approach the nearest to them. De Geer observes that the common wood-louse,[1] which in its adult state has fourteen legs; when it first leaves the egg, has only six pairs and six segments;[2] thus doubling the number of the Hexapods and *Julus;* and in this animal and its relation, *Ligia*, the thoracic legs are all used in locomotion; but when we examine the *aquatic*, especially the *marine*, genera of this Order, as *Idotea*, *Stenosoma*, &c., we find that the first pair of thoracic legs is taken from that function, and made auxiliary to the organs of the mouth.

Leaving the Isopods, if we go to the *Decapods*, amongst those with a long tail,[3] which from their cylindrical form and other circumstances, are nearer to the Chilognathan Myriapods than to the Chilopodan, taking the lobster for our type, we find the organs analogous to the six legs of Hexapods, exhibiting a new character: for from the outer side of their basal joint issues

1 *Oniscus Asellus.* 2 vii. 551. 3 *Macrouri.*

an organ which is peculiar to these legs. The organ I allude to is called, by M. Savigny, a *flagrum* or whip; and, by M. Latreille, a *flagelliform palpus* or feeler; it usually consists of two parts, an elongated exarticulate base, representing the *handle* of the whip; and an annulated or jointed part generally forming an angle with it, representing the *lash:* the mandibles also have feelers of the usual structure. The organs above alluded to, show that all the representatives of the legs of Hexapods in the lobster, are converted to a new function—whether precisely analogous to that of feelers is not clear.

In the lobster the basal joints of the first pair of maxillary legs are dilated, and the whole organ may be regarded as maxilliform; but in the second it is palpiform, and in the third it resumes the joints and appearance of a crustaceous leg, and is densely ciliated, which seems to indicate that it is used in swimming.

In the common crab,[1] amongst the short-tail Decapods,[2] the legs in question seem all taken from locomotion, and the second pair does not differ from those of the lobster; but the last, though consisting of the same number of joints, is very different, the two intermediate joints being dilated, and the two legs together forming as it were a pair of folding-doors, which close the mouth externally, the three last joints resembling those of the legs. These animals, therefore, in some sort, the flatness of their body and this double auxiliary lip considered, present the same analogy to the *Chilopodan* Myriapods, that the lobster does to the *Chilognathan.* In both we see, by their feelers, there is a further conversion of these organs into instruments connected with the mouth; so as to bring them nearer to the nature and use of maxillæ or under jaws, and of a labium or under-lip.

It appears from the experiments and observations of Rathke[3] that the long-tailed Decapod Crustaceans do not change the form, or increase the number of locomotive organs, that distinguish them when they issue from the egg.[4] Once residing a few weeks on the northern coast of Norfolk, where the sea, at low water, retires to a considerable distance from the high water mark, I had an opportunity of witnessing the proceedings of a species of crab very common there,[5] and varying greatly in

1 *Cancer Pagurus.* 2 *Brachyuri.*

3 Récherches sur le dévélopement des Ecrevisses. Abstract of *Ann. des Sc. Nat.* xix. 442. 4 *Ibid.* 463.

5 *Cancer Mænas.* L. Mr Westwood, in a letter received since this went to press, expresses his conviction that Crustaceans do *not* undergo any metamorphosis. Besides a variety of other arguments which he will himself bring

size, some, if my memory does not deceive me, scarcely exceeding the size of a pea, others being three or four inches in diameter, and all exactly corresponding in every particular; so that it seems probable that the short-tailed tribe also undergo no change, except of size, though, as we have seen above, the terrestrial Isopods acquire additional legs in their progress to maturity. The legs, however, of these Crustaceans cannot be regarded as analogues of the legs of *Hexapods*, but rather of the *acquired* legs of the *Myriapods*.

In order to form a clear notion of the object of Providence in thus, as it were, taking certain organs from locomotion, and forming a new set for that purpose, and multiplying those connected with the seizing and mastication of the food of the animals in which this metamorphosis takes place, it would be necessary to watch their proceedings in their native element, the water, to ascertain the nature of their food, their mode of taking it, and other circumstances connected with its conversion into a pulp proper for digestion; but as few can have an opportunity of doing this, we can only conjecture that this multiplicity of organs is rendered necessary by the circumstances in which they are placed, and the element they inhabit; for, as we have seen, no such conversion occurs in the *terrestrial* Crustaceans; probably the denser medium requires a more complex structure and more powerful action in the instruments connected with the nutriment of the animal.

Having considered these instances of the *legs* of Hexapods being, as it were, metamorphosed into organs more especially connected with nutrition, I shall next mention, more briefly, some cases in which the oral organs themselves are modified to discharge *other* functions than what is usually their primary one.

To begin with the *Arachnidans* or spiders. In these the two-jointed *mandibles* or cheliceres, as Latreille calls them, are not organs of mastication solely; for though, from the vast strength and power of the first joint and its flat internal surface, we may conjecture that it assists in pressing the juices out of their prey, yet at the extremity of the second is a poison fang, being furnished, like the tooth of a viper or centipede, with a pore for emitting venom, which though not easily discovered in the smaller species, is visible under a lens in the larger; with these

forward in due time, he lately met with young specimens of this crab at Conway, in N. Wales, only 1-16 of an inch in length, which did not differ from adult ones.

fangs, which communicate with a poison vesicle, the spider dispatches the insects struggling in his toils, which otherwise he could not so easily master, and having sucked out their juices casts away the carcass. The fang, by folding upon the apex of the basal joint of the organ we are considering, which is toothed on each side, and has a channel to receive it when unemployed, can be formed into a forceps, resembling that which arms the anterior thoracic leg of the shrimp, or that of the mantis, and which is probably, in some circumstances, used for prehension.

The subject of *poison-fangs* affords a striking example of the adaptation and modification of different parts and organs to the discharge of the same or similar functions, according to the circumstances in which an animal is placed; the viper, the centipede, and the spider have their sting in their *mouth*, or in its vicinity; the scorpion and the bee and wasp have it at the *other extremity* of the body; while the male of the *Ornithorhynchus*, or Duck-bill, and *Echidna*, or New Holland Porcupine, have it in their *hind legs*. Considering the evident affinity between these last animals and the *birds*, their poison-spur seems evidently analogous to the spur that distinguishes the males of many gallinaceous birds; and, reasoning from analogy, we may conclude that this organ is given to the males of the *Monotremes* as a weapon to be used in their mutual combats.

Whoever examines the underside of a spider will find the feelers and the eight legs arranged nearly in a circle, with their first hip-joints parallel; with some this joint in the feelers is dilated, but in others it is of the same shape with the analogous joint of the legs, only a little longer. It forms the *maxilla* or under-jaw, and between the first pair is the under-lip. The function of the maxillæ is to assist the, so called, mandibles, in pressing out the juices of the flies and other insects submitted to their action, and the analogous and parallel joints in the eight legs add some momentum to it.

The *Palpi*, or feelers—which in some cases emerge from the side of the maxilla, and appear a distinct organ, and in others are merely a continuation of it—in one sex undergo a singular conversion, and discharge a function connected with reproduction; and in the other, the female, are said sometimes to assist in supporting the egg pouch, which many of these creatures carry about with them, and guard with maternal solicitude.

It has been made a question by physiologists what the mandibles, and maxillæ with their palpi, of the Arachnidans really represent; whether they are the analogues of organs bearing

the same name in Hexapod Condylopes, or of others to be found in the Crustaceans or Myriapods. Latreille, in his latest work, regards the pieces immediately following the upper lip as analogues of the same parts in the Crustaceans, namely, a pair of palpigerous mandibles, two pairs of pediform maxillæ, and two pairs also of maxillary feet, analogous to the four anterior feet of insects.[1] Of the above organs, the mandibles and two pairs of maxillæ may be regarded as having their prototype in the Hexapods; for the second pair of maxillæ of the Crustaceans, in the Chilognathans, is the piece that represents the labium, or under-lip, of the first named animals.

Savigny, however, is of opinion that the auxiliary *maxillæ*, or, according to Latreille, maxillary *feet*, of the crab, except the first pair, become the *mandibles* and *maxillæ* of the spider; and that the *thoracic* legs of the same animal, with the same exception, become also its *ambulatory* legs:[2] thus accounting for the reduction of the number of the latter from *ten* to *eight*, perhaps he was induced to adopt this opinion, with respect to the oral organs, by considering the mandibles of the spider as analogous to the poison-fang which arms the second pair of auxiliary feet of the *Scolopendra*.

I feel, however, rather inclined to adopt the opinion of the former learned entomologist, from the consideration of an *Arachnidan*, which seems evidently to lead towards the Hexapods. The animal I allude to is one of ancient fame, of which, once for all, I shall here give the history.

Ælian relates that a certain district of Æthiopia was deserted by its inhabitants in consequence of the appearance of incredible numbers of scorpions, and of those *Phalangians* which are denominated *Tetragnatha*, or having four jaws. An event mentioned also by Diodorus Siculus and Strabo.[3] Pliny likewise alludes to this event, but calls the last animal *Solpuga*,[4] a name which, in another place,[5] he says was used by Cicero to designate a venomous kind of *ant*.

The epithet *Tetragnatha*, applied by Ælian, &c. to the animal which, in conjunction with the scorpion, expelled the Æthiopians, as just stated, from the district they inhabited, seems clearly to point to the Solpuga of Fabricius, for any per-

1 Latr. *Cours D'Entomologie*, 167.

2 *Anim. sans Vertêbr.* ii. 57, Note *a*.

3 Bochart. *Hierozdic.* ii. l. iv. c. 13.

4 *Hist. Nat.* l. viii. c. 29. This name seems derived from the Greek, *Heliocentris*.

5 L. xxix. c. 4.

son, not skilled in natural science, would, when he saw the expanded forceps of their mandible, pronounce that they had *four* jaws;[1] and the animals of this genus, in their general form and aspect, exhibit no small resemblance to an *ant*, so that it is not wonderful that Pliny should regard them as a kind of venomous ant. It seems, therefore, almost certain that the ancient and modern Solpuga are synonymous. Pliny, indeed, mentions a certain kind of spider—one of which he describes as weaving very ample webs—under the name *Tetragnathii;* but these appear to have no connection with the *Phalangia tetragnatha* of Ælian, &c.

Olivier was the first modern naturalist who described the animals now before us, to which he gave the generic appellation of *Galeodes;* but if, as the above circumstances render very probable, they are really synonymous with the ancient *Solpuga*, that name, revived by Fabricius, should be retained.

Whether these animals are really as venomous and maleficent as they were said to be of old, and as their terrific aspect may be thought to announce, seems very doubtful. We learn from Olivier that the Arabs still regard their bite as mortal, and that the same opinion obtains in Persia and Egypt; and Pallas relates several facts, which, he says, he witnessed himself, which appear to prove that, unless timely remedies are applied, they instil a deadly venom into those they bite. Oil is stated to be the best application. On the other hand, Olivier, who found these Arachnidans common in Persia, Mesopotamia, and Arabia, affirms that every night they ran over him, when in bed, with great velocity, without ever stopping to annoy him; no one was bitten by them, nor could he collect a single well-attested fact to prove that their bite was so dangerous: to judge by the strong pincers with which the mouth is armed, he thought it might be painful, but he doubts whether it is accompanied by any infusion of venom. The manibles have clearly no fang with a poison-pore, like those of the spiders.

To return from this digression. I principally mentioned this tribe of animals, because, as was long ago observed by Walckenaer,[2] and the observation was repeated by L. Dufour,[3] the head, in them, is distinct from the trunk; and, as well as *Phrynus* and *Thelyphonus*, it has only six thoracic legs: so that, as the latter writer remarks, though its physiognomy and manners arrange it naturally with the Arachnidans, these characters exclude it from them.[4] Latreille, indeed, seems to regard

1 L. Dufour. *Annal. Génér. des Sc. Nat.* iv. *t.* lxiv. f. 7, *a.*
2 *Tableau des Araneid.* 1. 3 *Ubi supr.* 18. 4 *Ibid.* 20

the head and trunk of this animal as not distinct, but as forming together what he names a *cephalothorax*, or headthorax; yet he admits that the three last pairs of legs are attached to as many segments of the trunk,[1] which certainly infers the separation above alluded to.

Savigny says, with respect to the feelers of *Solpuga*, that they, and the two anterior legs, so closely resemble each other, that they may either be called feelers or legs; but in the species described by L. Dufour,[2] and another in my cabinet,[3] this is not altogether the case, for the feelers, though pediform, are not terminated by a claw, but by a membranous vesicle, from which issues, when the animal is irritated, an apparatus probably used as a sucker, and which gives them a prehensory function; while the organs that represent the anterior pair of legs of the other Arachnidans, at the base of their maxillary or sciatic joint, are soldered, as it were, to the corresponding joint of the feelers, with which they agree in the number and kind of their articulations, except that they do not protrude a sucker; neither are they armed with a claw like the other legs, but are probably simply *tentacular*, or exploratory. There seems no slight analogy between these united maxillæ and what Savigny denominates the first and second pair of maxillæ of the millepedes, also united, which appear to me to represent the lower-lip and maxillæ of the hexapods, and in this case the two pair of feelers that issue from the coxo-maxillæ, as they are sometimes called, or sciatic joints in the *Solpuga*, may be regarded as representing the *labial* and *maxillary* feelers of the hexapods; the second pair are also analogous, both in their place and their function, to the first pair, or tentacular legs of *Thelyphonus* and *Phrynus*. In the *Solpuga*, the labium, or under-lip, of the spiders, is represented by a bilobed organ, which Savigny calls a *sternal* tongue.

From the consideration of this animal we seem to have obtained the elements, or type, in reference to which the oral, prehensory, and locomotive organs of the Arachnidans were formed; that their mandibles, maxillæ, and feelers; their second maxillæ, and the, so called, anterior legs emerging from them, are analogous to the mandibles, labium and labial feelers, and maxillæ and maxillary feelers of the hexapods; and the remaining three pairs of legs, of their six legs; the sternal tongue, so called by Savigny because it is a process of the sternum, will thus be an organ *sui generis*, unless it may be regarded as, in

1 *Cours D'Entomolog.* 548.
2 *Galcodes intrepidus.*
3 *Solpuga fatalis.*

some sort, the analogue of the prosternum of insects. If this view is correct, we have here various conversions, as of *maxillæ* and *palpi* into *legs;* a *labium* into *maxillæ;* and a *prosternum* into a *labium.* In the *Pedipalps*—with the exception of the scorpions,—*e. g.* in *Thelyphonus* and *Phrynus*, especially the latter, the *first* pair of legs of Octopods seem to wear the form, and in some measure to discharge the functions of *antennæ.*

In the *shepherd-spiders*[1] *all* the legs, in some degree, imitate antennæ, especially in their *tarsi*, which sometimes consist of more than *fifty* joints, rendering them very flexible, so as to assume any curve, and fits them, as their long legs do the *crane-fly*,[2] to course rapidly over and among the herbage and the leaves of shrubs, &c. When reposing upon a wall, or the trunk of a tree, this animal arranges its legs so as to form a circle as it were of rays around the body, the thigh forming a very obtuse angle with the rest of the leg, and so, though the body is so small, they occupy a considerable space; but, if a finger, or any insect, &c. touches them, it elevates these angles into very acute ones, so as to form a circle of arcades round the central nucleus or body, under which any small creature can pass, but if this does not succeed, it makes its escape with a velocity wonderful for an animal furnished with legs more than ten times the length of its body.

In the *scorpion* and the *book-crab*,[3] as well as the shepherd-spider, the mandibles, which are short, have a movable joint, and are converted into a forceps, like the anterior legs of the crab or the lobster; their feelers also, which are very long, terminate in the same way, and form an organ by which they can catch their prey; the former being armed besides with a long jointed tail, furnished at the end with a sting, which they can turn over their back, and thus, either annoy their assailants, or dispatch any captive whose resistance they cannot otherwise easily overcome.

To what a variety of uses are analogous organs applied in the diversified instances here adduced; and in all these variations from a common type, how apparent are the footsteps of an intelligent First Cause, taking into consideration the intended station and functions of every animal, and how the structure may be best adapted to them, not only in general, but in every particular organ.

As far as we can lift up the mystic veil that covers the face of nature, by means of observation and experiment, we find

1 *Phalangium.* 2 *Tipula.* 3 *Chelifer, Obisium*, &c.

that every iota and tittle of an animal's structure, is with a view to some end important to it; and the Almighty Fabricator of the Universe and its inhabitants, when he formed and moulded, *ex præjacente materia*, the creatures of his hand, decreed that the sphere of locomotive and sentient beings should be drawn together by mutual attraction, and concatenated by possessing parts in common, though not always devoted to a common use; thus leading us gradually from one form to another, till we arrive at the highest and most distinguished of the visible creation; and instructing us by his works, as well as by his word, to cultivate peace and union, and to seek the good of the community to which we belong; and, as far as our influence goes, of the whole of His creation.

## CHAPTER XVII.

*Motive, locomotive, and prehensory Organs of Animals considered.*

THE remarkable circumstances noticed in the last chapter with regard to the legs of Crustaceans and Myriapods, and their employment in aid of manducation, sheds no small light upon the subject of locomotive organs in general, and their primary function; it will therefore not be out of place, if, in the present chapter, I consider those organs, as far as they are *external*, according to their several types, as exhibited in the entire sphere of animals; upon which, indeed, the due accomplishment of their various functions, and the exercise of their several instincts—which in most of the succeeding classes assume a new and more developed character—mainly depend. This is a wide field, but one full of interest, and which, studied as it deserves, conspicuously illustrates the higher attributes of the Deity.

We are placed in a world full of *motion;* of all motions, none fall more immediately under our notice than those of the various members of the animal kingdom; and the external organs by which they are effected, attract every eye both by their infinite diversity, and the adaptation of their individual structure to the occasions and wants of the animal in whom they are found, so that they may, in the best and safest manner, effect such changes of place as are necessary for their purposes.

Nutrition may be stated as the primary object of the motions and locomotions of the members of the animal kingdom in general. No sooner is the fœtus or embryo so separated from its parent stock, as not to imbibe its food from it, than it begins to employ instinctively its prehensory and motive organs in collecting it. And, whether we descend to the foot of the scale of animals, or mount to its summit, we shall find that their—*Daily Bread*—is the principal object that in every Class sets the members in motion.

The *motive* organs may be divided into *two* classes, those that are employed by an animal in *locomotion*, and those that are used for *prehension;* but as many of the locomotive organs are also prehensive, and prehension is often in aid of locomotion—

as in climbing and burrowing—it will not be easy to consider the motive organs separately with regard to these functions, I shall therefore consider them generally, according to certain types or kinds, under which they may be arranged, and which present themselves very obviously, when, with this view, we survey from base to summit, or rather from pole to pole, the entire sphere which constitutes the animal kingdom.

Generally speaking, in this survey, as well as in the peculiar motions of the various groups of animals, we have no trouble in ascertaining what are the external organs by which the Creator has enabled and instructed each animal to accomplish them; but there is one anomalous tribe, or, perhaps, it might be denominated, *Sub-kingdom*, in one Class of which, at least, this is not so obvious. I allude to Ehrenberg's Tribe of *Plant-animals*,[1] particularly his first or polygastric Class,[2] in which the organs of their various locomotions, enumerated in a former part of this work,[3] remain unknown, and some, as those that have an oscillatory movement, one might almost suspect were moved by an *external* cause. The little Monad, parasitic on the eye-worm of the perch,[4] which alternately spins round like a top, and then darts forward like an arrow,[5] seems as if, like a watch, it required to be wound up before it could go.

Before I confine myself to those motive organs which are local and planted in certain parts of the body of an animal, as legs, wings, fins, &c., I shall first mention those motions in which the whole body is concerned. Of this description is the alternate contraction and expansion of some, as the Salpes and Pyrosomes and other Tunicaries;[6] the annular motion propagated from one extremity of the body to the other, as in the earth-worms,[7] geometric caterpillars, and many other larves; the undulating movements of the flexile bodies of many aquatic animals, as fishes, particularly the serpentiform ones; and the gliding motion of serpents themselves over the surface of the earth as well as their undulations. Many of the animals here alluded to are provided with subsidiary organs—as the earth-worm with lateral bristles;[8] the geometric larves, with legs at each extremity of their body; the leech with suckers; which, however, would be of little use without the expansion and contraction of its body;[9] and the fishes with fins: but if

1 *Phytozoa.* 2 See above, p. 83. 3 *Ibid.* 82.
4 *Diplostomum volvans.* 5 See Appendix.
6 See p. 120, 122. 7 *Ibid.* p. 184. 8 *Ibid.*
9 *Ibid.* p. 181.

we consider the form and circumstances of all these animals, we shall see, in each case, the design and contrivance of Supreme Wisdom. Without the power of contraction and expansion, by which the Salpes, Pyrosomes, &c., alternately attract and repel the waters which they inhabit, they might indeed, from their absorbent structure, be saturated, but nutrition could not take place. The earth-worm again, a subterranean animal, but which occasionally emerges, by the annular motion of its body can much more easily wind its sinuous way without obstruction when it seeks again its dark abode under the earth. The denser medium compared with air, through which the aquatic animals pass, renders great flexibility a very important quality, to enable them to overcome the resistance it opposes to their progress.

Having premised these observations on motions produced by the action of the whole body, or successively propagated from one extremity to the other, I shall now proceed to consider those external organs, which are its obvious instruments in the great majority of animals, beginning with those that are found in the *lowest* groups.

1. *Rotatory Organs.* In some species of Infusories, even in Ehrenberg's first Family of his Polygastric Class, the oral aperture is *fringed* with a circlet of bristles, but whether the animal by their means creates a vortex in the water, or whether they are analogous to the tentacles of the polypes, and are employed in collecting its food, seems not to have been clearly ascertained. Lower down in this Class, and approaching the Rotatories, we find a singular animal,[1] with bristles, by their position, simulating legs, which, as was before observed,[2] revolve with wonderful rapidity. But it is in the Class of *Rotatories* that these revolving organs are most conspicuous. They are described as shaped like a tunnel, the tube of which terminates in a deep-seated pharynx armed with jaws, and the external dilated orifice fringed with fine hairs or bristles, to which the animal communicates a very rapid rotation, whence they are called *wheel-animals.* Some, as the vorticels,[3] the wheel-animals by way of eminence, appear to have

1 *Discocephalus Rotator*, Plate I. A. Fig. 6.

2 See Appendix.

3 *Vorticella.* Müll. They constitute chiefly the *Rotifera* of Lamarck, and are divided by Ehrenberg into numerous genera. His genus *Vorticélla*, the type of which is *V. convallaria*, Müll. is placed in his Polygastric Class, in a section of his fourth Family (*Anopisthia*), which section he names *Vorticellina.*

*two* wheels, others *three*, or even *four*: Lamarck is of opinion, from the observations of Du Trochet, that what are taken for two or more wheels, are only one, bent so as to form partial ones;[1] but in some they are certainly distinct organs.[2] The object of the rapid gyration of this wheel or wheels is to create a vortex in the water, whose centre is the mouth of the animal, a little charybdis bearing with it all the animalcules or molecules that come within its sphere of action, and by this remarkable mechanism it is enabled by its Creator, as long as it is encircled by a fluid medium, to get a due supply of food. These wheels are merely foraging organs, for on a surface the locomotions of these singular animals resemble those of the leech described in another place.[3]

In surveying the organs by which animals procure their food, we are struck by the wonderful diversity and multiplicity of means by which the same end is attained, and yet, through all this diversity, a series of approximations may be traced, proving that the same hand directed by the Wisdom, Power, and Love of one and the same Infinite Being fabricated the whole host of creatures endowed with powers of voluntary motion. What care does it manifest, and attention to the welfare of these invisibles, and what contrivance, that they should be fitted with an organ, by means of which, when they are awakened from a state of suspended animation, and from a long fast perhaps of months, or even years, by water coming in sufficient contact with them, they can start up into life, and by the gyrations of their wheels immediately begin to breathe, and to procure a sufficient supply of food for their sustenance, while they continue animated.

2. *Tentacles.* Nearly related to these bristle-crowned rotatory appendages of the mouth of some animalcules are what are named Tentacles, so called probably from their being usually exploring organs. In its most restricted sense, this term is understood to signify organs, appendages of the mouth, which have no *articulations*,[4] but, in a larger sense, the term has been applied also to all jointed organs in its vicinity, and used for a similar purpose, which indeed are the precursors of feelers and antennæ. The structure of the first-mentioned, or proper tentacles, and the means by which they perform their motions, and fulfil their functions, have been before explained.[5] It is to these organs, as well as for their food, that the polypes are

1 See Baker *On the Microscope*, i. 91. *t.* viii. *f.* 5.
2 *Ibid. f.* 6.
3 See above, p. 181.
4 See Savigny *Syst. des Annelides*, iii. 4.
5 See above, p. 88

indebted for what constitutes their principal ornament, that resemblance which, though born to blush unseen, even in the depths of the ocean, their Creator has enabled them to assume, of a plant or shrub in full blossom adorned with crimson or orange-coloured flowers.

In the *fixed* polypes, the tentacles are the only motive organs, but in those that can *shift their quarters*, as the *Hydra*,[1] they move by fixing each extremity like the leech, probably by means of something analogous to suckers. As the former, like their analogues in the vegetable kingdom, are fixed by their base, and consequently cannot move from place to place in search of food, Divine Goodness has compensated this to them, and they obtain all the advantages of locomotion by the progressive multiplication of their *oscula* or mouths, each surrounded by a coronet of tentacles, so that they have, on all sides, and at all heights, numberless sets of organs constantly employed in collecting food from the fluid they inhabit; some, it is stated, by creating a vortex, like the wheel-animals, and the majority, probably, by means of minute suckers, or some viscid tentacious secretion. What each individual collects does not merely serve for its own nutriment, but also contributes something to that of the whole community,[2] so that though some may contribute more to the common stock and others less, yet the deficiency of one is made up by the redundancy of another.

The tentacles of the fresh-water polypes forming the locomotive genus *Hydra*, are not, as those of the fixed marine ones, shaped like the petals of a blossom, but are long hair-like flexile arms, somewhat resembling the branches of a chandelier,[3] which explore the waters around them, and lay strong hold of any small animals or substances they come in contact with,[4] so that they seem to throw out lines, fitted with hooks, to catch their prey.

Amongst the *Radiaries*, in the Order of *Gelatines*,[5] tentacles exist in some genera and not in others, and, where they do exist, their functions and situation are not clearly ascertained. In the *Pelasgic Medusa* there are four broad flexible arms, and round the margin eight narrow tentacles, as they are called, both of which the animal is stated to employ in seizing its prey, so that both may be entitled in this view to the denomination of *tentacles*, yet one may be respiratory organs and the

1 See above, p. 92. 2 *Ibid.* 91.
3 Lasser. L. *Théologie des Ins.* i. *t.* ii. *fr.* 28—32.
4 See above, pp. 88—91. 5 *Ibid.* 104.

others merely prehensory.[1] But the Medusidans vary greatly with regard to these organs, some having neither arms nor tentacles;[2] others having tentacles but no arms;[3] others again arms but no tentacles;[4] and lastly, others both these organs.[5]

In the two first sections of the Order of Echimoderms, consisting of the *Stelleridans* and *Echinidans*, the mouth has no coronet of tentacles, but, instead, is armed with five pieces, which, in the latter particularly, assume the form and function of *mandibles*;[6] but the Fistulidans present again a floriform coronet of tentacles, not simple but expanded, and branching at their extremity, with which they seize their prey. In the *Holothuria*, besides these, the mouth is armed with five teeth or mandibles.

Tentacles, but not conspicuously, surround the mouth of only some of the *Tunicaries*, it will therefore be sufficient merely to mention them, and proceed to certain oceanic animals amongst the *Annelidans* whom their Creator has adorned, if I may so speak, with rays of glory, which, when expanded, surround their head, or rather mouth, with a most magnificent coronet. The animals I allude to constitute the genus *Amphitrite* of Lamarck, and the *Sabella* of Savigny; this coronet, in some species, is formed by numerous tentacles, called, by the authors just named, *Branchiæ*, or gills; but as they are stated to be employed in collecting their food, as well as in respiration,[7] they seem in this respect perfectly analogous to the tentacles of the polypes, and wheels of the rotatories, which are also respiratory organs. The great difference seems to consist in their being divided into two fan-like organs in the Amphitrites, in which the digitations or tentacles proceed from a common base, and which together form the coronet. In some the digitations, like the sticks of a fan, are connected by an intervening membrane, thus resembling two expanded fans;[8] in others, this pair of organs forms two bunches, set, as it were, with numerous spirally convoluted plumes;[9] in a third each bunch of plumy tentacles is convoluted, but not spirally;[10] but the most magnificent species of the genus, if indeed it belongs to it, is that figured in the fifth volume of the *Transactions of the Linnean Society*,[11] under the name of *Tubularia magnifica*. I

1 Carus. *Comp. Anat.* i. 47.
2 *Eudora.* Lam.
3 *Equorea.* Lam.
4 *Cassiopea.* Lam.
5 *Aurelia.* Lam.
6 Plate III. Fig. 9—11.
7 Lamarck, *Anim. sans Vertebr.* v. 355.
8 *Amphitrite Infundibulum. Linn. Trans.* ix. *t.* viii.
9 *A. volutacornis. Ibid.* vii. *t.* vii. *f.* 10.
10 *A. vesiculosa. Ibid.* xi. *t.* v. *f.* 1.
11 *Ibid. t.* ix. *f.* 1—5

say, *if indeed it belongs to it*, because, if the figure quoted is correct, which I am not aware there is any reason to doubt, the gills or tentacles, call them which we will, are not, as in the other species, divided into two fasciculi or bundles, the rays of which sit upon a common base; but form one glorious and radiant coronet, whose rays are beautifully annulated with red and white; there appears indeed to be a double circle or series of these rays, the interior ones shorter than the exterior; but there is not the least appearance of their division into *two* bunches, each forming a semicircle. The rays differ little from those of many of the polypes, except in being more numerous and longer, for the diameter of the circle, when the rays are all expanded, is nearly six inches, and it is not stated that the figure is magnified.

Whenever the animal is alarmed it withdraws this gorgeous apparatus of respirato-prehensory organs within its tube, and the tube itself into its burrow in the living rock, as a safe refuge from its enemies. Whoever compares the above figure of this expanded animal-blossom with the nectaries of some species of passion-flower, will be struck by the resemblance they exhibit to each other,[1] and by the analogy that evidently exists between them. As prehensory organs, the principal object of their unusual length and numbers may probably be their capturing, as in a net, a quantity of rock animals, or animalcules, sufficient for their support, and perhaps their very beauty may be a means of attraction and bring them within their vortex.

With these splendid animals we bid farewell to those whose oral organs seem analogous to the blossoms of vegetables, and also to those in whom the organs of prehension and respiration are united; or in which the same organs collect food and also act the part of gills.

Though tentacles are not henceforth employed in *respiration*, yet they still exist in several other classes of animals as exploratory, prehensory, and locomotive organs. But in none are they more remarkable, both for their structure and uses, than in the Cephalopods or cuttle-fish. In these animals they are used, as we have seen, as arms for prehension, as legs for locomotion, as sails for skimming the surface of the ocean, as oars for passing through its waves, as a rudder for steering, and as an anchor to fix themselves.

These organs, like the tentacles of the polypes, surround the mouth; in some genera, as the poulpe,[2] and sepiole,[3] besides

1 See Linn. Trans. ii. *t.* iii. *f.* a. b.

2 *Octopus.*

3 *Sepiola.*

eight shorter arms,[1] there is a pair of very long ones, which are usually denominated tentacles, by way of eminence, which the animal probably uses, and for which purpose a claw arms their extremity,[2] to lay hold of prey at a distance. The means by which the tentacles perform the locomotions of these animals, and enable them to seize their prey, I shall advert to under another head.

But though, in the great body of the Cephalopods, the tentacular organs do not exceed *ten*, we find, from Mr Owen's admirable memoir on the *Pearly Nautilus*,[3] that, in that animal, they are extremely numerous, and strikingly different in their structure. The mouth and its appendages are retractile within the head, which forms a sheath for them, the orifice of which is anterior. The proper tentacles are of two kinds: 1. Brachial ones, finely annulated, emerging from thirty-eight three-sided arms, disposed irregularly, nineteen on each side, all directed forwards, and converging towards the orifice of the oral sheath. 2. Labial ones, similar to the others in their structure, and emerging from four broad flattened processes, arising from the inner surface of the sheath, and more immediately embracing the mouth and lip: from each of these processes emerge twelve tentacles, rather smaller than the brachial ones. Besides these two descriptions of tentacles, there is a pair, one on each side, emerging from two orifices in the inner part of the hood or foot, arranging with the arms, and perhaps to be reckoned with the brachial tentacles, thus making up the whole number of tentacles of a similar structure eighty-eight. It is to be observed that neither the parts that sheath them, nor the tentacles themselves, are furnished with any acetabula or suckers.[4]

Besides the tentacles, this animal has four analogous organs of a different structure, one before and one behind each eye, which Mr Owen likens to antennæ, and which are lamellated, or composed of a number of flattened circular disks, appended to a lateral stem;[5] a circumstance indicating a variation in their functions.

From their being retractile, it should seem that in this animal the tentacles are not in constant use, as they are in the naked Cephalopods, and that they require protection; from their finely annulated structure they appear to be flexible and easily applicable to any surface, but whether they are tentacular or prehensory organs, or both, is unknown. In the account

1 Plate VII. Fig. 3. *a*. 2 *Ibid. b*. 3 *Nautilus Pompilius*
4 Owen's *Memoir*, &c. 13, *t*, i. *n*. 5 *Ibid*. 14.

of the *Loligopsis*, a species of cuttle-fish, by the able pen of that eminent zoologist Dr Grant, the part apparently analogous to the labial tentaculiferous processes of the Nautilus, is called the *outer-lip*, and is stated to send out a muscular band to the base of each *arm*,[1] which seems to indicate that the arms of the naked Cephalopods are analogous to the labial tentacles of the animal we are considering. The labial processes, with their tentacles, present some resemblance to a many-fingered hand,[2] and from their situation immediately next the mouth may be conjectured to be most concerned either in the capture or transmission of its food: but whether either set of tentacles is used in its locomotions, as they are in the naked Cephalopods and the Argonaut, seems very problematical.

As far as its locomotion on a surface is concerned, in its hood, it appears to be furnished with an expansile foot, approaching that of the *Gastropods*,[3] so that its tentacles seem not necessary to transport it from place to place on the bed of the ocean; by what means it elevates itself, as it is known to do, to the surface, and floats upon the waves, has not been ascertained.

In comparing the organs that surround the mouth of the Nautilus with those of other Cephalopods, we see that a vast change has taken place. They are no longer the principal organs of locomotion, that function being transferred to an expansile foot; their number is increased in nearly a tenfold ratio: being deprived of suckers, they seem destitute of any powerful means of prehension and retention, and so are scarcely able to overcome the resistance of the larger Crustaceans. As their principal organ of locomotion is one that seems to preclude all idea of rapid motion in pursuit of their prey, it is most probable, as their mandibles are fitted for crushing crust or shell, that certain Molluscans, animals which must be equally slow in their motions, and can scarcely resist them, are their destined food.

We may further observe, that, regard being had to the organs which surround the mouth, a very wide interval separates the great body of the Cephalopods, known in a recent state, from the animal now before us; even the *Spirula*, which Mr Owen conjectures may belong to the same Order, in this respect is formed upon a very different type, precisely that of those Cephalopods.[4]

1 *Trans. of Zool. Soc.* I. i. 23.
2 Owen, *ubi supr. t.* iv. *f, i i, g g.*
3 Owen's *Memoir*, &c. 12, *t.* i. *n.*
4 Plate IV. Fig. 2.

This animal, in the above respect, being so completely insulated, it seems, as if in its means of entrapping its prey it was formed upon a plan not connected with that of any other Molluscan, but quite *sui generis:* probably, were we acquainted with the animals belonging to what are deemed fossil Cephalopods, we should find the hiatus vastly narrowed.

In this instance we see clearly that adaptation of means to an end which distinguishes all the works of the Creator; the striking variation which this creature exhibits from the oral apparatus of its Class, is evidently connected with the kind and circumstances of the animals which it is commissioned to keep within their proper limits; its mandibles, or beak, indeed, resemble those of the other Cephalopods, indicating that its prey are covered with solid integuments, requiring great force to crush them; but the other oral organs, and its snail-like foot, as we see, indicate that they are not of a kind that can easily escape from their assailants.

Two objects seem to have been principally in the mind of the Almighty planner of the universe of beings: one seems to have been the concatenation of all subsistences, seriatim and collaterally, into one great system; and the other, so to order and vary the structure of each individual that it may be duly fitted to answer a certain end, and produce a certain effect upon such and such points of that system, and this in such a way that these effects, though *diverse,* might not be *averse,* but proceed, if I may so speak, in the same direction. Thus, in the subject before us, the general commission given to the Cephalopods, is to assist in reducing the *armed* population of the ocean within certain limits, and to all are given instruments and organs, varying indeed in their structure, but proper to enable them to effect this purpose; all, however, concurring to bring about a common and connected object, and one taking one department and another another.

The tentacles of the *Univalve Molluscans,* for the headless animal of the *Bivalves* has no such organ, are neither used for locomotion nor prehension, and therefore seem to have no claim to a place in the present chapter. But as they are clearly the analogues of the tentacles of the animals we have been considering, and though not prehensory, are certainly exploring and sensiferous organs, which are probably connected with prehension, I shall make a few observations upon them. They vary in their number, some having none,[1] others only two;[2] others

1 *Chiton.* 2 *Cypræa. Voluta.* PLATE VI. FIG. 1. *b*

again four;[1] and lastly, others six.[2] They are without articulations, though they sometimes exhibit an annulated appearance:[3] they are also often retractile, and in the snail and slug they form a hollow tube, which can be inverted like the finger of a glove; in others they appear to be composed of longitudinal fibres, intersected by annular ones, which render them capable of great extension. In form they are either filiform, setaceous, or conical; but in the remarkable genus *Laplysia*, or the Sea-hare, the upper pair are shaped like the ears of the animal from which they take their name. Their sense of touch is much more delicate than that of the rest of the body. They are intimately connected with what are usually deemed the organs of sight of the Univalve Molluscans, which in some genera they seem to inclose. Some of these eyes are placed, in the form of a black pupil, at the summit of the tentacle, which surrounds them as the iris does the pupil of the perfect eye; in others they are imbedded in the middle of that organ, and in others at its base; in some, as in the Sea-ear,[4] they are seated in a separate footstalk. In many of the carnivorous species the pupil is surrounded by an iris,[5] which seems to indicate that the tentacles perform, in some sort, the functions of that part of the eye. The upper pair of tentacles in the Molluscans seem analogues of the *antennæ* of Condylopes, and the lower pair of their *feelers;* and the functions for which the Creator has formed and fitted both are probably not very dissimilar. The extreme irritability of the tentacles of snails and slugs is evident to every one who observes their motion: at the approach of a finger they are immediately retracted; they therefore give notice to the animal of the approach of danger, so as to provide against it, and when necessary to withdraw itself into its shell: the eyes, from their situation in many of them, supposing them to have a greater range and power of vision than they appear to have, cannot direct them in the choice of their food, in these their lower tentacles may have this office. Snails and slugs, we also know, issue forth from their places of concealment when the earth is rendered moist enough, by showers, for them to travel easily over its surface; so that they must be endued with some degree of *aëroscepsy*, of which probably these delicate organs are the instruments.

1 *Helix. Limax.*

2 *Clio.* The tentacles in this genus are retractile, and when retracted form two tubercles, which make the head appear bilobed.

3 *Voluta Æthiopica*, PLATE VI.

4 *Haliotis.*

5 PLATE VI. FIG. 1, *a.*

Whether the barbs appended to the mouths of many fishes, as the barbel, the Siluridans,[1] and the Fishing-frog,[2] may be regarded as a kind of tentacle cannot be certainly affirmed, but from their proximity to the mouth, it seems most probable that they exercise some function connected with the procuring of its food. Cuvier regards them as a kind of tactors, and they also present some analogy to antennæ and palpi.

In many of the Annelidans, tentacles of the present description are found not only in the vicinity of the mouth, but also upon the pedigerous segments of the body, and appear to be equally used in exploring objects.[3]

I shall next consider some tentacular organs, which differ from those we have been considering in being more or less jointed. These, on that account, have been considered as a different class of organs, and by many have been denominated *cirri* or tendrils, or more properly, by Savigny, tentacular cirri. I have before described organs of this kind in my account of the *Cirripedes*,[4] by which it appears that they are employed for the same purposes as the tentacles of the ploypes. Under this head also the antennæ of Crustaceans and insects may be noticed, which seem, as I have lately observed, analogous to the tentacles of the Molluscans, and the barbs of fishes; in some instances, indeed, they are used instead of the fore legs.[5] The reason why their structure differs from the soft, inarticulate tentacles above described, at least in most cases, appears to be the different nature of the integuments of the animal, which being incased in a kind of coat of mail, it seems requisite that both its locomotive and oral organs should be similarly defended, and in this case, unless they had been jointed, they would have lost their flexibility, and so could not have exercised the functions assigned to them by their Creator. It may, perhaps, be objected that the shell of the snail is nearly as hard as the crust of the lobster; but when we consider that the former, when moving, can thrust forth the greatest part of its soft body, as it were from a house, while the crust of the other is really its skin, this objection seems to vanish.

*Suckers.*—The organs I am next to consider, *acetabula*, or suckers, are, in many cases, so intimately connected with tentacles, as to form the most essential feature of them, without which they can be of no use. In fact, in the Cephalopods,

1 Plate XII. Fig. 1.
2 *Lophius*. Plate XIII. Fig. 2.
3 *Fn. Groenland*, 294.
4 See above, p. 189.
5 *Introd. to Ent.* ii. 308

they bear the same relation to the organ just named that the hand or foot do to the arm or leg, or the fingers and toes to the hand, in higher animals: they are the part by which the animal takes hold of what it wants to seize; and by the alternate fixing and unfixing of which, upon a solid substance, it moves from place to place. A sucker[1] may be defined—An organ by which an animal is enabled to create a vacuum between it, (the organ,) and any surface on which it rests, so as to produce a pressure of the atmosphere upon its upper part, and thus causing it to adhere firmly.

Cuvier, speaking of the suckers of the Cephalopods, thus describes their action. When the animal approaches one or more of its suckers to a surface, in order to apply it more intimately, it presents it flattened; when it is fixed to it by the perfect union of the surfaces, it contracts its sphincter, which produces a cavity, in the centre of which a vacuum is formed. By this mechanism, the sucker attaches itself to the surface with a force proportioned to its diameter, and to the weight of the column of water or of air of which it is the base. This force, multiplied by the number of suckers, gives that with which the whole or part of the legs attaches itself to the body, so that it is more easy to tear the legs, than to separate them from the object which the animal wishes to retain.[2]

In some cases, the action of the suckers, as suckers, seems not sufficient for the animal's purposes, and claws are superadded. This structure is to be found in the suckers of the animal that fixes itself to the gills of the bream, the *Diplozoon*, before described,[3] and to those of some Cephalopods a stout claw is added.

When we consider the nature and predatory habits of those Cephalopods whose tentacles are furnished with suckers, often pedunculated, on that side which is prone when the animal moves, we shall at once see the reason that this change from the more common Molluscan structure of an expansile foot, took place, for had their principal locomotive and prehensory organ been of this description, or different from what it is, their motions must necessarily have been so slow, and their powers of prehension so weak, that they could never have overtaken and captured, and maintained their hold of the well defended and formidably armed Crustaceans, which are their destined prey. Uncouth, therefore, and misshapen, and monstrous, as

1 Suckers are denominated scientifically *Acetabula*, and *Cotylæ*, or Cotyloid processes.

2 *Anat. Comp.* i. 410. Roget, *B. T.* i. 260.

3 See Appendix.

these animals, at the first glance, appear, we see that in these organs, and doubtless in all others, they are exactly fitted to answer the end, and fulfil the purposes of Divine Providence in their creation.

The suckers of the *Diplozoon* exhibit a complex structure in aid of its powers of suction, not easily developed and understood. Dr Nordmann supposes, that though the animal could attach itself strongly by these organs, additional means were necessary to render its attachment sufficiently firm; and that, therefore, while it is fixing itself by the suckers, it requires the aid of the apparatus of hooks, or claws and arches, to keep itself from being misplaced.[1]

The Class of *Annelidans* exhibits a great variety of locomotive organs, amongst the rest, in the last Order, we find *suckers*, these being the principal organs for motion of the *Hirudineans* or leeches, the animals of which Order, however, M. Savigny is disposed to think are essentially distinct from the rest of the Annelidans, on account of their want of *setæ* or lateral bristles. The *oral* sucker of that division of the animals I am considering, to which the common leech[2] belongs, is disguished from the *anal* one by being formed of many segments, whereas the latter consists of only one. Their motions, by means of these suckers, and the annular structure of their bodies I have before sufficiently described.[3] Their suckers also enable them to lay hold of any aquatic animals that come in their way, especially the *oral* one, which once fixed they soon make an entry and begin to imbibe its blood.

We see, in this, the reason why their Maker, instead of bristles for locomotion, has given them organs by which they can not only move from one place to another, but also fix themselves firmly to their prey.

I shall next advert to a kind of sucker which really becomes both the hand and foot of the animals that bear them. I allude to those of the *Echinoderms*, described on a former occasion,[4] in which the ampullaceous part within the shell presents the first outline of a shoulder or thigh, the exerted extensile part that of an arm or leg, and the dilated part with which the animal seizes its prey or walks, the hand or foot; the two first constituting the tentacle, and the last the sucker.

I have, on a former occasion, given some account, under

1 See *Nordmann*, i. 61. *t.* v. *f.* 3, 4, 5.

2 *Sanguisuga medicinalis.* Sav.

3 See above, p. 181.

4 See above, pp. 108, 111. Plate III. Fig. 5.

the name of the *Perch-pest*,[1] of a singular animal, belonging to the *Lerneans*, whose history has been given by Dr Nordmann, and which is distinguished by a sucker common to *two* legs. Several other Lerneans have similar suckers.[2]

Amongst insects are a variety of animals which are known to walk against gravity, we see the common flies, and other two-winged and four-winged insects, walk with ease upon the glass of our windows, and course each other over the ceilings of our apartments, without, in either case, falling from their lubricous, or seemingly perilous station. Writers on the subject are not agreed as to the means by which this is effected, some supposing that it is by atmospheric pressure, produced by suckers;[3] while others maintain that it is by a thick-set brush, composed of short bristles, on the underside of the foot, or by certain appendages at the apex of the claw joint of that organ.[4] Probably both these causes are in action, for though the pulvilli or foot-cushions of flies may adhere by mechanical means, those of some *Hymenoptera* and *Orthoptera* seem evidently furnished with suckers.[5] In both cases the design of an Intelligent Cause is apparent; His wisdom, which, under different circumstances, contrives different means to attain the same end; His power, which gives effect to that purpose and contrivance; and His goodness, which causes every varied mean to subserve to the more convenience and comfort of the animals in which each obtains. Could we trace exactly the history and habits of every group of animals, nay, of each individual species, we should discover that the slightest variation was to answer a particular end; and that even its very hairs and pores were all numbered with reference to special uses, foreseen by Divine Wisdom.

Amongst other purposes for which suckers were given to the Class of Insects, one bears relation to the intercourse of the sexes. This is particularly observable in the males of the predaceous beetles,[6] especially the aquatic ones. In the terrestrial ones[7] indeed something of the kind takes place, for the males may be known by having the three or four first joints sometimes only of the anterior tarsi, and sometimes of the intermediate, more or less dilated and furnished underneath with short bristles, intermixed, it should seem, with very minute

1 See above, pp. 200, 205. 2 See Nordmann, *t.* vii. viii.

3 *Philos. Trans.* 1816. 322. *t.* xviii. *Introd. to Ent.* ii. 322. White's *Selborne*, ii. 274. *Ed. Markw.*

4 Blackwall in *Linn. Trans.* xvi. 487.

5 *Philos. Trans.* ubi sup. *t.* xix. xxi.

6 *Carnivora.* Lat. 7 *Cicindelidæ*, *Harpalidæ*, *Carabidæ*, &c.

suckers, and in some with transverse ones.[1] But these organs are most conspicuous in the male of our most common water-beetles,[2] in which the three first joints of the anterior tarsus form a dilated orbicular shield, covered with minute suckers, sitting on a tubular foot-stalk, with two exceeding the rest greatly in size. The intermediate legs also have the three first joints thickly set with minute suckers.

Leaving the invertebrated animals the occurrence of suckers becomes very rare; very few instances are upon record, in the whole Sub-kingdom of vertebrated animals, of this kind of formation, two in the Class of fishes and the other in that of reptiles, namely the lump-fishes,[3] the sucking-fishes,[4] and the Gecko lizards.[5] Under the name of *lump-fishes* I include all those whose ventral fins unite to form a disk or sucker by which they are enabled to adhere to the rocks, constituting Cuvier's family of *Discoboles*. But the most celebrated of this tribe, in ancient as well as modern times, are the sucking-fishes or *Echenëis* which Pliny says were so called from their impeding the course of the vessels to which they adhered. On the back of their head they have an oval cotyloid disk fitted with numerous transverse laminæ denticulated at their posterior edge, forming a double series; by the aid of this apparatus, which appears to adhere by means of the teeth of its laminæ as well as by suction, this animal attaches itself to the whale, the dolphin, the shark, the turtle, and other inhabitants of the waters, and even to vessels that are sailing, and thus organs, which at first sight appear to stop all locomotion in the animal, are the means which enable it, like certain barnacles,[6] to traverse half the globe. The fins of this animal do not permit it to swim with ease and velocity; and therefore this must be regarded as a compensating contrivance, by which it can the more readily fulfil its functions and instincts. Though they are disengaged with difficulty by human force from the vessel to which they are fixed, they very easily detach themselves, and swimming on their back, pursue any object that attracts their attention or excites their cupidity.

It is singular to remark that in the case of two such animals, as the barnacle amongst the *Cirripedes*, which has naturally no locomotive powers and organs; and the Echenëis amongst the fishes, in which they are insufficient to transport it far from

1 E. G. *Harpalus caliginosus*. F.
2 *Dyticus marginalis*, &c. *Philos. Trans.* ubi supr. *t.* xx.
3 *Cyclopterus Lumpus*, &c.
4 *Echenëis*.
5 *Gecko*. Daud. *Stellio*. Schn. *Ascalabotes*. Cuv.
6 See above, p. 191.

its native rocks and haunts, such means should be afforded by a kind Providence of visiting in safety the most distant oceans. These animals, though they may be called parasitic, from their adhering to other animals, yet, as they do not appear to imbibe any nutriment from them, the design of this singular instinct seems to be merely their transport, for purposes not yet fully ascertained.

But there are other fishes whose mouth is a suctorious organ, analogous to that of the leech, by which they suck the blood of the aquatic animals they adhere to; of this description are the *Lamprey*[1] and the *Hag*,[2] but upon these I shall not further enlarge.

The other sucker-bearing vertebrated animals, which I mentioned, were those Saurians which form the genus *Gecko*, and the object of this structure, in them, is to enable them to walk against gravity, that thus they may be empowered to pursue the insects, possessing the same faculty, up perpendicular or along prone surfaces. These suckers,[3] consisting of transverse laminæ, occupy the terminal part of the underside of the toes. By aid of these organs they can mount the smooth chunam walls of houses in India. Another Saurian genus,[4] the Gecko, of the West Indies, has a similar organ, by means of which it climbs up trees, as well as the walls of houses, in the pursuit of insects.

The adhesion of suckers and their relaxation, especially in locomotion, in order to answer the end for which they were given, must be as perfectly dependent upon the will of the animal, as our steps on the plane we are moving on are upon ours; and yet in some instances, as in the perch-pest,[5] the animal, when once fixed, can scarcely disengage itself; but in this case, having attained its ultimate station, this is of no importance.

If we study the individual cases of all the sucker-bearing animals, we shall find that this kind of organ was necessary, and all its modifications, to enable them to fulfil effectually their several instincts, and to do the work appointed them by their allwise Creator. For instance, in vain would the Cephalopods pursue and endeavour to seize and devour the crab or the lobster, if, instead of tentacles set with numerous suckers, they had the paws and retractile claws of the Feline race: or how would the Gecko be enabled to overtake its insect provender, if its feet were like those of the rest of its class?

1 *Petromyzon.*
2 *Myxine.*
3 *Philos. Trans.* 1816. *t.* xvii. *f.* 2.
4 *Anolius.*
5 *Achtheres Percarum.* See above, p. 252.

As supplementary to this account of suckers, I may mention a locomotive organ, given to a very numerous tribe of invertebrated animals, which, as I observed on a former occasion, appears in some degree to partake of the nature of a sucker, and which is eminently adapted to the structure, circumstances, and wants of the animals that are provided with it. I mean the expansile foot of the great majority of Molluscans: these animals are the only instance of a *unipede* structure in creation, but this one foot answers every purpose of a hand or leg; it spins for the bivalves their byssus,[1] is used by others as an auger,[2] by others as a trowel,[3] and by others for other manipulations, and is generally their sole organ of locomotion: from its soft and flexible substance it can adapt itself to the surfaces upon which it moves, and by the slime that it copiously secretes lubricates them to facilitate its progress. In very dry weather, however, it cannot move with ease over the arid soil, but when humid from rain, the whole terrestrial Molluscan army issues forth, naked, or in various panoply, each according to its kind, covering the face of the earth, so that it is not easy to avoid crushing them.

The most careless observer of God's creatures must be struck by the correspondence between this foot, and the animal to which it is given; had its locomotions been by means of an organ of a solid substance, or by means of several such organs, the harmony of structure which now strikes us, and relationship between its different parts would be done away, and we should think we beheld a mongrel monster engendered by strange mixtures of animals, rather than a creature harmoniously moulded by the hands of an allwise Creator.

I may also mention here a few other organs which seem to present some analogy to suckers, and which, though aiding in locomotion, are not, strictly speaking, locomotive organs, or those by which locomotion is effected. I allude to the spurious legs, or prolegs of the larves of insects. These are usually retractile fleshy organs, analogous to the bristle-armed protuberances of the Annelidans, rendered necessary by the length of these animals, and supporting them as props, and which usually, by means of a coronet or semicoronet of hooked spines or claws, and by applying their prone surface to the plane of position, take strong hold of it: these legs do not step; the six anterior jointed legs, where they exist, are the walking legs; but these organs having been fully described in another

1 See above, p. 135. 2 *Ibid.* p. 133. 3 *Ibid.* p. 156.

joint work of Mr Spence and myself,[1] I must therefore refer the reader for further information on the subject to that work.

What are called the *pectines* or comb-like organs of scorpions, and those pedunculated ones which are attached to the hind legs of the *Solpuga* or *Galeodes*, are conjectured by M. Latreille to be connected with the respiration of these animals. Amouroux seems to regard the former as a kind of sucker, but no actual observations have as yet ascertained their real nature, except that the author last named, states that he has seen the animals use them as feet.

*Setæ* or *Bristles.* Having fully considered suckers and their analogues, I shall next advert to a species of locomotive organ, principally confined to the *Annelidans*, animals whose locomotions are chiefly produced by the contraction and expansion of the rings of which their body is composed, but which are also furnished with lateral setiform organs, which assist them in their motion, by pushing against the plane of position.

The majority of these animals are aquatic, and some of them grow to a great size ; I have a specimen, which I purchased from the collection of the late lamented Mr Guilding, which is more than a foot long, and as thick as the little finger : it has a double series of what may be denominated its legs, each furnished at its extremity with a bunch of very fine retractile bristles, and those of the dorsal series having besides a branchial organ or gill on each side, consisting of numerous threads. This remarkable animal appears to belong to Savigny's genus *Pleïone*, and is probably his *P. Pedunculata*, and the *Nerëis gigantea* of Linné. The bristles on these legs seem not calculated for pushing on a solid surface, but are rather ogans of natation, analogous, in some degree, to the branching legs of the Branchiopod Entomostracans. In the earth-worms[2] the lateral bristles are simple, and used to assist their motions, either on the surface, or when they emerge from the earth, or make their way into it.

At first sight, one would not suppose the bristles of the Annelidans to be analogues of jointed legs, or preparatory to their appearance in the great plan of creation ; but when we reflect upon the approach which many of the Nerëideans of Savigny make to the *Myriapod Condylopes*,[3] and that these bristle-bearing legs, in Mr Guilding's genus *Peripatus*,[4] begin to assume the appearance of articulations, and are armed at their apex

1 *Introd. to Ent.* iii. 134.
2 *Lumbricus.*
3 See above, p. 186. Plate VIII. Fig. 1, 4.
4 *Ibid.* Fig. 1.

with claws;[1] it seems clear that the bristles of the Annelidans, and the base within which they are retractile, are really legs, and lead the way to the jointed ones of the Condylopes.

I have before noticed the conversion of legs into oral organs, or their use as auxiliaries to them in the case of the Myriapods.[2] Mr Savigny, in his description of an animal,[3] which seems the analogue of the electric centipede,[4] observes that its four anterior legs are converted into tentacular cirri, affording an additional argument for the ancient opinion that the *marine* Myriapods, as they might be denominated, have some affinity with the *terrestrial*, since, at least in this instance, the same number of legs are used as auxiliaries to the mouth.

The great majority of the Annelidans inhabit the water, and the tufts of bristles, sometimes forming fans, issuing in many cases from a dorsal and ventral conical protuberance, denominated by Savigny oars, and occasionally expanding so as somewhat to resemble them, seem in some degree analogous to the branching legs of the Branchiopod and Lernean Entomostracans,[5] and are probably natatory as well as ambulatory organs, and means by which their Creator has fitted the locomotive ones to make their way through the matted sea-weeds and the mud, when creeping after their prey, as well as to row through the water like a stately bireme. These oary feet, emulating in number those of the terrestrial Myriapods, and forming moreover, as was before stated, both a dorsal and ventral series, must enable them to move with considerable rapidity: those indeed that have observed their proceedings, describe them as both swimming and running with admirable ease and speed.[6]

There is a Class of vertebrated animals, the *Ophidians* or serpents, which exhibit considerable analogy to many of the Annelidans, not only by their form and undulating movements, but also by the organs which effect their progressive motions, not indeed by means of bristles, but of parts that, pushing against the plane of position, propel the animal in any direction according to its will.

But the way in which this is effected having been clearly and most ably explained by an eminent and learned physiologist,[7] I need not here enlarge upon it, but only observe that

1 *Ibid.* Fig. 2. *c. c.*
2 See above, p. 224.
3 *Lycoris ægyptia.* Plate VIII. Fig. 4.
4 *Geophilus electricus.*
5 Plate IX. Fig. 3.
6 See Otho Fabricius *Faun. Groenland*, 289, 298, &c.
7 Dr Roget.

the motion of one tribe of the Myriapods, though produced by *legs*, exactly imitates that of the Ophidians, though produced by *ribs;* and very amusing it is to see the propagation of it from one extremity to the other in the Millipedes, like wave succeeding wave in the water: a still more striking analogy, as has been already remarked,[1] is exhibited by the larger centipedes, which seem almost models of the skeleton of a serpent.

Serpents thus can move not only horizontally, but also up the trunks of trees, probably in a spiral direction, and some are said to have the power of darting from one tree to another. As these animals are not annulated, like the Annelidans, and cannot originate and continue motion by the alternate contraction and extension of the rings or segments of their body, which the nature of their integuments, their vertebral column, and muscular fibre probably preclude, the wisdom of their Creator has subjected their ribs to their will, so that they can use them as motive organs.

*Natatory Organs.*—The spurious bristle-armed legs of the Annelidans, especially those of *Peripatus*,[2] have as it were led us to the mighty host of animals furnished with *articulated* locomotive or prehensory organs, or real legs and arms, varying in number—but as these will best finish the subject, I shall first consider those external instruments of motion which are peculiar to animals inhabiting the water, or moving through the air, beginning with the first, or those distinguished by *natatory* organs. I have already mentioned some of this description, as the oars of the paper nautilus[3] and Annelidans,[4] and also the sails expanded by the former animal and several Molluscans.[5] Before I consider the organs in question, where they are most conspicuous, in the fishes, I must give some account of those to be met with amongst the invertebrated animals, particularly the Condylopes. Several of the Cephalopods and Pteropods, and other Molluscans, have natatory appendages; in the former, as to many species, looking like little wings, often nearly round, attached to the lower part of the mantle that envelopes them;[6] and in the latter assuming the shape and station of the dorsal and other fins of fishes,[7] though totally different in their structure, not being divided into jointed rays as in the animals just named.

1 See above, p. 225.
2 Plate VIII. Fig. 1, 2.
3 See above, p. 167.
4 See above, p. 258.
5 See above, p. 142.
6 Plate VII. Fig. 1.
7 Plate V. Fig. 6, 7, 8.

Having mentioned these, I shall next advert more fully to the organs by which the great Sub-kingdom of animals with articulated legs move in the waters, whether they always inhabit them, or occasionally visit them. They may be divided into *three* distinct kinds. 1. Jointed legs dilated towards their extremities, as in the common whirl-wig,[1] the little beetle that forms circles in the water, and in the tribe of crabs termed swimmers,[2] these I would call *Pediremes*. 2. Jointed legs, that terminate in a fasciculus of setiform branches, and are also connected with the respiration of the animal, these might be denominated *Branchiremes*, and are found in the Branchiopod Entomostracans.[3] 3. Those in which the inner side of the jointed leg has a dense fringe of hairs, called by Linné, by way of eminence, *pedes natatorii*, such as are found in many diving[4] and other aquatic beetles, these might be named *Setiremes*. As the spurious legs to which the eggs are attached, observable on the underside of the abdomen of the female lobster, crayfish, and other long-tailed Crustaceans, are used also as natatory organs, they are ciliated for that purpose, and belong to this tribe. The same observation will also apply both to maxillary legs, and other legs of several animals of that Class. The velocity with which the diving-beetles move in the water by the action of these legs, and their suspension of themselves at the surface, by extending them so as to form a right angle with the body, when they come up for air, and the weather is fine and the water clear, affords a very interesting spectacle.

Amongst natatory organs I must not overlook the *tails* of the long-tailed Decapod and several other Crustaceans, which terminate in a powerful natatory organ, consisting usually of five plates, densely ciliated at their apex, the intermediate one formed of the last segment of the abdomen, and the lateral ones articulating with a common footstalk giving them separate motion, the outer consisting sometimes of two articulations, as in the common lobster, and sometimes of only one, as in the thorny lobster; the intermediate plate, as in *Galathea*, sometimes consists of two lobes; these laminæ when expanded form a most powerful natatory organ, which, if we consider the weight of their body, must be necessary to keep them from sinking, and by its vertical motion to enable them to rise or sink in the water. But natatory organs are not confined to those of the trunk and abdomen, even those of the head sometimes assist in this kind of motion. Thus in *Cypris*, an Ento-

1 *Gyrinus*.
2 *Nageurs*. Lam.
3 Plate IX. Fig. 4. *c*.
4 *Dyticus*.

mostracan genus, resembling a muscle, the mamdibles and first pair of maxillæ have branchial appendages used also in swimming, and their antennæ are likewise terminated by a fasciculus of threads, which, according to Jurine, the animal developes, more or less, as it wants to move faster or slower.[1]

But the most important natatory organs are those which enable the *vertebrated* inhabitants of the waters, from the giant whale to the pigmy minnow, to make their way through the waves; it will be interesting to trace the analogies of the fins of these animals to the locomotive organs, whether wings or legs of other animals, especially Mammalians. Some we shall find *sui generis*, and calculated particularly for the circumstances in which the Creator has placed the great Class of *fishes* and the rest of the marine animals; and others, in the course of our analysis, we shall observe gradually assuming the character and uses of an arm or leg.

The fins of fishes are membranes, usually supported by osseous or cartilaginous rays, which can open or shut, more or less, like a fan, but in some instances they consist of membrane without *rays*, and in others of rays without membrane. The rays are usually divided into two kinds; those which consist of a single joint, usually less flexible and pointed, whence they are called *spiny rays*, and those which consist of numerous small articulations, generally branching at their extremity, which are called *jointed rays*, these jointed rays may be regarded as precursors of the phalanxes of fingers and toes in the hands and feet of the terrestrial vertebrated animals. The first pair of fins, which are seldom wanting, and answer to the *fore-legs* or arms of those animals, are called *pectoral*, and are usually placed on the side behind the gill-covers. The second pair, supposed to be analogous to the hind-leg, are called *ventral*, and are placed under the abdomen. Besides these, there is often a fin along the back, sometimes subdivided, named the *dorsal* fin; another under the tail, called the *anal*, and the tail itself terminates in a fin, one of the most powerful of all, which is named the *caudal*, and in some respects may also claim to be regarded as the analogue of the legs.

The, so called, fins of Cetaceans, are not properly fins, but legs adapted to their element as marine animals, the anterior pair having all the bones proper to those of mammiferous animals, covered with a thick skin, and wearing the appearance of a fin. In the sea-cow there are rudiments of nails in their pectoral fins, and they use them, both for crawling on shore,

1 Latr. *Cours D'Ent.* i. 430.

and for carrying their young, on which account they are called *Manatins*,[1] of which *Lamantins*, their French name, is probably a corruption. The tail also of the Cetaceans, which is in the shape of the caudal fin of fishes, and somewhat forked, but placed horizontally, contains some bones, which appear like rudiments of those of legs, thus, for their better motion in an element they never leave, covered by their Creator with a tendinous skin, and enabling them by an up and down motion to sink to a prodigious depth, or to rise from the bottom to the surface of the ocean.

If we go from the Cetaceans to the *Amphibians*, we see a further metamorphosis of the organs of motion. The pectoral fins of the former are now become arms, with phalanxes of fingers, claw-armed, but still connected by skin for natatory purposes, and their caudal fin is converted into rudimental legs, with a very short intervening tail, and these legs are still of most use in the water. These circumstances induce some suspicion, especially when we consider that the caudal fin of fishes is their most powerful locomotive organ, that it is the real analogue of the hind-legs of the terrestrial mammalians.

The ventral fins sometimes seem to change place with the pectoral ones. This is the case with the fishing-frog tribe, in which the former are nearest to the head, and seem analogous to a pentadactyle hand, while the pectoral ones resemble a leg and foot, and the creature looks like a four-footed reptile.[2] The Rays,[3] in a system, are placed at a wide distance from these, and yet they possess several characters in common, particularly in having the hinder part of the body attenuated into a tail more or less slender, and the enormous mouth and gullet of others[4] are armed, as in the sharks, with a tremendous apparatus of teeth. Cuvier observes of one of them,[5] that it can creep on the earth by means of its fins, like small quadrupeds, and that their pectorals discharge the function of hind-legs;[6] so that there seems some ground for thinking that they are a branch diverging from the Selacians towards the Reptiles.

Fins, and their analogues, were given to aquatic animals, it should seem, solely for locomotion; and could we witness the motions of their different tribes, each in its place, and observe the play of these appendages, we should find them all so located in the body of the fish, and so nicely measured with

1 *Manatus Americanus.*
2 See Plate XIII. Fig. 1, 3. *Lophiadæ. Lophius.* L.
3 *Raiadæ. Raia.* L.
4 Plate VIII. Fig. 3.
5 *Chironectes.*
6 *Regne Anim.* ii. 251. Last Ed.

regard to volume and weight, as to suit exactly the wants of the animal in its station, and to act as a mutual counterpoise, so that it should not be overswayed by the preponderance of one organ over another; every thing proving that the momentum and action of each, both independently, and in concert with the rest, had been nicely calculated before its creation, by one whose Wisdom knew no bounds, whose Will was the well being and well doing of his creatures, each in its place, and whose Power enabled him to give being to what his Wisdom planned, and his Will decreed.

Nothing is more graceful and elegant than the motions of fishes in their own pure element. Not to mention the shifting radiance of their forms, as they glance in the sunbeam; their extreme flexibility, and the ease with which they glide through the waters, gives to their motions a character of facile progress which has no parallel, unless, perhaps, in the varied flight of the wing-swift swallow, amongst their analogues, the birds. How rapidly do they glide, and are lost to our sight by a mere stroke of their tail! at another time, less alarmed, how quietly do they suspend themselves, and cease all progressive motion, so that we can discover them to be alive only by the fan-like movement of their *pectoral* fins, an action which seems, in some sort, connected with their respiration; for they move them, as I have observed, more rapidly, when, in sultry weather they seek the surface, and their muzzle emerges. These fins, the analogue, as has been before observed, of the hand or fore foot, except in a few instances, may be regarded as usually the first pair of oars that propel the vessel. Some fishes, in front of these, have another locomotive organ and weapon,[1] not intended, however, for motion so much in the *water* as on the *earth;* this is a powerful, and, usually, serrated bone,[2] articulating with the shoulder bones, and is to be found in the Siluridans, with the exception of the electric species, which its Creator has fitted with other arms.

The second pair of fins, as they most commonly occur, are the *ventral*, but sometimes, where fishes have a large head, they are placed forwarder, and in general they are under the most bulky part of the body; by this arrangement, we may gather that they are intended to counteract the force of gravity, as well as to act as oars. These fins are wanting in all the

1 Plate XII. Fig. 1. *a*. 2.

2 N.B. The figure of the bone (2) in the Plate was taken from one dug up in this neighbourhood in forming a manure heap, which Mr Owen informed me belonged to a *Silurus*.

fishes called, on that account, *apodes*, or footless, to which the eels, and other serpentine fishes belong, some of which also have no pectorals.

The *caudal* or tail fin, which directs the locomotions of fishes as a rudder, and gives to them the chief part of their force and velocity, in the majority of real fishes is vertical, but in flat-fish, which have no natatory vesicle, it is horizontal, as it is likewise in the Cetaceans and Amphibians; in all these, its motion is vertical.

The *dorsal* is also a powerful fin, consisting of spiny rays; in some tribes, as the perch, though wanting in others, it is sometimes divided into two or three fins. By its various undulations, and by the differently inclined planes which it presents to the water, this fin augments the means of fishes to move in any direction, and adds much to the speed with which those last named pursue their prey: it counterbalances the effect of the caudal fin in cross-currents; but, if the animals could not depress it, it might occasionally destroy the equilibrium, and overset them.

The *anal* fin seems, in many fishes, intended as an antagonist to the dorsal, to prevent the above effect and maintain the fish in its due position.

But fins were given to fishes not only to be the instruments of motion in their own element, but likewise in that of terrestrial animals; to some they were given to enable them, under particular circumstances, to vie with the birds in their aërial flights; to others, that like quadrupeds, they may undertake excursions upon *Terra firma;* and to a third description, amongst other means, to assist them in climbing the trees in quest of their food. Every body knows that the pectoral fins of the different species of flying fishes are very long; that by them, when leaping out of the water to avoid the pursuit of their enemies, the bonito,[1] and other rapacious fishes, they are supported in the air for a short time; but the action is really not *flying*, since they use these fins merely as an aëronaut, in descending, uses a parachute, for a support in the air; in fact, flying from aquatic enemies, they are soon attacked by aërial ones, and the frigate,[2] and other marine birds, make them their prey—so that they take short flights, as well as short voyages—and though they swim rapidly, they are soon tired, which is the means of saving those that escape from their numerous enemies, and preventing the extinction of the race. Besides the

1 *Scomber Pelami.* 2 *Tachypetes Aquila.*

common flying-fish,[1] the *Pegasus*,[2] a small fish, inhabiting the Indian ocean, when pursued, leaps out of the water, and takes a short flight.

I mentioned on a former occasion,[3] the terrestrial excursions of the *Hassar*, and from the statement of Piso, in his Natural History of the Indies, published in 1658, and from that of Marcgrave, of Brazil, quoted by Linné in the *Amœnitates Academicæ*,[4] it appears that the *Callicthys*[5] migrates in the same way. Dr Hancock mentions a fish, perhaps a *Loricaria*, which has a bony ray before the ventral as well as the pectoral fins, and which creeps on all fours upon the bed of the rivers, perhaps even when they are dry. These little quadruped fishes must cut a singular figure upon their four stilts.

I have given a full account of a climbing fish amongst the migratory animals,[6] and shall therefore now take my leave of the finny tribes.

Perhaps the fins of the Cetaceans and Amphibians, above described, inasmuch as they are enveloped not in a membrane, like the fins of fishes, but are real feet adapted to their element, may be regarded as more analogous to what are called *paddles*, by which term the natatory apparatus of the Chelonian reptiles, and of the marine Saurians, hitherto found only in a fossil state, are distinguished. These in the former, the turtles, are formed by the legs and toes being covered by a common skin, so as to form a kind of fin, the two first toes of each leg being armed with a deciduous nail. The coriaceous turtle,[7] the parent of the Grecian lyre, which presents no small analogy to the Amphibians, has no scales either upon its body or feet, but both are covered with a leathery skin, even its shell resembling leather, and therefore it connects the paddles of the Chelonians with those of the marine Mammalians. It may be defined as a natatory organ, formed of several jointed digitations, covered by a common leathery or scaly integument. In the fossil Saurians the paddle appears to be formed of numerous bones, arranged in more than five digitations, but it is shorter and smaller, and seems better calculated for still waters and a waveless sea than to contend with the tumultuous fluctuations of the open ocean.[8]

Next to the *paddles* of the turtles, and fossil Saurians, come

1 *Exocœtus exiliens* in the Mediterranean, and *E. volitans* in the ocean, but doubts are said to rest upon this species.

2 *P. Draco, volans*, &c.

3 See above, p. 64.

4 I. 500. *t.* xi. *f.* 1.

5 Plate XII. Fig. 1.

6 See above, p. 65.

7 *Sphargis coriacea.*

8 See *Philos. Trans.* 1816. *t.* xvi. and 1819. *t.* xv.

the palmated or web-foot of the aquatic tortoises, and of numerous oceanic birds, in which the toes are united by a common skin. In the paddle the leg and toes together form the natatory organ; in the palmated, or lobed foot, the toes. Thus from fins we seem to have arrived at digitated legs.

*Wings.*—Turning from the denser medium of water, we must next inquire what organs have been given to animals by their Creator to enable them to traverse the rarer medium of air, to have their hold upon what to the sight appears a nonentity, and to withstand the fluctuating waves of the atmospheric sea, and the rush of the fierce winds which occasionally sweep through space over the earth. The name of *wings* has by general consent been given, not only to the feathered arm of the *bird*, but also to those filmy organs extended, and often reticulated, by bony vessels—the longitudinal ones in some degree analogous to the rays of the fins of the fishes, especially of the flying fishes—which so beautifully distinguish the *insect* races; as well as to the rib-supported membrane forming the flying organs of the *dragon;* and those hand-wings by which the *bats* with so much tact and such nice perception steer without the aid of their eyes through the shrubs, and between the branches of trees; those also of other mammiferous animals, such as the *flying squirrel* and *flying opossum* use in their leaps from tree to tree.

Savigny is of opinion that certain dorsal scales, in pairs, observable in two of the genera[1] of his first family of Nerëideans,[2] are analogous to the elytra and wings of insects: this he infers from characters connected with their insertion, dorsal position, substance and structure, but not with their uses and functions; for, as he also states, they are evidently a species of vesicle, communicating by a pedicle with the interior of the body, which, in the laying season, is filled with eggs,[3] a circumstance in which they agree with the egg-pouches of the Entomostracans; and therefore Baron Cuvier's opinion, that there is little foundation for the application of this term to these organs[4] seems to me correct.

Wings may be divided into organs of *flight* and organs of *suspension.* The first are found in *insects,* in which they are distinct from the legs; in *birds,* in which the anterior leg of

1 *Halithea* and *Polynoe.* See *Aphrodita Clava.* Montague in *Linn. Trans.* ix. 108, *t.* vii. *f.* 3.

2 *Aphroditæ.*

3 *Syst. des Annel.* 27.

4 *Regn. Anim.* iii. 206.

quadrupeds becomes a wing; and in *bats* and *vampyres*, in which both the anterior and posterior legs support the wing.

The second kind of wings is found in the *flying cat*, the *flying squirrel*, and the *flying opossum*; and, under a different form, in the *flying dragon* of modern zoologists.

The wings of *insects* differ materially from those of birds, and of certain Mammalians: for instance, the bats and vampyres, since in them they are not formed by skin or membrane, attached to the fore-leg, or both legs, but are distinct organs implanted in the trunk, usually leaving the animal its classical number of legs, for its locomotions on *terra firma*. These organs are composed of two membranes, closely applied to each other, and attached to elastic nervures issuing from the trunk, and accompanied by a spiral trachea or air-vessel. These nervures vary in their number and distribution: in some insects the wing has none except that which forms its anterior margin,[1] and in others the whole wing is reticulated by them;[2] the longitudinal ones often give an inequality to the surface, and form it into folds, which probably, in flight, it can relax or contract according to circumstances. In some genera[3] the wing is folded longitudinally in repose, and in others also transversely.[4] In the higher animals the wings never exceed a single pair; but in insects the typical number is four; and though some are called *Dipterous*, or two-winged, yet even a large proportion of these have, in the winglets,[5] the rudiment of another pair. The anterior pair, called elytra, &c. in the beetles, and some others, are principally useful to cover and protect the wings when unemployed, still they produce some effect in flight, and they partake in a reduced degree of the motion of the wings, those of the cock-chaffer[6] describing an arc equal to only a fourth part of that of the latter organs.

M. Jurine, in which he is followed by M. Chabrier, has regarded the primary wing of insects as analogous to the wing of birds; but though this may hold good in some respects, it does not in its main feature. If we consider that the wing of birds is really the analogue of the fore-leg of quadrupeds, and replaces it; and also that insects have a representative of that leg fixed to the anterior segment of the trunk, thence called the *Manitrunk*, in contradistinction to the *Alitrunk*, which bears the wings; it seems not probable that the anterior leg, and the anterior wing which belong to *different* segments, should

1 *Psilus*, &c. See Jurine *Hymenopt. t.* v. and xiii. G. 48.
2 *Libellulinæ* 3 *Vespidæ.* 4 *Coleoptera.*
5 *Alulæ.* 6 *Melolontha vulgaris.*

be analogues of the same organ. The first pair of wings, or their representatives, the elytra, are connected with the hip-joint,[1] by an intermediate piece called the scapular ;[2] and the posterior wings are connected with the same joint of the posterior legs by the *parapleura*,[3] so that, in some sort, the wings of insects may be regarded as appendages,—not of the *fore-legs*, or arms, which are the real analogues of the fore-leg of quadrupeds, and wing of birds,—but the first pair of the mid-legs, and the second of the hind-legs.

Some winged insects, especially the dragon-flies, like the crabs and spiders, can retrograde in their flight, and also move laterally, without turning ; thus they can more readily pursue their prey, or escape from their enemies. The situation of their wings is usually so regulated in the majority with respect to their centre of gravity, as to enable them to maintain nearly a horizontal position in flight ; but in some, as the stag-beetles,[4] the elytra and wings have their attachment in advance of that point, so that the head, prothorax, and mandibles do not fully counterpoise the weight of the posterior part of their body, occasioning this animal to assume a nearly vertical position when on the wing.

The apparatus and conditions of flight in birds and insects are very different, varying according to the functions and structure of the animal. In birds a longer and more acute anterior extremity distinguishes the wing, by which their Creator enables them to pass with more ease through the air ; but in insects that extremity is not a trenchant point that can win its own way, but usually is very blunt, opposing either the portion of a circle, or a very obtuse angle to it ; hence perhaps it is that the common dung-beetle,[5] which is a short obtuse animal, "wheels its droning flight" in a zig-zag line, like a vessel steering against the wind, and thus it flies, as every one knows, with great velocity as well as noise. This also may be one reason why insects have usually a greater volume of wing than birds, and that a very large number are fitted and adorned with *four* of these organs, which can sometimes hook to each other, by a beautiful contrivance,[6] and so form a single ample van to sail on the aerial waves, and bear forward the bluff-headed vessel. The motions, in the air, of numerous insects are an alternate rising and falling, or a zig-zag onward flight, in a direction up and down, as all know who have ob-

1 *Coxa.* See *Introd. to Ent.* iii. 661.
2 *Scapulare. Ibid.* 561.
3 *Ibid.* 575.
4 *Lucanus.*
5 *Geotrupes stercorarius*, &c.
6 *Mon. Ap. Angl.* i. 108.

served the flight of a butterfly, or a kind of hovering in the air, or a progress from flower to flower, or backwards and forwards and every way in pursuit of prey,—how admirably has their Creator furnished them to accomplish all these motions with the greatest facility and grace. And though their wings are usually naked, without any representative of those plumes which so ornament the wings of birds, and give them as it were more prise upon the air, yet in one numerous tribe,[1] the moths and butterflies, they rival the birds, and even exceed them, both in the brilliancy of the little plumes, or rather *scales*, which clothe the wings, and the variety of the pattern figured upon them, and likewise of their forms and arrangement. So that every one, who minutely examines them in this respect with an unbiassed mind, can hardly help exclaiming,—I trace the hand and pencil of an Almighty Artist, and of one whose understanding is infinite, and who is in himself the architype of all symmetry, beauty, and grace!

The wings of a variety of insects, though few, save the *Lepidoptera*, are ornamented with scales, are planted with little *bristles*, more or less numerous or dispersed; these Chabrier thinks, as well as the scales now alluded to, amongst other uses, are means of fixing the air in flight, as well as augmenting the surfaces, and points of arrest, in each wing.[2] They also strengthen the wing and add to its weight, and doubtless have other uses not so easily ascertained. Hair, in scripture, is denominated *power*, and probably those fluids, which we can neither weigh nor coerce, find their passage into the body of the animal, or out of it, by these little conductors; and thus the various piligerous, plumigerous, pennigerous, and squamigerous animals, may offer points and paths not only to the air, but to more subtile fluids, either going or coming, whose influences introduced into the system, may add a momentum to all the animal forces, or, which having executed their commission and become neutralized, may thus pass off into the atmosphere.

But of all the winged animals which God has created and given it in charge to traverse the atmosphere, there is none comparable to the great and interesting Class of *birds*, which emulating the insects on one side by their diminutive size and dazzling splendours, on the other vie with some of the Mammalians in magnitude and other characters. Here we have the humming-birds of America, scarcely bigger than the humble-bee; and there the savage condor of the same country,

1 *Lepidoptera.* 2 *Sur le Vol des Ins.* 24.

whose outstretched wings would serve to measure the length of the giant elephant or rhinoceros. Though we cannot mount into the air ourselves, yet every one, from the peasant to the prince, that is able to follow the flight of the birds with his eyes, is delighted with the spectacle of life that they exhibit in the aërial regions, and we should scarcely miss the beasts of the earth and all the creatures that are moving in all directions and paces over its surface, than we should the disappearance of the birds of every wing from the atmosphere. And therefore the prophet in his sublime description of the desolation of Judah, makes the disappearance of the birds of heaven the most striking feature of his picture. *I beheld the earth*, says he, *and lo, it was without form and void: and the heavens, and they had no light; I beheld the mountains, and lo, they trembled, and all the hills moved lightly. I beheld, and lo, there was no man, and all the* birds *of the heavens were fled*[1].

The wing of these animals, in many cases, so powerful to bear them on through the thin air, and counteract the gravity of their bodies; to take strong hold of that element which man cannot subdue like water, to move through himself, and so to push themselves on, often with the swiftness of an arrow, through its rushing winds or almost motionless breath: the wing of birds is in fact the fore-leg or arm adapted and clothed by Supreme Intelligence, for the action it has to maintain, and for the medium in which that action is to take place, and consists of nearly the same parts as the fore-leg in Mammalians, for there is the shoulder,[2] fore-arm,[3] and the hand,[4] with the analogue of a thumb, called the winglet,[5] and of a finger.[6] The ten *primary* quill feathers are planted in the hand, and the *secondaries*, varying in number, on the fore-arm, these quill-feathers, being very principal instruments of the wing in flight, are also named the *remiges* or rowers of the vessel. The primary feathers usually vary in length, the external ones being the longest, so as to cause the wing to terminate in a point; those that cover the shoulder are called *scapulars;* and those short ones that cover the base of the wings above and below are called *coverts*.[7] Wings usually curve somewhat inwards, are convex above and concave below, and are acted upon by very powerful muscles. Wonderful is the structure of the feathers that compose them, and each is a master-piece of the Divine Artificer. In general it is evident that each has been

1 *Jerem.* iv. 23—25.
2 *Humerus.*
3 *Cubitus.*
4 *Carpus* and *Metacarpus.*
5 *Alula.*
6 *Digitus.*
7 *Tectrices.*

measured and weighed with reference to its station and function. Every separate feather resembles the bipinnate leaves of a plant; besides the obvious parts, the hollow quill, and solid stem bearded obliquely on both sides with an infinity of little plumes; each of these latter is also formed with a rachis or mid-rib set obliquely with plumelets, resembling hairs, and exactly incumbent on the preceding one, and adhering, by their means, closely to it, thus rendering the whole feather not only very light, but, as it were, air-tight. In the goose, the mid-rib of the plumelets of the primary feathers is dilated towards the base into a kind of keel, so that each plumelet at the summit looks like a feather, and at the base like a lamina or blade.

By the use of very fine microscopes of garnet and sapphire Sir David Brewster succeeded in developing the structure of the plumelets; he discovered a singular spring consisting of a number of slender fibres laid together, which resisted the division or separation of the minute parts of the feather, and closed themselves together when their separation had been forcibly effected.[1]

If we examine the whole wing, and the disposition and connection of the feathers that compose it, we shall find that one great object of its structure is to render it impervious to the air, so that it may take most effectual hold of it, and by pushing, as it were, against it, with the wing, when the wing-stroke is downwards, to force the body forwards. A person expert in swimming or rowing, may easily get an idea how this is effected, by observing how the pressure of his arms and legs, or of his oars, against the denser medium, though not in the same direction, carries him, or his boat, forwards. In the case of the bird, the motion is not backwards and forwards, but upwards and downwards, which difference, perhaps, is rendered necessary by the rarer medium in which the motion takes place.

To facilitate the progress of the bird through the air, the head usually forms a trenchant point, that easily divides it and overcomes its resistance; and often to this is added a long neck, which, in the case of many sea-birds, as wild geese and ducks, is stretched to its full length in flight; while in others, where centre of gravity requires it, as in the heron,[2] bittern,[3] &c., it is bent back.

The swiftness of the flight of some birds is wonderful, being four or five times greater than that of the swiftest quadruped. Directed by an astonishing acuteness of sight, the *aquiline*

1 Lit. *Gazette*, Oct. 11, 1834, 690.

2 *Ardea cinerea.* 3 *A. stellaris.*

tribes, when soaring in the air beyond human ken, can see a little bird or newt on the ground or on a rock, and dart upon it in an instant, like a flash of lightning, giving it no time for escape. But though some birds are of such pernicious wing, there are others of the most gigantic size, for instance the *ostrich*,[1] *emu*,[2] &c. that have only rudiments of wings, and which never fly, and for their locomotions depend chiefly upon their legs, to which the muscles of power are given, instead of to the wings.

Amongst the terrestrial animals that give suck to their young, there is a single Family which the Creator has gifted with organs of excursive flight, and these afford the only example of the *third* kind of those organs mentioned above. These cannot, like insects and birds, traverse the earth upon *legs*, as well as flit through the air upon *wings;* for the analogues of the legs of quadrupeds, not solely of the anterior pair, as in birds, but of both pairs, form the bony structure by which the wing is extended and moved, and to which it is attached. It will be immediately seen that I am speaking of the *bats* and *vampyres*. These animals, which form the first Family of Cuvier's Order of Carnivorous Mammalians,[3] are denominated *Cheiroptera*, or hand-winged, because in them the four fingers of the hand, the thumb being left free, are very much elongated so as to form the supports and extensors of the anterior portion of the membrane of which the wing is formed; while the hind leg and the tail, in most, perform the same office for the posterior portion of the wing: so that two wings appear to be united to form one ample organ of flight. The membrane itself, which forms the wing, is only a continuation of the skin of the flanks: as in the wings of insects, it is double, very fine, and so thin as to be semi-transparent; it is traversed by some blood-vessels, and muscular fibres—doubtless accompanied by nerves—which when the wings are folded form little cavities placed in rows, resembling the meshes of a net. As bats are not provided with air-cells, or air in their bones, like birds, and their flight is unassisted by feathers, these wants are compensated to them by wings four or five times the length of their body. Their flight is of a different character from that of birds, resembling rather the flitting of a butterfly; when we consider that the peculiar function of bats is to keep within due limits the numbers of crepuscular and nocturnal insects, especially moths, we see how necessary it was that they should be enabled to traverse every spot frequented by the objects their

1 *Struthio.* 2 *Casuarius.* 3 *Les Carnassiers.*

instinct urges them to pursue and devour. For this purpose their wings are admirably adapted not only by their volume, but by their power of contracting them, and giving them various inflections in flight, so that their speed is regulated by the object they are pursuing.

When we further reflect that their eyes are small and deep-seated, we may conjecture that it requires extraordinary tact and delicacy of sensation in some other organs to supply this defect in its sight. Spallanzani found that blind bats fly as well as those that have eyes; that they avoided most expertly threads of fine silk which he had so stretched as just to leave room for them to pass between them; that they contracted, at will, their wings, if the threads were near, so as to avoid touching them; as well as when they passed between the branches of trees; and also that they could suspend themselves in dark places, such as vaults, to the prominent angles. He deprived the same individuals of other organs of sensation, but they were equally adroit in their flight, so that he concluded they must have some sensiferous organs different from those of other animals to enable them to thread the labyrinths through which they ordinarily pass.

Dr Grant observes on this subject—"Bats are nocturnal, but, contrary to what is generally the case with nocturnal animals, their eyes are minute and feeble, and indeed, comparatively speaking, of minor importance, for so exquisite is the sense of feeling diffused over the surface of their membranous wings, that they are able to feel any vibration of air however imperceptible by us; they can tell, by the slight rebound of the air, whether they are flying near any wall, or opposing body, or in free space though their eyes be sealed or removed."[1] A similar observation was long ago made by Mr Bingley.[2]

We see in the circumstances here detailed a remarkable instance of the Power, Wisdom, and Goodness of the Creator, in compensating for the absence or imperfection of one or more senses, by adding to the intensity of another, and in establishing its principal seat in organs so nicely adapted to derive most profit by the information communicated.

An animal nearly related to the vampyres, the *cat-ape*,[3] commonly called the flying cat, and by some the flying dog, though nearly related to the bats, and included by Cuvier in the same Family, differs essentially from them, in being furnished with organs formed by the skin of the flanks connected with the

1 Quoted in *Lit. Gaz.* Feb. 9, 1834. 2 *Mem. of Brit. Quad.* 34.
3 *Galeopithecus.*

legs of each extremity, which are calculated for *suspension* rather than flight, being used, as Cuvier remarks, merely as a parachute, and thus belong to the *second* kind of wings, mentioned above. This animal, which climbs like a cat, vaults from one tree to another, by the aid of the above skin, which supports it in the air. The *petaurists*,[1] or flying squirrels, and the *phalangists*,[2] or flying opossums are similarly equipped, and for a similar purpose. The common *squirrel*,[3] using its tail as a rudder, leaps with great agility from tree to tree, without the aid of this kind of parachute, the force of its spring being sufficient to counteract that of gravity. Providence has evidently added an organ of suspension, in the case of the three former animals, either because their vaults were necessarily longer, or because the greater weight of their bodies required it.

The dreaded name of *dragon*, attached to the monsters of fable, has excited in our imagination ideas of beings clothed with unwonted terrors, from our earliest years, so that when we find the only animal that inherits their name is an insignificant *lizard*, not more than eight inches long, we are tempted to exclaim, *Parturiunt montes.* This little animal, under the name of wings, is furnished with two dorsal appendages independent of the legs, formed of the skin, and actually supported by the six first short ribs, which, instead of taking their usual curvature, are extended in a right line. These organs are not used to fly with, but to support the animal in its leaps from branch to branch, and from tree to tree.

We see in this instance, how exactly the means are adapted to the end proposed. This animal walks with difficulty, and consequently seldom descends from the trees. It is therefore enabled to move from one part of a tree to another, not by its legs, but by an organ formed out of its *ribs!* How various and singular, in this instance, as well as in that of serpents, before alluded to,[4] are the means adopted by a Being, who is never at a loss to answer the foreseen call of circumstances by wise expedients.

*Steering Organs.*[5]—But wings are not the only organs of flight with which the Creator has fitted those animals, to which he has assigned the air as the theatre of their most striking and interesting locomotions. They would be like a ship at sea without a *rudder*, and be altogether at the mercy of every wind of heaven, had they no means to enable them to steer their vessel through the fluctuations of the viewless element assigned

1 *Petaurus.* 2 *Phalangista.* 3 *Sciurus vulgaris.*
4 See above, p. 258. 5 *Gubernacula.*

to them. The eagle and the vulture would be gifted in vain with the faculty of seeing objects at a great distance, had they no other organ than their sail-broad vans to direct them in their flight. The same remark will apply as well to the insect as to the bird, which would in vain endeavour to discharge its functions, unless it could steer its course according to the direction of its will and the information furnished by its senses. But, upon examination, we shall find that God hath not left himself without witness in this department, but hath furnished every bird and insect with such an organ of steerage as the case of each required; nay, even amongst the beasts and the reptiles we may discover similar means of directing their motions, especially when they leap, whether from the ground, or from tree to tree.

The *caudal fin*, or tail of fishes, may be regarded as belonging in some degree to this head; but as this is also their principal organ of locomotion, I thought it best to consider it with the other fins.

The *abdomen* of many insects seems to serve them as a rudder, being composed of several inosculating rings formed each of a dorsal and ventral segment; it is capable of considerable flexion in almost all directions; it can be elevated or depressed, and turned to either side, so that it seems, in a great degree, calculated to enable insects to change the course of their flight according to their will. But besides this important organ—which by the air it is constantly inspiring adds force also to the internal impulse, and to the air-vessels in the wings—insects have other auxiliaries to keep them in their right course. Whoever has seen any grasshopper take flight, or leap from the ground, will find that they stretch out their hind legs, and, like certain birds, use them as a rudder. The tails also of the day-flies[1] seem to be used by them as a kind of balancer in their choral dances up and down in the sun's declining beam.

But the most interesting and beatiful organ for steering animals in the air, is that formed by the tail feathers of birds, called by ornithologists, *rectrices*, or *governing* feathers, because they are used to direct their course; these are feathers planted in the rump,[2] usually twelve in number—but in some amounting to nearly twenty—constituting two sets of feathers of six each, and forming together a kind of fork like the caudal fin of some fishes; the inside of each feather is set with much larger plumelets than the outside, so that there is a double series of corresponding feathers beginning one on the right side, and the

1 *Ephemera*. 2 *Uropygium*.

other on the left; the middle feathers in each series differ sometimes from the five exterior ones, being more acute, and wearing a different aspect. In flight the tail-feathers appear to be expanded, and probably the bird, by giving an impulse to either series, can turn this way or that; or by their depression or elevation, judging from their analogy with the caudal fin of fishes, rise or fall. The rudder-tail here described is that of the male bull-finch;[1] in many birds of the Gallinaceous Order, as the common cock and peacock, these feathers form a glorious ornament, but seem to lose their use as a steering apparatus. In the black game[2] the two sets of feathers of the tail turn outwards, one on each side, and so form a fork; and, in our domestic poultry, these sets of feathers, when not expanded, fold upon each other. Some of the waders,[3] the tail-feathers of which are short, use their long *legs*, like the grasshoppers, as a rudder in flight, stretched out straight behind them.

Many of the web-footed birds,[4] as the goose and duck tribes, also have these feathers very short, which seems a convenient provision for aquatic birds, but whether their legs assist in directing their course seems not to have been ascertained. Some of them, however, as the pin-tail duck[5] have the middle feathers of the tail elongated, as they are in many other birds; in the swallow tribe,[6] and the sea-swallow,[7] the external feathers of the tail are elongated, as these birds are frequently turning when in the air, and flying backwards and forwards; their Creator has thus equipped them for their ever changing evolutions. Some birds, as the thrushes,[8] magpies,[9] and other crows, have all the tail feathers long, which gives great power to them in flight.

The tails of quadrupeds, both oviparous and viviparous, appear, in many cases, to act in some degree as a rudder. They are not only useful to those lately mentioned, that by the assistance of a kind of parachute, leap from tree to tree; but likewise to the feline race, when they spring upon their prey; the tail is then extended stiffly in a right line, as if to guide them through the air straight to the object they have been watching from their lair. The long tail also of many lizards may, in their sinuous windings, serve some purpose connected with their locomotion related to the one under discussion, though we have not data sufficient to speak positively on the subject.

1 *Loxia pyrrhula.* 2 *Tetrao Tetrix.* 3 *Grallatores.*
4 *Palmipedes.* 5 *Anas acuta.* 6 *Hirundo.*
7 *Sterna* 8 *Turdus.* 9 *Corvus Pica.*

*Legs.*—We are now arrived at organs that are the most perfect instruments of locomotion and prehension, organs which are found in their greatest perfection in the highest animals, articulated *legs* and *arms*, terminating in the most perfect instrument, upon the due employment or misemployment of which the weal or woe of the whole human race, as far as second causes are concerned, depend.

The legs of animals may be considered generally as to their *number*, *composition*, and *adaptation to their functions.*

As to their *number*, taking the legs of vertebrated animals, which may be regarded, being the most perfect, as a standard to measure others by, we may assume that *four* is the most perfect number. Thus, in man, the highest animal, there are two for locomotion, and two principally for prehension. Taking, therefore, man for the ultimate point to which all tend, let us see how, in this respect, the scale is formed.

We observed in certain tribes of the Annelidans, an approach to jointed legs, and it should seem a link, connecting, in some degree, that Class with the *Myriapods;* with these last, therefore, we may start in our consideration of articulated locomotive organs, and here we find a long body moved by numerous legs, gradually acquired, as we have seen, with its increasing length. We may observe, that in the superior tribes of animals, the four legs being planted in pairs at each extremity of the body, the gradual increase of stature did not require additional props, but only the proportionate growth of the existing or natal legs and arms; but in the Myriapods, where the great increase of the body in length is not between the original extremities, but beyond them, additional supports were requisite, so that as the body increased in length, its Creator, in his goodness willed—that it might not draw its slow length along like a wounded snake—that it should be furnished at the same time with a proportionate increase in the number of its locomotive organs. These animals then, with respect to number of legs, may be regarded as at the foot of the scale, and are the furthest removed from man.

From the Myriapods, we go to the great *Crustacean* host, in which, including the maxillary legs, the real analogue of the legs of Hexapods, the typical number is *sixteen;* and from these, the transition is naturally to the *spiders*, which have half that number, and from them to the *insect* tribes, walking only upon six legs. Having arrived at a hexapod type, we may obseve that one pair of the legs has a direction towards the head, and are located in the anterior segment of the trunk; and that the other two pairs have a direction the contrary way, towards the ab-

domen, and are located in that part of the trunk which bears the wings, and of these, the last pair may be regarded as the representatives of the legs in man, and of the hind legs of quadrupeds.

As to the *composition* of legs, if we take the arm and leg of man for the type or standard with which to compare all the articulated organs of locomotion and prehension with which animals are gifted, we shall find a considerable, though not an entire, correspondence between them. Anatomists usually divide the *arm*, or anterior extremity, into *four* principal portions, namely, the *shoulder-blade*,[1] the *shoulder*,[2] the *fore-arm*,[3] and the *hand*;[4] but the *leg* only into *three*—the *thigh*,[5] the *shank*,[6] and the *foot*.[7] The first of these, however, the thigh, inosculates with the lower part of a bone, called the *nameless bone*,[8] which in very young subjects forms three, named the *haunch*,[9] the *share-bone*[10] and the *hip-bone*:[11] now this bone appears evidently the analogue of the shoulder-blade in the anterior leg or arm, and thus, admitting this, both extremities in the number of principal parts correspond with each other.

As the vertebrated animals, for the most part, agree with their prototype in the greater articulations of their anterior and posterior extremities, though much modified in particular instances and for particular uses, I shall now only compare the legs of the great sub-kingdom of Condylopes, or invertebrated animals with jointed legs, with those of man, and other Mammalians, and inquire how, in the above respect, they consist of analogous parts.

The remarkable distinction which separates the vertebrated from the invertebrated animals, namely, that, in the former, the muscles have no *external* points of attachment; and, in the latter, with a few partial exceptions, no *internal* ones—must produce a marked difference in all parts of their several structures, and, amongst the rest, between their organs of locomotion and prehension: and therefore it is not to be expected that they will be perfectly analagous in their composition. Thus in the *invertebrates* the parts corresponding with the fore-arm and shank of the *vertebrates* do not consist of two parallel bones; the hand and the foot also are essentially different; and the

1 *Scapula.* 2 *Humerus.*
3 *Cubitus*, including two parallel bones, the *Ulna* and *Radius.*
4 *Manus.* 5 *Femur.*
6 *Crus*, including also two parallel bones, *Tibia* and *Fibula.*
7 *Pes.* 8 *Os innominatum.* 9 *Os ilium*
10 *Os pubis.* 11 *Os ischium.*

parts by which the extremities in one case articulate with the vertebral column towards its summit and base, and in the other with the trunk of the animal at various points, are usually extremely dissimilar: in several beetles, however, the basilar joints, especially of the hind legs, assume something of the character and form of the shoulder-blade of Mammalians; and in certain water-beetles[1] the posterior pair are immovable. In quadrupeds, usually, the thighs are remarkably clothed with muscle, especially towards their base; but, in the Condylopes, with the exception of some beetles and jumping insects, where a powerful muscular apparatus was requisite, they are not conspicuously incrassated, so as to contain muscles of great volume.

From these circumstances I am induced to confine my observations to the *numerical* composition of the locomotive and prehensory organs of Condylopes, and animals that give suck to their young.

In order to perceive clearly how far they agree or disagree in this respect, it will be advisable first to inquire whether these organs in Condylopes themselves can be reduced to a common type.

The Crustaceans and Arachnidans, including under the latter denomination all regarded by Latreille as belonging to the Class, at the first inspection of the organs in question, appear to have one joint more than insects. This supernumerary joint is the *fourth*, in *The Introduction to Entomology* named the *Epicnemis*,[2] which is there regarded as an accessory of the shank. But from further observation, and from a comparison of this joint of the Arachnidans with an analogous one in the Crustaceans, in which it is longer and more conspicuous, I feel convinced that, short as it is in them, it is really the *shank* in that Class, and that the long joint usually regarded as the shank is analogous to the first, often dilated and elongated,[3] joint of the tarsus in insects. That this joint belongs to the tarsus or foot will be further evident from the following circumstance. If we examine the anterior leg, or arm, of the *lobster* or *crab*, we shall find that the joint in question, which is the fifth of the leg,[4] is what is called the metacarpal joint, a process of which forms the index or finger of the didactyle hand or forceps of these animals, and the succeeding and terminal joint the opposing thumb. It is evident, therefore, that this

1 *Dytiscus*. L. 2 Vol. iii. 668.
3 E. G. In the Bees and many other *Hymenoptera*.
4 Plate X. Fig. 1.

joint belongs not to the shank or cubit, but to the foot; and that consequently a Crustacean or Arachnidan leg or arm numerically corresponds in its greater articulations with that of an insect.

Having proved, I hope, to the satisfaction of the reader, that the legs of Condylopes, with regard to the number of their principal articulations are reducible to one type,—unless we may except some of the *Acaridans*, or mites, and the *Branchiopod Entomostracans*, which appear reducible to no general rule—I shall next endeavour to show that the Condylope leg does not usually differ numerically from that of the quadruped or mammalian; and that the former consists of only *four* principal articulations as well as the latter, and it will not require many words, or any laboured disquisition, to prove this. The, so called, *trochanter* is, with great propriety, considered by M. Latreille as being a joint of the thigh, as it really is, and in many cases, especially in Coleopterous insects, has no separate motion; consequently if this opinion be admitted, the number of articulations, both in the Condylopes and Mammalians will be the same.

Animals that are built upon a skeleton, or incased in an external crust or rigid integument, in order to have the power of free locomotion and prehension, must necessarily be fitted with *jointed* organs, whose articulations are more numerous at the extremity, where the principal action is, that those parts may so apply to surfaces as to enable the animal to take sufficient hold of them for either of the above purposes.

There is a circumstance connected with the legs of insects which, at first sight, seems to throw some doubt upon this conclusion. The shank has often at its apex, and sometimes the cubit, certain little movable organs, which have been called *spurs*, but which really appear to aid the animal in its locomotions,[1] and in some they even terminate in suckers:[2] as these organs are co-ordinate with the jointed tarsus, they seem in some sort a kind of auxiliary digitation. In the *mole-cricket*[3] the structure is still more anomalous, the cubit terminating in four strong digitations or claws, opposed to which is the, so called, tarsus, which seems analogous in some sort to a jointed thumb, so that the whole represents a pentadactyle hand. A similar anomaly distinguishes the posterior pair of legs of one of the Entomostracans, the *king-crab:* in these, besides the

1 *Introd. to Ent.* iii. 674.
2 *Philos. Trans.* 1816, *t.* xix. *f.* 8, 9.
3 *Gryllotalpa.*

tarsus armed with two claws, there are four movable digitations.[1]

Though the Creator has evidently connected the sphere of animals by some organs or characters common to the whole, and generally speaking, in the tribes that we are comparing, has formed the organs which I am considering, as to their articulations, upon a common type; yet occasionally we see departures from a strict adherence to the likeness, as in the cases here specified, where the circumstances and functions of an animal required such departure.

*Adaptation of Legs.*—It is by the adaptation of its legs to the circumstances of an animal, and to the functions which it was created to exercise, that the design of an Intelligent Cause is apparent, and the power, wisdom, and goodness of the Creator manifested.

The well known adage, *Natura non facit saltus*, is exemplified in the passage, with respect to their locomotive organs, from the expansile Annelidans to the rigid Condylopes; for in numberless instances, we have in the larvæ of insects a kind of intermediate animal, in some degree expansile, some of which move like the leech,[2] and others are apodes, like worms, moving by the contortions of their bodies, a large proportion at the same time having the jointed legs of their Class when arrived at perfection, and in their spurious legs imitating, in some sort, the locomotive organs of the Annelidans.

The principal offices of legs are to enable the animal to procure the kind of food which its nature requires; to be employed in operations connected with the continuation of its kind; and to be instrumental in its escape from danger and from the pursuit of its enemies; and the means by which these ends are accomplished are the comparative *length* of its legs; their *volume*, either in whole or in part; the structure of their *extremity*, either for locomotion or prehension; or where the extremity of the legs is not adapted to the latter function, certain compensating contrivances calculated to supply that want.

To enable some animals to come at their food, sometimes a great difference, as to *measure*, between their anterior and posterior extremities, is necessary. At the first blush, and before we were acquainted with its habits, should we chance to meet with a *giraffe*,[3] so striking is the seeming disproportion of many of its parts, that we should be tempted to take it for an abortion

1 Savigny, *Anim. sans Vertebr.* i. *t.* viii. *f.* 1. k.

2 The Geometric caterpillars or loopers.

3 *Camelopardalis Giraffa.*

in which the posterior parts were not fully developed. Observing its length of neck and elevated withers, the apparently unnatural declivity of its back, and the comparative lowness of its hind quarters, we should conclude that such must be the case. But if we proceeded to inquire into the nature of its food, and were told that it subsisted by cropping the branches of certain trees which thus it was enabled to reach, the truth would flash upon us, we should immediately perceive the correspondence between its structure and its food, and acknowledge the design and contrivance of a benevolent Creator in this formation.

A similar idea would perhaps occur to us the first time we saw a *jerboa*,[1] or a *kanguroo*.[2] Hasselquist says of the former—that it might be described as having the head of a hare, the whiskers of a squirrel, the snout of a hog, the body, ears, and fore-legs of a mouse, hind-legs like those of a bird, with the tail of a lion; and an ancient zoologist would have made a monster of it that might have rivalled the chimæra. The kanguroo also would have met with a similar fate. Though the jerboa is not a marsupian animal like the kanguroo, yet they have many characters in common. They both have very slender fore-quarters, and short and slender fore-legs; their hind-quarters, on the contrary, are remarkably robust and incrassated, and they sit erect, resting upon them like a hare; both have a long powerful tail, which they use as a fifth leg. The object of this formation, at the first glance, so at variance with all ideas of symmetry, appears to be a swifter change of place, and more ready escape from annoyance or violence. The jerboa is stated to take very long leaps, and those of the *kanguroo* are said to extend from twenty to twenty-eight feet, and they rise to an elevation of from six to eight feet. When they leap they keep their short fore-leg pressed close to their breast, and their long and robust tail, having first assisted them in their leap, is extended in a right line. A double end is answered by their peculiar structure; sitting on their haunches, they can leisurely look around them, and if they spy any cause of alarm make off by the means just stated. Their attenuated fore-quarters and short fore-legs rendering it much more easy for them, overstepping every obstacle, to dart into the air; their centre of gravity is then removed nearer the hind quarters, so that the tail can act as a counterpoise to the anterior part of the body.

The *jerboa* also, like the kanguroo, when alarmed, springs into the air. When ready to take flight, it stands, as it were,

1 *Dipus.* 2 *Macropus.*

on tip-toe, supporting itself by its tail. Its fore-legs are then applied so closely to the breast as to be invisible, whence the ancients call it *Dipus*, or biped;[1] having taken their spring they alight upon their fore-feet, and elevating themselves again, they are off so rapidly, that they seem to be always, so to speak, upon the wing. They use their long tail to support themselves when they recover from their leaps, giving it the curvature of the letter S reversed, thus, ꝏ. When their tail has been shortened at different lengths, it has been found that their leap is diminished in the same proportion; and when it was wholly cut off they could not leap at all.

We see, in one Order of the *Birds*,[2] the *Waders*, a remarkable disproportion of the legs to those of the rest of the Class; they look as if they walked upon stilts, whence the name of the Order, so disproportionally long are their legs to those of the generality of birds. I have before noticed the use of these legs to them in flying,[3] but the principal object of this structure is to enable them to prey upon aquatic animals, fishes, worms, and the like. Whoever is in the habit of frequenting estuaries, and other waters, will generally see some of these birds, as herons and bitterns, standing in them, where shallow, and ever and anon dipping their heads, and then emerging swallow their capture. The design of this structure must be obvious to every eye, namely, to qualify these birds of prey to assist in keeping within due limits the population of the various waters of our globe, which other predaceous animals cannot come at.

Another tribe of long legged birds, which Cuvier considers as belonging to the present Order, though their habits and *habitat* are altogether different, and which constitute his family of short-winged waders,[4] is that to which the Ostrich[5] and Emu[6] belong, but in these the object of this structure is to fit them not for standing in the water, but for running in the sandy desert; and such is the velocity of the ostrich that it can outstrip the fleetest Arabian courser when pursued. Other birds are remarkable for the *shortness* and strength of their legs; of this description are the *aquiline* race, which are thus fitted by their Creator for seizing and holding fast any prey which their piercing sight discovers.

1 Herodot. *Melpon.* § 192. Ed. Reizii.

2 It is to be observed in general, with respect to the Class of *Birds*, that the conspicuous part of their legs is not the *shank*, which is chiefly covered by muscle and feathers, but is formed of the tarsal and metatarsal bones united into one.

3 See above, p. 276

4 *Echassiers brevipennes.*

5 *Struthio Camelus.*

6 *Casuarius Emeu.*

There is one, and a very elegant bird, belonging to this Order, the secretary-bird,[1] the legs of which are so long, that many ornithologists have arranged it with the waders. It is, however, very properly placed amongst the predaceous birds. Its long legs are given it to enable it to pursue the serpents, which form its food. We see, in this instance, a departure from one of the typical characters of its own tribe, and those of another adopted in order to accommodate the animal to the circumstances in which it was the Divine will to place it, and to fit it for the function which it was there to exercise.

Amongst the *Reptiles* there is little diversity, as to the relative proportions of the organs we are considering, and their parts; in the *Batrachians*, or frogs and toads, which are mostly leaping and swimming animals, the hind legs are elongated to accommodate them to those kinds of locomotion; and in some of the Saurians or lizards, which are approaching to the Ophidians or serpents, the legs are very short,[2] and sometimes reduced to a single pair;[3] even in some serpents rudiments of a pair of legs have been discovered, particularly in the *Boa*.[4]

Some *insects* are remarkable for the vast length of their anterior pair of legs; what may be the object of this formation has not been discovered except that, in one instance,[5] it is found only in one sex. The animal I allude to belongs to the tribe of Capricorn beetles,[6] and seems not to be uncommon in Brazil. The fore-legs of the male are more than twice the length of the body, while those of the female, though longer than the others, are scarcely half so long.

Many insects are formed, in some degree, after the pattern of the kanguroo and the jerboa, in order to enable them to transport themselves by leaping beyond the reach of their enemies. The thighs of their hind legs are incrassated so as to afford a box capable of containing muscles sufficiently powerful, by their action, to send them through the air to an almost incredible distance. If we examine the sructure of the posterior legs of any common *grasshopper*, we immediately see, both from the position of the joints with respect to each other, and the shape and volume of the elongated thigh, that they are made for leaping. The shank, when the animal prepares to leap, forms an acute angle with the thigh, so that being suddenly unbent, it springs forward, often to the distance of two hundred times its own length. Many carriages are set upon

1 *Ophiotheres cristatus*. Veill.
2 E. G. in *Seps*.
3 As in *Bipes*.
4 *Zool. Journ.* iii. 253.
5 *Acrocinus longimanus*.
6 *Cerambyx*. L.

springs made to imitate the position of this insect preparing to leap, which are known by the name of grasshopper springs.[1]

Several *beetles* rival the grasshoppers in their leaps, and have their posterior thighs much disproportioned to the bulk of their bodies, which allow space for a sufficient muscular apparatus, to send them, like an arrow from a bow, to a great distance. If a finger be held to a leaf covered by the *turnip flea*,[2] in the twinkling of an eye, all skip off and vanish. We may hence imagine with what expedition they disappear at the approach of any insectivorous bird. Thus their Creator, who cares for the meanest of his creatures, has furnished them with means of escape, to prevent their annihilation, and to preserve them in such force, as may best answer his end in creating them.

But besides *partial* modifications of the structure of these organs for particular uses, others are more *general* and affect the whole leg. Every one is aware how well adapted, by their fleetness, some of the *Ruminant* Mammalians are to make their escape from their ravenous pursuers, the most adroit and the most ruthless of which is the *mighty hunter*, man.

If we look at the legs and hoofs of the *deer* tribe,[3] the former long, slender, and elastic; and the latter calculated for sure footing; and if we consider besides the quickness of their senses of seeing and hearing, we see at once that their structure is the effect of *design*, and that the deepest intellect presided at its first fabrication.[4] Though man, as well as every ferocious beast, pursues these beautiful and elastic animals, it is only because he is *Gulæ deditus*, seldom with any view to seek their alliance, or to turn them to his purposes. There are some, however, as well as the rein-deer,[5] cherished by the Laplander as his principal treasure, but pursued by the American savage only to be devoured, which probably might be employed with advantage, as well as the dog, in countries not suited to our beasts of burthen; and it has been supposed that the Wapiti[6] might be trained and rendered useful, I am ignorant, however, whether any steps have ever been taken to ascertain this.

But the legs, as well as instruments of flight and escape, are adapted in fiercer animals to the pursuit and prehension of their prey, and in this, and many other respects, their *hand* or

1 See *Introduction to Entomology*, ii. 310.
2 *Haltica oleracea, Nemorum*, &c.
3 *Cervus*. L.
4 See Roget, *B. T.* i. 506.
5 *Cervus Tarandus*.
6 *C. Stongyloceras*.

*foot* is the part principally interesting. This is used for so many various purposes, that perhaps it will be best to take a summary survey, in this respct, of all the Classes of animals with articulated legs, and briefly point at their different structures and their uses.

As I have already given an account of the two kinds of forceps of Crustaceans,[1] I shall begin with the legs of the *Arachnidans*, or spiders. Every one who examines the web of a common spider, whether it is formed of concentric circles supported by diverging rays, or whether it imitates any finely woven substance, will be convinced that she must be furnished with a peculiar set of organs to effect these purposes: that she must have something like a *hand* to work with. Amongst the small things that are wise upon earth, Solomon mentions the spider; and the way by which he tells us she shows her wisdom is by her prehensory powers—*she takes hold with her hands.*[2] And truly what Arachne does with her hands and her spinning organs is very wonderful, as I shall have occasion hereafter to show; I shall now only make a few observations upon the organs by which she takes hold.

Spiders are gifted with the faculty of walking against gravity, even upon glass, and in a prone position. According to the observations of Mr Blackwall, this is not effected by producing atmospheric pressure by the adhesion of suckers, but by a brush formed of "slender bristles fringed on each side with exceeding fine hairs gradually diminishing in length as they approach its extremity, where they occur in such profusion as to form a thick brush on its inferior surface."[3] These brushes he first discovered on a living specimen of the *bird-spider*,[4] and the same structure, as far as his researches were carried, he found in those spiders which can walk against gravity and up glass. This is one of the modes by which they take hold with their hands, and thus they ascend walls, and set their snares in the palace as well as the cottage. Whoever examines the underside of the last joint or digit of the foot of this animal with a common pocket-lens, will see that it is clothed with a very thick brush, the hairs of which, under a more powerful magnifier, appear somewhat hooked at the apex; in some species this brush is divided longitudinally, so as to form two.

But the organs that are more particularly connected with the weaving and structure of the snares of the spiders are most

1 See above, p. 208, 209.
2 *Prov.* xxx. 28.
3 Blackwall in *Linn. Trans.* xvi. 481. *t.* xxxi. *f.* 5.
4 *Mygale avicularia.*

worthy of attention. Setting aside the hunters[1], and others that weave no snares to entrap their prey, I shall consider those I intend to notice, under the usual names of *weavers*[2] and *retiaries*.[3]

Before Mr Blackwall turned his attention to the proceedings of these ingenious and industrious animals, it had not been ascertained, in what respect their modes of spinning their webs, and the organs by which they formed their respective manufactures differed. But Mr Blackwall, whose observations were principally made upon one of the weavers[4] which frequents the holes and cavities of walls, and similar places, observes that it spins a kind of web of different kinds of silk, the surface of which has a flocky appearance, from the web being as it were ravelled.

This web is produced, he observes, by a double series of spines, opposed to each other, and planted on a prominent ridge of the upper side of the metatarsal joint, or that usually regarded as the first joint, of the foot of the posterior legs on the side next the abdomen. These spines are employed by the animal as a carding apparatus, the low series combing, as it were, or extracting, the ravelled web from the spinneret,[5] and the upper series, by the insertion of its spines between those of the other, disengaging the web from them.[6] By this curious operation, which it is not easy to describe clearly, the adhesive part of the snare is formed, thus large flies are easily caught and detained, which the animal, emerging from its concealment, soon despatches and devours.

The organs by which the *retiary* spiders form their curious geometric snares have generally been described as three claws, the two uppermost armed with parallel teeth like a comb, and the lower one simple and often depressed; but Mr Blackwall found, in a species related to the common garden spider,[7] *eight* claws, seven of which had their lower side toothed.[8] The object of this complex apparatus of claws simple and pectinated, is to enable these animals to take hold of any thread; to guide it; to pull it; to draw it out; to ascertain the nature of any thing ensnared, whether it be animate or inanimate; and to suspend itself. In fact the Creator has made their claws not only hands but eyes to these animals.

1 *Araneæ. venatoriæ.*
2 *A. textoriæ.*
3 *A. retiariæ.*
4 *Clubiona atrox.*
5 *Mammulæ.*
6 Blackwall, *ubi sup.* 473.
7 *Epeira Diadema.* The species examined by Mr B. was *E. apoclisa.*
8 Blackwall, *ubi sup.* 476.

Besides these organs, scattered movable spines or spurs are observable upon the legs, especially the *three* last joints, which I consider as forming the foot, but sometimes also upon the thighs of spiders, which, as they can be elevated and depressed at the will of the animal, probably are used as a kind of finger, when occasions require it.

In the multiform apparatus of these ingenious animals, as far as we understand its use, we see how they are fitted for their office, by contributing to deliver mankind from a plague of flies, which would otherwise, like those which swarmed in Egypt, annoy us beyond teleration, and corrupt our land.

If *the spider taketh hold with her hands*, and spreads her snare in kings' palaces, what shall we say of the *bee*, who with her hands erects *herself* her many-storied palaces, each story consisting of innumerable chambers, far more durable, and built of a materal infinitely exceeding the flimsy webs of Arachne. Her Creator hath instructed her, and fitted her with the means, to gather from every flower that blows a pure and sweet nectar, from which, received into her stomach, she elaborates the beautiful and important product of which her wondrous structures are formed; and from the same source she is also instructed to load herself with a fine ambrosial dust, which, kneaded by her into a paste, constitutes the chief subsistence of herself and the young of the community to which she belongs.

Almost every organ, implanted in her frame by her beneficent Creator, is employed by this symbol and exemplar of virtuous industry as a hand in her several works and manipulations. Her *antennæ*, those still mysterious organs, inform her in what flowers she may find honey, and which to pass by; they plan and measure her work, and by them she examines whether all is right; she also uses them to converse with her associates, and for various other purposes; her *tongue* is likewise an instrument equally useful to her; it can assume various shapes as occasions demand; it collects the honey from the nectar-organs of the flower; it tempers the wax for building and prepares it for the action of the *mandibles*. With these last organs she works up the wax till it is fit for use. The plumy *hairs* of her body, especially in the humble-bees, are useful in detaining the dust of the anthers. Her *legs*, more particularly the posterior pair, though not used immediately in her structures, are extremely important organs, both for preparing her food and the material with which she builds her palace. At the junction of the shank, with the first joint of the foot of this pair, a kind of *forceps* is formed, by the angle at the apex of the former and the base of the latter, with which

the bee takes a plate of wax from the wax-pockets under her abdomen, and delivers it to the anterior pair of legs, by which it is submitted to the action of the mandibles. The *shanks* of the posterior legs likewise on their upper side have a cavity surrounded with hairs, which form a kind of basket, in which the diligent labourer carries a mass of pollen, kneaded by the aid of the comb at the end of the shank into a paste, which is deposited in the cells, and contributes to form the family store of provision.

What a number of compensating contrivances does this single animal exhibit, and how wonderfully and admirably has Supreme Wisdom and Goodness contrived for her, and Almighty Power given full effect to what they planned! Nothing is superfluous in her, every hair and every angle has its use; so that well may we adore Him who created the honey-bee, and, at whose bidding, and by whose instruction, she erects those wonderful edifices that have been the admiration of every age.[1]

Instinct directs many animals, as well as traversing the surface of the earth, to seek a subterranean abode within its bosom. Amongst insects, though there are many that burrow, none is more remarkable than the *mole-cricket*.[2] The most superficial observer, when he looks at this creature, must see at once from its structure, especially that of its fore-legs, what its function is. If he compares other crickets with it, a singular change will strike him, the bulk of the posterior thighs, far exceeding that of the same joint in the other legs, will appear to be chiefly transferred to the anterior pair of legs, which, the size of the creature considered, are as powerful instruments for excavating the earth as can be found in any animal now in existence: all the joints of this leg are very much dilated, especially the haunch and the thigh, which contain the powerful muscles that move the apparatus for burrowing. This consists of a triangular joint, the analogue of the shank of the other legs, but assuming the form of a hand with the palm turned outwards, as in the mole, and terminating in four strong claw-like digitations; on the side next the head these fingers, in the middle, are longitudinally elevated and naked; while the sides are longitudinally excavated and hairy, which give this part some resemblance to the foot and claws of burrowing quadrupeds. The thigh is hollowed out underneath, evidently to receive the joint just described, and overhanging this cavity, at the base, is a stout triangular tooth, which probably is em-

1 See Bochart *Hierozoic*. ii. 515. a.

2 *Gryllotalpa*.

ployed to clean the hand when necessary; on the outside opposed to the hand is the analogue of the tarsus consisting of three joints, the two first large and triangular, with the upper edge curved and the lower straight and hairy at the base, the other is of the ordinary form, and armed with two straight claws. These teeth, as well as those of the shank, have a trenchant edge on the straight side, and together are supposed to act the part of a pair of shears, and to cut any roots that may interfere with its progress. Rösel, however, thinks, the use of these teeth of the tarsus is merely to clean the burrowing hand, which it may also do. It is to be observed that the trenchant edge is opposite in the teeth of the shank and tarsus, as in a pair of scissors, which favours the idea that they are used sometimes for cutting. The position of the shank is vertical, with the teeth next the ground, so that the animal, when disposed to burrow, has nothing to do but to plunge these claws into the soil and push outwards, and then extricating her arms proceed in the same way till she has accomplished her object. The apex of the shanks, of the two posterior pairs of legs, is armed with several spines which probably assist either in making progress, or, when necessary, to retrograde.

"It might, I think, be asserted," observes Dr Kidd, in his valuable and interesting memoir *On the anatomy of the mole-cricket*,[1] "without fear of contradiction, that throughout the whole range of animated nature, there is not a stronger instance of what may be called intentional structure, than is afforded by that part of the mole-cricket (*the anterior leg*), which I am now to describe." And certainly, we see and own without hesitation, as even the most sceptical would scarcely refuse doing, that this arm was planned, and all its various parts, dependent upon and mutually affecting each other, by a calculating Mind, which framed and put the whole together to answer a particular purpose.

The Class of *reptiles* affords no very striking instances of the adaptations we are considering, except in the case before noticed of the gecko lizards, and the tree-frogs,[2] which, by means of suckers, are enabled to support themselves and walk against gravity. Like Mammalians, reptiles are usually furnished, but not invariably, with four legs, and a pentadactyle foot.

In an animal of this Class, celebrated from of old, the *Chameleon*,[3] a remarkable modification of this structure is observable. It is stated with respect to this animal, that it moves very slowly, that it will sometimes remain whole days on the

1 *Philos. Trans.* 1825, 217. 2 *Hyla*. 3 *Chamæleo Africanus*, &c.

same branch: and it is only with great circumspection, and after taking great care to get firm hold with its prehensile tail, that it ventures to set a few steps: it may be expected, therefore, that its principal organs of locomotion should be adapted to give it secure footing on the branch it selects for its station.

Aristotle, in his account of this animal,[1] observes that "each of its feet is divided into two parts, an arrangement resembling that of our thumb, opposed to the rest of the hand; and a little short of this,[2] each of these parts is divided into certain fingers; in the fore-legs the internal ones being three, and the external two,[3] but in the hind the internal fingers are three, and the external two,[4] and these fingers have crooked claws." By this structure of the feet, and arrangement of the fingers or toes, the three-toed lobe is on one side of the branch at the anterior extremity of the animal, and on the other at the posterior, and by this counteraction of each other's pressure, enable it to maintain its position against any force that may be likely to disturb it. The lobes are longer than the fingers, and thus by their means it can hold very firmly, and watch the flies and insects which form its food, and are entrapped by the gluten with which its long tongue is besmeared.

The analogue of the fore-leg of quadrupeds in *birds*, as we have seen, is converted into an organ of flight, and cannot be employed as an organ of prehension; sometimes, indeed, in their combats, it is used to annoy their opponents, and is occasionally armed with a spur, but the prehensory faculty is transferred to the beak and the remaining pair of legs; with these latter the eagles and other birds of prey usually seize the animals that they devour; with these also fructivorous birds, as the parrots, paroquets, &c. hold the fruit while they eat it, and the Gallinaceous Order scratch the earth to find food for themselves and chicks; the foot of birds is most commonly tetradactyle, with one toe or thumb at the heel and the other three in front; in one Order,[5] the birds forming which have occasion to fix themselves firmly on their perch, the thumb and the external toe both point backwards, so as to form a cross with the others and the rest of the leg. In the emu the foot consists of three toes, and in the ostrich of only two, there being no thumb in either. Many of the aquatic birds have the toes

1 Aristot. *Hist. Anim.* l. ii. c. 11.

2 Gr. Επι βραχυ. Meaning, I suppose, that the toes are not so long as the primary division of the foot.

3 Plate XIV. Fig. 2 4 *Ibid.* Fig. 3. 5 *Scansores.*

connected by membrane, and so forming oars for swimming; and in some each toe has a margin of membrane, which is usually notched, these last are called lobed feet.

But the absence of the fore-leg in birds is admirably compensated by the *beak;* with this they generally *collect*, as well as devour their food. Some indeed employ their *tongue* in this service. Of this description is the woodpecker[1] and the humming Bird;[2] the former using it to catch insects[3] and the latter to imbibe the nectar of flowers, for which purpose these little gems amongst the birds have a long slender tongue, somewhat resembling that of a butterfly, and moved by an apparatus, in some degree, like that of the woodpecker.[4] The beak of birds is uniformly constructed with respect to their food, and varies ad infinitum. Perhaps in none is it more remarkable than in those of Cuvier's two last Orders, the waders and web-footed birds. These, especially the last, can use their legs only for locomotion, either on shore or in the water, and therefore their beaks have the whole function, not only of taking, but of *hunting* for food devolved upon them, and accordingly are fitted for it by their structure.[5] Generally speaking, they may be stated to be of two kinds. Beaks for catching *worms*, and beaks for catching *flshes;* of the first description are those of the woodcock,[6] snipes,[7] and numerous other waders; and of the last, amongst the most remarkable, are those of the spoonbill[8] and pelican.[9] The former—which the French, perhaps with more propriety, call the spatula-bill,[10] as its beak resembles a spatula rather than a spoon—dabble with their bill in the mud, for which it is well calculated, and thus capture small fishes, shell-fish, reptiles, and other aquatic and amphibious animals, which the tubercles within it are also calculated to retain and crush. But the latter, the pelican, has the most remarkable organ for taking its food, and is a bird known and celebrated from the earliest ages. The lower mandible is fitted with a kind of sac, formed of the dilated skin of the throat, which Vieillot says can be so expanded as to contain between two and three gallons of water.[11] When fishing, these birds sometimes rise to a prodigious height, at others they skim the surface of the water, or hover, at a moderate elevation, that they

1 *Picus.*
2 *Trochilus.*
3 See Dr Roget, *B. T.* ii. 132.
4 See Vieillot. *N. D. D'Hist. Nat.* vii. 342. *t.* B. 38.
5 Roget, *B. T.* ii. 391.
6 *Scolopax rusticola.*
7 *Sc. gallinago*, and *gallinula.*
8 *Platalea leucorodia*
9 *Pelecanus Onocrotalus.*
10 *Spatule.*
11 *N. D. D'Hist. Nat.* xxv. 139

may more readily precipitate themselves upon their prey. The sudden fall of so powerful an animal, the whirling round, the boiling which the great extent of its wings occasions in the water, so astounds and stuns the fishes that few escape. Then rising again and again descending, it continues this manœuvre till it has filled its pouch. When this is accomplished it retires to some rocky eminence where it devours what it has caught, which sometimes, Vieillot says, will amount to as many fishes as would satisfy six men.[1] It presses its pouch against its breast when it feeds its young, in order to disgorge the fishes, whence probably arose the fable of its feeding them with its own blood.

But the beak is not only used by birds in collecting their food, some also it assists in *climbing;* parrots are remarkable for this, and also employ their *tail* for the same purpose.

Truly, when we examine and compare all these organs of prehension as well as manducation, and the infinite modifications of them, to suit the peculiar kind of food and circumstances of every tribe, we cannot help exclaiming—God is here, we behold the evident footsteps of infinite wisdom, power, and goodness. Well might our Saviour say, *Behold the fowls of the air; for they sow not, neither do they reap, nor gather into barns; yet your Heavenly Father feedeth them.*[2]

The legs of *Mammalians*, with respect to their extremity, may be considered as divided into those that have powers of prehension, more or less, and those that have only powers of locomotion. I shall begin with the latter.

1. These consist of Baron Cuvier's *seventh and eighth* Orders of the Class above mentioned; namely, the *Pachyderms*, or thick skinned beasts, and the *Ruminants*, or those that chew the cud.

The great man, just named, considers the horse and ass, constituting the equine genus,[3] as forming a Family of the first of these Orders, to which he has given the ancient appellation of *Soliped*,[4] or whole-hoofed. He originally regarded the Solipeds as forming a separate Order, and, indeed, comparing them with the other Pachyderms, as the elephant, rhinoceros, hippopotamus, hog, &c., the horse genus seems scarcely to belong to the same order. Illiger, who altered the name, but without sufficient reason, to *Solidungula*, considers them as distinct.

1 *Ubi supr.* 138.
2 *Matth.* vi. 26.
3 *Equus.*
4 Gr. Μονυξ. Aristot.

Though the speed of the deer, except in a single instance, on account of their usually slight form and slender limbs, has not been applied by man to his purposes, and to add to the velocity of his progress, yet in the soliped race, especially in that noble quadruped the *horse*, we have an animal endowed with equal speed and greater strength, and by their undivided hoof, where speed as well as strength is required, calculated, with much more advantage and less injury, to traverse—both as beasts of burthen and draft, and as adapted peculiarly for the conveyance of man himself—not only soft and verdant prairies, but hard and rocky roads. Hence this animal has been employed by man from a very early period of society. We do not indeed know whether the mighty hunter, Nimrod, went to the chase of man and beast on horseback, though it is not improbable ; but both the horse and the ass were common in Egypt in Joseph's time,[1] the latter was used by Abraham to ride upon,[2] and asses are enumerated amongst his possessions when he went up from Egypt fifty years before.[3]

The sole organs of prehension of this tribe are their mouth and upper lip. Every one knows how adroit the horse and ass often become in the use of these organs, not only in gathering their food, but in opening gates that confine them to their pastures.

In the genuine Pachyderms the foot begins to show marks of division. In the rhinoceros there are three toes, in the hippopotamus four, and in the Proboscidians of Cuvier, including the elephant and *Mastodon*, or fossil elephant, there are five toes, three of the nails of which only appear externally, and four on the hind foot of the Asiatic species.[4]

The *Swine* family divide the hoof like the Ruminant ; it consists of two intermediate toes, large, and armed with nails or hoofs, and two lateral ones much shorter and not touching the ground ; in this respect also resembling many Ruminants. In hilly and mountainous districts these upper toes are probably useful in locomotion.

The prehensory organ of the animals here enumerated is usually the *snout*, with this the *hog*[5] turns up the ground in search of roots or grubs, often doing great injury to pastures. The male is armed with a defensive and offensive weapon in his tusks.

That hideous animal of this tribe, the *Æthiopian boar*,[6] is armed with four tusks, two proceeding from the upper jaw,

1 *Genes.* xlvii. 17. 2 xxii. 3. 3 xii. 16
4 *E. indicus.* 5 *Sus scrofa.* 6 *Phascocharus Africanus.*

which turn upwards like a horn, sometimes nine inches long and five inches in circumference at the base; the other pair issuing from the lower jaw, projecting not more than three inches from the mouth, flat on the inside, and corresponding with another plain surface in the upper tusks. The Boshies men, Sparrman relates, say of this animal, "We had rather attack a lion in the plain than an African wild boar; for this, though much smaller, comes rushing on a man as swift as an arrow, and throwing him down snaps his legs in two, and rips up his belly before he can get to strike at it, and kill it with his javelin."[1] They inhabit subterranean recesses; and turn up the earth very dexterously, probably by the aid of their tusks, in search of roots, which form their food.

The *Babiroussa*[2] or *Babee rooso*, a name which signifies *Hog-deer*, given to this animal probably on account of its longer legs and slender form, is distinguished by a pair of long tusks from the upper jaw, which rising above the head, then turning down, form a semicircle, and have the appearance of horns, for which they have been mistaken. They are only found in the male, which is stated to use them as hooks to suspend himself to the branches of trees, thus resting his head, so as to sleep upright. As the animal feeds upon the leaves of the Banana and other trees, it is not improbable that these tusks may be used to pull down the branches.

The *Rhinoceros* is said to use its horn for digging up the roots of plants, which compose the principal portion of its food. I am speaking of the two-horned rhinoceros of Sparrman. The Hottentots and the colonists assert that this animal uses only its *second* or shortest horn for digging up roots, which appeared to him worn by friction, marks of which the anterior one never exhibited. When engaged in that employment it was stated to turn that horn on one side[3] out of the way.

But one of the most wonderful compensating contrivances and structures of Divine Wisdom, Power, and Goodness, and which has excited the admiration of every age, is the *proboscis* of the *elephant*. The weight of the enormous head of this animal is such as to preclude its being employed, if it terminated in a common mouth, either to break the boughs of trees, or to crop the grass, for it could not easily be either elevated or depressed for these purposes; in its proboscis, however, it is supplied with an instrument that amply compensates this deficiency. Almost every one is aware that this beautiful organ,

1 Voyage, ii. 23.
2 *Sus babyrussa.*
3 Sparrman. *Voyage*, ii. 98.

beautiful I mean for its structure,[1] answers a variety of purposes; that it is given by its Creator to this mighty animal to be to it an instrument almost of sight, of most delicate touch, of scent and breathing, of prehension as adroit as that of a hand; added to this, that by the extraordinary flexibility with which he has endowed it, it can not only be inflected inwards to carry things to its mouth, but be bent upwards, downwards, or laterally, to lay hold of things above, below, or on each side of it, and that by the assistance of a single finger at its extremity, it can take hold of any thing as readily as we do by the assistance of four fingers and a thumb. As the brain of these gigantic animals, compared with their bulk, is very small, it is thought, by modern zoologists, that their intellect has been exaggerated, and that it does not surpass that of dogs, and many other carnivorous animals. Others have imagined that their sagacity is wholly the result of their being provided with so wonderful an organ; but this organ would be of very little use without the *nervous* apparatus by which it is moved according to the will of the animal.

Amongst the *Ruminants*,—which appear to connect with the Pachyderms in two points, by the swine tribe and Solipeds, the latter possessing several characters in common with the *Gnu*,[2] which seems between them and the bovine genus;[3] and the former approaching them by their common character of dividing the hoof,—there is another animal, which may be considered as the horse of the desert, exhibiting in some degree a union of characters not found in the remainder of the Order; it chews the cud, but does not actually divide the hoof. I am speaking of the *Camel*, but though not actually, the hoof is superficially divided. Considering the deserts of loose and deep sand that it often has to traverse, a completely divided hoof would have sunk too deep in the sand; while one entire below would present a broader surface not so liable to this inconvenience. Boys, when they want to walk upon the muddy shores of an estuary at low water, fasten broad boards to their feet, which prevent them from sinking in the mud; I conceive that the *whole* sole of the camel's foot answers a similar purpose: its superficial division probably gives a degree of pliancy to it, enabling it to move with more ease over the sands; upon which these animals often trot with great rapidity, travelling sometimes twelve miles within the hour; its common amble, which is exceedingly easy, is nearly six; this pace, if properly fed every evening, or in cases of emergence, only once in two days,

1 Roget, *B. T.* i. 520. 2 *Catoblepas Gnu.* 3 *Bos.*

the camel will continue uninterruptedly for five or six days: with these qualities, so suitable to barren and sandy deserts, what a valuable gift of Providence was this, especially to the descendants of Ishmael; who, according to the prophecy, have maintained undisturbed possession of their deserts and their necessary accompaniment, the camel, from the time of their progenitor to the present day, a period of between three or four thousand years. They have been wild men, always assailing and assailed, and yet maintaining their ground. But the time will assuredly come, when *The flocks of Kedar, and the rams of Nebaioth,*[1] shall forsake their deeds of spoliation and robbery and be gathered to the church.

Though the Ruminants, in general, by the structure and division of their hoof, are calculated for sure footing, so as to enable them best to exercise their several functions; as the camel, the ox, and the rein-deer at the bidding of their master man; and others, as the chamois and the goat, for the ascent of mountains and precipices, seemingly inaccessible, where they can laugh at their pursuer; and others again, as the deer and antelope tribes for speed that almost mocks pursuit; yet with respect to *prehension* these organs are of no use to them. Their mouth and lips, and tongue, are the only means by which they can help themselves to their food; they have no tusks like the Pachyderms in general, nor nasal horns like the rhinoceros, to cut or dig with; but as their food is most commonly the herbage that covers the earth, these are fully sufficient to enable them to supply themselves with *Food convenient for them.* The camel and dromedary differ from the other Ruminants, not only in their long neck, which probably is useful to them in gathering their food, but also in having a cleft lip, which doubtless, adds to the prehensory powers of that organ. The lofty neck is still more striking in the Camelopard, the long tongue of which is also used by them as a hand to pull down the branches of the mimosa, from they derive their subsistence.

2. I shall now consider those Mammalians, whose legs are more or less prehensory, next above the Pachyderms and Ruminants. Cuvier's *sixth* Order consists of a tribe of animals which he denominates *Edentate,*[2] because they have no foreteeth. The *Monotremes* form the last Family of the Order, and precede the Pachyderms. In many points they seem connected with the birds; one genus[3] having a mouth resembling the bill of a duck, and being almost web-footed; it has also

1 *Isai.* lx 7. 2 *Edentés.* 3 *Ornithorhynchus.*

been stated to be oviparous;[1] the male, as I before observed,[2] is armed with a sting, like a serpent. The other genus, *Echidna*, approaches nearer the *pangolins*,[3] and *anteaters*,[4] having, like them, an extensile viscid tongue, by means of which they entrap and devour the ants. The other animals of the Order are remarkable for their great nails, almost approaching to hoofs; in the Family which precedes the Monotremes[5] they are often used for burrowing.

Next above the *Echidna* is a singular animal, wearing the outward aspect and Scales of a Saurian, the pangolin, which rolls itself up like an armadillo, and is the ant-eater of the old world. It is singular that a real lizard, the chameleon, should have the same instinct of catching its insect prey by means of a long tongue besmeared with slime. In the new world the pangolin is replaced by the ant-eaters, which have the same habits, and the same mode of procuring their food. With the long nails of their fore-feet they penetrate the nests of the white ants and common ants, and inserting their long tongue, besmeared with a viscid saliva, into these nests, retract it covered with game; and this with such velocity, that the eye can scarcely follow them. Their nails, which require to be kept sharp, for the operation just mentioned, when not employed, are folded inwards, so as to prevent their being blunted. In one species[6] in the fore-foot there are only two nails.

Amongst the animals that are clothed in armour, in this Order, the most remarkable is the *Chlamyphorus*,[7] whose feet are armed with five long and sharp nails, especially the anterior ones, which must enable it to excavate its subterranean abode very rapidly. From the formation of its foot and these nails it does not appear to dig with them laterally, but in a line with the body; its singular clubbed tail therefore would be a very useful organ, if, as Mr Yarrel supposes, it is used in removing backwards the loose earth accumulated under its belly by the action of the fore-legs.[8] This animal, which is a native of Chili, is reputed to carry its young beneath the scaly armour attached principally to the spine, which covers it loosely like a cloak.

The last family, as we ascend, in the present Order, is very well distinguished by the name of *Tardigrades*, from the excessive slowness of their motions. Their nails are enormously

1 Cuv. *Règne Anim.* i. 234, note 2.
2 See above, p. 233.
3 *Manis.*
4 *Myrmecophaga.*
5 *Edentés ordinaires.* Cuv.
6 *M. didactylas.*
7 Plate XVI.
8 *Zool. Journ.* iii. 551

long, compressed, and crooked, and exactly calculated for laying strong hold, so as to enable them to maintain their station on the trees, whose leaves and buds form their food. Their English appellation, the *Sloth*,[1] indicates their character; when they have satisfied their appetite, like most of the other Edentates, they can roll themselves up and take a long and reckless sleep. But I need not enlarge further upon this tribe, since Dr Buckland has excellently—*Justified the ways of God to man*,—and, in the present instance, demonstrated, by most convincing arguments, that these animals, instead of being an abortion, imperfect, misshapen, and monstrous, are exactly, and in every respect, adapted for the station which God has assigned to them, and for the work which he has given them in charge.[2]

Next above the Endentate Mammalians is an Order, the *fifth* of Cuvier, consisting of a greater number of Genera and Subgenera than any other in the Class, which, instead of having no front teeth or incisives, have very conspicuous ones, rendered more so by being separated by a void space from the grinders. From these teeth, which are neither calculated to seize or lacerate their food, but merely to nibble and gnaw it, they have received their name of *Nibblers* or *Gnawers*.[3]

The great majority of this Order are gregarious, and live in burrows, or common habitations, which they excavate or fabricate themselves. Like the Hymenopterous Class of insects, many are noted for the sagacity and skill which they manifest in their united labours for the good of the community, and also for the organs by which they are enabled to answer the bidding of instinct.

One of the most remarkable of these is the *Beaver*;[4] this animal has five toes on all its feet, which in the hind pair are connected by membrane; those of the fore-leg, which it uses as a hand to convey its food to its mouth, are very distinct. They carry also with these hands the mud and stones which they mix with the wooden part of their buildings. But their incisor teeth are their principal instruments, with these, as Dr Richardson states, they cut down trees as big or bigger than a man's thigh; when they undertake this operation they gnaw it all round, cutting it sagaciously on one side higher than on the other, by which it is caused to fall in the direction they wish; they use these powerful organs not only to fell the trees

1 *Bradypus*.
2 *Linn. Trans.* xvii. 17.
3 *Rodentia*.
4 *Castor Fiber*.

they select, but also to drag them to the place where they want them. It is said, that a beaver, when at its full strength, can at one stroke bite through the leg of a dog.

It has been affirmed that beavers employ their tail both as a trowel to plaster their houses, and as a sledge to carry the trees that they fell; but both these assertions seem to be built upon conjecture rather than observation, and are not credited by those who have had the best opportunities of observing their manners, as Hearne, Cartwright, and Dr Richardson. The fabrics they are taught by their Creator to erect, and impelled by the instinct he has implanted in them, are sufficiently wonderful without having recourse to fiction to exaggerate it. Their tails, probably, are useful to them in the water as natatory organs.

There is a very singular animal discovered by M. Sonnerat, in Madagascar, called the *Aye-Aye*,[1] which seems, in some degree, to approach the Quadrumanes. The fore-feet have five excessively long fingers, and what is singular, the middle one is much slenderer than the rest. In the hind feet there is a thumb opposed to the other fingers, by which structure it is enabled to take firmer hold of the branches of trees. It is said to use the slender finger of its hand for the same purpose that the wood-pecker uses its barbed tongue, to extract the grubs from the trees.

The squirrels, which form the first genus in this interesting Order, are known to use their fore-legs for prehension, which indeed is the case with the majority of animals included in it. They are also, at least a large proportion, remarkable for sitting, when at rest, upon their haunches, and also for their ready use of their fore-legs.

Having before noticed the most remarkable animal in Cuvier's *fourth* Order, the *Marsupians*, which suckle their young in a pouch, I shall only mention one other animal belonging to it, the *Koala*,[2] a New Holland quadruped, in some respects resembling the bear; like the chameleon, it has the five toes or fingers of the fore-foot divided into two groups, the thumb and fore-finger forming one, and the three remaining fingers the other; the object of this structure is evidently to enable it to take firm hold of the branches of the trees on which it passes part of its life; this is of the more importance to it, as it carries its young upon its back. It sometimes, probably in

1 *Cheiromys.* 2 *Lipurus.*

the night, retires to burrows which it excavates at the foot of the trees.

We have now arrived at the foot of Baron Cuvier's *third* Order, containing the *predaceous* Mammalians, which, though a very comprehensive group, will not detain us long, as the first and last family, the *Bats* and *Seals,* have been noticed in another place.[1] The rest of the Order consists of the insectivorous and carnivorous Mammalians; the latter is further subdivided into two tribes, which are denominated the *Plantigrades* and the *Digitigrades.*

Those last mentioned usually walk more upon their toes, and consist of the feline, canine, and several other tribes, all swift in their locomotions, and making use of their paws or fore-foot, either for scratching and burrowing, or to seize their prey, and they have all, I believe, five toes.

The *Plantigrades* are so called because they walk, like man, upon the whole foot, and consist of the bear,[2] the glutton,[3] and similar animals. This structure enables the former to rear itself on its hind feet, and walk erect; and their fore-foot will grasp a staff like a hand; it is armed with long claws, with which they scratch up roots which form part of their subsistence, excavate burrows, climb the trees, and seize their prey.

These armed paws are fearful weapons, both in the lion and the bear, to which few would like to be exposed; but an heroic youth, beloved of God and man, regarded them not when, as a faithful shepherd, he rescued a lamb of his father's flock from their grasp and voracity.

The two most remarkable animals in the *insectivorous* tribe of predaceous Mammalians are the mole,[4] and the harmless, though persecuted hedgehog,[5] but they are both too well known, the former for its piquants, and the latter for its hand turned outwards and moved by an enormous apparatus of muscles, to enable it to excavate its subterranean habitation.

We are now arrived, in our progress upwards, at Cuvier's *second* Order of Mammalians, which he names *Quadrumane,* or four-handed, and which consists of apes,[6] baboons,[7] and monkeys,[8] whose hind as well as fore-foot is usually furnished with a thumb opposite to the fingers, so that they can use all their

1 See above, p. 262, 272.
2 *Ursus.*
3 *Gulo.*
4 *Talpa.*
5 *Erinaceus.*
6 *Simia*, &c.
7 *Cynocephalus*, &c.
8 *Lemur*, &c.

feet for prehension: the object of Providence by this structure is to enable these animals to move about amongst the branches of the trees, which are their usual habitations, and to fix themselves securely upon them, so that they can use their hands to gather fruit or any other purpose. Thus also they can perambulate the trees with as much ease and safety as we do our houses; and run up and down the branches with as much celerity as we do our staircases: but they cannot make equal progress on the earth, or a plane surface, whether they go on four feet or two.

Even man himself, though he ordinarily cannot use his toes for prehension, yet is sometimes placed in such circumstances, as to acquire the power of doing so. I remember, when a boy, going to see a girl who was born without arms, and was exhibited by her parents to the public. She could use her toes as fingers; could hold scissors, cut out watch-papers, sew, and even write. An account was given in the St James's Chronicle, not long ago, of a youth similarly circumstanced, who being cruelly turned out by his father, but patronized by his sister, learned to draw with his toes. In India they are used as fingers, and are sometimes called foot-fingers. The Hindoo tailor twists his thread with them, and the cook holds his knife while he cuts fish, vegetables, &c., the joiner, weaver, and other mechanics all use them for a variety of purposes; and I am told by a friend, who has often been in India, that they can even pick up pins with them.

We are now arrived at man himself, who, as we see, takes his particular denomination from the hand. He is the only *Bimane.*

The physiology and anatomy of the *Human Hand,* that wonderful organ, have been explained and reasoned with great ability in a separate treatise, by the eminent comparative anatomist to whom that subject was assigned; I shall not, therefore, here say any thing on its structure and its uses: but as it has not been treated of as a *moral* organ; as being in intimate connexion with the heart and affections; as their principal index and premonstrator; and as the mighty instrument by which a great part of the physical good and evil which befalls our race is wrought, I may be permitted to make a few observations upon it as far as these are concerned.

God made the body in general a fit machine, not only to execute the purposes of its immaterial inhabitant the soul; but, in some sort, he made it a mirror to reflect all its bearings and character; to indicate every motion of the fluctuating sea within, whether its surges lift themselves on high elevated by

the gusts of passion; or all is calm, and tranquil, and subdued. None of the bodily organs, by its structure and station in the body, is so evidently formed in all respects for these functions as the HAND. The eye indeed is, perhaps, the most faithful mirror of the soul's emotion; yet though it may best pourtray and render visible the internal feeling, it can in no degree execute its biddings; but the hand is the great agent and minister of the soul, which not only reveals her inmost affection and feeling, and, in conjunction with the tongue—and these two in connection are either the most benificent or maleficent of all our organs—declares her will and purpose; but is also employed by her to execute them. Thus HEART and HAND, the principle and the practice, have been united, in common parlance, from ancient ages. The earliest dawn of reason in the innocent infant is shown by the signs it makes with its little *hands;* by them it prefers its petitions for any thing it desires, and, in imitation of this, God's children are instructed *to lift up holy hands* in prayer.[1] Love, friendship, charity, and all the kindly affections of our nature, use the hands as their symbol and organ; the fond embrace, the hearty shake, the liberal gift, are all ministered by them. Joy, gladness, applause, welcome, valediction, all use these organs to represent them. Penitence smites her breast with them; resignation clasps them; devotion and the love of God stretches them out towards heaven.

But the hands are not employed to express only the kindly affections of the soul. Those of a contrary and less amiable character use them as their index. Anger threatens, and more violent and hateful passions destroy by them. They are indeed the instruments by which a great portion of the evil, and mischief, and violence, and misery, that our corrupt nature has introduced into the world, are perpetrated.

The hand also, on some occasions, becomes the spokesman instead of the tongue. The fore-finger is denominated the *index*, because we use it to indicate to another any object to which we wish to direct his attention. By it the deaf and dumb person is enabled to hold converse with others so as not to be totally cut off from the enjoyment of society; and by it we can likewise mutually communicate our thoughts when separated by space however wide, even with our Antipodes.

The Deity himself, also, condescends to convey spiritual benefits to his people by means of the *hands* of authorized persons, as in Confirmation and Ordination; and the Blessed Friend, and Patron, and Advocate and Deliverer of our race,

1 1 *Tim.* ii. 8.

when he was upon earth, appears to have wrought most of his miracles of healing by laying on his hands;[1] in benediction also, when children were brought unto him he laid his hands on them; and at his ascension he lifted up his hands to bless his disciples.[2]

To enumerate all the modes by which the internal affection of the soul is indicated by the hand would be an endless task. I shall therefore only further observe, that the greater part of the instances I have adduced are natural, and not conventional or casual modes of expressing feeling, as is evident from their being employed, with little variation, in all ages, nations, and states of society.

How grateful then ought we to be to our Creator for enriching us with these admirable organs, which more than any outward one that we possess, are the immediate instruments that enable us to master the whole globe that we inhabit, not merely the visible and tangible matter that we tread upon, and its furniture and population, but even often to take hold as it were of the invisible substances that float around it, and to bottle up the lightning and the wind, as well as the waters. Thus by their means do we add daily increments to our knowledge and science, and consequently power; to our skill in arts and every allied manufacture and manipulation; to our comforts, pleasures, and every thing desirable in life.

If now—having arrived at the most perfect instrument, as to its uses, and the most important to the happiness and welfare of the Human race, whether it be considered as an instrument of good or evil—we turn back and review this long train of organs for every kind of motion, and every kind of operation, and consider moreover the animal to which each belongs with respect to its place and station, connection, powers of multiplication, relative magnitude, form, composition, structure, functions, and at the same time take into further consideration the theatre upon which each is destined to appear, the medium in which it is to move and breathe, and the beings, whether vegetable or animal, with which it is to come in contact, and upon which it is to act.

When, I say, we take this review, what an infinite diversity in every respect bewilders our thought, and we are unable to form any distinct idea of the general effect and harmony that we know to be produced, nor how all these instruments, dovetail, as it were, so as to form the whole into one great fabric or sphere of agents, all contributing to fulfil the purposes of the

1 *Mark*, viii. 23—25. 2 *Mark*, x. 16. *Luke*, xxiv. 50.

Great Being who fabricated it, and promoting the general health and welfare of the whole system. But this we *can* understand that the Fabricator of this sphere must have taken a *simultaneous* survey of all the circumstances here mentioned; must have calculated the momentum of each individual, have weighed and measured it, so that it should not exceed a certain standard; must have seen at once all that it wanted to fit it for its station; must, before he made it, have formed a correct estimate of all the requisite materials, whether gaseous, aquiform, or solid, so as to put together the whole harmonious compages without failing in a single atom; and give full accomplishment to his will.

He who could effect all this could only be one whose *Understanding is infinite*, and whose *Power and Goodness* are equally without bounds.

## CHAPTER XVIII.

### *On Instinct.*

THERE is no department of Zoological Science that furnishes stronger proofs of the being and attributes of the Deity, than that which relates to the *Instincts* of animals, and the more so, because where reason and intellect are most powerful and sufficient as guides, as in man, and most of the higher grades of animals, there usually instinct is weakest and least wonderful, while, as we descend in the scale, we come to tribes that exhibit, in an almost miraculous manner, the workings of a Divine Power, and perform operations that the intellect and skill of man would in vain attempt to rival or to imitate. Yet there is no question, concerning which the Natural Historian and Physiologist seems more at a loss than when he is asked—what is INSTINCT? So much has been ably written upon the subject, so many hypotheses have been broached, that it seems wonderful so thick a cloud should still rest upon it. It must not be expected, where so many eminent men have more or less failed, that one of less powers should be enabled to throw much new light upon this palpable obscure, or dissipate all the darkness that envelopes the *secondary* or intermediate *cause* of Instinct. Could even the bee or the ant tell us what it is that goads them to their several labours, and instructs them how to perform them, perhaps we might still have much to learn before we should have any right to cry with the Syracusan Mathematician, Ἐυρηκα, I have unveiled the mystery. Still, however unequal to the task, I cannot duly discharge the duty incumbent upon me, who may be said to be *officially* engaged to prove the great truths of Natural Religion from the *Instincts* of the animal creation, to leave the subject of Instinct, considered in the abstract, exactly as I found it; a field, in which whoever perambulates, may wander "in endless mazes lost." I will, therefore, do my best to make the way, in a small degree, more level, and less intricate, than it has hitherto been.

But, before I proceed, lest the reader should feel disposed to accuse me of contradicting the opinions on this subject stated in the *Introduction to Entomology*, I beg to direct his attention to the following paragraph in the advertisement to the third

volume of that work. "It will not be amiss here to state, in order to obviate any charge of inconsistency in the possible event of Mr Kirby's adverting in any other work to this subject, that, though on every material point, the authors have agreed in opinion, their views of the *theory of Instinct* do not precisely accord. That given in the second and fourth volumes is from the pen of Mr Spence."

It is not without considerable reluctance that the author of this essay takes the field, in some degree, against his worthy friend and learned coadjutor, but as he is thus left at liberty to do it, and the nature of his subject requires it, he will state those views, which seem to himself most consistent with nature and truth, and most accordant with the general plan of creation. It is doubtful whether the ancients had any distinct idea of that impulse upon animals, urging them necessarily to certain actions, which modern writers have denominated *instinct.* Aristotle, indeed, in a passage of his physics quoted by Bochart,[1] alludes to certain writers who doubted whether spiders, ants, and similar animals were directed in their works by intellect, or by any other faculty. The Stagyrite himself resolves the causes of motion into intellect and appetite,[2] but I have not been able to discover that he has recorded any opinion as to what cause the, now called, instincts of animals, whether to appetite or intellect, are to be attributed: he says much on the subject of the hive bee, but it is merely a history of its proceedings, unaccompanied by a single syllable from which we might conjecture that he attributed any part of these proceedings, wonderful as he must have thought them, to any faculty distinct from intellect, and what seems more extraordinary, without any expression of admiration at the expertness, and art, and skill, so evident in all that this little creature almost miraculously accomplishes. On another occasion, indeed, he observes, that "Some of the animals that have no blood, have a more intelligent soul than some of those that have blood, as the bee and the ant genus."[3] A much later Greek writer has asked the question, "*Who taught the bee, that wise workman, to act the geometer, and to erect her three-storied houses of hexagonal structures?*"[4] And this is the question I shall now endeavour to answer.

1 *Hierozoic.* ii. 599, b.

2 *De anima,* l. iii. c. 11.

3 *De Part. Animal.* l. ii. c. 4.

4 Τις την μελιτταν, την σοφην την εργατιν
Γεωμετρειν εποιησε, και τριωροφως
Οικους εγειρειν εξαγονων κτισματων.
Pisidius, *De Mundi Opificio,* quoted by Bochart.

When we consider the infinite variety of instincts, their nice and striking adaptation to the circumstances, wants, and station of the several animals that are endowed with them, of which numerous instances will be given hereafter, we see such evident marks of design, and such varied attention to so many particulars, such a conformity between the organs and instruments of each animal, and the work it has to do, that we cannot hesitate a moment to ascribe it to some power who planned the machine with a view to accomplish a certain purpose, and when we further consider that all the different animals combine to fulfil *one* great end, and to effect a vast purpose, all the details of which the human intellect cannot embrace, we are led further to acknowledge that the whole was planned and executed by a Being whose essence is unfathomable, and whose power is irresistible.

I must here previously observe, that in considering this mysterious subject, we must avoid, as much as possible, building our theories upon facts which, if properly interpreted, are extraneous to the subject, and wear such an aspect of the marvellous, as to appear out of the regular course of nature, and the ordinary proceedings to which its instinct urges any animal. The cases here alluded to, if true, to the full extent of the statements concerning them, would rather indicate a particular interposition of Divine Providence, either to prevent some calamity, or to produce some blessing or benefit to the individuals concerned. Thus the account of Sir H. Lee's dog, mentioned by Mr French,[1] which saved its master's life, by taking and maintaining its station, which it had never before done, under his bed; and that given by Dr Beattie, of a dog, who, when his master was in a situation of the most imminent peril, after fruitlessly attempting to save him, ran to a neighbouring village, and by significant gestures at last prevailed upon a man to follow him, and saved his master's life. These and many more such cases, can scarcely be regarded as belonging to the ordinary instinct of the species, for if it did, more murderers would be disappointed of their intended victim by the agency of his or her dog. I knew myself an instance, in which a most valuable life was saved by a dog, which, being condemned to the halter by a former master, and escaping from those appointed to dispatch him, at last established himself, after repeated expulsion, in my friend's family, and afterwards, there is every reason to believe, by the sacrifice of his own life, prevented his master from being drowned.[2] These cases are

1 *Zool. Journ.* i. 7. 2 *Annal. des Sc. Naturel.* xxi.

remarkable, but they do not appear to belong to instinct, but rather to the doctrine of a particular Providence.

Some cases upon record, with respect to dogs and other animals, belong to intellect and memory rather than instinct. M. Dureau de la Motte, in a memoir on the influence of domesticity in animals, mentions a dog, which being shut out, would use the knocker of the door;[1] and I had myself a cat, which indicated its wish to come in or go out, by endeavouring with its fore paws to move the handle of the door-latch of the apartment; and used every morning to call me by making the same indication at the door of my bed-room: other cats have attempted to ring the bell. But the most remarkable instance, is one related, by the writer just named, of a very intelligent dog, which was employed to carry letters between two gentlemen, and never failed punctually to execute his commission—first delivering the letter, which was fastened to his collar, and then going to the kitchen to be fed. After this, he went to the parlour window, and barked, to tell the gentleman he was ready to carry back the answer.[2]

The remarkable case of the ass Valiante,[3] and of other animals that find their way to their old quarters from a great distance, may be attributed, I think, rather to natural sagacity and memory, than to any instinctive impulse. The animal just alluded to might have sagacity enough to keep near the sea, or a concurrence of accidental circumstances might befriend her.

Divine Providence has at its disposal the whole animal creation, and can employ all their instincts and their faculties to bring about its own purposes, both with respect to individuals and mankind in general. Man, who may be called, under God, the king of the visible creation, makes a similar use of the creatures that are placed at his disposal; of some, as the horse and the ox, he employs the physical powers; of others, as the bee and the dog, he avails himself of the instinct. Some he instructs how they are to do his work; others, he takes as he finds them. So the Deity, it may be presumed, with a secret hand, guides some to fulfil his will, instructing them, as it were, because their unaided instinct would not alone avail, in the decree they are to execute, while others, merely by following the bent of their nature, do the same. In many cases, also, he may be supposed merely to direct them to the field in which he means they should labour, and then leave them to their instincts

1 *Annal. des Sc. Naturel.* xxi. 52. 2 *Annal. des Sc. Naturel.* 66.
3 *Introd. to Ent.* ii. 496. Note a.

to accomplish his purposes. In the case of the dog who saved his master from intended assassination, a supernatural impulse might carry him to his chamber and cause him to maintain his station there, and when the hour of danger arrived, his natural instinct would suffice for the defence and liberation of his master from the threatened danger.

When we consider the work that animals have to do in this globe of ours, each in a particular department, and to a certain extent, it seems absolutely necessary that, on many occasions, the interference of a Supreme Power should take place, to say to each, "*Hitherto shalt thou come and no further*," and only an Omnipresent Being, infinite in power, wisdom, and goodness, could check the further progress of any body of his workmen when he foresaw it would be noxious, exceed his intentions, and derange his plans.

> "*Nec Deus intersit, nisi dignus vindice nodus*
> *Inciderit*,"

was the dictum of a poet, who had as much judgment, and good sense, as he had genius; and it is only where ordinary means are evidently insufficient to account for any fact, that we are at liberty to ascribe it to the extraordinary interposition of the Deity; or to any *intermediate* supernatural agency employed by him to produce it: and no class of facts so loudly proclaim their Great Author as those which are the result of the nice balancing of conflicting energies and operations observable in the different departments of the animal kingdom.

We may observe, however, that when our Saviour says to his disciples concerning sparrows—*One of them shall not fall to the ground without your Father. But the very hairs of your head are all numbered*;[1] the observation implies that nothing escapes the notice, or is too mean, or insignificant, to be below the attention and care of Him who is all eye, all ear, all intellect; who directeth all things to answer his purposes, *according to the good pleasure of his will*,[2] which is the universal good of his creatures.

Having premised these general observations, I shall now proceed to inquire into the proximate cause of instinct; admitting, as proved, that every kind of instinct has its origin in the will of the Deity, and that the animal exhibiting it, was expressly organized by Him for it at its creation.

1 Matth. x. 29, 30. 2 *Ephes.* i. 5.

The proximate cause of instinct must be either metaphysical or physical, or a compound of both characters.

1. If *metaphysical*, it must either be the *immediate* action of the Deity, or the action of some *intermediate* intelligence employed by him, or the *intellect* of the animal exhibiting it.

2. If *physical*, it must be the action or stimulus of some physical power or agent employed by the Deity, and under his guidance, so as to work His will upon the organization of the animal, which must be so constructed as to respond to that action in a certain way; or by the exhibition of certain phenomena peculiar to the individual genus or species.

3. If *compound* or *mixed*, it will be subject occasionally to variations from the general law, when the intelligent agent sees fit.

1. With respect to the *first* Hypothesis, one of the principal promulgators and patrons of which is Addison,[1] it nearly amounts to this, as that amiable writer confesses, that "God is the soul of brutes." It is contrary, however, to the general plan of Divine Providence, which usually produces effects indirectly, and by the intervention and action of means or secondary causes, to suppose that it acts *immediately* upon insects and other animals, and is so intimately connected with them as to direct their instinctive operations; such an action, it should seem, would be infallible, and never at fault, whereas observation has proved that animals are sometimes mistaken, where their instinct should direct them. For, if God were their *immediate* instructor, would it be possible for the flesh-fly, as I have seen that she does, to mistake the blossom of the carrion-plant,[2] for a piece of flesh, and lay her eggs in it; or for a hen to sit upon a piece of chalk, as they are stated to do,[3] instead of an egg? Still all instincts are from God, He decreed them, and organized animals to act according to that decree, and employed means to impel them to do so.

Other arguments might be adduced proving that this Hypothesis does not rest upon a sound foundation; but as I shall hereafter advert to some of these, I shall now proceed to consider whether instinct be the action of some *intermediate* intelligence, employed by the Deity, upon the animal exhibiting it.

An ingenious and acute writer, Mr French, is the author of this Hypothesis, which appeared in the first number of the Zoological Journal. He infers, "That the Divine Energy does in reality act, not *immediately*, but *mediately*, or through

1 See *Spectator*, ii. p. 121.
2 *Stapelia hirsuta*.
3 Spectator, ii. n. 120.

the medium of moral and intellectual influences, upon the nature or consciousness of the creature, in the production of the various, and in many instances, truly wonderful actions which they perform; that brutes are governed by such agencies, *good* and *evil*, but under the control of Providence; and that such agencies act by impressions upon their conscious nature, but unperceived by it in a moral or intellectual sense."[1] He thus opens the way to his theory. "If it be asked by what intermediate agency the operations of brutes are thus directed;—I reply that it is generally admitted by a large class of mankind, at least, that superior (yet intermediate) powers of some kind, are in actual connection with the human mind."[2]

From the passages here quoted, it seems evident (though the author declares that he will not even "venture a suggestion as to the nature of the superior powers here alluded to,")[3] that he had in his mind those good and evil intelligences that are generally acknowledged to be in actual connection with the human mind; or, to use the common phraseology, *Angels* and *Demons*. The former being the cause of the *beneficent*, and the latter of the *ferocious* instincts of animals.

When he further observes—"Upon these principles the mixed natures of some animals are satisfactorily explained;—as in the instance of the *Phoca ursina*, the males of which species manifest the most singular tenderness towards their young progeny; and, at the same time, a savage and persecuting disposition towards their females."[4]

From this passage it would seem that the author was of opinion that the same animal was subject to the agency both of good and evil intermediate intelligences, the one producing its affection, and the other its ferocity.

When our Saviour denominates *serpents* and *scorpions* the power of the *enemy*,[5] it may perhaps be thought that he affords some countenance to this opinion, especially as the evil spirit actually made use of the serpent, as his organ and instrument, when he accomplished the fatal lapse of our first parents from the original rectitude of their nature. But, if we pay due attention to the context, we shall find that, in this passage, as often in other parts of Scripture, the symbol is put for the thing symbolized. "*I beheld Satan, as lightning, fall from Heaven,*" says our Lord. "*Behold, I give unto you power to tread on serpents and scorpions, and upon all the power of the enemy.—Nevertheless in this rejoice not that the* spirits *are subject to you.*"[6] The

1 *Zool. Journ.* i. 5, 6. 2 *Ibid.* 3 *Ibid.* 6.
4 *Ibid.* 7. 5 *Luke*, x. 19. 6 *Ibid.* 18—20.

treading therefore on serpents and scorpions was treading upon the *spirits* of which they were figures.

If we duly reflect upon the incongruity of an angel and a demon influencing the same animal, in so far as it exhibits instincts partly benevolent and partly ferocious, we shall be convinced that this hypothesis, pursued to all its consequences, cannot stand. Intermediate agents between the Deity and the brute are as much in the place of a soul to the latter, as the Supreme Intelligence would be if his action upon them were immediate, so that the same irrational animal would be alternately a machine impelled by a good or evil intelligence. According to this hypothesis, the bee, that symbol of wisdom, when she sets out upon her beneficent errand of collecting honey and pollen, is acted upon by the *good* angel; but, if she meets with any thing that excites her fear or her anger, she is stimulated to take vengeance upon the object of her displeasure, and to make him feel the puncture of her poisoned dart, by the *evil* one.

This can never be admitted. The same objection too lies against this hypothesis as against the last, that it does not account for the mistakes sometimes made by the animal when endeavouring to accomplish its instinct. It cannot be supposed that, in the case before mentioned, the intelligent intermediate agent would stimulate the flesh-fly to deposit her eggs upon the blossoms of the carrion-plant, where the young must inevitably perish from hunger, instead of upon real flesh.

I am next to consider whether instinct be the result of the intellectual powers of the animal itself that exhibits it. If we survey the different tribes of the animal kingdom, we shall find a vast difference between them with respect to intellect. That wonderful pulp, which of all substances is alone able to respond to incorporeal agency: to receive and store up the information collected by the organs of sensation, that it may be ready for future use, and which is the seat of the intellectual faculties, that wonderful pulp appears under very different circumstances in the different Classes of animals; but it has not been made evident that the acuteness of the intellect, though in some instances it seems to do so,[1] depends altogether upon the comparative volume of the brain; for that of the mouse, compared with its size, is greater than that of the half-reasoning ele-

1 The brain of the elephant is five times the size of that of the rhinoceros, being as 182 to 35. The space for the brain is smaller in the parrot than in any other bird. *Lit. Gaz. May* 28, 1831. *Philos. Trans.* 1822. 42.

phant.[1] Man indeed, generally speaking, has the largest brain of all animals, but it seems a singular anomaly that persons of very weak intellects have often disproportionately large heads, indicating a great volume of brain. When we leave the vertebrated animals, we find the nervous system, in most, materially altered and degraded, so that more power is given apparently to instinct and less to intellect. In other animals, as we descend, the nervous system becomes more and more dispersed, so that in those at the foot of the scale we discern no traces of intellect, and very few of instinct; and only so much apparent sensation as is necessary for the purposes of nutrition and reproduction. I have made the above observations because they bear in some degree on the question now before us. For if we pay due attention to the proceedings of animals, we shall find that those whose nervous system is cerebral usually exhibit the most striking proofs of intellectual action, are most capable of instruction, and are less remarkable for the complexity and intenseness of their instincts; while those of the next grade, whose nervous system is ganglionic, as far as we know them, though not devoid of intellect, are endued with a much smaller portion of it, while their instinctive operations are all but miraculous, and that where the nervous system is still less concentrated both are greatly weakened, till at the bottom of the scale they almost disappear. From hence it seems to follow that extraordinary instinctive powers are not the result of extraordinary intellectual ones.

But when we reflect further, that even in cases where the instincts are most complex and wonderful, the animal practises them *infallibly*, without guide or direction, and is as expert at at them when it first emerges into life, as when it has been long engaged in the practice of them; it follows that it must be instructed in them from the first moment of its existence in the state in which it exercises them, by an infallible teacher. The bee, the moment it emerges from the pupa, begins to collect honey and pollen, and to perform all the other manipulations that belong to her instincts.

In the higher animals the case is somewhat different. When they emerge into life, from the womb, or from the egg, it is usually in a state of helplessness, in which at first they can do little or nothing for themselves but suck, or receive food from, their dam. As their organization developes they gradually gain new powers, till they arrive at their acme, or age of puberty.

1 Cuv. *Anat. Comp.* ii. 148.

The young beaver generally remains with its parents till it is three years old, when they couple, and build a cabin for themselves and offspring. The unfledged bird remains quietly in its nest, and is content to receive its food and warmth from its parents, but no sooner are its feathers grown, and its beaked prow and plumy oars and rudder fit it to win its way, in the ocean of air, than, incited by parental exhortations, it makes the attempt, and henceforth is equal to support itself, and to fulfil the biddings of instinct as well as of intellect and appetite. This *storge* stimulates the parent animal while its care of its young is necessary to them and then ceases. This is therefore chiefly instinctive; but in the most intellectual of all animals, where instinctive love ceases, rational love begins; and care and anxiety for the welfare of our offspring, and affectionate regard for their persons, continues after they cease to have any need of our help and attention.

It is not always easy in this tribe of animals to distinguish those actions that are purely instinctive from those that are not so, and writers on this subject, as was before observed, often ascribe to instinct actions that are produced by other causes. Animals of the higher grades, by means of their organs of sensation, acquire ideas upon which they in some sort reason, by comparing one with another; thus they get experience, and as they grow older literally grow wiser. Hence we see old ones often very cunning and expert in removing obstacles, finding their way, and the like.

With regard to truly instinctive actions, they invariably follow the development of the organization; are neither the result of instruction, nor of observation and experience, but the action of some external agency upon the organization, which is fitted by the Omniscient Creator to respond to its action.

Indeed, if intellect was the sole fountain of those operations usually denominated instinctive, animals, though they sought the same end, would vary more or less in the path they severally took to arrive at it; they would require some instruction and practice before they could be perfect in their operations; the new born bee would not immediately be able to rear a cell, nor know where to go for the materials, till some one of riper experience had directed her. But experience and observation have nothing to do with her proceedings. She feels an indomitable appetite which compels her to take her flight from the hive when the state of the atmosphere is favourable to her purpose. Her organs of sight—which though not gifted with any power of motion, are so situated as to enable her to see whatever passes above, below, and on each side of her—enable her

to avoid any obstacles, and to thread her devious way through the numerous and intertwining branches of shrubs and flowers; some other sense directs her to those which contain the precious articles she is in quest of. But though her senses guide her in her flight, and indicate to her where she may most profitably exercise her talent, they must then yield her to the impulse and direction of her instincts, which this happy and industrious little creature plies with indefatigable diligence and energy, till having completed her lading of nectar and ambrosia, she returns to the common habitation of her people, with whom she unites in labours before described,[1] for the general benefit of the community to which she belongs.

More reasons might be adduced to prove that intellect is not the great principle of instinct, but enough seems to have been said to establish that point. It should be borne in mind, however, that though intellect is not the great principle, yet it must be admitted that all animals gifted with the ordinary organs of sensation, more or less employ their intellect in the whole routine of their instinctive operations, as I shall show under another head.

2. But if no metaphysical power can be satisfactorily demonstrated to be the intermediate cause of instinct, then it seems to follow that it must be either a physical one, or one partly physical and partly metaphysical.

In the former case, it must be the action of some physical power or agent, employed by the Deity, and under his guidance so as to work his will, upon the organization of the animal; which must be so constructed as to respond to that action in a certain way, or by the exhibition of certain phenomena peculiar to the individual genus or species.

Mr Addison has observed—"There is not, in my opinion, any thing more mysterious in nature than this instinct in animals, which thus rises above reason, and falls infinitely short of it. It cannot be accounted for by any properties in matter, and at the same time works after so odd a manner, that one cannot think it the faculty of an intelligent being. For my own part, I look upon it as upon the principle of *Gravitation* in bodies, which is not to be explained by any known qualities inherent in the bodies themselves, nor from any laws of mechanism, but according to the best notions of the greatest philosophers, is an immediate impression from the First Mover, and the Divine Energy acting in the creatures."[2]

1 See above, p. 288, and *Introd. to Ent.* ii. 173.
2 Spectator, ii. n. 120.

I have quoted this passage not as if Addison intended to patronize the hopothesis now before me, but to refer to his illustration of instinct by comparing it with *Gravity*. If Gravity be the result of physical agency, and not an immediate impression of the First Mover, so may Instinct be likewise. Reasoning from analogy it seems inconsistent with the customary method of the Divine proceedings with regard to man, and this visible system of which he is the most important part—for a being that combines in himself matter and spirit, must be more important than a whole world that does not combine spirit with matter—to act *immediately* upon any thing but spirit, except by the intermediate agency of some physical though subtile substance, empowered by him to act as his vicegerent in nature, and to execute the law that has received his sanction.

If we consider the effects produced by the great physical powers of the heavens, by whatever name we distinguish them: that they form the instrument by which God maintains the whole universe in order and beauty; produces the cohesion of bodies; regulates and supports the motions, annual and diurnal, of the earth and other planets; prescribes to some an eccentric orbit, extending, probably, into other systems;[1] causes satellites to attend upon and revolve round their primary planets; and not only this, but by a kind of conservating energy empowers them to prevent any dislocations in the vast machine; and any destructive aberrations arising from the action of these mighty orbs upon each other. If we consider further what God effects both upon and within every individual sphere and system, throughout the whole universe, by the constant action of those viceregal powers, if I may so call them, that rule under him, whatever name we give them; I say, if we duly consider what these powers actually effect, it will require no great stretch of faith to believe that they may be the *inter-agents* by which the Deity acts upon animal organizations and structures to produce all their varied instincts.

An eminent French zoologist[2] has illustrated the change of instincts, resulting from the modification of the nervous system, which takes place in a butterfly, in the transit to its perfect or imago state from the caterpillar, by a novel and striking simile. He compares the animal to a portable or hand organ, in which, on a cylinder that can be made to revolve, several tunes are noted; turn the cylinder and the tune for which it is set is played; draw it out a notch and it gives a second;

1 *La Place*. E. T. ii. 337. 341.

2 Dr Virey.

and so you may go on till the whole number of tunes noted on it have had their turn. This, happily enough, represents the change which appears to take place in the vertebral chord and its ganglions on the metamorphosis of the caterpillar into the butterfly, and the sequence of new instincts which result from the change. But if we extend the comparison, we may illustrate by it the two spheres of organized beings that we find on our globe, and their several instinctive changes and operations. We may suppose each kingdom of nature to be represented by a separate cylinder, having noted upon it as many tunes as there are species differing in their respective instincts—for plants may be regarded, in some sense, as having their instincts as well as animals—and that the constant impulse of an invisible agent causes each cylinder to play in a certain order all the tunes noted upon it: this will represent, not unaptly, what takes place, with regard to the devolopment of instincts, in the vegetable and animal kingdoms; and our simile will terminate in the inquiry, whose may be that invisible hand that thus shakes the sistrum of Isis,[1] and produces that universal harmony of action, resulting from that due intermixture of concords and discords, according to the will of its Almighty Author, in that infinitely diversified and ever moving sphere of beings which we call *nature*.[2]

What, if the powers lately mentioned, and which, in the Introduction to the present work, I hope I have made it appear, are synonymous with the physical Cherubim of the Holy Scriptures, or the heavens in action which under God govern the universe; what, if these powers—employed as they are by the Deity so universally to effect his Almighty will in the upholding of the worlds in their stated motions, and preventing their aberrations,—should also be the intermediate agents, which by their action on plants and animals produce every physical development and instinctive operation, unless where God himself decrees a departure that circumstances may render necessary from any law that he has established?

With regard to the *vegetable* kingdom, consisting of organized beings without sense or voluntary motion, few would deny that they are subject to the dominion of the elements, and respond to the action of those mysterious powers that rule, under God, in nature. But when the query is concerning the *animal* kingdom, most of the members of which to organization and life add a will and powers of voluntary motion, and many have a degree of intelligence residing within them which governs

1 The Sistrum of Isis symbolized the elements. 2 Φυσις παναιολη.

many of their actions, we hesitate as to the answer we shall return to it.

It will furnish a presumptive proof that those actions which are instinctive in animals are the results of the action of those intermediate powers to which I have just alluded, if it can be shown, that there is any thing in plants at all analogous to the instincts of animals, for if there be, one can scarcely suppose that they are produced by a different cause. Let us, therefore, now leaving the animal kingdom,—which to us perhaps appears the sole theatre in which instincts manifest themselves—and turning our attention to the vegetable, inquire whether any thing analogous to these springs of action is discoverable there.

One remarkable distinction, between the animal and the vegetable is in the difference of the principles that form their pabulum. The former does not become the nutriment of the latter till it is chemically decomposed; whereas the latter becomes the food of the former, either in its green, or ripe state, and is not decomposed and turned to nutriment till it is passed into its stomach, and is subject to various actions of various organs, or their products, so that, though the food of both is decomposed in order to be assimilated, yet with regard to the vegetable this happens before it enters it, but to the animal after it enters it, the decomposing powers being without the plant and within the animal. In the former case it is the action of the atmosphere unassisted by the organization of the plant—in the latter it is the same action assisted by the organization of the animal.

Another thing may be here observed—that as the most remarkable instincts of animals are those connected with the propagation of the species, so the analogue of these instincts in plants is the development of these parts peculiarly connected with the production of the seed—so that the expanded flower and the operations going on in it is the analogue of the reproductive instinct of the animal: this is all produced by physical action upon the organization of the plant. Now if we consider the infinite variety of plants, and the wonderful diversity of their parts of fructification, and that these are all produced in their several seasons and stations by the action of some physical powers upon their varied organization, and by means of the soil in which they are planted, we shall think it nearly as wonderful and accountable as the instinctive operations of the various creatures that feed upon them. That the same action should unfold such an infinite variety of forms in one case and instincts in the other is equally astounding and equally difficult to explain.—Compare the sunflower and the hive-bee, the

compound flowers of the one, and the aggregate of combs of the other—the receptacle with its seeds, and the combs with the grubs.

Again, as all plants have their appropriate fructification, so they have other peculiarities connected with their situation, nutriment, and mode of life, corresponding in some measure with these instincts that belong to other parts of an animal's economy. Some with a climbing or voluble stem, constantly turn one way, and some as constantly turn another. Thus the hop twines from the left to the right, while the bindweed goes from right to left;[1] others close their leaves in the night, and seem to go to sleep; others show a remarkable degree of irritability when touched; the blossoms of many, as the sunflower, follow the sun from his rising to his setting; some blossoms shut up, as in the anemone, till the sun shines upon them; others close at a certain hour of the day, as the goatsbeard;[2] another, *Hedysarum gyrans*, slowly revolves. The same physical action upon a peculiar organization produces all these effects.

We may further observe that the great majority of plants send forth radicles which presenting their points to the sources of vegetable life and nutrition on all sides, absorb each its portion, and convey it to the stem from which they issue; analogous, in this respect, to the polypes, which unfold and expand their tentacles for a similar purpose. Ivy planted against a wall or trunk of a tree supports itself by innumerable radicles, but I once saw a plant reared as a standard which sent forth none. This seems analogous to some animal instincts, which, depending upon circumstances, may be called *conditional;* as when, in the case of a sterile queen, the bees do not, as usual, massacre the drones.[3]

There is another parallelism between the plant and the animal, especially the insect, which appears to prove that their instincts are ruled by the same physical agent, I mean their *hybernation.* In extratropical countries, or a great proportion of them, as the year declines, and the amount of heat, received from its great fountain, is diminished by the shortening of the days, the deciduous trees and shrubs cast their leaves, plants of every description cease more or less their growth, and all vegetable nature seems to become torpid. At the same period, and under the influence of the same cause, the decrease of the amount of caloric, several of the higher animals, all the reptiles,

1 See Willd. Princip. of Botany, § 18. n. 51. *a. b.* Plate ii. *f.* 32, 25.
2 *Tragopogon.* 3 *Introd. to Ent.* ii. Lett. xx.

as well as nearly the whole world of insects, retire from the exercise of their wonted instincts, and conceal themselves, some under the earth, and others under bark, under stones, in crevices, moss, and similar hiding places, where they take their winter's sleep, till a more genial temperature whispers to them —*Awake*—and they return to their several employments. This effect in both the plant and the animal, seems to spring from the same *physical* cause—the periodical lowering of the temperature; so that heat appears to be the *plectrum*, and the organization of the animal, the strings it touches, which cause it to exhibit the prescribed sequence of its instincts. Whoever has been in the habit of attending to the motions of *insects* will find them most alert in sultry weather, especially in an electric state of the atmosphere before a thunder storm. Heat and electricity also accelerate the growth of *plants*, if duly supplied with moisture.

It is remarkable, and worthy of particular observation, verifying the old adage that extremes meet, that an approach towards the *maximum* of heat produces sometimes the same effects upon organized nature that an approach towards the *minimum* does. In tropical countries they do not divide the year into winter and summer, but into the rainy and dry seasons; as to temperature, the former would, perhaps, be judged to correspond with our winter, and the latter with our summer, but with respect to the state of animals and vegetables, the reverse would appear to be most consistent with facts. The great rains, according to M. Lacordaire,[1] "begin to fall in Brazil about the middle of September, when all nature seems to awake from its periodical repose; vegetation resumes a more lively tint, and the greater part of plants renew their leaves; the insects begin to reappear: in October the rains are rather more frequent, and with them the insects; but it is not till towards the middle of November, when the rainy season is definitively set in, that all the families appear suddenly to develope themselves; and this general impulse that all nature seems to receive continues augmenting till the middle of January, when it attains its acme. The forests present then an aspect of movement and life of which our woods in Europe can give no idea. During part of the day we hear a vast and uninterrupted hum, in which the deafening cry of the tree-hopper[2] prevails; and you cannot take a step, or touch a leaf, without putting insects to flight. At 11 A. M. the heat is become

1 *Annal. des Sc. Natur.* xx. Juin. 1830. 193.

2 *Tettigonia. Cicada*, &c.

insupportable, and all animated nature becomes torpid—the noise diminishes—the insects, and other animals disappear—and are seen no more till the evening. Then, when the atmosphere is again cool, to the matin species succeed others whose office it is to embellish the nights of the torrid zone. I am speaking of the glow-worms[1] and fire-flies;[2] whilst the former, issuing by myriads from their retreats, overspread the plants and shrubs; the latter crossing each other in all directions, weave in the air, as it were, a luminous web, the light of which they diminish or augment at pleasure. This brilliant illumination only ceases when the night gives place to the day.

As during our winters, some part of the insect population occasionally appear and dance in the sunbeam, so in Brazil, according to M. Lacordaire, during the months of May, June, July, and August, the season of great drought, when all nature is embrowned, and consequently affording no proper food for perfect insects; the caterpillars of *Lepidoptera* are those mostly to be met with, while in the rainy season those only that live in society occur.

The great object of the Creator appears to be the employment of the various tribes of animals, to do the work for which he created them at its proper season; and where the object is particularly to keep within due limits the growth of plants, or to remove dead or putrescent substances before they generate *miasmata*, we may conjecture, that when their services are not wanted, they would be allowed a season of repose, so that during winter with us, when there is little or no vegetation of the plant, and a hot sun does not cause putrescent substances to exhale unwholesome effluvia, the great body of labourers in these departments, we may say, are sent to bed for a time, till their labours are again necessary. So also in tropical countries, where drought and heat united are sufficient to do the work of nature's pruners and scavengers, by stopping vegetation, and immediately drying up animal and other substances, before putridity takes place, they then abstract themselves, and retreat to their winter quarters; but when the rainy season revives the face of nature, they return, each to exercise his appointed function, at the bidding of his Creator.

All these circumstances indicate an analogy between certain phenomena observable in the history of *plants*, and some of the instincts of *animals*: and tend to prove that the proximate cause of both may be very nearly related; and that as the immediate cause of the vegetable instinct is clearly *physical*, so may be

1 *Lampyris. Pygolampis.* K. 2 *Elater noctilucus*, &c.

that of the animal. With regard to all actions, in the latter, which are the result of *intellect*, they, of course, are produced by some principle residing within, as when the senses guide it, or it exercises its memory; and these aid it in following the impulse of instinct. The greatest of modern chemists has observed, with respect to some such agent, "that the immediate connection between the sentient principle and the body may be established by kinds of etherial matter, which can never be evident to the senses, and which may bear the same relation to heat, light, and electricity, that these refined forms or modes of existence bear to the gases."[1] I may observe upon this passage, that the farther any matter is removed from our knowledge and coercion, the more powerful it really is. Thus liquids are more powerful than solids, gases than liquids, imponderable fluids than gases, and so we may keep ascending till we approach the confines of *spirit*, which will lead us to the foot of the throne of the Deity himself, the Spirit of spirits, the only Almighty, the only All-wise, and the only All-good.

Dr Henry More, a very eminent philosopher and divine of the seventeenth century, under the name of the *Spirit of Nature*, speaks of a power between matter and spirit, which he describes as—"A substance incorporeal, but without sense and animadversion, pervading the whole matter of the universe, and exercising a plastical power therein, according to the sundry predispositions and occasions in the parts it works upon, raising such phenomena in the world, by directing the parts of matter and their motion, as cannot be resolved into mere mechanical powers—which goes through and assists all corporeal beings, and is the vicarious power of God upon the universal matter of the world. This suggests to the *spider* the fancy of spinning and weaving her web; and to the *bee* of the framing of her honey-comb; and especially to the *silk-worm* of conglomerating her both funeral and natal clue; and to the *birds* of building their nests, and of their so diligent hatching their eggs."[2]

This Spirit of Nature of Dr More seems not very different from the Etherial Matter of Sir H. Davy; and it is singular, that Dr Paris, in his interesting life of our great chemist—speaking of a monument to be erected to his memory at Penzance—should thus express himself. "It was to be erected on one of those elevated spots of silence and solitude where he delighted, in his boyish days, to commune with the elements,

1 *Consolations in Travel*, 214.

2 *On the Immortality of the Soul*, B. iii. c. 12, 13.

and where the *Spirit of Nature* moulded his genius in one of her wildest moods."[1]

But—to return from this digression to Sir H. Davy's etherial matter bearing the same relation to heat, light, and electricity, that they do to the gases—I would ask, if such may be the powers by which the soul moves the body, and produces those actions that are in our own power to do or not to do, depending upon the will, does it seem incongruous that light, heat, and air, or any modification of them, upon which every animal depends for life and breath, and nutrition and growth, and all things, should be employed by the Deity to excite and direct them, where their intellect cannot, in their instinctive operations? That their organization, as to their instruments of manducation, motion, manipulation, &c. has a reference to their instincts every one owns; can we not, therefore, conceive that the organization of the brain and nervous system may be so varied and formed by the Creator, as to respond, in the way that he wills, to pulses upon them from the physical powers of nature; so as to excite animals to certain operations for which they were evidently constructed, in a way analogous to the excitement of appetite? The new-born babe has no other teacher to tell it that its mother's breast will supply it with its proper nutriment; it cries for it; it spontaneously applies its mouth to it; and presses it under the bidding of appetite resulting from its organization. When it arrives at the age of dentition, it as naturally uses its teeth for mastication; it wants no instructor to inform it how they are to be employed to effect that purpose; and so with respect to other appetites which the further development of its organs produces.

It may, perhaps, be urged, in the case lately alluded to, of the infant growing up to puberty, that the instinctive operations that take place under the bidding of appetite fall under the general law of instinct; but it must be admitted that the gradual development of the organization is the consequence of the action of physical powers in the processes going on in the body. Or, as a learned writer on the subject asks,—"In effect is instinct any thing else, but the manifestation without of that same wisdom which directs, in the interior of our body, all our vital functions."[2]

Having rendered it probable that those instincts, which result evidently from what are called *bodily* appetites, are the consequences merely of physical action upon an organization

1 *Life of Sir H. Davy*, 4to. edit. 517.
2 Dr Virey, *N. D. D'Hist. Nat.* xvi. 293.

adapted to respond to it, I shall next inquire whether this may not be the case in instances which are not to be regarded in that light.

We may divide instincts into *three* general heads:—

α. Those relating to the multiplication of the species, especially the care of animals for their young both before and after birth.

β. Those relating to their food.

γ. Those relating to their Hybernation.

α. The pairing of animals usually begins to take place in the spring, when the winter is passed, the earth is covered with verdure and adorned by the various flowers that now expand their blossoms, in proportion as the great centre of light and heat more and more manifests his power over the earth; the birds sing their love-songs; the nightingale is now—"Most musical, most melancholy;"—the cuckoo repeats his monotonous note; and every other animal seems to partake of the universal joy. All this appears the result of a *physical* rather than a *metaphysical* excitement.

As to their care of their future progeny, a great variety of circumstances take place. Viviparous animals have generally to give suck to their young for a time; oviparous ones either to construct a nest to receive their eggs, and, after hatching, to provide them with appropriate food during a certain period, or to deposit their eggs where their young progeny, as soon as hatched, may infallibly find it. But first, I must say something of that *Storge*, or instinctive affection, which is almost universally exhibited by females for their progeny both before and after parturition; a feeling of affection not generally common to the males, or rather only in a few instances, as where the male bird assists the female in incubation. Yet this instinctive fondness, as soon as it ceases to be necessary, vanishes; except, as was before observed,[1] in the human species; a fact that seems to prove that it is not the result of the association of ideas, but of an impress of the Creator interwoven with the frame. But that this impress is by means of a physical interagent, seems to follow from this circumstance—that the *hen* shows the same instinctive attachment to the young *ducklings* that have been hatched under her, that she would do to chickens, the produce of her own eggs; and if the new-born offspring of any mammiferous animal is abstracted from her, and another substituted, even of a *different* kind, the same affectionate ten-

1 See above, p. 315.

derness is manifested towards it, as its own real offspring would have experienced. Now was it a metaphysical, and not a physical, impulse, surely this would not be the case. This is only one of many instances, which prove that instinct is not infallible: and, in truth, with regard to the higher animals, many associations may take place between the child and parent that help to endear the former to the latter. In the first place, the very circumstance of its being the fruit of her own bowels, and fed with milk from her own breast must bind it to her by the tenderest of ties; especially as, at the same time, it relieves her from what is troublesome. There is something also in infant helplessness, and infant gambols, calculated to win upon the doting mother. The subsequent alienation and estrangement of the female from her young, which takes place in all animals except man, appears, in the first instance, to be produced by their becoming troublesome and annoying to her; which, in some degree, may account for her desire to cast them off. Examining the subject, therefore, on all sides, in the highest grades of animals, and those in whom maternal affection appears most intense, intellect and associations may be a good deal mixed with instinct in producing it. As we descend in the scale, the intensity of the feeling seems much reduced; and, in numerous tribes, is confined solely to the circumstances of parturition. So that the *Storge*, and its cessation, do not appear altogether so extraordinary and unaccountable as a cursory view might tend to persuade us.

The *Mammalians*, in general, appear to have recourse to very few striking preparatory actions previously to bringing forth their young, since they have usually no nest to prepare for their reception. Cats, however, it may be observed, search about very inquisitively for a snug and concealed station; and burrowing animals naturally retire to the bottom of their burrows, when their feelings tell them their hour is come, and there are relieved of their precious burthen. Several others of the *Rodentia*, or gnawers, as the dormouse, make beds of their own hair to receive their young. In most cases that fall under our daily observation, the young are dropped where the mother happens to be when the pains of labour overtake her. The animals we are speaking of have at hand immediately a plentiful supply of food for the nutriment of their new-born offspring; they have not, like the birds, to search for provision for them, but, from their own bodies, furnish them with a delicious fluid suited to their state, which forms their support till they are able to crop and digest the herbage, when they are left to shift for themselves. Some are born more independent of maternal

care than others; thus domestic animals, as the calf, the lamb, and the young colt, can move about almost as soon as they are born, and can immediately use their organs of sight; whereas the progeny of beasts of prey usually come into the world blind, and some time elapses before they can run about, so that the dam, if she wishes to remove them, must carry them herself, which she generally does, in her mouth.

As the proper food of herbivorous quadrupeds is almost every where abundant, they are soon tempted, without the intervention of the mother, to browse upon the herbage: but the predaceous beast whose food must be pursued and captured, takes more pains to instruct her young how to maintain themselves; thus the cat lays the mouse or bird, that she has caught, before her kittens; and it is laughable to observe how they are excited, and with what resolution and ferocity the little furies endeavour to keep possession of the prey their dam has brought to them.

But of all classes of animals the *birds* are the most remarkable for the labours they undergo preparatory to laying their eggs. In those that migrate a long aerial voyage is previously to be undertaken, the stimulus to which, in the swallow, appears to be altogether physical,[1] and is probably so in other migrators. But what is it that directs them in their flight, and enables them to return to the countries from which they had migrated? Did the swallow[2] steer her course within sight of land, it might, perhaps, be supposed that her *memory* was her director: but these birds are often found at sea, hundreds of miles from any shore,[3] where, one would think, there could be no index either in the clouds or the ocean to instruct her which way to steer her adventurous course. The only atmospheric phenomenon affecting her would be the change of temperature as she went northward. But we can only conjecture in this case—observation, as well as Scripture, tells us, indeed, *The stork in the heaven knoweth her appointed times; and the turtle, and the crane, and the swallow observe the time of their coming*,[4] but God, who decrees the end, appoints the means, which often remain amongst his *Secret Things*. Yet, though the immediate agent that guides the swallow over the expanse of water, from the torrid to the temperate zone is latent, we may still inquire, when she has made the shores of Britain, what is it that urges her to seek her old vicinity, and to build

1 See above, p. 55. See Jenner, *Philos. Trans.* 1824. 20.
2 *Hirundo rustica.*
3 *Philos. Trans.* ubi supr. 13.
4 *Jerem.* viii. 7.

her nest in the very spot where she herself first drew breath, as Dr Jenner's experiments prove that swallows do?[1] Here may we not conjecture that her intellect and memory become her guides? She recognizes the spot in which she committed herself to the sea breeze; and there, probably, again flies inland, and will have no great difficulty in pursuing the line of country which leads to her native village, and to the very roof under the eaves of which she was born.

But of all the instincts of the feathered part of the creation, there is none more remarkable, more varied, and more worthy of admiration than that which directs them in the situation and structure of their nests.—One nidificates upon the ground;[2] another under ground, or in the sand;[3] some select the chimney or eaves of houses for their clay-built structures;[4] those gelatinous nests, which the Chinese epicures and orators so highly prize, are formed in caverns and dark places by the little bird[5] whose work they are. The great majority, however, nidificate in trees and bushes, and where they are within reach their nests are carefully concealed.

The structure and materials of nests are also infinitely various, and may be considered to result, as well as all the proceedings of animals with regard to their young, from an excitement analogous to that which Dr Jenner first noticed in the swallow;[6] upon which he observes—"The economy of the animal seems to be regulated by some *external* impulse which leads to a train of consequences,"[7] and which does not cease its action till it has accomplished the end for which it was given; namely, the procreation; oviposition preceded by nidification; incubation; hatching, or birth; nutrition and education of the young progeny of each individual kind, according to the general law of the Creator.

We know very little of the proceedings of the remaining Classes of Vertebrates—which are distinguished by having cold blood—the *Reptiles*, namely, and the *Fishes;* except that they do not feel that instinctive love for their young, after birth, exhibited by the quadrupeds and birds. They, however, are invariably instructed by the Creator to select a proper place in which to deposit their eggs where they can be hatched either by artificial or solar heat. Those of some *Ophidians*, as snakes, are buried in sand, and not seldom even in heaps of ferment-

1 *Philos. Trans.* ubi supr. 16.
2 *Motacilla Troglodytes.*
3 *Hirundo riparia.*
4 *H. rustica et urbica.*
5 *H esculenta.*
6 *Philos. Trans.* 1824. 20.
7 *Ibid.* 25.

ing manure; while those of venomous ones are hatched in the womb of the dam, and come forth in the serpentine form. The *Saurians* also select a proper place for their eggs, and then desert them; the crocodile buries hers in the sands near the river; where many, however, are devoured by the ichneumon, and its other enemies, and are even relished by man. In the *Batrachian* Order one species of *salamander*[1] commits a single egg to a leaf of the *Persicaria*, which it protects by carefully doubling the leaf, and then, proceeding to another, repeats the same manœuvre, till her oviposition is finished:[2] the *toads* and *frogs* lay their eggs in the water, the former producing two long strings resembling necklaces, formed, as it were, of beads of jet, inclosed in crystal; while those of the latter consist of irregular masses of similar beads. This gelatinous or transparent envelope forms the first nutriment of the embryo. The nuptial song of the Reptiles is not, like that of birds, the delight of every heart, but is rather calculated to disturb and horrify than to still the soul. The hiss of serpents; the croaking of frogs and toads; the moaning of turtles; the bellowing of crocodiles and alligators,[3] form their gamut of discords.

With regard to the Class of *Fishes*, the general object of those that migrate appears to be the casting of their spawn; this it is that causes the different species of the *salmon* genus to leave the sea for the rivers; for this the *herring* travels southward, and the *mackarel* seeks the north; all of them guided by the law of the Most High, showing itself by an indomitable instinct, to seek those stations for oviposition that are best suited to the aëration, hatching, and rearing of their spawn;—but as no very striking traits are upon record with regard to the oviposition of fishes, I shall merely refer the reader, with respect to the instinct of the migrators, to a former part of the present work, where that subject is discussed more at large.[4]

Under this head I shall only further notice the numerous tribes of the *insect* world, which have all their seasons, varying according to their several destinies, for fulfilling the great law of nature, and to which the organization of each species is adapted: and when the period for laying their eggs is arrived each is directed to place them where their young, when disclosed, may find their appropriate nutriment. From the instance of the flesh-fly, above related,[5] we learn that it is their *scent* that

1 *Salamandra platycauda*.
2 *Edinb. Phil. Journ.* ix. 110.
3 See above, p. 17.
4 *Ibid.* p. 57.
5 *Ibid.* p. 311.

directs insects to a proper station for their eggs. When we recollect that every plant, almost, is the destined food of some peculiar insect, we may conjecture that the sense of smelling must, in them, be far more nice than in the higher animals, so as to enable them to distinguish from all others the appropriate nutriment of their own descendants. Where the parent, as is sometimes the case, feeds upon the same plant with the children, she requires no such guide, but with respect to the majority of insects, especially the infinite host of *Lepidoptera*,—which, after they arrive at their perfect state, never touch what forms their nutriment while they are larves,—some such guide is absolutely necessary.

*β*. Another Class of Instincts relates to the different modes by which animals procure their *food*. Nothing affords a more striking proof of Creative Wisdom, and of the most wonderful adaptation of means to an end, than the diversities of structure with a view to this particular function. If we consider the infinite variety of substances, animal and vegetable, produced from the earth, which form the nutriment of its inhabitants—some solid and not easily penetrable; others soft and readily severed and comminuted; others again fluid, or semi-fluid;—we may conceive what a vast diversity of organs is necessary to effect this purpose. To render solid food, of any kind, fit for deglutition and digestion, the same mouth must be furnished with several kinds of teeth, some for incision, others for laceration, others again for grinding and mastication—while those that only absorb liquids merely require an organ adapted for suction, though often, at the same time, fitted to pierce the substance from which the nutritive fluid is to be derived. How various, also, must be the organs for swallowing, and digesting the food according to its nature; others for elaborating it, and abstracting from it all those substances that are required by the several systems at work in the body, and conveying them to their proper stations; and the means also for rejecting from the body the residuum after the secernment for the above purposes of the finer life-supporting products. Here are a variety of organs, admirable in their structure, and fitted for action in an infinity of ways; some at the bidding of the will stimulated by the appetite; others independent of the will, such are the distillations, percolations, chemical and electrical processes, constantly going on in the body of every animal, to separate all the products that its nature and functions require, all speak of a *mechanical* agency at work within, not independent in its

operation, but fulfilling a law which must be obeyed.[1] It has been found that *Galvanic action* will supply the place of the *will* upon the nerves and muscles, for by it the eyes can be opened, and other muscular movements be produced in a dead body.[2] Sir H. Davy was of opinion that the air inspired carries with it into the blood a subtile or ethereal part probably producing animal heat, since those animals that possess the highest temperature consume the greatest quantity of air, and those that consume the smallest quantity, are cold blooded.[3]

The herbivorous *Mammalians* are generally not remarkable for any *artificial* means of procuring their food. Providence has spread a table before them, and invites them to partake of it, without any other trouble, than bending their necks to eat it; but the carnivorous ones,—as their destined pabulum is endued with locomotive powers, which enable it often to escape from them, and disappoint their expectations,—must have recourse to stratagems, and lie in wait for their prey; these, however, consist chiefly in concealing themselves and springing suddenly upon it. The fox, of all quadrupeds, is the most celebrated for his stratagems and finesse in entrapping his game, and his patience is equal to his craft. Some have doubted whether this animal can *fascinate* poultry, as has been often asserted, but I know one instance which fully confirms it. A friend of mine one night hearing a noise, upon looking out in its direction, saw a fox under the hen-roost, peering up at the hens, which both he and his wife, who told me the story, saw, as they did also the fox running away, in spite of their shouting, with one in his mouth. Indeed, on any other principle we cannot account for his depopulating the hen-roosts in the night.

The *birds* are less noted, than even the quadrupeds, for their stratagems, or any remarkable means of providing food for themselves or their young. Those of prey boldly attack and seize their destined food wherever they find it; the owls, indeed, like the cats, their analogues, seem to use artifice as much as strength to attract the mice. The carrion-feeders, as the vultures and crows, soon discover the carcasses of dead animals.[4] Some of the sea-birds, especially the gulls, indicate the approach of bad weather, by leaving the coast, and seeking the interior; and, during the intense frosts of a severe winter, the web-footed

1 See Dr Roget's excellent statements on these subjects, *B. T.* ii. chap. iii.—ix.

2 See Dr Wilson Philip in *Philos. Trans.* 1829. 271, 278.

3 *Consolations in Travel*, 196, 197.

4 Roget, *B. T.* ii. 407.

birds and waders, quitting their summer stations in the more northern regions, fly to the south and seek the unfrozen springs and waters of the inland districts, where they find a supply of food. All these physical actions seem to arise from a physical cause, and easily to be accounted for, without having recourse to any other.

With regard to the cold-blooded animals, the fishes and reptiles, we know but little of their habits in this respect, or of any particular stratagems to which they have recourse to procure their food. Some of the predaceous fishes, as the pike and perch, appear to lie in wait in deep water, and so dart upon their prey; others, as the shark, with open mouth pursue and devour them; the fly-catching ones, as the several species of the carp and salmon genus,[1] are equally upon the watch, but nearer the surface, to seize a may-fly[2] or ephemera; the fishing-frog[3] hangs out its lines in the sea to catch other fishes; the serpents are said to fascinate the birds; the enormous boa lies in wait for the antelopes and other quadrupeds, and coiling itself round them in mighty folds, crushes them to render them more fit for deglutition; the Batrachians, Chelonians, and numerous Saurians are on the alert after insects and small game; while the vast and ferocious crocodiles and alligators, looking like trunks of trees, lie basking near the surface of the water, ready to spring upon any large fish, or even man, that may chance to come within reach.

Of all animals, *insects* afford the most numerous instances of instinctive proceedings with this sole end in view; the pitfalls of the ant-lion;[4] the webs and nets of the various sorts of spiders spread over the face of nature; and many more, furnish instances of stratagems to secure their daily food; while an infinity of others acquire it, aided only by their senses and natural weapons. Let any one look at the prominent eyes, tremendous jaws, and legs and wings formed for rapid motion on the earth or in the air of the tiger-beetles,[5] and he will readily see that they want no other aid to enable them to seize their less gifted prey: and numerous other tribes both on the earth and in the water emulate them in these respects. The *pacific* or herbivorous insects also are mostly fitted with an extraordinary acuteness of certain senses to direct them to their appropriate pabulum. The sight of the butterfly and moth invariably leads them to the flowers, to suck whose nectar their mul-

1 *Cyprinus* and *Salmo*.
2 *Phryganea*.
3 *Lophius*.
4 *Myrmeleon*.
5 *Cicindela*.

tivalve tubes are given them. The scent of the dung-beetles and the carrion-flies allures them to their respective useful, though disgusting, repasts. A very numerous tribe of those that derive their nutriment from other animals, neither entrap them by stratagem, nor assail them by violence; but, as the butterfly and the moth deposit their eggs upon their appropriate *vegetable*, so do these upon their appropriate *animal* food. Every bird almost that darts through the air, every beast that walks the earth, every fish that swims in its waters, and almost all the lower animals, and even man himself, the lord of all, are infested in this way.

Upon the food of the *Crustaceans*, *Molluscans*, and all the lower grades of animals, I have before sufficiently enlarged; I need not, therefore, here resume the subject.

Thus we see the Almighty and All-wise manifests his *goodness*, as well as his wisdom and power, in providing for the wants of all the creatures that he has made; fitting each with peculiar organs adapted to its assigned kind of food, both for procuring it, preparing it, digesting it, assimilating it, and for rejecting the residuum of all these operations. A physical action upon each of these organs and systems, fitted by him to receive and respond to it, is all that the case seems to require in the majority of instances: in those, however, that depend upon artifice and stratagem for their food, the exciting cause is less obvious. These, indeed, belong to the higher instincts considered under the *first* head.

γ. That class of Instincts which relates to the *hybernation* of animals having been considered in another place,[1] I shall only observe here, that the action of a physical cause is in no department of the history of animals more evidently made out.

My learned friend and coadjutor, Mr Spence, has, in the *Introduction to Entomology*, produced several facts, as not easily reconcilable to the hypothesis with respect to the cause of Instinct which I am now considering; and probably a great many more might be brought forward; but my object here is merely to consider the general principle; it would, indeed, be needless and endless to discuss particular cases, and fully to account for all aberrations, which, in the present state of our knowledge, it would not be possible to do.

But there is one circumstance of a less confined nature, and upon which a good deal of the question hinges, to which it will be proper to advert. I mean the change that has been observed in the nervous system of some insects in their pass-

1 See above, p. 320.

age from one state to another. It is contended that this change has nothing to do with any alterations that then take place in their instincts, but only with those in their organs of sense or motion.[1] In confirmation of this opinion it is further affirmed, that in three whole Orders,[2] the structure of the nervous chord is not altered, and yet they acquire new instincts.

But though no change has been *noticed* to take place in the number of ganglions of these orders, there must necessarily be a development in those that render nerves to the wings and reproductive organs ; so that, though some ganglions may not become confluent, as in the *Lepidoptera*, yet the range of their nerves is increased. In this respect, they are in much the same situation with the higher animals, though their nervous system, as to its organization, undergoes no material change, yet from the period of their birth, it is gradually more and more developed till they arrive at the age of puberty, when new appetites are experienced and new powers acquired, not by *metaphysical*, but by *physical*, action upon their several systems. In the three orders referred to by Mr Spence, there is not that difference between the different states of the insects that compose the majority of them, that there is between those whose pupes are not locomotive. The larves of the locust, for instance, are stated to emigrate, as well as the perfect insect, and live upon the same food; the only difference is in the locomotive and reproductive powers of the latter, both of which, as I have just said, must be connected with some change in their nervous system, operated gradually by a physical agent.

From what has been stated, with respect to these several classes of instincts, it appears, that, as far as can be judged from circumstances, they have their beginning in consequence of the action of an intermediate physical cause upon the organization of the animal, which certainly renders it extremely probable that such is the general proximate cause of the phenomena in question. I would, however, by no means, be understood to assert this dogmatically, but merely that it appears to me the most probable hypothesis, and most consistent with the analogy of the divine proceedings in this globe of ours, as well as with his general government of the heavenly bodies ; and though I have mentioned heat, electricity, and other elements as concerned in the production of these phenomena, yet I do not assert that other physical principles may not be commissioned to have a share in it. This field is open both to the

1 *Introd. to Ent.* iv. 27, 28.

2 Viz. *Orthoptera*, *Hemiptera*, and *Neuroptera*.

speculatist and experimenter; they may each assist the other in traversing and exploring it, and the well known adage, *Dies diem docet*, be verified more and more by their united efforts.

Some may still feel disposed to ask,—Is it within the sphere of probability, or even possibility, that by the mere action of physical powers, however subtile, upon the brain and nerves of an animal there should be produced such a wonderful sequence of actions and manipulations as we know to be exhibited by the *beaver*, the *bee*, the *spider*, and the *ant?* Actions confessedly above the range of their intellect. But to this I would answer, we know that with God all things are possible that do not imply a contradiction; and His Wisdom, Power, and Goodness, may be as evidently, and more evidently, manifested, by the infinite varieties in the organization necessary to excite the appetite for such and such instinctive employments and operations; and to stimulate animals always to run the same prescribed routine of action from day to day, and year to year; than if he did it by his *own* immediate action upon them, or that of his *ministering*, or *other*, *spirits*.

When we examine a time-piece contrived by a skilful artist, containing within it various wheels and other movements, all acted upon by one main spring or pendulum; by means of which, influencing all, seconds, minutes, and hours are indicated as they pass; and the latter are struck successively, and repeated if required: we admire the work, but more the art and hand that contrived and executed it; but our admiration would be much diminished, if, instead of these effects being produced by the action of a main spring or pendulum upon its organization, if I may so call it, it was necessary that the maker of the machine, or one of his operatives, should always be present to move the hands or strike the hours. So it seems most to magnify the Power and Wisdom of the Creator, if we suppose him to act by physical means in all cases above the intellect of the animal. If he governs the physical universe by such means, is it much to suppose, that by the same he moves a bird, or a bee, to glorify him by their admirable instincts? Where action is indeed from the Deity *upon spirit*, as upon the soul of man, in a certain sense, it is *by spirit;* either immediately as by the Holy spirit; or mediately as by an angelic nature; but *below* spirit, it is surely most consonant to every thing that we see and know, that it should be by an agent below spirit.

3. I am now arrived at the last supposition or hypothesis—

that the cause instinct may be *compound* or *mixed*—in some respects physical, in others metaphysical. In this case it will be subject occasionally to variations from the general law when the intelligent agent sees fit.

But upon this head I shall not be very long, and I only introduce it here, to show that the Deity sometimes dispenses with the general law of instinct, or permits it occasionally to be interfered with by the will of the animal, or other agency. All animals that exercise instinctive operations, have in their several organs of sensation, certain guides given to enable them to fulfil those instincts so as to bring about the purposes of Providence.

Sight, hearing, scent, taste, touch, perception, influence the will, and direct each animal to the points in which its instinctive actions are to commence; and so far instinct is, as it were, *mixed* with intellect. I have seen it somewhere observed—that instinct in conjunction with a principle of limitation,—*the intellectual faculties*,—rules the actions of all *sentient and organized* beings; just as gravity with the principle of counteraction—*repulsion*—determines the place and composition of all *inorganic* bodies.

With regard to the Deity, he retains in his hands the power of suspending or altering the action of the laws that have received his sanction; and permits other metaphysical essences to do the same. When females overcome that *storge* or instinctive love for their offspring, either from the dread of shame, or worse motives, and destroy them, in common parlance, we say that they were tempted by an *evil spirit* to commit the crime. Mr Bennet, in his interesting *Wanderings in New South Wales, &c.*, relates that it is common for the females of the oboriginal tribes, if they experience much suffering in their labour, to threaten the life of the poor infant, which when born they barbarously destroy.[1] This is a fearful counteraction of instinct flowing from an *evil* source.

The Deity himself, doubtless when there is—*Dignus vindice nodus*—sometimes suspends the action of an instinct. It is related in the Holy Scripture, that when the ark of God was taken by the Philistines, in order to ascertain whether the plagues that were sent upon them were from God, they yoked two milch kine that had calves to the cart in which it was sent to Bethshemesh, and the kine went straight to that place, their instinct being mastered by a strong hand, though they went lowing after their calves all the way.[2] Here the Deity ruled

1 I. 122.

2 1 *Sam.* vi. 7. 12.

the instinct. God interferes with the instincts of animals also when he prescribes their course and sends them in any particular direction to answer his purpose: as in the case of the prophet Jonah.[1] Properly speaking, those interpositions of the Deity by which the law of instinct is suspended, to answer a particular purpose of his Providence, like that just related, must be regarded as miraculous; but yet, though unrecorded, they may happen oftener than we are aware in the course of his *moral* government; sometimes perhaps also to remedy some *physical* evil. This appeared therefore a proper place to advert to them.

1 See above, p. 142.

## CHAPTER XIX.

*Functions and Instincts. Arachnidan, Pseudarachnidan, and Acaridan Condylopes.*

Having wandered long enough, perhaps too long, in a wide and mazy field, but fertile everywhere in proofs of the Power, Wisdom, and Goodness of the Creator, it is time to return to the high road from which we diverged.

The Class of animals which led me into this digression were the Myriapods, concerning which I observed, when I commenced my account of them, that on quitting the Crustaceans, the way seemed to branch off from the long-tailed Decapods by them, and from the short-tailed ones by the Arachnidans. We are now then to give a history of the latter Class.

Latreille, in which he has been followed by most modern Arachnologists, in his work in aid of Cuvier's last edition of the *Règne Animal*,[1] divides his Arachnidans into two Orders, *Pulmonaries*, or those that breathe by *gills*, and *Trachearies*, or those that breathe by *spiracles* in connection with *tracheæ*. In his latest work,[2] which he did not live to finish, he added a third Order, including some parasites, infesting marine animals, such as the whale louse.[3] These, from their having no apparent respiratory apparatus, he named, *Aporobranchians*.

As the pulmonary *Arachnidans* of Latreille differ from the Trachearies, &c., not only in having their body divided into two sections, but likewise both in their respiratory organs and those of circulation, I have always regarded them as forming a distinct Class.[4]

The following characters distinguish this Class:

Body covered by a coriaceous or horny integument, divided into two segments. *Head* and *trunk* confluent so as to form a single segment, denominated the *Cephalothorax*. *Eyes*, 6—8.

1 *Les Crustacés, les Arachnides, et les Insectes.*
2 *Cours D'Entomologie.*
3 *Nymphon grossipes.*
4 *Introd. to Ent.* iii. 19. 24.

*Legs*, 8. *Spinal chord*, knotty. A *heart* and *vessels* for circulation. *Respiration* by *gills*. *Sexual organs*, double.

This Class consists of two Orders.

1. *Araneidans*. *Integument* coriaceous. *Mandibles*, also called *cheliceres*, consisting of a single joint, armed with a claw, perforated near the apex for the transmission of venom, and when unemployed folding upon the end of the mandible. *Gills*, 2—4. *Abdomen* united to the trunk by a foot-stalk. *Anus* furnished with 4—6 spinning organs.
2. *Pedipalps*.[1] *Integument* horny. *Feelers* extended before the head, armed with a forceps or didactyle claw. *Abdomen* sessile. *Gills*, 4—8.

1. *Araneidans*, or spiders.

No animals fall more universally under observation than the *spiders;* we see them everywhere, fabricating their snares or lying in wait for their prey, in our houses, in the fields, on the trees, shrubs, flowers, grass, and in the earth; and, if we watch their proceedings, we may sometimes see them, without the aid of wings, ascend into the air, where, carried by their web as by an air-balloon, they can elevate themselves to a great height. The webs they spin and weave are also equally dispersed; they often fill the air, so as to be troublesome to us, and cover the earth. M. Mendo Trigozo[2] relates, that at Lisbon, on the 6th of November 1811, the Tagus was covered, for more than half an hour, by these webs, and that innumerable spiders accompanied them which swam on the surface of the water. I have in another place[3] given an account of the instruments by which they weave them; and shall now say a few words upon those by which their Creator has enabled them to produce the material of which they are formed.

At the posterior extremity of the abdomen, formed usually by a prominence, is the anus, immediately below which, planted in a roundish depressed space, are four or six jointed teat-like organs, of a rather conical or cylindrical shape. The exterior pair is the longest, consisting of three joints; but these have no orifices at their extremity for the transmission of threads: the other four[4] consist each of two joints, and are pierced at their extremity with innumerable little orifices, in some species amounting to a thousand from each, from which their web

1 *Manipalps* would be a more proper term, as the feelers are used for prehension, not for walking.

2 Latr. *Cours. D'Ent.* i. 497.

3 See above, p. 286.

4 *Mammulæ, Introd. to Ent.* iii. 391.

issues at their will, or bristled with an army of infinitely minute biarticulate spinnerets,[1] each furnishing a thread at their extremity. These teats are connected with internal reservoirs, which yield the fluid matter forming the thread or web. These reservoirs in some species consist of *four*, in others of *six* vessels folded several times, and communicating with other vessels in which the material that forms their web is first elaborated.[2]

Such are the organs which furnish the material of those wonderful and diversified toils which the spiders weave to entrap the animals that form their food.

The threads, after they issue from these organs, are united, or kept separate, according to the will or wants of the animal; and it is stated, that from them certain spiders can spin *three* kinds of silk.[3] Their ordinary thread is so fine, that it would require twenty-four united to equal the thickness of that of the silkworm. These threads, fine as they are, will bear, without breaking, a weight sextuple that of the spider that spins them. They employ their web, generally, for three different purposes; in the construction of their snares, of their own habitations, and of a cocoon to contain their eggs.

Spiders were divided by the older Arachnologists, after Lister, into families according to the mode in which they entrap or seize their prey. More modern writers[4] on the subject, have taken their respiratory organs as regulating the primary division of the Order: upon this principle, the spiders are formed into two tribes, those that have two pairs of gills;[5] and those that have only one pair.[6] M. Walckenaer, who has studied the Order more than any man in Europe, has not only divided the above two tribes into genera, &c., from characters taken from their form and organization; but has also considered them with respect to their habits, and under this head, divides them into four sections:

1. *Hunters*, wandering incessantly to entrap their prey.
2. *Vagrants*, watching their prey, concealed or inclosed in a nest, but often running with agility.
3. *Sedentaries*, forming a web in which they remain immovable.
4. *Swimmers*, swimming in the water to catch their prey, and there forming a web.

1 *Fusi*, *Introd. to Ent.* iii. 392. 2 Latr. *Cours D'Ent.* i. 496.
3 Blackwall, in *Linn. Trans.* xvi. 479. 4 L. Du Four. Latreille.
5 *Tetrapneumones*. Latr. *Theraphosa*, &c. Walck.
6 *Dipneumones*. Latr. *Aranea*. Walck. excluding *Dysdera*.

To the first tribe, those, namely, with *four* gills, some spiders belong, the instincts of which are very remarkable. One of the largest, and most celebrated, is the bird-spider.[1] It forms the tube which it inhabits of a white silk like muslin, which it fixes amongst leaves, and in any cavities, and there watches its prey; it is accused by some of destroying even birds, whence its name, especially the humming-bird:[2] but this rests upon questionable authority; and writers are not agreed as to its general habits. Probably several species are confounded under the same name. I shall not therefore enlarge further on its history; I mention it merely as the largest spider known.

The proceedings of those called the *trap-door* spiders[3] are better authenticated, as those of the mason-spider by the Abbé Sauvages,[4] and those of another species very recently, in the annals of the French Entomological Society, by M. V. Audoin, one of the most eminent of modern entomologists, under the name of the *pioneer*;[5] of his interesting memoir, I shall here give a brief abstract.

Some species of spiders, M. Audoin remarks, are gifted with a particular talent for building: they hollow out dens; they bore galleries; they elevate vaults; they build, as it were, subterranean bridges: they construct also entrances to their habitations, and adapt doors to them, which want nothing but bolts, for without any exaggeration, they work upon a hinge, and are fitted to a frame.[6]

The interior of these habitations, he continues, is not less remarkable for the extreme neatness which reigns there; whatever be the humidity of the soil in which they are constructed, water never penetrates them; the walls are nicely covered with a tapestry of silk, having usually the lustre of satin, and almost always of a dazzling whiteness. He mentions only four species of the genus as at present known. One which was found in the Island of Naxos;[7] another in Jamaica;[8] a third in Montpellier;[9] and a fourth, that which is the subject of his Memoir, in Corsica; to which I may add a fifth species, found frequently by Mr Bennet, in different parts of New South Wales.[10]

The habitations of the species in question are found in an

1 *Mygale avicularia.* 2 *Trochilus.* 3 *Cteniza.*
4 *Ct. Sauvagesii.* 5 *Ct. fodiens.*
6 The French word is *féyure*, which I cannot find in the dictionaries, but it means, the circular frame of the mouth of the tube which receives the door.
7 *Cteniza ariana.* 8 *Ct. nidulans.* 9 *Ct. cœmentaria.*
10 *Wanderings in N. S. Wales, &c.* i. 328.

argillaceous kind of red earth, in which they bore tubes about three inches in depth, and ten lines in width. The walls of these tubes are not left just as they are bored, but they are covered with a kind of mortar, sufficiently solid to be easily separated from the mass that surrounds it. If the tube is divided longitudinally, besides this rough cast, it appears to be covered with a coat of fine mortar, which is as smooth and regular as if a trowel had been passed over it; this coat is very thin, and soft to the touch ; but before this adroit workman lays it, she covers the coarser earthy plaster-work with some coarse web, upon which she glues her silken tapestry.

All this shows that she was directed in her work by a Wise Master ; but the door that closes her apartment is still more remarkable in its structure. If her well was always left open, she would be subject to the intrusion of guests that would not, at all times, be welcome or safe; Providence, therefore, has instructed her to fabricate a very secure trap-door, which closes the mouth of it. To judge of this door by its outward appearance, we should think it was formed of a mass of earth coarsely worked, and covered internally by a solid web; which would appear sufficiently wonderful for an animal that seems to have no special organ for constructing it: but if it is divided vertically, it will be found a much more complicated fabric than its outward aspect indicates, for it is formed of more than thirty alternate layers of earth and web, emboxed, as it were, in each other, like a set of weights for small scales.

If these layers of web are examined, it will be seen that they all terminate in the hinge, so that the greater the volume of the door, the more powerful is the hinge. The frame in which the tube terminates above, and to which the door is adapted, is thick, and its thickness arises from the number of layers of which it consists, and which seem to correspond with those of the door; hence, the formation of the door, the hinge, and the frame, seem to be a simultaneous operation; except that in fabricating the first, the animal has to knead the earth, as well as to spin the layers of web. By this admirable arrangement, these parts always correspond with each other, and the strength of the hinge, and the thickness of the frame, will always be proportioned to the weight of the door.

The more carefully we study the arrangement of these parts, the more perfect does the work appear. If we examine the circular margin of the door, we shall find that it slopes inwards, so that it is not a transverse section of a cylinder, but of a cone, and on the other side, that the frame slopes outwards, so that the door exactly applies to it. By this structure, when the door

is closed, the tube is not distinguishable from the rest of the soil, and this appears to be the reason that the door is formed with earth. Besides, by this structure also, the animal can more readily open and shut the door; by its conical shape it is much lighter than it would have been if cylindrical, and so more easily opened, and by its external inequalities, and mixture of web, the spider can more easily lay hold of it with its claws. Whether she enters her tube, or goes out, the door will shut of itself. This was proved by experiment, for though resistance, more or less, was experienced when it was opened, when left to itself, it always fell down, and closed the aperture. The advantage of this structure to the spider is evident, for whether it darts out upon its prey, or retreats from an enemy, it is not delayed by having to shut its door.

The interior surface of this cover to its tube is not rough and uneven like its exterior, but perfectly smooth and even, like the walls of the tube, being covered with a coating of white silk, but much more firm, and resembling parchment, and remarkable for a series of minute orifices,[1] placed in the side opposed to the hinge, and arranged in a semicircle; there are about thirty of these orifices, the object of which, M. Audoin conjectures, is to enable the animal to hold her door down, in any case of emergency, against external force, by the insertion of her claws into some of them.

The principal instruments by which this little animal performs her various operations, are her mandibles or cheliceres, and her spinners. The former, besides the two rows of tubercles, between which, when unemployed, her claw, or sting, is folded, has at the apex, on their inner side a number of strong spines.[2] As no one has ever seen her at work upon her habitation, it cannot be known exactly how these organs, and probably her anterior legs, are employed in her various manipulations.

I have, in my collection, a tube or nest of the Jamaica trap-door spider,[3] consisting merely of the web, which is much larger than that just described, being more than six inches long, and three quarters of an inch in diameter in the narrowest part, but near the mouth more than an inch. In this species the trap-door is semicircular, having a sloping margin; it is lined, as well as the upper part of the tube, with a strong close

1 Plate XI. b. Fig. 2. *a*.

2 *Observations sur le nid d'une Araignée lu à l'Acad. des Sc. le* 21 *Juin* 1830, *par M. Victor Audoin*: and *Ann. de la Soc. Ent. de France*. ii. 69.

3 Plate XI. b. Fig. 4.

web, resembling parchment. I can detect in it no series of orifices, but I see here and there little holes where the claws appear to have been inserted. This door is entirely formed of layers of web, without any intermixture of earth.

Mr Bennett, in his *Wanderings, &c.*[1] gives some interesting particulars of the species discovered by him in New South Wales. He describes the tube, as about an inch in diameter at the mouth, and the lid as formed of web incorporated with earth, and exactly fitting the mouth of the tube, in this resembling the *pioneer*. He heard of a person who used to amuse himself with feeding one of these insects: when its meal was finished, it would re-enter its habitation, and pull down the lid with one of its claws. He further observes, that to discover their habitations when the lid is down, from its being so accurately fitted to the aperture, was very difficult.

Though the particulars I have here stated, of the history and habits of these subterranean spiders, demonstrate, in every respect, as far as we know them, the adaptation of means to an end, far above the intelligence of the animal that exhibits them; yet fully to appreciate the Wisdom, and Power, and Goodness, that fabricated her, and instigated her to exercise these various arts, and to employ her power of spinning webs, in building the structures necessary for her security, as well as for the capture of her prey, we ought to be witnesses to all her proceedings, which would probably instruct us more fully why she forms so deep a tube, and one so nicely covered with a peculiar tapestry from the mouth to the bottom. One of these ends, is, doubtless, to keep her tube dry.

2. Various are the modes of capturing their prey, exercised by the *second* Tribe of spiders, which have only *two* gills, some fabricating webs of various kinds for that purpose, and others lying in wait for them, and catching them by mere agility. The first of these are called *weavers*,[2] and the last, *hunters*[3].

Some of the former construct silken tubes of an irregular texture, open at both ends, in which they conceal themselves. Of this description is one, remarkable for having only six eyes,[4] which sits at the mouth of her tube, with her four anterior legs out of it, reposing by their extremity upon as many fine threads, which diverge from the mouth of the tube as from a centre, and probably contribute to form the toils, or are connected with them, which De Geer observed her to construct in front of her den[5] and in which large flies are taken, which, by

1 i. 328. 2 *Aranéidæ textoriæ.* 3 *A. venatoriæ.*
4 *Segestria senoculata.* 5 vii. 261.

means of her stout mandibles, she soon kills, and then sucks their juices.[1]

Another species,[2] which spins a similar web with diverging threads, forming so many snares, is remarkable for the pertinacity with which it clings to its tube. The most effectual way to expel it, is to put in a live ant: scarcely has it entered, when the spider, in a violent agitation, uses its utmost efforts to frighten the intruder; if the ant disregards its menaces, it rushes out precipitately, and does not stop till it is two or three inches distant, when it halts to watch the motions of the ant, which, usually, when disengaged from the web, falls to the ground; upon this taking place, the former re-enters its tube backwards. This species, though driven from its habitation by so small an insect, will fearlessly attack the largest flies, and it has been seen even to seize a very active wasp.[3]

The webs of the *retiary* or geometric spiders, which belong to another division of the weavers, are so well known that it is not necessary to give a very detailed account of their proceedings; but as Mr. Blackwall, in a very interesting Memoir in the *Zoological Journal*,[4] has added much to our previous knowledge on this head, especially with respect to the spiral circumvolutions that distinguish the webs of the tribe in question, I shall abstract, as briefly as I can, the main features of his account. Having formed the foundation of her net, and drawn the skeleton of it, by spinning a number of rays converging to the centre, she next proceeds, setting out from that point, to spin a spiral line of unadhesive web, like that of the rays, which it intersects, and to which she attaches it, and after numerous circumvolutions, finishes it at the circumference. This line, in conjunction with the rays, serves as a scaffolding for her to walk over, and it also keeps the rays properly stretched. Her next labour is to spin a spiral or labyrinthiform line from the circumference towards the centre, but which stops somewhat short of it; this line is the most important part of the snare. It consists of a fine thread, studded with minute viscid globules, like dew, which by their adhesive quality retain the insects that fly into the net. The snare being thus finished, the little geometrician selects some concealed spot in its vicinity, where she constructs a cell, in which she may hide herself, and watch for game; of the capture of which, she is informed by the vibrations of a line of communication between her cell and the centre of her snare.

1 Walck. *Araneïd. de France.* 195.
2 *Segestria perfida.*
3 Walck. *Araneïd. de France.* 202.
4 v. 181.

The insects that frequent the waters require predaceous animals to keep them within due limits, as well as those that inhabit the earth, and the water-spider[1] is one of the most remarkable upon whom that office is devolved by her Creator. To this end her instinct instructs her to fabricate a kind of *diving-bell* in the bosom of that element. She usually selects still waters for this purpose. Her house is an oval cocoon, filled with air, and lined with silk, from which threads issue in every direction, and are fastened to the surrounding plants; in this cocoon, which is open below, she watches for her prey, and even appears to pass the winter, when she closes the opening. It is most commonly, yet not always, entirely under water; but its inhabitant has filled it with air for her respiration, which enables her to live in it. She conveys the air to it in the following manner: she usually swims upon her back, when her abdomen is enveloped in a bubble of air, and appears like a globe of quicksilver; with this she enters her cocoon, and displacing an equal mass of water, again ascends for a second lading, till she has sufficiently filled her house with it, so as to expel all the water. The males construct similar habitations, by the same manœuvres. How these little animals can envelope their abdomen with an air-bubble, and retain it till they enter their cells, is still one of Nature's mysteries that have not been explained. We cannot help, however, admiring and adoring the Wisdom, Power, and Goodness manifested in this singular provision, enabling an animal that breathes the atmospheric air, to fill her house with it under the water; and which has instructed her in a secret art, by which she can clothe part of her body with air, as with a garment, which she can put off when it answers her purpose. This is a kind of attraction and repulsion that mocks all our inquiries.

Amongst the spiders called the *hunters*, and the *vagrants*, some seize their prey like the lion or the tiger, with the aid of few or no toils, by jumping upon them, when they come within their reach. I have often observed a white or yellowish species of crab-spider[2]—a tribe so called because their motions resemble those of crabs—which lies in wait for her prey in the blossoms of umbelliferous and other white-blossomed plants, and can scarcely be distinguished from them, which when a fly or other insect alights upon the flower, darts upon it before she is perceived.

There is a very common black and white spider,[3] amongst

1 *Argyroneta aquatica.* 2 Related probably to *Thomisus citreus.*
3 *Salticus scenicus.*

the *vagrants*, which may always be seen in summer, on sunny rails, window-sills, &c.: when one of these spiders, which are always upon the watch, spies a fly or a gnat at a distance, he approaches softly, step by step, and seems to measure the interval that separates him from it with his eye; and, if he judges that he is within reach, first fixing a thread to the spot on which he is stationed, by means of his fore-feet, which are much longer and larger than the others, he darts upon his victim with such rapidity, and so true an aim, that he seldom misses it. Whether his station is vertical or horizontal is of little consequence, he can leap equally well from either, and in all directions. He is prevented from falling, by the thread just mentioned, which acts as a kind of anchor, and enables him to recover his station, when without such a help he would be, as it were, driven out to sea.

We see in these latter instances, that though the art and means of weaving snares to entrap their prey have not been granted to these hunters and vagrants, yet that their Creator has endowed them with increase of agility, and the power of moving, without turning round, in all directions, which fully make up to them for that want.

Before I conclude this history of spiders, I must mention a very remarkable one, described and figured by Freycinet, under the name of *Aranea notacantha*,[1] but which appears to belong to no known genus of the Order. It is stated to have at its posterior extremity a long cylindrical tube, terminated by two eyes!! But this, surely, must be a mistake. At the anterior part of the thorax are four eyes, in a square, and one on each side. The form of the abdomen and its tube are very remarkable. This spider was found in a small island near Port Jackson, in an irregular web attached to the shrubs.

2. The *Pedipalps*, forming the *second* Order of Arachnidans, will not detain us long. The principal animals belonging to it, are the *scorpions*, which are not only remarkable for the powerful organs by which they are enabled to seize their prey, but also for their jointed tail terminating in a deadly sting. Their aspect alone, when they are moving with their open forceps advanced before their head, and their tail turned over it, is enough to create no little alarm in the beholder; and if he were told that one genus of the tribe goes by the name of *man-killer*,[2] and should read in Aristotle, that though some were

1 Plate XI. Fig. 2. 2 *Androctonus*.

harmless, the sting of others was fatal both to man and beast,[1] the degree of his alarm would not be diminished. But though the venom of these creatures, when provoked and put upon self-defence, may sometimes prove fatal to man and the higher animals, yet this is not the main purpose for which their Creator has given them such means of annoyance. Their food consists of various beetles and other insects, arachnidans, and wood-lice; many of which they could not easily master and devour, after they have seized them with their forceps, without the aid of their tail and its sting;[2] this they can turn over their head, and moving it in any direction, immediately kill their prey, however strong and active, by the fatal venom it instils.

Our Saviour alludes to the scorpion as one of the symbols of the evil spirit: and as a zodiacal sign with the Egyptians, it represented Typhon, which seems to prove that our Saviour's application of it was in conformity with a current opinion.

The other Pedipalps,[3] though one of them has a jointed tail like the scorpions,[4] are not armed with a sting. Probably the animals that they feed upon offer less resistance than the prey of the latter.

With regard to the Arachnidans in general, the object of their creation appears to have been to assist in keeping within due bounds the insect population of the globe. The members of this great and interesting Class are so given to multiply beyond all bounds, that were it not for the various animals that are directed by the law of their Creator to make them their food, the whole Creation, at least the organized members of it, would suffer great injury, if not total destruction, from the myriad forms that would invest the face of universal nature with a living veil of animal and plant devourers. To prevent this sad catastrophe, it was given in charge to the spiders, to set traps everywhere, and to weave their pensile toils, from branch to branch, and from tree to tree, and even to dive under the waters. And, more particularly, to them we are mainly indebted for our deliverance from a plague of *flies* of every description, which, if the spiders were removed, of which they form the principal food, would subject us to incredible annoyance.[5]

The scorpions, and other Pedipalps, are found only in warm climates, where they are often very numerous, and, like the centipedes, creep into beds.[5] Insects multiply, beyond con-

1 *Hist. Animal.* l. viii. c. 39. Comp. *N. D. D'Hist. Nat.* xxx. 431.
2 See above, p. 312.
3 *Phrynus, &c.*
4 *Thelyphonus.*
5 See above, p. 225.

ception, in such climates, and unless Providence had reinforced his army of insectivorous animals, it would have been impossible to exist in tropical regions. The animals we are speaking of, not only destroy all kinds of beetles, grass-hoppers, and other insects, but also their larves, and even eggs.

### *Pseudarachnidan Condylopes.*

This Class, which is formed from the *Tracheary Arachnidans* of Latreille, differs from the preceding principally in the organs of *Respiration* and *Circulation.*

Body coriaceous, or crustaceous. *Spiracles* connecting with *tracheæ* for respiration. *Circulation* obscure. *Eyes* 2—4. *Legs* 6—8. *Sexual ogans* single.

The Class consists of two Orders, perfectly analogous to those of the Arachnidans, which may be denominated, *Pseudo-scorpions* and *Phalangidans.*

1. *Pseudo-scorpions.* Body oblong, divided into several segments. *Eyes* 2—4. *Legs* 6—8.

2. *Phalangidans.* Body consisting of one segment, with the analogue of the abdomen consisting of folds. *Eyes* 2. *Legs* 8, elongated.

1. I have already given an account of the most interesting genus of this Order, the *Solpuga*, on a former occasion ;[1] and there is little known of the history of the *book-crabs,*[2] except that they are often found in books ; I have also occasionally met with them in the drawers of my insect cabinets, moving slowly on, with their arms expanded, probably they were in search of the mite that is so injurious to specimens of insects; they are also often found upon flies. One genus,[3] in this tribe, has *four* eyes, all the rest of the Class have only *two.*

2. The most remarkable genus[4] of the second Order of Pseudarachnidans is one described in the *Linnean Transactions,*[5] in which the posterior legs exhibit a raptorious character, and seem fitted either to seize or retain their prey. The common Phalangidans, or harvest-men, have been treated of in another place.[6]

The animals of this class seem to be universally insectivorous, though fabricating no snares.

1 See above, p. 234.
2 *Chelifer.*
3 *Obisium.*
4 *Gonyleptes.* K.
5 xii. 450. *t.* xxii. *f.* 16.
6 See above, p. 237.

## *Acaridan Condylopes.*

We are now arrived at a Class of Condylopes, that, with respect to their *food*, have a much more extensive commission than those which we have lately considered, the Arachnidans, and Pseudarachnidans. Under the name of *mites* they are universally known, and when some of our most essential articles of food, as cheese and flour, get old, or in any degree musty, they soon swarm with these minute animals, which, wherever they are established, multiply beyond conception; mites also attack not only decaying substances, but also living ones; in man they are the cause of a most revolting distemper;[1] under the name of ticks they attack dogs and other animals, and few insects altogether escape from their annoyance; and they not only infest the inhabitants of the earth and air, but are also found swimming in every pool; so that their field of action seems to be the whole creation of organized beings.

The class may be thus characterized:

Body without any insection or impression marking out its parts, consisting of a single segment, and without folds. *Mouth* and organs various. *Eyes* 2. *Legs* 6—8, short.

Latreille has divided this Class, including in it the preceding one, into *seven* Families; but perhaps it would be better to consider it as divided into *two* Orders, *mites*,[2] and *ticks*,[3] or those that do not *suck* their food, and those that are fitted with an organ adapted to suction.

I shall select an instance or two from animals of this Class, which show the care of the Creator, for these little beings apparently so low in the scale of Creation; His foresight of every circumstance in which they would be placed; and His adaptation of their structure to their assigned station.

This is particularly conspicuous in the case of a species of bat-mite,[4] which was first noticed by one of our most celebrated microscopical observers, Mr Baker, and has since fallen under the notice of M. V. Audoin, well known for his acute investigation of the external parts of Insects, who kindly sent me a memoir of his on this and other Acaridans, extracted from the *Annales des Sciences Naturelles* for the year 1832. If we consider the animal that this mite inhabits, the bat, and that it affords much less shelter than the birds, to any parasite that may be attached to it, especially as the species that I am

1 See *The Lancet*, i. 1834–5. 59.
2 *Acari*.
3 *Ricini*.
4 *Pteroptes*.

speaking of is stated usually to fix itself to the membrane of the wings, which being a naked membrane, would seem to expose it to be easily shaken off when the animal is flying: we easily comprehend that it stands in need of some particular provision to counteract this circumstance.

Like those of many other mites, its feet are furnished with a vesicle which is capable of contraction and dilatation, and which the animal can probably use as a sucker to fix itself; but if by any sudden jerk it is unfixed, to prevent its falling, it is gifted with the power of turning upwards, in an instant, two, four, six, or even all its legs, according to circumstances, sufficiently to support itself, and can walk in this position, as it were upon its back, as well as it does in the ordinary way with that part upwards; it may be often seen with four turned upwards while it walks upon the other four,[1] so that it is ready, upon any accident, instantaneously to use them, and to lay hold of the wing.

The bat is infested by another parasite, placed by Dr Leach at the end of the *Acaridans*, and by Latreille, but not without hesitation, after the *Diptera*. I may therefore be justified in introducing the animal in question here, since, inhabiting the same subject, their proceedings will serve to illustrate each other, and to demonstrate the agency and design of the Supreme Cause in the concurring structure of these parasites. The one I here allude to may be called the *bat-louse*.[2] Latreille, who has described very minutely a species of this genus,[3] informs us that their head is implanted in a singular situation, the back of the thorax, between the middle and the anterior extremity,[4] immediately behind the part to which the anterior legs are attached. The middle of the back, in the common species, presents a cavity, which terminates posteriorly in a kind of pouch,[5] so that the head can be thrown back and its extremity received by it. From this situation, it is evident that the animal cannot take its nutriment from the bat in the ordinary position, with the back upwards; it must, therefore, necessarily stand with it downwards when engaged in suction. When under the forming hand of the Almighty Creator, its legs were planted, it was not on the *lower* side of the trunk, as they usually are in other hexapods, but on the *upper* side or margin of that part.[6] Colonel Montague observes,—"So strange and

1 Baker *on Micr.* ii. 407. *t.* xv. *f.* E. F. G.
2 *Nycteribia*, Lat.
3 *N. Blainvillii.*
4 See Montague. *Linn. Trans.* xi. *t.* iii. *f.* 5
5 *N. Verpertilionis.*
6 *N. D. D'Hist. Nat.* xxxiii. 131, 132.

contradictory to experience is the formation of this Insect, that were it not for the structure of the legs, no one could doubt that the upper was actually the under part of the body.[1] From the account given by the last acute and indefatigable naturalist, the motions of this little creature are so rapid as to be almost like flight, and it can fix itself in an instant wherever it pleases. Putting some into a phial, their agility was inconceivable; not being able, like other Dipterous insects, to walk upon the glass, their efforts were confined to laying hold of each other, and during the struggle they appeared flying in circles."[2]

Their head is furnished with antennæ and feelers, immediately below the insertion of the former, on each side, is a slightly prominent eye, so that they have sight to guide them in their motions, which the *bat-mite* appears to be without.

I may conclude this account with the pious reflection of the worthy author lately mentioned. The very singular structure of this insect, which, at first, appears to be a strange deformity in nature, and excites our astonishment, will, like all other creatures, constructed by the same Omnipotent hand, be found to be most admirably contrived for all the purposes of its creation; and the scrutinizing naturlist will soon discover this unusual conformation to be the character which at once stamps its habits and economy.[3]

One of the most singular animals of this Class is one called the *vegetating* mite.[4] These are fixed for a time, by an anal thread, to certain beetles, by means of which, as by an umbilical chord, they derive their nutriment from them. After a certain time, they disengage themselves, and seek their food in the common way of their tribe.

It is difficult to say where Latreille's Order of *Aporobranchians*[5] should properly be placed. Savigny considers them as leading from the Crustaceans to the Arachnidans by *Phalangium.* If they are parasitic upon marine animals, as there is reason to believe, might they not, in some sort, be regarded as one of those branches, which, without going by the regular road, form a link between tribes apparently distant from each other?[6] They seem, in some respects at least, to present an analogy, if not an affinity, to the Hexapod parasites, the bird-louse,[7] &c. I offer this merely as a conjecture.

1 *Linn. Tr.* xi. 12. 2 *Ibid.* 13. 3 *Ibid.*
4 *Uropoda vegetans.* 5 *Nymphon. Pycnogonum*, &c.
6 See above, p. 198. 7 *Nirmus.*

## CHAPTER XX.

### *Functions and Instincts. Insect Condylopes.*

The animals of the class we are next to consider, have been regarded by many modern zoologists, especially of the French school, as inferior both to Crustaceans and Arachnidans, on account of their having only, as it were, a rudimental heart, exhibiting indeed a kind of systole and diastole, but unaccompanied by any system of vessels by which the blood might circulate in them. A learned and acute writer, and eminent zoologist, amongst our own countrymen, has with great force controverted the justice of this sentence of degradation pronounced upon Insects; an opinion which has also been embraced by many other modern writers on the subject, and considerable doubt has been shown to rest upon the main foundations upon which the illustrious and lamented Baron Cuvier, who was the father of the hypothesis, had built it.[1]

But the important discoveries of Dr Carus, who first proved that a *circulation* really exists in various larves of Insects, and afterwards that it is also discoverable in several perfect ones,[2] have placed the matter beyond all doubt. Taking, therefore, into consideration the *nervous* system of Insects, as well as those of circulation and respiration, as ought, in all reason, to be done —for upon comparison of these three systems so intimately connected with life and sensation, surely the first place is due to that by which alone the animal is conscious of its existence and that of the world it inhabits, and is enabled to run the race appointed by its Creator; surely if even no Carus had appeared to demonstrate the existence of a circulation in these animals, still the perfection of their nervous system, compared with that of the Molluscans, in determining their respective stations, would be a sufficient counterpoise to a heart and vascular system for circulation; and if to this superiority we add

1 Mac Leay, *Hor. Entomolog.* 204, 297.

2 *Introd. to Comp. Anat. E. T. by Gore*, ii. 392. *Act. Acad. Cæs Nat. Cur.* xv. ii.

the number and nature of the several organs by which this system acts, and the fruits of such agency in the activity and various instincts of the animals endowed with it, embodying the moving will, the informing sense, the impelling appetite, compared with the inertness and sluggish motions, and apathetic existence, and paucity of instinctive actions in the great majority of the Molluscans,—who is there that will hesitate to conclude that he who created the *Insect* world, gifted them with so many and such wonderful instincts, inspired them with such incessant activity, fitted them with such various organs for such a diversity of locomotions under the earth, on the earth, in the air and in the water, meant to place them far above the headless *Oyster*, with scarcely any organs of sensation, and scarcely any motion but that of opening and shutting its shell, or even than the *Cuttle-fish*, though furnished with eyes, and even three hearts, and a very extraordinary animal, yet destitute of many organs of the senses and of locomotion found in Insects, and most of those that they have not formed upon the plan of the higher animals, but rather borrowed from the confessedly lower Classes of Polypes and Radiaries ?[1]

With regard to the *Crustaceans* and *Arachnidans*, setting aside the superiority of *Insects* in their instincts, the single circumstance of the *reproduction* of mutilated organs in the former seems to prove an inferiority of rank and a tendency towards the Polype.[2]

When we consider attentively these little beings, the infinite variety of their forms, the multiplicity and diversity of their organs, whether of sense or motion, of offence or defence, for mastication or suction; or those constructed with a view to their several instincts, and the exercise of those functions devolved upon them by the wisdom of their Creator; the different kinds also of sculpture which is the distinction of one tribe, and of painting, which ornaments another, the brilliant colours, the metallic lustre, the shining gold and silver with which a liberal and powerful hand has invested or bespangled numbers of them; the down, the hair, the wool, the scales, with which He, who careth for the smallest and seemingly most insignificant works of his hand, hath clothed and covered them; when all these things strike upon our senses, and become the subject of our thoughts and reflection, we find a scene passing before us far exceeding any, or all of those, that we have hitherto contemplated in our progress from the lowest towards the highest members of the animal kingdom, and which for its

1 See above, p. 163. 2 Mac Leay, *Hor. Ent.* 206, 298.

extent, and the myriads of its mustered armies, each corps distinguished as it were by its own banner, and under its proper leaders, infinitely outnumbers all the members of the higher Classes, which stand as it were between aquatic and terrestrial animals, many of its tribes under one form inhabiting the water, and under another the earth and the air.

The following characters distinguish this great Class:

Body, covered with a horny or coriaceous integument. *Spinal chord* knotty, terminating anteriorly in a bilobed brain; a *heart* and imperfect *circulation*, sometimes vascular, and sometimes extra-vascular; *respiration* by *tracheæ*, receiving the air by *spiracles; legs* jointed, in the perfect insect always *six*.

The Class of Insects may be divided into two *Sub-classes*,[1] viz. *Ametabolians*, or those that do *not* undergo any *metamorphosis*, and have no wings; and *Metabolians*, or those that undergo a *metamorphosis*, and are usually fitted with wings in their final state.

*Sub-class* 1.—*Ametabolians* are further subdivided into two *Orders*, *Thysanurans* and *Parasites*.

*Order* 1.—The *Thysanurans* are remarkable for their anal appendages, which consist either of jointed organs resembling antennæ, and approaching very near to the caudal organs of the cockroach,[2] the use of which is not certainly known; or of an inflexed elastic caudal fork bent under the abdomen, which enables them to leap with great agility. To the first of these tribes belongs the common *sugar-louse*,[3] and to the last the *spring-tails*.[4].

It must be observed, however, that this is not a *natural* Order, for there is no analogy between the jointed tails of the sugar-louse, which some have supposed to belong or approach to the *Orthoptera*, and the unjointed leaping organ of the spring-tail. The latter animals, indeed, seem to form an *osculant* tribe, without the pale of the Class of Insects, and perhaps having some reference to the *Chilopodans* amongst the Myriapods, with which they agree, in having only *simple* eyes, like spiders, on each side of the head. Those of the spring-tails consist of eight such eyes, arranged in a double series, and planted in an oval space, in shape resembling an Insect's eye. The Chilopodans have only four on each side. The Insects of this Order probably feed upon detritus, whether animal or

1 See above, p. 198.
2 *Blatta*.
3 *Lepisma*.
4 *Podura*, *Sminthurus*.

vegetable, their masticating organs being very weak, and fitted to comminute only putrescent substances.

*Order* 2.—The Order of *Parasites*—consisting of the most unclean and disgusting animals of the whole Class, infest both man, beast, and bird, and no less than four[1] species, accounted by Linné, &c. as varieties, being attached to the former—may be divided into two sections, those that live by suction, and those that masticate their food. To the first of these belong the human and the dog-louse, and to the other the various lice that inhabit the birds,[2] of which almost every species has a peculiar one.

I have, on a former occasion, alluded to the Order of *Parasites*, when speaking of punitive animals:[3] here I must observe, that like other instruments employed by God to visit the sins of mankind, they are intended to produce a *sanative* effect, as well as to punish.[4] It is generally known that they abound only on those whose habits are dirty, in whom they may prevent the diseases which such habits would otherwise generate, as well as stimulate them to greater attention to personal cleanliness. The *bird-louse* is probably useful to birds in devouring the sordes which must accumulate at the root of their plumes.

*Sub-class.* 2.—*Metabolians*, by most modern writers on Insects, are considered, from their oral organs, as constituting *two* Sections, which are denominated *Haustellate* and *Mandibulate* Insects. I may here observe that the instrument of suction in a *Haustellate* mouth consists of pieces, though differently circumstanced, precisely analogous to those employed in mastication in a *Mandibulate* one, which has been most satisfactorily demonstrated, and with great elegance, by M. Savigny, in the first part of his *Animaux sans Vertèbres.*[5]

As there are several Orders called *Osculant*, that are intermediate between these Sections, I shall arrange the whole in three columns.

OSCULANT ORDERS.

1. *Aphaniptera.*
2. *Homaloptera.*
3. *Trichoptera.*
4. *Dermaptera.*
5. *Strepsiptera.*

1 *Pediculus*, *Capitis*, *Corporis*, *Nigritarum*, and *Phthirus Pubis.*
2 *Nirmus.*
3 See above, p. 7. See *Introd. to Ent.* i. 83.
4 Ibid, p. 253.
5 t. i.—iv.

| HAUSTELLATE ORDERS. | MANDIBULATE ORDERS. |
|---|---|
| 6. *Diptera.* | 10. *Hymenoptera.* |
| 7. *Lepidoptera.* | 11. *Neuroptera.* |
| 8. *Homoptera.* | 12. *Orthoptera.* |
| 9. *Hemiptera.* | 13. *Coleoptera.* |

With regard to the characters of these Orders:

*Order* 1.—The *Aphaniptera* (*Flea, Chigoe*) are apterous and parasitic, but differ from the Order of *Parasites* by undergoing a metamorphosis. They connect the *Suctorious Parasites* with the *Diptera.*

*Order* 2.—The *Homaloptera* (*Forest-fly, &c.*) called also *Pupipara,* because their eggs are hatched in the matrix of the mother, where they pass their larve state, and are not excluded till they have become pupes. Most of them have two wings, but one genus is apterous:[1] these seem intermediate between certain *Acaridans,* as the bat-mite, and the *Diptera;* they seem also, in some respects, to connect with the *Arachnidans,* whence they have been called *spider-flies.*

*Order* 3.—The *Trichoptera* (*Caseworm-flies*) have four *hairy* membranous wings, in their nervures resembling those of *Lepidoptera,* the under ones folding longitudinally. The mouth has four palpi, but the masticating organs are merely rudimental. Their place seems to be somewhere between the *saw-flies* and those *moths* whose caterpillars clothe themselves with different substances.

*Order* 4.—The *Dermaptera* (*Earwigs*) have two elytra and two wings of membrane, folded longitudinally, and their tail is armed with a forceps. They appear to be between the *Coleoptera* and *Orthoptera.*

*Order* 5.—The *Strepsiptera* (*Wild bee-fly, Wasp-fly*), parasitic animals, that have two ample wings, forming the quadrant of a circle, and of a substance between coriaceous and membranous, and two elytriform subspiral organs, appendages of the base of the anterior legs. Their place is uncertain, some placing them between the *Coleoptera* and *Dermaptera;* and others between the *Lepidoptera* and *Diptera.*

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*Order* 6.—The *Diptera* (*Two-winged Flies and Gnats,* &c.), as their name indicates, have only *two* membranous wings, usually accompanied by *two winglets,* representing the under wings of the Tetrapterous Orders, and *two poisers,* which appear connected with a spiracle.

1 *Melophagus.* The *Sheep-louse.*

*Order* 7.—The *Lepidoptera* (*Butterflies and Moths*) have *four* membranous wings, covered with minute scales, varying in shape.

*Order* 8.—The *Homoptera* (*Tree-Locusts, Frog-hoppers, Froth-hoppers*) have four deflexed wings, often of a substance between coriaceous and membranous.

*Order* 9.—The *Hemiptera* (*Bugs*, &c.) have four organs of flight, the upper pair being horny or coriaceous, but tipped, in the generality, with membrane, the lower pair being membranous.

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*Order* 10.—The *Hymenoptera* (*Saw Flies, Gall Flies, Ichneumon Flies, Bees, Wasps, Ants*, &c.), which are the analogues of the *Diptera*, have four membranous wings, and the tail of the female is usually armed with a sting, or instrument useful in laying their eggs.

*Order* 11.—The *Neuroptera* (*Dragon Flies, Lace-winged Flies, Ephemeral Flies, White Ants*, &c.) have four membranous wings, usually reticulated by numerous nervures, but no sting or ovipositor. They are analogues, especially *Ascalaphus*, of the *Lepidoptera*.

*Order* 12.—The *Orthoptera* (*Cockroaches, Locusts, Praying-insects, Spectres, Grasshoppers, Crickets*, &c.) have mostly two *tegmina*, or upper wings, of a substance between coriaceous and membranous, and two under ones, formed of membrane, and folded longitudinally when unemployed. These are analogues of the *Homoptera*.

*Order* 13.—The *Coleoptera* (*Beetles*) have two upper organs, of a horny or leathery substance, called *elytra*, to cover their two membranous wings, which are folded longitudinally and transversely. These are analogues of the *Hemiptera*, especially those with no apical membrane.

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In considering the three descriptions of Orders here enumerated and characterized, it must be recollected that we are not following the usual order of arrangement in systems, that of *descending* from the highest to the lowest; but that we are *ascending* in an inverse direction, consequently that, in the above tables, the *lowest* numbers indicate the *lowest* and not the *highest* Orders.

I shall now make some remarks, as to their *functions* and *uses*, upon the animals constituting these several Orders, en-

livening them occasionally with such histories, not before produced, or not well known, as may interest the reader and answer the great end of this treatise, the glory of God, as manifested in the history and instincts of animals.

Before, however, I enter upon the separate consideration of these Orders, I must premise a few remarks upon the circumstance which distinguishes them from the preceding Sub-class, their *metamorphoses*. I have, on a former occasion,[1] mentioned some beneficial effects resulting from this law of the Creator; and its action and the results of it have been so ably explained and illustrated in another treatise,[2] that it is quite unnecessary for me to enter largely into the subject. The striking remarks made upon the developments of the higher animals, towards the close of the treatise alluded to,[3] merit particular attention.

It has been observed by an ingenious and learned writer[4] on this subject—that every species of plant, in the course of the year, exhibts itself in different states. First are seen the succulent stems adorned with the young foliage, next emerge the buds of the flowers, then the calyx opens, and permits the tender and lovely blossoms to expand. The insects destined to feed upon each plant must be simultaneous in their development. If the butterfly came forth before there were any flowers, she would in vain search for the nectar that forms her food; and if the caterpillar was hatched after the leaves had begun to fade and wither, she could not exercise her function.[5] In another passage he thus illustrates this analogy between the metamorphoses of the insect and the successive developments of the plant. If we first place an egg, says he, next to its caterpillar, further on its chrysalis, and lastly the butterfly; what have we but an animal stem, an elongation perfectly analogous to that of the plant proceeding from its seed, by its stem and its appendages to the bud, the blossom, and the seed again?[6] For the different kinds and forms of larves and pupes I must refer the reader to another work,[7] merely observing that, in their forms, the larves seem to represent all the preceding Classes of Condylopes, and also some Annelidans and Molluscans. The great majority of pupes are not locomotive, and take no food, while the rest are locomotive and continue to feed. This circumstance sometimes exposes the former to the attacks of their enemies, the ichneumons, and thus numbers are destroyed which would otherwise escape; but though, in

1 See above, p. 201. 2 Roget. *B. T.* i. 302—316. 3 *Ibid.* ii. 631.
4 Dr Virey. 5 *N. D. D'H. N.* xx. 348.
6 *Ibid.* 355. 7 *Introd. to Ent.* iii. Lett. xxx. xxxi.

this state, they are thus exposed to the attack of one enemy, they are more effectually concealed from those of another, the insectivorous birds. Those that bury themselves in the earth seem still more privileged from attack.

*Orders* 1, 2, and 6. There is so close a connection between the *fleas*, the *pupiparous insects*, and the *two-winged flies*, that it will be best to consider them under one head. The former of these, the fleas,[1] the mosquitoes, or gnats[2] and the horse-flies,[3] all suck the blood of man, as well as that of beast or bird.[4] The wonderful strength and agility of the *flea* are well known,[5] and it appears to have been endowed with those faculties by its Creator, to render its change of station from one animal to another, and means of escape, more easy; and though the bite of mosquitoes, and other blood-suckers, is, at certain times of the year and in certain climates, an almost intolerable annoyance;[6] yet, doubtless, some good end is answered by it; with regard to *cattle*, it is evident that, while they are suffering from the attack of these blood-letters, their feeding is more or less interrupted; a circumstance which may be attended by beneficial effects to their health; and probably even to man, the torment he experiences may be compensated, in a way that he is not aware of, on account of which, principally, a wise Physician prescribed the painful operation, and furnished his chirurgical operators with the necessary and indeed most curious knives and lancets.

Another group connecting the *bat-mite* and *bat-louse*, and the *Arachnidans*, perhaps, with the *Diptera*, are those two-winged insects, called *pupiparous* or *nymphiparous*, because their young when extruded from the abdomen of the mother, though appearing like eggs, are really in the state of *nymph* or *pupe*. It is remarked of this group, which is parasitic upon beasts and birds, that its internal structure is particularly accommodated to this circumstance; it is furnished with a regular matrix, consisting of a large musculo-membranous pocket, and with ovaries totally different from those of other insects; but, by their configuration and position, exhibiting a considerable resemblance to those of a woman.[7] The reason of this singular aberration from the gestation of other *Diptera*, which, with few exceptions, are oviparous, seems connected with their peculiar

1 *Pulex.*
2 *Culex.*
3 *Tabanus. Stomoxys.*
4 *Introd. to Ent.* 1. 100, 109, 112, &c.
5 *Ibid.* ii. 310. iv. 195.
6 *Ibid.* 113.
7 Latr. *Crust. Arachn. et Ins.* ii. 542.

habits: in their perfect state they are usually winged, and attach themselves externally to horses, oxen, &c.; it may therefore be the means of preserving the race from extinction, that they are supported in the womb of their mother, in some inscrutable way, during their grub state, and only leave her when their next change will enable them readily to attach themselves to their destined food.

The *gad-flies*,[1] though they do not, like the forest flies, nourish their young in their own womb; yet their Creator instructs some of them to deposit their eggs in a situation where means are provided for ther conveyance to a more capacious matrix, ministering to them a copious supply of lymph, which forms their nutriment, in the stomach and intestines of the horse, for this animal, with its own mouth, licks off the eggs, wisely attached, by this fly, to the hairs of its legs in such parts as are exposed to this action; and thus unwittingly, itself conducts its foes into its citadel: others of the same genus undermine the skin of the ox, of the sheep, and in some countries, even of man himself. The grubs, by their action in their several stations, produce a purulent matter, which they imbibe, and which is stated by those who have studied them, to be beneficial to the animals they attack.[2] Another tribe of this Order, the *flesh-flies*,[3] lay their eggs on dead bodies, and soon remove those nuisances, and the putrid and pestilential miasmata which they occasion, from the face of our globe. This function is of such importance to the welfare of our species, that some of these *flies*, in order that no time may be lost, are viviparous,[4] and bring forth their young in a state in which they can begin their work as soon as they are born.

The *aphidivorous flies*[5] have another function, in conjunction with the *lace-winged flies*,[6] *lady-birds*,[7] and some other insects, to reduce and keep within due limits the infinite myriads of the *plant-lice*,[8] which, in these climates, are the universal pests of the garden, the orchard, and the field. There are also flies[9] that lay their eggs in the combs of *humble-bees*, which, as it were, wear their livery, for the hairs that clothe their body are so disposed and coloured, as to imitate that of the bee, whose nests they frequent; so that, probably, they are often mistaken

1 *Œstrus, &c.*

2 The species of gad-flies here alluded to are *Gastrus Equi*, and *Œstrus Bovis*, *Œ. Ovis* and *Œ. Hominis*.

3 *Sarchophaga.*

4 *Se-vivipara.*

5 *Syrphus, &c.*

6 *Hemerobius.*

7 *Coccinella.*

8 *Aphides.*

9 *Volucella, &c.*

for members of the family, and effect their mischief unmolested.

Another tribe of flies, called *hornet-flies*,[1] with some others related to them,[2] like a hawk or other predaceous bird, seize their prey with their legs, or their beak,[3] but it can only be with the view of sucking its juices, as they have no masticating organs.

Dipterous insects, however, are not confined to *animal* food, whether living or putrescent, many also subsist upon a *vegetable* diet. Mushrooms and other agarics sometimes swarm with the grubs of certain flies or gnats;[4] others pass their first states in decaying timber; the narcissus and onion flies[5] feast upon the bulbs from which they take their name; and a little gnat,[6] when a grub, feeds upon the pollen of the flowers of the wheat.

To these may be added those flies, that in their first state, may be regarded as purifiers of stagnant waters, and other offensive fluids or semi-fluids. The larves of the *gnat* or mosquito are aquatic animals which may be seen either suspended at the surface, or sinking in most stagnant waters, compensate in some degree, for the torment of their blood-thirsty attacks, by discharging this function, and assisting to cleanse our stagnant waters from principles that might otherwise generate infection. A variety of others contribute their efforts to bring about the same beneficial purpose. Almost all the *Diptera*, in their perfect state, even the blood-suckers, emulate the bees, in imbibing the nectar from the various flowers with which God has decorated the earth, and thus assist in keeping within due limits, the, otherwise suffocating, sweets that they exhale.

From the statement here given, we see that the Creator has provided the members of this Order with a very diversified bill of fare, and that their efforts in their several states, and various departments, are of the first importance, as scavengers and depurators, to remove or mitigate nuisances, that would otherwise deform and tend to depopulate our globe. What they want in volume, is compensated for by numbers, for perhaps the *individuals* of no Order are so numerous. It is true, in particular periods, the locusts and aphides seem to outnumber them; yet, ordinarily, the two-winged race, are those which

1 *Asilus.*
2 *Empis.*
3 *Introd. to Ent.* i. 274.
4 *Mycetophila, &c.*
5 *Eristalis Narcissi*, and *Scatophaga Ceparum.*
6 *Cecidomyia Tritici.*

everywhere most force themselves upon our attention; during nearly three-fourths of the year we hear their hum, and see their motions, in our apartments, and even in the depth of winter, in sunny weather, by their myriads, dancing up and down under every hedge, they catch our attention in our walks.

*Order* 10.—If we next turn our attention to the *mandibulate* Order, which stands most in contrast with the *Diptera*, the *Hymenoptera* immediately occurs to us, in which we find a variety of forms, which seem made to imitate those of flies, or vice versa. Thus there are flies[1] that resemble saw-flies; others that simulate the ichneumonidan parasites; others again that resemble wasps, bees, and humble-bees.

Though the Insects belonging to this Order are included in the mandibulate Section; for their mouth is furnished with mandibles and maxillæ; yet they do not generally use them to *masticate* their *food*, but for purposes usually connected with their sequence of instincts, as the bees in building their cells;[2] the wasps in scraping particles of wood from posts and rails for a similar purpose, and likewise to seize their prey; but the great instrument by which, in their perfect state, they collect their food is their *tongue*, this, the bees particularly have the power of inflating, and can wipe with it both concave and convex surfaces; and with it they, as it were, *lick*, but not *suck*, the honey from the blossoms, for, as Reaumur has proved, this organ acts as a *tongue* and not as a *pump*.[3] In the numerous tribes that compose this most interesting of the Orders, the tongue is lambent, and varies considerably in its structure, but in the great majority it is a flattish organ, often divided into several lobes.

Some entomological writers have bestowed upon the members of the present Order the title of *Principes*, as if they were the *princes* of the Class of Insects, and if we consider the conspicuous manifestation of the Divine attributes of Power, Wisdom, and Goodness, exhibited in the wonderful instincts of those of them that are *gregarious*, we shall readily concede to them this title. If superior wisdom and devotedness to the general good are the best titles to rank and station; the laborious and indefatigable *ant*, and the *bee*, celebrated from the earliest ages for its wonderful economy, its admirable structures, and its useful products, are surely entitled to it, though they cannot vie with the insects of many of the other Orders

1 *Aspistes*, Meig. 2 See above, p. 288. 3 *Mem.* &c. v. 322.

in size, and in the brilliancy and variety of their colours, and the pencil of the Creator has not decorated their wings with the diversified paintings which adorn those of the butterfly.

The functions which are given in charge to the several members of this Order are various. Some, like the predaceous and carnivorous tribes of the *Diptera*, appear engaged in perpetual warfare with other insects; thus the *wasps* and *hornets* seize flies of every kind that come in their way, and will even attack the meat in the shambles; the *caterpillar-wasp*[1] walks off with *caterpillars*, the *spider-wasp*[2] with *spiders*, and the *fly-wasp*[3] with *flies*. But the motive that influences them, will furnish an excuse for their predatory habits. They do not commit these acts of violence to gratify their own thirst for blood, like many of the flies, but to furnish their young with food suited to their natures. The wasp carries the pieces of flesh she steals from the butcher to the young grubs in the cells of her paper mansion. The other wasps I mentioned each commit their eggs to the animal they are taught to select, and then bury it; so that the young grub when hatched may revel in plenty.[4]

Some of the *Hymenoptera* prefer a vegetable diet, and assist the *Lepidoptera* in their office. The caterpillars which infest many species of willow are hatched from the eggs of the *saw-flies*;[5] one genus[6] nearly related to them confines itself to timber, to which it is sometimes very destructive.

Another tribe affect plants in a very remarkable manner. Their egg-placer, like a magician's wand, is gifted with the privilege, by a slight puncture in the twig or leaf of any shrub or tree, or the stalk of any plant, to cause the production of a wonderful and monstrous excrescence, sometimes resembling moss, as in the Bedeguar of the rose, at other times, a kind of apple, or a transparent berry, both of which seeming fruits, the oak, when touched by two of these little gall-flies of different species, produces as well as acorns: various other forms[7] their galls assume, which need not be here mentioned. It is to be observed that the eggs of these gall-flies grow after they are laid, and perhaps these singular productions are more favourable to their growth, being softer and more spongy and succulent than the twigs themselves would be. Even here Creative Power, Wisdom, and Goodness are conspicuously manifested,

1 *Ammophila.*
2 *Pompilus.*
3 *Bembex.*
4 See *Introd. to Ent.* i. 346.
5 *Cimbex, Tenthredo, Lyda, &c.* See *Introd. to Ent.* i. 255.
6 *Sirex.*
7 *Introd. to Ent.* i. 446.

in providing such wonderful nests for these little germ-like eggs; these excrescences, indeed, instead of deforming the plants they are produced from, are often ornamental to them; and besides this are also, some of them, of the highest utility to mankind—witness the Aleppo oak-gall,[1] to which learning, commerce, the arts, and every individual who has a distant friend, are so deeply indebted.

Another tribe is equally useful in a different department; I allude to those Hymenoptera that are parasitic upon other Insects, particularly upon the destructive hordes of caterpillars that are often so injurious both to the horticulturist and agriculturist. These insects are denominated by Latreille *Pupivorous*, not, as some may suppose, because they devour insects in their second, or *pupe* state, but from the *classical* meaning of the word, because they devour them before they are arrived at their perfect or adult state. This tribe may be considered as divided into two great bodies, one represented by the *proper* Ichneumons of Linné, which have, usually, veined wings, and the abdomen connected with the trunk by a footstalk; the other forming the *Minute Ichneumons* of that great reviver of Natural History, distinguished, usually, by having wings with few or no veins on their disk, and by a sessile abdomen. These attack eggs and chrysalises, as well as caterpillars. Though the latter are the principal, yet they are not the only object of the great Ichneumonidan host, for they attack insects of every order indiscriminately; they seem, however, to annoy beetles, grasshoppers, bugs, and froghoppers, less than others. They may, with great propriety, be called *conservatives*, since they keep those under that would otherwise destroy us.[2] A little fly, before alluded to in these pages,[3] which appears very *destructive* to *wheat* when in the ear, is rendered harmless, by the goodness of Providence, by not less than three of these little benefactors of our race.[4]

Connected with the subject of parasites is a singular history communicated to me by the Rev. F. W. Hope, one of the most eminent entomologists of the present day. In the month of August 1824, in the nest of a species of *wasp*,[5] he found more than fifty specimens of a singular little *beetle*, which may be called the *wasp-beetle*,[6] long known to frequent wasps' nests. From their being found in cells which were closed by a kind of operculum, he conjectures that they lay their eggs in the

1 *Cynips Scriptorum.*
2 *Introd. to Ent.* i. 267.
3 See above, p. 362.
4 *Linn. Trans.* v. 107.
5 *Vespa rufa.*
6 *Ripiphorus paradoxus.*

grub of the wasp, upon which they doubtless feed. Subsequent to this, upon opening some of the cells, he was surprised to find, instead of the beetles, several specimens of an Ichneumon belonging to Jurine's genus, *Anomalon.*[1] Upon another examination, some days after this, no more of these last insects appearing, he discovered that they had been pierced, in their chrysalis state, by a minute species belonging to the family of *Chalcididans*, of which he found no less than twenty specimens flying about in search of their prey.

"From the above facts," Mr Hope remarks, "we have a convincing proof, if such were wanted, of a Superintending Power which ordains checks and counterchecks to remedy the superfecundity of the insect world." First the wasp, a great destroyer of flies and various other insects, and often a troublesome pest and annoyance to man himself, is prevented from becoming too numerous, amongst other means, by the wasp-beetle; then, lest it should reduce their numbers so as to interfere with their efficiency, this last is kept in check by the *Anomalon*, which, in its turn, that it may obey the law, *Thus far shalt thou come, and no further*, becomes the prey of another devourer. Mr Hope observed, and the fact is curious, that the specimens of the wasp-beetle obtained from the *female* wasps were about one third larger than the others.

But of all the Hymenopterous, or indeed any other Insects, there are none, as I before observed, that illustrate the primary attributes of the Deity more strikingly than those that are *gregarious*, which build for the members of their societies spacious colleges, if I may so call them, capable often of containing many thousand inhabitants, and remarkable for the pains they bestow upon the nurture and education of their young. There are three great tribes in the present Order, distinguished by this instinct,—the *wasps* and *hornets*, the *bees* and *humble-bees*, and the *ants*.

The *wasps* and *hornets* are remarkable for the curious papier-maché edifices, in the construction of which they employ filaments of wood,—scraped from posts and rails with their own jaws,—mixed with saliva, of which the hexagonal cells, in which they rear their young, are formed, and often their combs are separated and supported by pillars of the same material; and the external walls of their nests are formed by foliaceous layers of their ligneous paper.[2] Latreille mentions a Brazilian species that makes an abundant provision of *honey*.

1 Latrelle is of opinion that this is not a natural genus. *N. D. D'H. N.* ii. 128.

2 See *Introd. to Ent.* i. 501.

In the book of Joshua we are informed[1] that God, by means of some animal of this genus, drove out the two kings of the Amorites from before the Children of Israel. In the second volume of Lieut. Holman's Travels—in whom the loss of sight has been compensated by a wonderful acuteness of mental vision—the following anecdote is related illustrative of this fact.[2]

"Eight miles from Grandie ———, the muleteers suddenly called out 'Marambundas, Marambundas!' which indicated the approach of a host of *wasps*. In a moment all the animals, whether loaded or otherwise, laid down on their backs, kicking most violently; while the blacks, and all persons not already attacked, ran away in different directions, all being careful, by a wide sweep, to avoid the swarms of tormentors that come forward like a cloud. I never witnessed a panic so sudden and complete, and really believe that the bursting of a water-spout could hardly have produced more commotion. However it must be confessed that the alarm was not without a good reason, for so severe is the torture inflicted by these pigmy assailants, that the bravest travellers are not ashamed to fly the instant they perceive the terrific host approaching, which is of no uncommon occurrence on the Campos."

I shall now turn to those admirable creatures, which though, as a wise man observes, *they are little among such as fly, their fruit is the chief of sweet things*,[3] those Heaven-instructed mathematicians, who before any geometer could calculate under what form a cell would occupy the least space without diminishing its capacity, and before any chemist existed to discover how wax might be elaborated from vegetable sweets, instructed by the Fountain of Wisdom, had built their hexagonal cells of that pure material, had closed them at the bottom with three rhomboidal pieces, and were enabled, without study, so to construct the opposite story of combs, that each of these rhomboids should form one of those of three opposed cells,[4] thus giving strength to the structure that, in no other place, could have been given to it. Wise in their government, diligent and active in their employments, devoted to their young and to their queen, they read a lecture to mankind that exemplifies their Oriental name—*she that speaketh*. Whoever examines their external structure, as has been before observed,[5] will find every part adapted to their various employments.

1 xxiv. 12.
2 Quoted in *Lit. Gazette*, Jan. 3, 1835, p. 4.
3 *Ecclus.* xi. 3.
4 Plate XI. Fig. 3.
5 See above, p. 288, and *Introd. to Ent.* i. 481—497, and ii. Lett. xix. xx.

These valued animals, so worthy of the attention of the sage, as well as the culture of the economist, are almost the only ones of the Order that are guilty of no spoliation, and injure no one: they take what impoverishes none, while it enriches them and us also, by the valuable products which are derived from their skill and labour—true emblems of honest industry.

I shall merely mention the humble-bee,[1] and their subterranean habitations, which are of a much ruder architecture than those of the hive-bee: the cells, however, are made of a coarse kind of wax, but placed very confusedly, not exhibiting the geometrical precision observable in the latter.[2]

I may here observe that all insects of this Order, in their perfect state, imbibe the nectar from the flowers, but none, the hive and humble-bees and one species of wasp excepted, with the view of storing it up for future use.

The last Hymenopterous tribe[3] includes the *ants*, and is almost equally interesting with the preceding one, for the wonderful industry of the animals just mentioned. They are universal collectors; every thing that comes in their way, whether animal or vegetable, living or dead, answers their purpose; and the paths to their nests are always darkened with the busy crowds that are moving to and fro. Their great function seems to be to remove every thing that appears to be out of its place, and cannot go about its own business. I have seen several of them dragging a half-dead snake, about the size of a goose-quill. They do not, however, like the bees, usually store up provisions, but they will imbibe sweet juices from fruits and also from the plant-lice, which may be called their cows.[4] However, almost all their cares and labour are connected with the nurture and sustenance of their young.

I am indebted to the kindness of Lieutenant-Colonel Sykes, of the Bombay army—well known for the zeal and ability with which he investigated the animal productions of the western provinces of India—for some interesting observations upon three species of ants, particularly one, which, from making its nests on the branches of trees, is called the *Tree-ant*, singularly exemplifying the extraordinary instincts of these laborious and provident insects, and which I have his permission to insert in this work.

The *Tree-ant*[5] inhabits the Western Ghauts, in the collectorate of Poona, in the Deccan, at an elevation of from 2,000 to

1 *Ibid.* Lett. xviii.
2 See *Linn. Trans.* vi. t. xxvii.
3 *Heterogyna.* Latr. See *Introd. to Ent.* i. 476—481. ii. Lett. xvii.
4 *Ibid.* ii. 87—91.
5 *Myrmica Kirbii.* Sykes.

4,000 feet from the level of the sea. It is of a ferruginous colour, two-tenths of an inch in length; head of the neuter disproportionably large;[1] the thorax is armed posteriorly with two sharp spines. When moving the insect turns the abdomen back over the thorax,[2] and the knotty pedicle lies in a groove between the spines. The male is without the spines.[3]

These ants are remarkable for forming their nests,[4] called by the Marattas *moongeeara*, on the boughs of trees of different kinds; and their construction is singular, both for the material and the architecture, and is indicative of admirable foresight and contrivance: in shape they vary from globular to oblong, the longest diameter being about ten inches, and the shortest eight. The nests consist of a multitude of thin leaves of *cow-dung*, imbricated like tiles upon a house, the upper leaf formed of one unbroken sheet, covering the summit like a skull-cap. The leaves are placed one upon another, in a wavy or scalloped manner, so that numerous little arched entrances are left, and yet the interior is perfectly secured from rain. They are usually attached near the extremity of a branch, and some of the twigs pass through the nest. A vertical section presents a number of irregular cells, formed by the same process as the exterior. Towards the interior the cells are more capacious than those removed from the centre, and an occasional dried leaf is taken advantage of to assist in their formation. The nurseries for the young broods in different stages of development are in different parts of the nest. The cells nearest the centre are filled with very minute eggs, the youngest members of the community; those more distant, with larger eggs,[5] mixed with larves; and the most remote, with pupes near disclosure. In fact, in these last cells only were found winged insects. The female is in a large or royal cell, near the centre of the nest: she is about half an inch long, of the thickness of a crow-quill, white, and the abdomen has five or six brown ligatures round it, like the female of the white ants; the head is very small, and the legs mere rudiments: she is kept a close prisoner, and incapable of motion in her cell, a circumstance in which these appear to approach the white ants, and which indicates that they should form a distinct genus.

There was no store of provisions in the nests; they were indebted therefore for their support to daily labour. We may gain some idea of their perseverance when we consider that

1 Plate XI. c. Fig. 1, 3
2 Plate XI. Fig. 3.
3 *Ibid.* Fig. 2.
4 *Ibid.* Fig. 4.
5 It should seem from this that the eggs grow.

the material of which the nest is formed—cow-dung—must have been sought for on the earth, and probably carried from a considerable distance up the trees.

Colonel Sykes related to me another anecdote with regard to an Indian species of ant, which he calls the *large black ant*, instancing, in a wonderful manner, their perseverance in attaining a favourite object, which was witnessed by himself, his lady, and his whole household. When resident at Poona, the dessert, consisting of fruits, cakes, and various preserves, always remained upon a small side-table, in a verandah of the dining-room. To guard against inroads the legs of the table were immersed in four basins filled with water; it was removed an inch from the wall, and, to keep off dust through open windows, was covered with a table-cloth. At first the ants did not attempt to cross the water, but as the strait was very narrow, from an inch to an inch and a half, and the sweets very tempting, they appear at length to have braved all risks, to have committed themselves to the deep, to have scrambled across the channel, and to have reached the object of their desires, for hundreds we found every morning revelling in enjoyment: daily vengeance was executed upon them without lessening their numbers; at last the legs of the table were painted, just above the water, with a circle of turpentine. This at first seemed to prove an effectual barrier, and for some days the sweets were unmolested, after which they were again attacked by these resolute plunderers; but how they got at them seemed totally unaccountable, till Col. Sykes, who often passed the table, was surprised to see an ant drop from the wall, about a foot above the table, upon the cloth that covered it; another and another succeeded. So that though the turpentine and the distance from the wall appeared effectual barriers, still the resources of the animal, when determined to carry its point, were not exhausted, and by ascending the wall to a certain height, with a slight effort against it, in falling it managed to land in safety upon the table. Col. Sykes asks,—is this instinct? I should answer, no: the animal's appetite is greatly excited, its scent probably informs it where it must seek the object of its desire; it first attempts the nearest road; when this is barricaded it naturally ascends the walls near which the table was placed, and so succeeds by casting itself down,—all the while under the guidance of its senses.[1]

It is observed, in the *Introduction to Entomology*, that though ants, "during the cold winters, in this country, remain in a

1 See above, p. 315, 336, and *Introd. to Ent.* ii. 62.

state of torpidity, and have no need of food, yet in warmer regions, during the rainy seasons, when they are probably confined to their nests, a store of provisions may be necessary for them.[1] Now, though the rainy season, at least in America, as has been stated on a former occasion,[2] is a season in which insects are full of life, yet the observation, that ants may store up provisions in warm countries, is confirmed by an account sent me by Col. Sykes, with respect to another species which appears to belong to the same genus as the celebrated *ant of visitation*,[3] by which the houses of the inhabitants of Surinam were said to be cleared periodically of their cock-roaches, mice, and even rats.[4] The present species has been named by Mr Hope, the *provident ant*.[5] These ants, after long continued rains during the monsoon, were found to bring up and lay on the surface of the earth, on a fine day, its stores of grass seeds, and grains of Guinea corn, for the purpose of drying them. Many scores of these hoards were frequently observable on the extensive Parade at Poona. This account clearly proves that, where the climate and their circumstances require it, these industrious creatures do store up provisions.

From these very interesting communications we may remark how the functions of animals are varied, the same function being often given in charge to tribes perfectly different in different climates. In temperate regions, the principal agents in disinfecting the air by devouring or removing excrement, belong to the Order of *beetles*, but in India, where probably more hands are wanted to effect this purpose of Providence, the *tree-ants* are called in to aid the beetles, by building their nests of this fetid mortar, and thus clear the surface of innumerable nuisances, which probably soon dry and become scentless. In Europe, again, no ants are found to verify Solomon's observation, literally interpreted, but in India we see, and probably it may also be the case in Palestine, provision for the future is not stored up solely by the bees, but the ants, where it is necessary, are gifted with the same admirable instinct.

A circumstance here requires notice, which is almost peculiar to the gregarious Hymenoptera dwelling in a common habitation; in all their communities, besides one or more *prolific* females and males, there is an order of sterile females, which have no connexion with the other sex, and are solely employed in labours and pursuits beneficial to the community at large

1 See above, p. 315, 336, and *Introd. to Ent.* ii. 46.
2 See above, p. 321.
3 *Atta cephalotes.*
4 *De Geer.* iii. 607.
5 *A. providens.*

to which they belong, especially the care and nurture of the young.

The wisdom and beneficial effects of this law, by which the Creator has regulated their communities, and prescribed to all their duties and functions, must be evident to every one. It sets free the majority of the community to give their whole attention to those labours upon which the welfare and existence of their several associations depend. Indeed, if they were all to be prolific, their societies would soon be dissolved, or destroyed by the evils attendant upon an overabundant population; or their increase would be so rapid, that the whole earth would soon be covered by them, to the great annoyance, if not destruction, of the rest of its inhabitants.

Now I am upon this subject, I may add a few remarks upon the kindred societies of *white-ants*, which, though they belong to a different Order, are, in many respects, analogous to those of the true *ants;* and the differences observable between them arise from a marked diversity in the nature of their metamorphosis; namely, that in the last named insects, both larves and pupes are incapable of locomotion, and all the labours of the society, as well as its defence and the care and nurture of the young, are devolved upon a description of its members that are not gifted with the faculty of reproduction: whereas, in the former, the white ants, the larves and pupes, in conformity to the law which, in this respect, regulates the Class to which they belong, are locomotive and more active in those states than in the last or reproductive one, and are therefore fully qualified to act in all the working departments, and to transact the general business of the society; but as this, in their case, required a conformation of the head and oral organs inconsistent with their use as offensive weapons, another order was necessary to act as sentinels, and to be entrusted with the defence of the nest or termitary, as it is called, and its inhabitants. That such an order exists, we learn from the statements of Smeathman and Latreille, who, both of them, had means of personal investigation, and the latter of whom brought to the investigation the deepest insight into his subject, and the most extensive knowledge of insects and their history possessed by any man in Europe. Upon the accuracy of his statements, therefore, the most entire reliance may be placed. The species[1] he investigated was discovered by himself, in the neighbourhood of Bordeaux, inhabiting the trunks of firs and oaks, immediately under the bark, where, without

1 *Termes lucifuga.*

attacking the bark itself, they formed a great number of holes and irregular galleries. In these societies he discovered, at all times, *two* kinds of individuals, which were without wings, elongated, soft, of a yellowish white, with their head, trunk, and abdomen distinct; they were active, furnished with six legs, their head large, and the eyes very small, or altogether wanting; but, in one of these kinds of individuals, which compose the bulk of the society, the head is rounded and the mandibles not extended; while in the others, which form not more than one twenty-fifth of the population, the head is much larger, elongated, and cylindrical, and terminated by mandibles that extend from it and cross each other; these Latreille always found stationed at the entrance of the cavities where the others were assembled in greatest numbers: towards the end of the winter and in the spring, he discovered individuals exactly resembling those first mentioned, but having the rudiments of four wings, and in June, the same individuals had acquired four ample wings, had become of a blackish colour, and consisted of males and females; a month later a few only were found in the termitary, which had lost their wings, and eggs now begun to apppear laid up in certain labyrinths of the wood.[1]

It is clear from this account that those with a round head and short mandibles are larves, which go through the usual metamorphosis of their tribe, not changing their form, but acquiring wings, first packed up in cases, and afterwards developed. The second description, with the elongated head and crossed mandibles, never acquired wings, and therefore correspond precisely with the neuters amongst ants, only as Providence always economizes means, and wills that nothing be lost or wasted, he has decreed that these locomotive larves and pupes should not live in idleness.

*Order* 7.—We now come to an Order, taking their food by suction, which appear to have been formed to deck our fields and groves with various beauty; but which in their first state, when they masticate their food, they mar and destroy, often stripping the trees of their leaves, and covering our hedges with their webs full of crawling myriads of devastators. It will be seen that I am speaking of the *Lepidopterous* Order, consisting of three great phalanxes, the *diurnal* fliers, or butterflies,[2] the *crepuscular* fliers, or hawkmoths,[3] the *nocturnal*

1 Latreille in *N. D. D'H. N.* xxxiii. 90.

2 *Papilio.* L.

3 *Sphinx.* L.

fliers, or moths,[1] each divided into several genera. Their caterpillars most generally feed upon the foliage of vegetables of every description; but those of some of the lower tribes[2] of moths devour animal substance, such as wool, fur, leather, grease, and the like; some even enter the bee-hive and devour the combs, others the cabinet of the entomologist to prey upon his insects, others even attack the books of the scholar. Their office seems to be to keep in check too luxuriant vegetation, and, in many of the latter instances, the removing of dead animal matter, and every thing putrescent from the surface of the globe.

But this is not the whole, they likewise help to maintain, as has been before observed,[3] half the birds of the air, forming a principal portion of their food; and in some countries, as well as the locusts and white ants,[4] they are eagerly devoured by man himself. There is a certain mountain, in New Holland, as we are informed by Mr Bennett,[5] called Bugong mountain, from multitudes of small moths, called *Bugong* by the natives, which congregate at certain times, upon masses of granite, on this mountain. The months of November, December, and January, are quite a season of festivity amongst these people, who assemble from every quarter to collect these moths. They are stated also to form the principal summer food of those who inhabit to the south of the snow mountains. To collect these moths, or rather butterflies,[6] the natives make smothered fires under the rocks on which they congregate; and suffocating them with smoke, collect them by bushels, and then bake them by placing them on heated ground. Thus they separate from them the down and the wings, they are then pounded and formed into cakes resembling lumps of fat, and often smoked, which preserves them for some time. When accustomed to this diet they thrive and fatten exceedingly upon it.[7] Millions of these animals were observed also, on the coast of New Holland, both by Captains Cook and King.[8] Thus has a kind Providence provided an abundant supply of food for a race that, subsisting solely by hunting or fishing, must often be reduced to great straits.

*Orders* 3 and 11.—The masticating tribe, which present the most striking analogy to the scaly-winged lepidopterous insects,

1 *Phalæna.* L.
2 *Tineidæ.*
3 See above, p. 202.
4 *Introd. to Ent.* i. 303, 307.
5 *Wanderings*, &c. i. 265.
6 *Euplœa hamata.* M'L.
7 Bennett, *ubi supr.* 271.
8 *Ibid.* 209, note *.

is one of very different habits; mostly bold, rapacious, and sanguinary, they are perpetually chasing other insects, and devouring them, and this they do, not in one, but in all their states. I am speaking here of the Neuropterous Order, especially the dragon flies, those insects of vigorous wing and indomitable force. Every one who compares these with the Heliconian butterflies, the wings of which are sometimes, more or less, denuded of their scales,[1] will perceive that they are analogues of each other; and one of this Order, the *Ascalaphus*, resembles a butterfly so strikingly, both by its wings and antennæ, that it has been described as one by a very eminent entomologist.[2] The Ant-lions, and lace-winged flies, in the port of their wings, resemble several moths; and the *Trichoptera*, an osculant Order, but still reckoned amongst the *Neuroptera* by Latreille, in its habit of clothing itself with a case made of various articles, imitate the clothes-moth, and others of that tribe, which invest themselves with cases made of wool, fur, and similar materials.

The dragon-flies in their two first states, by means of their wonderful mask,[3] destroy a vast number of aquatic insects, and in their last an equal number in the air.

The *white-ants*,[4] and some kindred insects, like the ants devour every thing but metal, that is exposed to their attacks, particularly timber. A deserted African village is soon removed by them, working under their covered ways; and, in tropical regions, a forest quickly springs up where a busy population ran to and fro a few years before. So that they are amongst the instruments in the hand of Providence, that the places deserted by man shall be restored again to the vegetable and animal races that were in possession before he cleared it for his own habitation. The white ants seem to connect this Order with the Hymenoptera by means of the common ants; which, however, as Colonel Sykes informs me, bear the most rooted enmity to them, and destroy them without mercy. In digging up some white ants' nests, in his garden at Poona, he once found *two* queens in one cell, a remarkable anomaly in their history. In the course of the present year I received a letter signed P. T. Baddeley, inclosing a drawing and specimens, of a singular species of white ant, with a head precisely resembling that of an elephant, except that there was no representation of the tusks. The head, which is enormously

1 E. G. *Heliconius Quirina, Hippodamia*, &c.
2 *Scopoli, N. D. D'H. N.* ii. 580.
3 *Introd. to Ent.* iii. 125.
4 *Termes.*

large compared with the size of the animal, terminates in a long proboscis. Mr Baddeley found it in great numbers about two years ago, under some teak timber; the only circumstance which he mentions of its habits.

*Orders* 8 and 9.—There are two Orders taking their food by suction, the *Homoptera* and *Hemiptera*, which perhaps should rather be regarded as *Sub-orders*, as Latreille considers them, and which were included by Linné in the same order with the *Orthoptera* of modern entomologists, to which, in fact, they are contrasted more or less. I shall therefore consider them together.

The *Homoptera* are herbivorous, sucking the sap of trees and plants,[1] and the principal tribe of them was celebrated of old, both by Grecian and Roman bards, under the names of *Tettix* and *Cicada*, for the far-resounding song of its males.

This order contains some of the most singular monstrosities that the insect world produces; animals armed with strange appendages and horns, which in the majority, are processes of the *trunk;* but, in the *lanthorn-flies*, of the *head:* the latter have been regarded, as their name imports, as a kind of lanthorn, given to the animal to afford it light; but considerable doubt has been thrown upon the fact. The use of the arms and processes of the trunk, which are found chiefly in the male, as well as in many male Lamellicorn beetles,[2] has not been satisfactorily ascertained; but probably, like the horns of quadrupeds, and the spurs of male gallinaceous birds, they use them in their mutual battles.

One of these animals, as producing the *manna* of the Pharmacopeia, may be regarded as of some use to mankind. And perhaps, in general, the tribe, in their perfect state, in which they imbibe the juice of plants and trees, if not too numerous, are probably of use to trees that are over vigorous, and full of sap. In their grub state, in America, they are very injurious to timber, and fruit trees, into which they introduce their eggs by a remarkable organ or ovipositor.

The proper *Hemiptera*, so called because their wing-covers at the base are of a substance resembling horn or leather, and are membranous at the tip, form the *last* suctorious Order; they are carnivorous, or more properly, *animal*-suckers;[3] for though many of them are found on particular trees and plants, it is not the juices of these that they usually imbibe, but those

1 *Phytomyza*, plant-suckers.
2 *Dynastes*, *Onthophagus*, *Copris*, &c.
3 *Zoomyza*.

of the insects that frequent them; there is one, however, too well known in this country, the *bed-bug*,[1] which is more ambitious, extending its attacks, like the flea, to the higher animals, being often found upon pigeons, upon rabbits, and more commonly infesting man himself, during his hours of repose. This Sub-order also presents a great variety of forms, and the bite of some is very venomous.

The *functions* of these are similar to those of other Insects, that derive their nutriment from the higher animals by sucking the blood or juices; but the bugs, being generally *Insect*-suckers, with their juices also suck away their lives, and so are employed to diminish their numbers. The *water-bugs*[2] attack other aquatic animals as well as Insects, such as fishes, Molluscans, &c.

*Order* 12.—The Orders that are placed as parallels to the *Homoptera* and *Hemiptera*, are the *Orthoptera* and *Coleoptera*. The former includes within its limits Insects of various habits, which may be divided, respect being had to their *food*, into *three* tribes:—those that are *herbivorous*, those that are *carnivorous*, and those that are *omnivorous*.

The *first* of these tribes includes all those Insects known by the common name of *grasshoppers*, and *locusts*;[3] several of those whose wing-covers and wings resemble leaves or flowers;[4] besides other kinds, which I need not mention. The ravages of those first mentioned, especially the locusts, are so well known,[5] that I shall not enlarge upon them.

The *second* tribe consists of what, from the posture they assume, have been called *praying-insects*,[6] some of which also resemble leaves. These are as ferocious and cruel as any of the insect tribes.[7]

The *last* tribe consists principally of the *crickets*[8] and *cock-roaches*,[9] animals that make their appearance only in the *night*, and feed both on animal and vegetable substances. It has been suggested to me by an eminent and learned Prelate, that the Egyptian plague of *flies*, which is usually supposed to have been either a mixture of different species, or a fly then called the *dog-fly*,[10] but which is not now known, was a *cock-roach*. His Lordship did not assign the reason that led him to adopt

1 *Cimex lectularius.*
2 *Hydrometra, Notoneeta, Nepa*, &c
3 *Locusta.*
4 *Pterophylla.* Stoll. *Saut* t. i. 3.
5 See above, p. 48.
6 *Mantis. Phyllium.*
7 *Introd. to Ent.* i. 278.
8 *Gryllus. Gryllotalpa*, &c.
9 *Blatta.*
10 Gr. κυνομυια.

this opinion, but the Hebrew name of the animal, which is the same by which the raven also is distinguished, furnishes no slight argument in favour of it. The same word also signifies the *evening*. Now the cock-roach at this time found in Egypt[1] is *black*, with the anterior margin of the thorax white, and they never emerge from their hiding places till the *evening*, both of which circumstances would furnish a reason to the name given it; and it might be called the *evening* Insect, both from its colour and the time of its appearance.

There appears to be a striking analogical resemblance between the bulk of the *Orthoptera* and *Homoptera* to the *Reptiles*, particularly the *Batrachian*; their leaping and song are the principal points in which they agree, whence the members of the latter Sub-order have usually been called *frog*-hoppers, but in some of the grass-hopper tribe there is also a singular coincidence in their form.[1]

*Order* 4.—The *earwigs*[2] form a truly *osculant* Order, between the *Orthoptera* and *Coleoptera*, and partaking of the characters of both, but their habits are so well known that it is not necessary to dwell upon them.

*Order* 13.—Of all the insect Orders which God has created and employed to work his will upon earth, by removing whatever deforms or defiles the face of nature, there is none more remarkable, both for its numbers, the diversities of form and aspect that it exhibits, and of armour both defensive and offensive, and also of its organs of various kinds, and for various uses, than that of which I am now, in the last place, to give some account, the *beetles*, namely, forming the Order *Coleoptera*.

The parallel to this Order amongst the suctorious insects, appears to be the *Hemiptera* Sub-order, the wing-covers of some of which,[3] having scarcely any membrane at their extremity, represent the elytra of the Order in question; indeed the substance of the base of these organs, in the generality, also corresponds with that of the beetles.

Of all the mandibulate Orders there is none that appears to have so universal an action upon every substance, both vegetable and animal, both living and dead, as the one before us, but it is difficult to class them according to their food without breaking up natural groups; thus in the great tribe of Lamellicorn beetles, forming Linné's genus *Scarabæus*, we find in-

1 Stoll. *Saut. t.* viii. b. *f.* 29.
2 *Forficula.*
3 *Lygæus apterus, brevipennis*, &c.

sects that feed upon a great variety of vegetable food, both liquid and solid; green and putrescent; the feces of animals; and in a few instances, on their flesh.

A very considerable number of this Order are *predaceous* in their habits, and devour without pity, any small animal they can seize and overpower. Of this discription is the whole tribe of *ground-beetles*, called by old writers clocks and dors, considered by Linné as forming one genus,[1] but now divided into more than a hundred.

One of the most remarkable of this tribe is the spectre-beetle[2] described by Hagenbach, which is found both in Java and China. In its general aspect, though evidently belonging to the Carabidans, it seems to represent the praying-insects, and the spectres;[3] and, from its great flatness, it probably insinuates itself into close places, either for concealment or to lie in wait for its prey.

The splendid tribe of *tiger-beetles*,[4] as they indicate by their fearful jaws, have the same habits, adding a swift flight to the rapid motions on foot which distinguish the other. The grubs of these emulate spiders in some respects, lying in wait for their prey in burrows in which they curiously suspend themselves.[5] In the waters a considerable tribe of Beetles pursue various aquatic insects, and by means of their oary hind legs swim very swiftly, often suspending themselves at the surface by their anal extremity, near which are two large spiracles for respiration, for they do not respire the water like fishes and the grubs of Dragon-flies. Their larves are armed with tremendous sickle-shaped jaws, through which they pump the juices from fishes as well as insects.

Besides those that are indiscriminate devourers, others confine themselves to particular tribes or species. Thus one of the most splendid of the, so called, *ground-beetles*, named the *sycophant*,[6] ascends the trees and shrubs after the caterpillars which are its destined food, and probably other species of the genus have the same commission. The *rove-beetles*[7] bury themselves in excrement in order to devour the grubs that frequent it. I have before mentioned[8] the wasp-beetle; there are others which, in the same way, attack those of the hive and other bees.[9] Another has a more remarkable instinct, by which it

1 *Carabus.*
2 *Mormolyce.* PLATE XI. FIG. 1.
3 *Phasma.*
4 *Cicindela, Manticora.*
5 *Introd. to. Ent.* iii. 152.
6 *Calosoma Sycophanta.*
7 *Staphylinus.* L.
8 See above, p. 366.
9 *Clerus apiarius*, and *alvearius.*

is impelled to seek its nutriment in the slimy snail.[1] There is an insect much resembling a bird-louse that is parasitic on wild-bees, which has been thought to be produced from the eggs of the great oil-beetle,[2] but some doubt still hangs on the fact.[3]

Another tribe of beetles have a different commission from their Creator, and instead of *living* ones, feed upon *dead* animals, of every description. To this tribe belong the burying beetles, long celebrated for the manner in which they bury pieces of flesh to which they have committed an egg;[4] other carrion beetles[5] may be found in considerable numbers of various species and kinds, under every carcass;[6] even *bones*, after they are denuded of the flesh, are attended by certain insects of this Order, by whose efforts they are completely stripped of every remnant of muscle.[7] Some even find their nutriment in the interior of horns.[8]

Lacordaire observes that the carcasses dry so rapidly in South America, that few necrophagous insects are found there: and that even in the Pampas, and at Buenos Ayres, where animals decompose as in Europe, there are but few of these insects: but their place is supplied by innumerable birds of prey. As soon as an animal is killed, they fly in crowds from every part of the horizon, though one before was not to be seen. The most destructive beetles in these countries are those that attack *leather* or skins. Two species of the same genus[9] commit dreadful ravages in the magazines of this article: and in spite of the constant pains that are bestowed to get rid of these insects and their grubs, great losses are suffered.

Another unsightly substance is removed by numberless beetles, whose office is that of scavengers; the celebrated *Scarabæus* of the Egyptians,[10] the symbol, as it is supposed, of the sun, is of this description; the pill-beetle also,[11] equal in fame to the burying one, for trundling its pills, each containing an egg, with the aid of his co-species: many of a smaller type are likewise devoted to the same office.[12]

It is worthy of remark that all these feed only on the excrement of *herbivorous* animals; none having been recorded, I

1 *Cochleoctonus.*
2 *Meloe.*
3 See *Introd. to Ent.* iii. 162. note 6.
4 *Introd. to Ent. i.* 352.
5 *Silpha.* L.
6 *Dermestes. Byrrhus*, &c.
7 *Nitidula*, &c.
8 *Trox.*
9 *Dermestes cadaverinus et vulpinus.*
10 *Scarabæus sacer.*
11 *Ateuchus pilularius. Introd. to Ent.* i. 351.
12 *Sphæridium*, &c.

believe, that feed on that of *carnivorous* ones, except a single species[1] that inhabits *human* excrement solely, but forms no burrow under it.

Others of the order make a transition to the *vegetable* kingdom, by attacking various kinds of fungi, as agarics, Boleti, puff-balls, and the like, which in fact seem to exhibit, in their substance, some analogy to *flesh.* Fabricius has given the name of *Agaric-eater*[2] to a genus that is chiefly found in the *Boletus;* another beetle, however, devours agarics, and is found, I believe, in no other fungus;[3] and the puff-ball affords a favourite nutriment to others.[4]

Some beetles, or tribes of beetles, are both predaceous, carnivorous, coprophagous, and fungivorous. The Histers will devour carrion, dung, funguses, and putrescent wood: I once found the autumnal dung-beetle[5] in considerable numbers in a dead bird, and Lacordaire mentions others that are carnivorous: he says that the habits of *Trox* approach those of the necrophagous beetles, it being always found under half-dried carcasses, of which they gnaw the tendinous parts. It is found also in the excrements of man and herbivorous animals. *Phanæus Milon* he observed principally under putrescent fishes on the shores of the River Plate.[6]

We have thus had a regular transition, with regard to their food, leading the beetle tribes through the animal to the vegetable world.

Vegetable feeders are innumerable amongst them, the gold,[7] tortoise,[8] and flea-beetles[9] all devour plants in both their active states, and some of these are extremely injurious to the farmer[10] and gardener. Many are destructive to seeds, fruits, and roots, numbers of the weevil tribe, and all the Bruchi are of this description.[11]

But of all the beetle tribes the *timber-devourers* are the most numerous; one of the most splendid and brilliant of the whole Order, the *Buprestidans*, belongs to this department, and the still more numerous and more varied *Capricorn* beetles,[12] though less refulgent with metallic splendour, add a vast momentum in the interminable forests of tropical regions, and must be of the greatest use in gradually reducing trees that have been

1 *Hybosorus geminatus.*
2 *Mycetophagus. Boletaria.* Marsh.
3 *Oxyporus maxillosus.*
4 *Lycoperdina.*
5 *Geotrupes autumnalis.*
6 *Ann. des Sc. Nat.* xx. 263. 265.
7 *Chrysomela*, &c.
8 *Cassida.*
9 *Haltica.*
10 *Introd. to Ent.* i. 187. 207.
11 *Ibid*, 172. 176, &c.
12 *Cerambyx.* L.

uprooted by tornadoes, or any other cause, to a state of putridity, and finally to dust. Other beetles, of smaller dimensions, and of a cylindrical form, which take their station between the bark and the wood, are instrumental in separating them so as to let in the wet,[1] and expose the timber more effectaally to the action of the elements.

The great majority, indeed, of this interesting Order derive their nutriment, in their first and last states, from the vegetable kingdom. The Lamellicorns afford a conspicuous instance of this. Even those of them that are coprophagous, feed upon vegetable detritus in some degree animalized; and some are stated to feed indifferently both on excrement and leaves.[2] The giants of the Order, the mighty Dynastidans,[3] appear to feed upon putrescent timber, burrowing in it as well as in the earth. The Melolonthidans, in their first state, devour the *roots* of grass, &c., whence one of the modern genera into which they are divided is named the *root-eater*;[4] in their perfect state, they emerge from their subterranean dwellings, and attack the *leaves* of trees and shrubs, and are sometimes very injurious to them. Again, there are others, which, as it were, disdaining such coarse food, devour the *blossoms* themselves, whence Latreille calls them *Anthobians*: and lastly, the lovely tribe of Cetoniadans, to which the rose-beetle[5] belongs, imbibe the *nectar* of the flowers they frequent.

Many of the weevil tribes are very destructive to stored grain;[6] and others equally so to certain fruits.[7]

Though the *Hymenoptera* and *Neuroptera* Orders are most celebrated for the *associations* which certain tribes instinctively form, this principle does not act in them solely, other Insects have their swarms at certain seasons, as in the case of the New Holland butterflies before noticed; and the beetles afford several instances of it. About the time of the summer solstice, the solstitial beetle[8] may be seen and heard buzzing in vast numbers over the trees and hedges, and a little earlier the cockchafer[9] does the same, and many others of the same family.[10] Lacordaire observed, in Brazil, that two species of *diamond bee-*

1 *Introd. to Ent.* i. 235. 260.
2 Lacordaire, *Ann. des Sc. Nat.* xx. 260.
3 *Dynastes.* M'Leay.
4 *Rhizotrogus.*
5 *Cetonia aurata.*
6 *Calandra.*
7 *Cordylia Palmarum.*
8 *Rhizotrogus solstitialis.*
9 *Melolontha vulgaris*
10 *Hoplia*, &c.

*tles*[1] clustered so on some kinds of Mimosa, that the branches bent under the weight of their glittering burthen.[2]

The same author mentions a curious distinction between the luminosity of the glow-worms and fire-flies in Brazil, which has been confirmed to me by a gentleman sometime resident in that country. In the former, he says the light perpetually scintillates, but in the latter it is constant;[3] the kind of glow-worm most common in that part of America, belongs to a tribe in which the shield of the thorax does not cover the eyes, and the females is winged as well as the male.[4] Thus in these little illuminators of tropical nights we have a kind of mimic stars and planets, the former of which are so numerous as to fill the air with their scintillations.

The immediate object of this faculty, in these beetles, and in other insects, has not been clearly ascertained; as the females are usually most luminous, it may be to allure the male; or, as most insects fly to the light, it may also bring their prey within their reach; or, again, it may be a defence from their own nocturnal enemies;[5] but whatever be its object with respect to the animals themselves that are gifted with this faculty, they give man an opportunity of glorifying his Creator, not only for the starry heavens, but also for these little flying stars that render night so beautiful and so interesting, where they occur.

In considering the great Class of Insects with reference to their *office*, the first thing that strikes us is their infinite number, not only of individuals of the same species, but of different species and even genera, and the vast variety of forms and structures that they necessarily include. When we began the present subject, and, dipping under the waves of ocean, visited the vast world of waters, to survey their various inhabitants; even amongst those that can be seen only by the assisted eye, we saw no traces of such diversity; the number of *individuals*, it is true, were incalculable, but though they have been the objects of research, with so many inquirers, and for so long a period, the number of *species* known fall short of half a thousand, while the number of Insects already in cabinets are stated to be more than two hundred times that number, and

1 *Entimus imperialis*, and *nobilis*. 2 *Ann. des Sc. Nat.* xx. 161.

3 *Ann. des Sc. Nat* xx. 247.

4 *In the Introduction to Entomology*, (ii. 407) this genus is named *Pygolampis*, after Aristotle, *Hist. Anim.* l. iv. c. l.

5 See above, p. 308.

even, in our own country, more than *ten thousand* have been enumerated and named.

The momentum of so vast a body of animals, everywhere dispersed, and daily and hourly at work in their several departments, must be incalculable; and this momentum must be doubled by the circumstance that so singularly distinguishes a large proportion of them; I mean that the different periods of their existence are passed under different forms, during which they have quite different functions assigned them, and are fitted with different organs, being, when they are first disclosed from the egg, masticators of solid and grosser food, and in their last state imbibing nectareous fluids. The connection of the first is with the *leaves* of the plant, to them they are committed by the mother as soon as they are extruded from her matrix, and they supply them with their earliest and latest food; but when she is disclosed in all her beauty, dressed as it were in her bridal robes, the connection is between her and the *flower*, her lovely analogue, from them she imbibes the sweet fluid which their nectaries furnish, and now, instead of a devourer, she abstracts merely what is redundant, which, while it contributes to her own enjoyment and support, in the case of the bee, enriches man himself.

We behold, then, this immense army of devourers, varying so infinitely in their instincts, as well as their forms, supplying many animals with the whole of their subsistence, and forming a considerable portion of that of others, and feel convinced that Providence has not placed them in their position, and given them such a variety of organs, except with the view to some great general benefit to those animals amongst whom he has placed them; and this benefit is not so much perhaps the reducing the numbers of their own class within due limits, though that is a most important object, as removing nusiances, which would deform, or in any way infect the earth and its inhabitants. For this the Insect world is principally distinguished as to its functions. It consists of the scavengers of the earth, and the pruners of its too luxuriant productions.

With respect to ornament and pleasurable sensations, which were certainly the object of our beneficent Creator, as well as our profit and utility—next to the birds, nothing adds more to the life of the scene before us, during the diurnal hours, and even sometimes the nocturnal, than the vast variety of insects that are flying, running, and jumping about in all directions, all engaged in their several pursuits,—the bees humming over the flowers; the butterflies opening and shutting their painted wings to the sun; the gnats, and gnat-like flies, rising and

falling alternately in the sunbeams; the beetle wheeling his droning flight; others coursing over the ground; the grasshopper chirping in every bank,—all adding to the general harmony, and combining to make the general picture one of life and LOVE; and speaking, each in different sort and manner, the praises of its Creator, and calling upon man to join in the general hymn.

## CHAPTER XXI.

### *Functions and Instincts. Fishes.*

THE animals we have hitherto considered have been destitute of an internal jointed vertebral column and its bony appendages; and though some, as the Cephalopods and some slugs,[1] have a kind of internal bone, and in one Order of Polypes[2] the axis is sometimes articulated, yet these, especially in the latter instance, merely indicate an analogical relation, but no affinity. In none of these instances is this internal bone perforated for the passage of a spinal marrow, as in a real vertebrated column; we now, however, enter that superior section of the animal kingdom, the individuals belonging to which, with scarcely any exception, are built upon the column in question, incasing a spinal marrow, and terminated at its upper extremity by a bony casket, calculated to contain and protect the most precious and wonderful of all material substances, the cerebral pulp, by which the organs of sense perceive; the will moves the members; the mind governs the outward frame; and, in the king of animals, an immortal spirit, is enabled to seek and secure a higher destiny.

This change in the *structure* of animals was rendered necessary by an increase in their *bulk*, for though there are some of the invertebrated Sub-kingdom, as the fixed Polypes and several of the Cephalopods, that are of as large dimensions, and a few of the vertebrated, as the humming birds,[3] and the harvest mouse,[4] that are not so large as some insects; yet the generality of those distinguished by a vertebral column form a striking contrast, as to magnitude, with those that are not. Besides this, as these animals, by the will of their Creator, were to be endowed as they ascended in the scale, with gradually increasing intellectual faculties, it was necessary that the principal seat of those faculties should be differently organized. A different organ of respiration also, as well as of circulation, in the

1 See above, p. 164.
2 *Ibid.* p. 94.
3 *Trochilus.*
4 *Mus messorius.*

great body of vertebrates, required an internal cavity defended from the effects of pressure.

Having premised these general observations, we are next to consider what animals form the basis of the vertebrated Sub-kingdom. Most modern zoologists appear to be of opinion that the *Fishes* occupy this position, and, taking all circumstances into consideration, this seems the station assigned to them by their Creator; still there are characters in some of the *Reptiles* that seem to connect them more immediately with the *Insects*. The metamorphoses, particularly of the Batrachian Order, are of this description; as is likewise the carapace, or shell of the Chelonians, of which the vertebral column and ribs form the basis. Those extraordinary animals, the hag[1] and the lamprey,[2] half worms and half fish, by means of the leech, evidently connect the Fishes with the Annelidans.[3] Perhaps those butterflies of the ocean, the flying fishes,[4] with their painted wing-fins with branching rays, may look towards the *Lepidoptera* amongst Insects, but there is no direct connection at present discovered between the two Classes.

The characters of the Class of Fishes are—*Body* with a vertebral column, covered with *scales*, and moved by *fins*. *Respiration* by permanent *gills*. *Heart* with only one *auricle* and one *ventricle; blood* red, cold.

Fishes are distinguished from the other vertebrated animals, especially birds and beasts, by their mode of *respiration;* the *latter* breathing the atmospheric air, are furnished with *lungs*, which receive that element, oxygenate the blood, and again expel it in a different state; while the *former*, which must decompose the water for respiration, breathe by means of *gills*, found also in many invertebrates; these are usually long, pointed plates, disposed like the plumules of a feather, or teeth of a comb, in fishes attached to bony or cartilaginous bows; each of them, according to Cuvier, covered by a tissue of innumerable blood-vessels; but, according to Dr. Virey,[5] having a minute vein and artery. In the gill of a cod-fish, which I have just examined under a microscope, a vein and artery traverse each plate longitudinally at the margin, which appear to be pectinated, at right angles on each side, with innumerable minute branches, and resemble, in this respect, the gills of Crustaceans.[6] Thus the blood is oxygenated by the air mixed

1 *Gastrobranchus.* (*Myxine.* L.)
2 *Pteromyzon.*
3 Sir E. Home, *Philos. Trans.* 1815, 265.
4 *Exocœtus volitans*, &c.
5 *N. D. D'H. N.* iv. 330.
6 Latr. *Cours. D'Ent. t.* 2. *f.* 2.

with the water, and carried to the heart, whence it is distributed to the whole body. So that the aërated water produces the same effect upon the blood in the branchial vessels, as the air does upon that in our lungs.

We know, by experience, how soon an animal that breathes by lungs, if it remains only a few minutes under water, and is cut off from all communication with the atmosphere, is suffocated and dies; and that all aquatic animals that have not gills, or something analogous, as all the water-beetles, the larves of gnats, &c. are obliged, at certain intervals, to seek the surface for respiration. Whence we may learn what an admirable contrivance of Divine Wisdom is here presented to us, to enable the infinite host of fishes to breathe as easily in the water as we do in the air.

When we sum up all the diagnostics of the Class we are considering, we can trace, at every step, so that, almost, *he that runs may read*, Infinite Power in the construction, Infinite Wisdom in the contrivance and adaptations, and Infinite Goodness in the end and object of all the various physical laws, and in all the structures and organizations by which they are severally executed, which strike the reflecting mind in this globe of ours. What else could have peopled the waters, and the air, with a set of beings so perfectly and beautifully in contrast with each other, as the fishes and the birds. Sprung originally from the same element, they each move, as it were, in an ocean of their own, and by the aid of similar, though not the same, means. The grosser element they inhabit required a different set of organs to defend, to propel and guide, and to sink and elevate the *fish*, from what were requisite to effect the same purposes for the *bird*, which moves in a rarer and purer medium; yet as both were *fluid* mediums, consisting of the same elements, though differently combined; analogous organs, though differing in substance, structure, and number, were required. For what difference is there between swimming and flying, except the element in which these motions take place? The fish may be said to *fly* in the *water*, and the bird to *swim* in the *air;* but perhaps the movements of the aquatic animal, from its greater flexibility and the number of its motive organs, is more graceful and elegant than those of the aërial. The *feathers* of the one are analogous to the *scales* of the other; the *wings* to the pectoral *fins;* and the *tail* of both acts the part of a *rudder*, by which each steers itself through the waves of its own element.

One distinctive character of fishes is taken from the *scales* that cover and protect their soft and flexile forms from injury.

Scales, however, are not peculiar to *fishes*, since many *reptiles*, as the Saurians, and some quadrupeds, as the Pangolin,[1] are armed by them. Scarcely any species of fish is really without them. In some, upon which when living they are not discoverable under a microscope, when they are dead, and the skin is dry, scales are readily detected and detached. These organs vary greatly in form: sometimes they resemble spines, at others they are tuberculated; but most commonly they are plates, often carinated, and varying in shape, some being round, others oval, others again angular; sometimes also they are finely denticulated. In some fish they are separated, in others they touch, often so as to form together the resemblance of a beautiful piece of mosaic, and in many they are imbricated.[2] In those that rarely approach the shore, and are exposed only to slight friction, they are fastened by a smaller portion of their circumference; but in in-shore fishes they are more firmly fixed, and covered partly by the epidermis, which, in those that live and burrow in the mud, almost entirely envelopes them. Some fishes set up their spines like a hedgehog; and most, when alarmed, seem to have the power of erecting them more or less. Had we the means of ascertaining the situation and circumstances of every individual, we should find that, in every case, the figure and connexion, and substance of the scales, was ruled by them. A proof of this may be seen in those fishes whose integument consists of hard scales, united together so as to form a tesselated coat of mail. I allude to the *Ostracions*, whose organs of locomotion seem not calculated to effect their escape when pursued; the want of speed, however, is compensated by a covering that the teeth of few of their enemies can penetrate: the same remark applies to those fishes that can inflate themselves into a globe,[3] in some of which the fins are so minute, as to be scarcely discoverable. In these the scaly spines, when erected, assist in preventing the attack of enemies.

I have given a detailed account of the *fins* of fishes on a former occasion.[4] I shall therefore here only consider the motions of which they are the organs, and their theatre.

Though the *birds*—if we consider the whole atmosphere of the globe, whether expanded over earth or sea, as their domain—may perhaps have a wider range than the *fishes*, yet when we further consider that, besides the whole extent of the ocean, and the seas in connexion with it, with all its unfathomable

1 *Manis*.
2 Roget, *B. T.* i. 116.
3 Roget, *B. T.* i. 433.
4 See above, p. 261.

depths and abysses, and all the rivers that flow into it—all the innumerable lakes also, and other stagnant waters, on mountains, and at every other elevation, that the earth's surface contains, belong to the fishes, and compare at the same time the greatest depth to which they descend with the greatest height to which birds ascend, we may conclude that, with regard to its *extent*, their habitable world may be nearly commensurate with that of their rivals or analogues.

As to their *motions*, in their element, birds of the most rapid and unwearied wing must yield the palm to them; the eagle to the shark, and the swallow to the herring and salmon. The form of fishes, generally speaking, is particularly calculated for swift and easy motion; and the resistance of the fluid in which they move seems never to impede their progress. While birds that undertake long flights are often obliged to alight upon vessels for some rest and renovation of strength, fishes never seem exhausted by fatigue, and to require no respite or repose. Sharks have been known to keep pace with ships during long voyages; and, like dogs, they will sport round vessels going at several knots an hour, as if they had plenty of spare force.[1] The thunny darts with the rapidity of an arrow, and the herring goes at the rate of sixteen miles per hour. But though many fishes thus pursue an unwearied course without any intervals of repose, yet there are some that often appear to sleep. Inflating its natatory vesicle, our fresh-water shark, the pike, in the heat of the day, rises nearly to the surface, and there remains perfectly motionless and apparently asleep: at this time he is easily snared, by passing a running noose of wire over his tail, and by a sudden jerk bringing him on shore.

The *eye* of fishes is like that of the higher animals, but of a substance that makes the access of the water to it no more troublesome than that of the air to terrestrial animals. Generally speaking, it is protected by no eyelid or nictitant membrane. One genus, however, removed from the *gobies*,[2] has the *former;* and a species of *bodian*,[3] from the equatorial seas, has a movable membranous valve above each eye, with which, at will, it can cover it, that seems analogous to the *latter*. The eye of the eel, and other serpentiform fishes, which are usually buried and move about in the mud, is covered, through the provident care of their Creator, by an immovable membrane; and in several species the organ can be withdrawn to the bottom of the socket, and even concealed, in part, under

1 *N. D. D'Hist. Nat.* xxvii. 247.
2 *Periophthalmus.*
3 *B. palpebratus.*

its margin. But the most singular kind of eye in the Class, and that in which the forethought of the Deity is most conspicuous, is that of the *Anableps*, a viviparous fish, inhabiting the rivers of Surinam, and called by the natives the *four-eyed* fish. If the cornea of this eye be examined attentively it will be found that it is divided into two equal portions, each forming part of an individual sphere, placed one above and the other below, and united by a little narrow membranous, but not diaphanous, band, which is nearly horizontal when the fish is in its natural position ; if the lower portion be examined, a rather large iris and pupil will be seen, with a crystalline humour under it, and a similar one with a still larger pupil in the upper portion. The object of Divine Wisdom in this unparallelled structure, if we may conjecture from the circumstances of the animal, is to enable it to see near and distant objects at the same time—the little worms below it that form its food, with one pupil and iris, and the great fishes above it or at a distance, which it may find it expedient to guard against, with the other.

The senses of smell and hearing have no external avenue in fishes. The former is the most acute of all their senses. Lacepede says it may be called their real eye, since by it they can discover their prey or their enemies at an immense distance; they are directed by it in the thickest darkness, and the most agitated waves. The organs of this sense are between the eyes. The extent of the membranes on which the olfactory nerves expand, in a shark twenty-five feet long, is calculated to be twelve or thirteen square feet.

The *teeth* of fishes may be divided into the same kinds as those of quadrupeds ; they have their laniary, incisive, and molary teeth ; they are differently distributed, according to the species and mode of life ; some are almost immovably fixed in bony sockets, others in membranous capsules, by which means they can be elevated or depressed at the will of the animal. They not only have often many rows of teeth in their mouth, but even their palate, their throat, and their tongue are sometimes thus armed.[1] And this accumulation of teeth is not confined to the fiercest monsters of the deep, but even some herbivorous fishes have several rows of molary teeth. An instance of this is afforded by a jaw of some unknown fish, perhaps a Siluridan, in my possession, in which there are six rows of such teeth, the anterior ones being somewhat conical. This specimen was found on the shore of one of the lakes in Canada,

1 Plate XIII. Fig. 3.

and belonged to a fish, which the friend who gave it to me stated was much relished by the Indians.

Many of the organs of the members of this Class are more independent of each other than those of warm-blooded animals; they seem less connected with common centres, in this respect resembling vegetables, for they may be more materially altered, more desperately wounded, and more completely destroyed, without any mortal effect. Many of their parts, as the fins, if mutilated, can be reproduced. Indeed a fish, as well as a reptile, can be cut, torn, or dismembered without appearing to suffer materially. The shark, from which a harpoon has taken a portion of its flesh, pursues his prey with the usual avidity, if his blood has not been too much exhausted. We see in this a merciful provision, that animals so much exposed to injury should suffer less from it than those which are better protected, either by their situation or structure.

Fishes are amongst the most long-lived animals. A pike was taken, in 1754, at Kaiserslautern, which had a ring fastened to the gill-covers, from which it appeared to have been put into the pond of that castle by the order of Frederick the Second, in 1487, a period of two hundred and sixty-seven years. It is described as being nineteen feet long, and weighing three hundred and fifty pounds!!

Though the animals of the Class under consideration are not generally remarkable for their sagacity, yet they are capable of instruction. Lacepede relates that some, which for more than a century had been kept in the basin of the Tuilleries, would come when they were called by their names; and that in many parts of Germany trout, carp, and tench are summoned to their food by the sound of a bell.[1]

At the first blush it seems as if fishes took little care or thought for their offspring; but when we inquire into the subject, we find them assiduous to deposit their eggs in such situations as are best calculated to ensure their hatching, and to supply the wants of their young when hatched; but sometimes they go further, and prepare regular *nests* for their young. Two species, called by the Indians, though of different genera,[2] by the name of the *flat-head* and *round-head hassar*, have this instinct, and construct a nest, the former of leaves and the latter of grass, in which they deposit their eggs, and then cover them very carefully; and both sexes, for they are monogamous, watch and defend them till the young come forth. General

1 *Hist. des Poiss. Introd.* cxxx. 2 *Doras* and *Callicthys*.

Hardwicke mentions a parallel instance in the *goramy*,[1] of the Isle of France, a fish of the size of the turbot, and superior to it in flavour, cultivated in the ponds of that island.

It has been observed that some fishes, when dead, emit a phosphoric light, I have particularly noticed this in the mackarel, but others do this when living. The *sun-fish*[2] which sometimes has been found of an enormous bulk,[3] when swimming yields a light, which looks like the reflection of the *moon* in the water, whence it has also been called the moon-fish—and the spectator in vain searches for that planet in the heavens. Sometimes many individuals swim together, and by their multiplied luminous disks, generally at some distance, compose a singular and startling spectacle; and if we take into consideration the magnitude of these animals,[4] we may conceive the wonder and amazement that would agitate the mind of any one when he first beheld such an army of great lights moving through the waters. For what purpose Providence has gifted the sun-fish with this property, and how it is produced, has not been ascertained. It may either be for defence or illumination.

Few animals, with regard to magnitude, present to the eye such enormous masses as some fishes; leaving the *whale* out of the question, which though aquatic, belong to another Class, what quadruped can compete with the *shark*, which is also a phosphoric fish. That tribe called by the French *Requins*,[5] which is thought to be synonymous with the *Carcharias* of the Greeks, and one of which was probably the sea-monster, mistranslated the *whale*, which swallowed the disobedient prophet—are stated to exceed thirty feet in length; another[6] of a different tribe, is still larger, sometimes extending to the enormous length of more than *forty* feet!![7] Next to the sharks, the *rays*, nearly akin to them, exceed in their magnitude; they are sometimes called sea-eagles, because in their rage and fury they occasionally elevate themselves from the water, and fall again with such force as to make the sea foam and thunder. An individual of a species[8] of this tribe, called by the sailors the *sea-devil*, taken at Barbadoes, was so large, as to require *seven pairs* of oxen to draw it on shore!![9]

1 *Osphromenus olfax.* 2 *Mola.*

3 One is said to have been caught in the Irish sea twenty-five feet long!!—Lacep. *Hist.* 511.

4 *Hist. of Waterford*, 271. Borlase, *Cornw.* 267.

5 *Carcharias.* Cuv. 6 *Squalus maximus.*

7 *N. D. D'H. N.* xxix. 192. xxxii. 74.

8 *Raia Banksiana.* 9 Lacep. *Hist. des Poiss.* ii. 116.

If we consider the vast tendency to increase of the oceanic tribes, that where a terrestrial animal gives birth to a single individual, a marine one perhaps produces a *million*, we may conceive that if no check was provided to keep their numbers within due limits, they would so fill the waters as to interfere with each other's and the general welfare. The Cod-fish alone, which, according to Leeuwenhoek and Lacepede,[1] produces more than nine millions of eggs in one year, if neither man, nor shark nor other predaceous fish, made it their food, would so fill the ocean in congenial climates, in the course of no long period of time, that there would scarcely be space for the motions or life of any other marine animal: the same may be said of almost all the migratory fishes. In these circumstances we see the reason why such enormous monsters were created that could swallow them by hundreds, why their yawning mouth and throat were planted with teeth and fangs of different descriptions, fixed and movable, arranged in many a fearful row of bristling points, and why this tremendous array has been mustered in the mouth of animals of such never-sated voracity, and of such unmitigated cruelty and ferocity.

Still though the scene is one of blood and slaughter, yet He whose tender mercies are over all his works, has fitted the creatures exposed to it for their lot. Cold-blooded animals, as I lately observed, do not suffer from the various dismemberments to which their situation exposes them, like those of a higher and warmer temperature, whence we may conclude, that great pain and anguish are not felt by them.

Another function of these tremendous animals is to devour all *carcasses*, which, from whatever cause, are floating in the water, thus they act the same part in disinfecting and purifying the ocean, that the hyænas and vultures, their terrestrial analogues, and other animals do, upon earth.

Another lesson may be learned from the existence of these terrible monsters; for if God fitted them to devour, he fitted them also to instruct. The existence of creatures so evil, and such relentless destroyers of his works in the material world, teach us that there are probably analogous beings in the spiritual world; and what occasion we have for watchfulness, to escape their destructive fury.

There is nothing more remarkable in the Class we are considering than the infinite variety and singularity of the figures and shapes of fishes. It has been thought that the ocean contains representatives of every terrestrial and aërial form. How-

1 Leeuwenh. *Epist.* iii. 188. Lacep. *Hist. Ibid.* 393.

ever this be, it may be asserted that the forms of fishes are more singular and extraordinary, more grotesque, and monstrous, than those of any other department of the animal kingdom ; but on this subject I need not enlarge.

Having made these general remarks upon fishes, I shall next say something on their *Classification.* Of all the Classes of animals, that of fishes, as Baron Cuvier observes, is the most difficult to divide into Orders. Linné considered what have been usually denominated *Cartilaginous Fishes,* as forming a section of his *Amphibians :*[1] but the former illustrious naturalist has very judiciously arranged them with the fishes. Ichthyologists in general agree with Cuvier in dividing this Class into two Sub-classes—viz. *Osseans,* in which the skeleton is *bony* and formed of bony *fibres;* and *Cartilagineans,* in which it is *cartilaginous* and formed of calcareous *grains.* Lacepede, the most eminent of modern Ichthyologists, has observed that there is a striking resemblance or analogy between certain points of these two Sub-classes, of which he has given a table drawn up in a double series, which I shall here subjoin.

| CARTILAGINEANS. | OSSEANS. |
|---|---|
| *Petromyzon. Gastrobranchus.* | *Cæcilia. Muræna. Ophis.* |
| *Raia* | *Pleuronectes.* |
| *Squalus* | *Esox.* |
| *Accipenser* | *Loricaria.* |
| *Syngnathus* | *Fistularia.* |
| *Pegasus* | *Trigla.* |
| *Torpedo. Tetrodon.* | *Gymnotus. Silurus.* |

Cuvier also remarks, with respect to the animals of the present Class, that they form two distinct *series,*[2] which in another place he says, cannot be considered as either superior or inferior to each other.

Many genera of the Cartilagineans, he thinks, approach the Reptiles by some parts of their organization, whilst it is almost doubtful whether others do not belong to the Invertebrates.[3] He has made no remark with respect to the connection of the *Osseans* with the above Class : though his thirteenth Family consists of fishes that have always gone by the name of *fishing-frogs,*[4] from the resemblance which they exhibit to that animal, and from their pectoral fins assuming the appearance of legs.[5] The species of one genus[6] resemble a fish with a lizard on its

1 *Nantes.*
2 *Règne Anim.* ii. 128.
3 *Ibid.* 376.
4 *Lophius.* L.
5 Plate XIII. Fig. 1.
6 *Malthus.*

back, the head being overshadowed by a conical horizontal horn, in the sides of which the eyes are fixed, so that the lower lobe simulates the head of a fish, and the upper one that of a lizard.[1] This family of fishes, as well as the *lump-fish*,[2] in his *Lectures on Comparative Anatomy*, Cuvier classed with the Cartilagineans.

It is not to be expected that I should be able to thread my way through a labyrinth, in which this great man confesses himself to be at a loss; and therefore I shall not attempt any alteration of his system, though confessedly the reverse of *natural* with respect to the *Orders* into which he divides it, but leave the subject to an abler hand, M. Agassiz, who is reported to have undertaken it, and in the mean time, give a popular summary of Baron Cuvier's Orders, as I find them in the last edition of the *Règne Animal.*

*Sub-class* 1.—The *Cartilagineans*, which, as allied to the Annelidans, I shall place first, are divided by Cuvier into *three* Orders,[3] viz. the *Cyclostomes*, or suckers; the *Selacians;* and the *Sturionians.*

*Order* 1.—The *Cyclostomes*, or suckers, with regard to their skeletons, are the most imperfect of all the Vertebrates. They have neither *pectoral* nor *ventral* fins. Their *body*, apparently headless and eyeless, terminates anteriorly in a circular or semicircular fleshy *lip*, supported by a cartilaginous ring. Their *gills* consist of pouches instead of pectinated organs. By means of their mouth, which, as well as the tongue, is armed with teeth, they fix themselves to fishes, and derive their nutriment from them. The *lamprey*,[4] *lamperne*,[5] and *hag*, &c. belong to this Order.

*Order* 2.—The *Selacians* have gills, fixed by their outer margin, and not disengaged as in the Osseans, and they expel the water by lateral openings. To this Order the *sharks* and the *rays* belong.

*Order* 3.—The *Sturionians* agree with the Ossean Fishes in their gills, but their skeleton is cartilaginous. They have only a single orifice, covered with an operculum. The sole genera included in this Order are the *Sturgeon*[6] and the *Sea-ape.*[7]

*Sub-class* 2.—The *Osseans* Cuvier divides in *four* Orders,

1 Plate XIII. Fig. 2 2 *Cyclopterus.*

3 *Ubi supr.* 128. where Cuvier arranges them in the Order here adopted, but when he gives the details of the Sub-class, he reverses it. *Ibid.* 378.

4 *Petromyzon fluvialis*, &c. 5 *P. branchialis ?*

6 *Accipenser.* 7 *Chimæra monstrosa.*

viz. *Acanthopterygians, Malacopterygians, Lophobranchians,* and *Plectognathians.* These Orders, for reasons before assigned,[1] I shall reverse.

*Order* 1. (*Cuv.* 6.)—*Plectognathian* Fishes. *Gill-covers* concealed under a thick skin. *Ribs* rudimental. *Ventral fins* wanting. To this Order belong the *Coat of Mail-fish,*[2] the *Sun-fish,*[3] and the *Bladder-fish.*[4]

*Order* 2. (*Cuv.* 5.)—*Lophobranchian* Fishes. So called because their gills are not pectinated, but disposed in tufts, as is the case likewise with some Annelidans;[5] body ridged longitudinally, covered with hard scales, united to each other; *mouth* elongated. To this Order belong those singular animals—the *dragonet,*[6] the *horse-head,*[7] or *sea-horse,* and the *sea-needle.*[8]

*Order* 3. (*Cuv.* 2.)—*Malacopterygian,* or soft-rayed Fishes. *Rays* not spiny, except sometimes the first of the dorsal or pectoral fins. This great Order Cuvier divides into three *Orders,* or rather *Sub-orders,* which I shall give inversely.

*Sub-order* 1. (*Cuv.* 4.)—*Apode Malacopterygians. Body* serpentiform, elongated; *skin* thick, soft, and slimy. To this Sub-order belong the *common-eel,*[9] the *conger-eel,*[10] and the *electric-eel,*[11] which have many points in common with the cyclostomous fishes of the preceeding Sub-class, and with respect to their form seem to look both towards the *Annelidans,* and more especially to the *Ophidian* Reptiles.

*Sub-order* 2. (*Cuv.* 3.)—The *Sub-brachian Malacopterygians. Ventral* fins attached under the *pectoral.* In this Order we find the *sucking-fish,*[12] the *lump-fish,*[13] the *flat-fishes,* and the *cod-fish,*[14] which seems an heterogenous mixture; the flat-fishes seem clearly entitled to rank as an Order.

*Sub-order* 3. (*Cuv.* 2.)—*Abdominal Malacopterygians. Ventral* fins attached under the abdomen and behind the *pectoral.* Here, as we ascend, we meet with the *sprat,*[15] the *herring,*[16] the *hassar,*[17] the *salmon,*[18] the *anableps,* the *roach,*[19] *tench,*[20] and *carp.*[21]

*Order* 4. (*Cuv.* 1.)—The *Acanthopterygians,* or spiny-rayed

1 See above, pp. 78, 358.
2 *Ostracion.*
3 *Mola.*
4 *Diodon.*
5 See above, p. 257.
6 *Pegasus.*
7 *Hippocampus.*
8 *Syngnathus.*
9 *Muræna Anguilla.*
10 *M. Conger.*
11 *Gymnotus.*
12 *Echeneis.*
13 *Cyclopterus.*
14 *Gadus.*
15 *Clupea Sprattus.*
16 *C. Harengus.*
17 *Doras. Callicthys.*
18 *Salmo.*
19 *Cyprinus rutilus*
20 *C. Tinca.*
21 *C. Carpio.*

Fishes. First rays of the *dorsal* fin, or of the *first* dorsal fin, spiny, or dorsal *spines* in the place of dorsal *fins*. Under this vast Order are arranged an infinity of families and genera, which Cuvier seems to lament that he was obliged to leave together.[1] The *tobacco-pipe-fish*,[2] the *razor-fish*,[3] the *fishing-frogs*,[4] the *lyre-fish*,[5] the *John Dory*,[6] the *sword-fish*,[7] the *mackarel*,[8] the *gurnard*,[9] the *mullets*,[10] and the *perch*,[11] are amongst those that belong to this Order.

It is impossible to consider the Orders of Fishes as we have done those of Insects, and give any satisfactory account of the functions and instincts of the several families and tribes that compose them. We cannot dip beneath the waves, to visit the depths of the ocean, that we may investigate their manners and history, but, doubtless, we may conclude, that the same Wisdom, Power, and Goodness, which we find so visibly manifested in the structure and operations of all the animals that are under our eyes and inspection, have equal place and are equally conspicuous, when brought into view, in the marine and other aquatic animals. We know by experience that a large portion of them are of the greatest benefit to mankind, and the rest, from the gigantic shark to the pigmy minnow, each in their place, and engaged in the fulfilment of their several functions, are, we may conclude, equally beneficial, though in a way that we cannot fully appreciate.

I have had more than one occasion to enlarge upon some of those parts of the history of fishes with which we are acquainted,[12] I shall therefore only add here some particulars with respect to the habits of a few individuals which may throw some light upon their history.

Amongst the Cyclostomous Cartilagineans the *hag* is distinguished by a singular means of escape from its enemies. This animal adheres to fishes by creating a vacuum by means of its lips; this effected, it lacerates them with its teeth, without their being able to shake it off, and then, like the leech, it sucks their blood and juices; but since, when thus fixed and employed, it might easily become the prey of other fishes, Providence has enabled it to conceal itself from them, by means

1 *Règne Anim.* ii. 131.
2 *Fistularia.*
3 *Coryphæna.*
4 *Lophius. Malthus, Batrachus.*
5 *Callionymus Lyra.*
6 *Zeus. Faber.*
7 *Xiphias.*
8 *Scomber Scombrus.*
9 *Trigla Gurnardus.*
10 *Mullus.*
11 *Perca.*
12 See above, pp. 57—66.

of the excrement which, when in danger, it emits, and which remains for a time near it, detained by the slime which exudes from its pores. This is so abundant that Kalm, having put one in a large tub of sea water, it became like a clear transparent glue, from which he could draw threads, even moving the animal with them. A second water, upon its being again immersed, in a quarter of an hour, became the same. Sir E. Home was of opinion that these animals are hermaphrodites.

Amongst all the diversified faculties, powers, and organs, with which Supreme Wisdom has gifted the members of the animal kingdom to defend themselves from their enemies, or to secure for themselves a due supply of food, none are more remarkable than those by which they can give them an electric shock, and arrest them in their course, whether they are assailants or fugitives. That God should arm certain *fishes*, in some sense, with the lightning of the clouds, and enable them thus to employ an element so potent and irresistible, as we do gunpowder, to astound, and smite, and stupify, and kill the inhabitants of the waters, is one of those wonders of an Almighty arm which no terrestrial animal is gifted to exhibit. For though some quadrupeds, as the cat, are known, at certain times, to accumulate the electric fluid in their fur, so as to give a slight shock to the hand that strokes them, it has never been clearly ascertained that they can employ it to arrest or bewilder their prey, so as to prevent their escape. Even man himself, though he can charge his batteries with this element, and again discharge them, has not yet so subjected it to his dominion, as to use it independently of other substances, offensively and defensively, as the electric fishes do.

The fishes hitherto ascertained to possess this power belong to the genera *Tetrodon*, *Trichiurus*, *Malapterurus*, *Gymnotus*,[1] and *Raia*.[2] The most remarkable are the three last.

The faculty of the *Torpedo* to benumb its prey was known to Aristotle,[3] and Pliny further states,[4] that conscious of its power, it hides itself in the mud, and benumbs the unsuspecting fishes that swim over it. The Arabians, when they cultivated the sciences so successfully, had observed this faculty both in the Torpedo and the Malapterurus, and perceiving an affinity between the electric fluid of the heavens and that of these fishes, called them Raash, a name signifying *thunder*.

1 The trivial name of the first *four* of these species is *electricus*.

2 *R. Torpedo*.

3 *Hist. An. l.* ix. *c.* 37.

4 *Hist. Nat. l.* ix. *c.* 42.

The electric organ in the *Malapterurus*[1] extends all round the animal, immediately under the skin, and is formed of a mass of cellular tissue, so condensed and thick as, at first, to look like bacon; closely examined, it is found to consist of tendinous fibres, which are interlaced together, so as to form a net work, the cells of which are filled with a gelatino-albuminous substance, the whole accompanied by a nervous system, differing from that of the *Torpedo* and *Electric-eel*, and similar to that of other fishes.[2] This organ is divided into two portions by a longitudinal septum.

The *Torpedo* is the most celebrated of the electric fishes. In this the organ of its power extends, on each side, from the head and gills to the abdomen, in which space it fills all the interior of the body. Each organ is attached to the parts that surround it, by a cellular membrane and by tendinous fibres. Under the skin which covers the upper part of these organs, are two bands, one above the other, the upper one consisting of *longitudinal* fibres, and the lower of *transverse* ones. The latter continues itself in the organ by means of a great number of membranous elongations, which form many-sided vertical bodies, or hollow polygonal tubes, some hexagonal, others pentagonal, and others quadrangular; each of these tubes is divided, internally, by a fine membrane into several dissepiments, connected by blood-vessels. In each of the organs, from two hundred to twelve hundred of these tubes have been counted in individuals of different age and size, some regular but others irregular, which may form electric batteries. Each organ is also traversed by arteries, veins, and nerves, in every direction, which last are remarkable for their size. The tubes, like those above mentioned, are also found in the non-electric Rays, but these terminate in pores without the skin, which are so many excretory organs of the matter contained in their interior; in the Torpedo, on the contrary, the tubes are completely closed, not only by the skin which is no where perforated, but further by the aponeuroses, or tendinous expansions of the muscles, which extend all over the electric organ; the gelatinous matter not being able to expand itself externally, is forced to accumulate in these tubes, from whence doubtless arises their size and their progressive numerical increase. The two surfaces of the electric organ are supposed to be one positive and the other negative. Reaumur observed that the back of the animal is rather convex, but when about to strike its convexity diminishes, and it becomes concave, but after the stroke it resumes its convexity.

1 *Silurus*. L. 2 Geoff. St. Hil. *Ann. du Mus.* i. 402.

These organs not only affect the animals upon which they act, by an agency imperceptible to the eye, but they are also stated to emit sparks; and they can strike at some distance, as well as by immediate contact. The author last named put a torpedo and a duck into a vessel filled with sea water, and covered it to prevent the escape of the latter, which, after about three hours, was found dead. These wonderful and complex organs, and their many-phialed batteries, the effect of which has attracted the notice of scientific men for so long a period, were doubtless given to these animals by their Creator, in lieu of the offensive and defensive arms which enable the rest of their tribe to act the part assigned to them, that they might procure the means of subsistence, and to defend themselves when in danger. Almost always concealed in the mud, like most of the *rays*, they can by this weapon kill the small fishes that come within the sphere of their action, or benumb the large ones; if they are in danger of attack from any voracious fish, they can disable him by invisible blows, more to be dreaded than the teeth of the shark itself.

The *Gymnotus*, or electric eel, is a still more tremendous assailant, both of the inhabitants of its own element, and even of large quadrupeds, and of man himself if he puts himself in its way. Its force is said to be *ten* times greater than that of the torpedo. This animal is a native of South America. In the immense plains of the Llanos, in the province of Caraccas, is a city called Calabozo, in the vicinity of which these eels abound in small streams, insomuch that a road formerly much frequented was abandoned on account of them, it being necessary to cross a rivulet in which many mules were annually lost in consequence of their attack. They are also extremely common in every pond from the equator to the 9th degree of north latitude.

Contrary to what takes place in the torpedo, the electric organs of the *Gymnotus* are placed under the *tail*, in a place removed from the vital ones. It has *four* of these organs, two large and two small, which occupy a third of the whole fish: each of the larger organs extends from the abdomen to the tail; they are separated from each other above by the dorsal muscles, in the middle of the body by the natatory vesicle, and below by a particular septum. The small organs lie over the great ones, finishing almost at the same point; they are pyramidal, and separated from the others by membrane. The interior of all these organs presents a great number of horizontal septa, cut at right angles by others nearly vertical. John Hunter counted thirty-four in one of the great organs, and

fourteen in one of the small ones, in the same individual. The vertical septa are membranous, and so close to each other that they appear to touch. It is by this vast quadruple apparatus, which sometimes in these animals is calculated to equal one hundred and twenty-three square feet of surface, that they can give such violent shocks. Mr Nicholson thought that the *Gymnotus* could act as a battery of 1,125 square feet. Humboldt says that its galvanic electricity produces a sensation which might be called *specifically* different from that which the conductor of an electric machine, or the Leyden phial, or the pile of Volta, cause. From placing his two feet on one of these fishes just taken out of the water, he received a shock more violent and alarming than he ever experienced from the discharge of a large Leyden jar; and for the rest of the day he felt an acute pain in his knees, and almost all his joints. Such a shock, he thinks, if the animal passed over the breast and the abdomen, might be mortal. It is stated that when the animal is touched with only one hand the shock is very slight; but when two hands are applied at a sufficient distance, a shock is sometimes given so powerful as to affect the arms with a paralysis for many years. It is said that females, under the influence of a nervous fever, are not affected.

Humboldt gives a very spirited account of the manner of taking this animal, which is done by compelling twenty or thirty wild horses and mules to take the water. The Indians surround the basin into which they are driven, armed with long canes, or harpoons; some mount the trees whose branches hang over the water, all endeavouring by their cries and instruments to keep the horses from escaping: for a long time the victory seems doubtful, or to incline to the fishes. The mules, disabled by the frequency and force of the shocks, disappear under the water; and some horses, in spite of the active vigilance of the Indians, gain the banks, and overcome by fatigue, and benumbed by the shocks they have encountered, stretch themselves at their length on the ground. There could not, says Humboldt, be a finer subject for a painter: groups of Indians surrounding the basin; the horses, with their hair on end, and terror and agony in their eyes, endeavouring to escape the tempest that has overtaken them; the eels, yellowish and livid, looking like great aquatic serpents, swimming on the surface of the water in pursuit of their enemy.

In a few minutes two horses were already drowned: the eel, more than five feet long, gliding under the belly of the horse or mule, made a discharge of its electric battery on the whole extent, attacking at the same instant the heart and the

viscera. The animals, stupified by these repeated shocks, fall into a profound lethargy, and, deprived of all sense, sink under the water, when the other horses and mules passing over their bodies, they are soon drowned. The *Gymnoti* having thus discharged their accumulation of the electric fluid, now become harmless, and are no longer dreaded: swimming half out of the water, they flee from the horses instead of attacking them; and if they enter it the day after the battle, they are not molested, for these fishes require repose and plenty of food to enable them to accumulate a sufficient supply of their galvanic electricity. It is probable that they can act at a distance, and that their electric shock can be communicated through a thick mass of water. Mr Williams, at Philadelphia, and Mr Fahlberg, at Stockholm, have both seen them kill from far living fishes which they wished to devour: Lacepede says they can do this at the distance of *sixteen* feet. They are said also to emit sparks.

Of all the *Gymnoti* the *electric* is the only species in which the natatory vesicle extends from the head to the tail; it is in that species of the extraordinary length of two feet five inches, and one inch and two lines wide, but the diameter diminishes greatly towards the tail: it reposes upon the electric organs. It has been asserted that this fish is attracted by the loadstone, and that by contact with it it is deprived of its torporific powers.[1]

It is singular that in the three principal animals which Providence has signalized by this wonderful property, the organs of it should differ so much, both in their number, situation, and other circumstances; but as there appears to be little other connection between them, it was doubtless to accommodate them to the mode of life and general organization of the fishes so privileged.

There is another little fish, of a very different tribe, which emulates the electric ones, in bringing its prey within its reach, by discharging a grosser element at them. It belongs to a genus,[2] the species of which are remarkable for the singularity of their forms, the brilliancy of their colours, and the vivacity of their movements. The species I allude to[3] may be called the *fly-shooter*, from its food being principally flies, and other insects, especially those that frequent aquatic plants and places.

1 The authors from whom my information on the electric fishes is chiefly derived are, Rudolphi, *Anatomische Bemerkungen*, &c. 1826; Geoffroy, *Ann. du Mas.* i.; Lacepede, *Hist. des Poissons;* Humboldt, *Observations de Zoologie et d'Anatomie comparée;* and Bosc, in *N. D. D'Hist. Nat.* xii. xiv. xxxiv.

2 *Chætodon.* 3 *C. rostratus.*

These, as Sir C. Bell relates,[1] it, as it were, *shoots* with a drop of water.

In a former part of this treatise I have given an account of those American fishes, which, when the water fails them in the streams they inhabit, by means of a movable organ, representing the first ray of their pectoral fin,[2] are enabled to travel over land in search of one whose waters are not evaporated. An analogous fact has been observed in China, by a friend and connexion of mine,[3] who paid particular attention to every branch of zoology when in the East. At Canton he informed me there is a fish that crosses the paddy fields from one creek to another, often a quarter of a mile asunder. The Chinese told him that this was done by means of a kind of *leg*.

I shall close this history of Fishes with some account of the tribe to which the *fishing-frog*[4] belongs. I have before alluded to their connection with the Reptiles;[5] in some points also they look to the rays and the sharks. The attenuated tail of all,[6] and the enormous swallow of others,[7] give them this resemblance, especially to the first, so that the French call them *fishing-rays*.[8] The best known of them is that called, by way of eminence, the *fishing-frog*. This is a large fish, sometimes seven feet long; it is found in all the European seas, and is often called the sea-devil. "This fish," says Lacepede, "having neither defensive arms in its integuments, nor force in its limbs, nor celerity in swimming, is, in spite of its bulk, constrained to have recourse to stratagem to procure its subsistence, and to confine its chase to ambuscades, for which its conformation in other respects adapts it. It plunges itself in the mud, covers itself with sea-weed, conceals itself amongst the stones, and lets no part of it be perceived but the extremity of the filaments that fringe its body, which it agitates in different directions, so as to make them appear like worms or other baits. The fishes, attracted by this apparent prey, approach, and are absorbed by a single movement of the fishing-frog, and swallowed by his enormous throat, where they are retained by the innumerable teeth with which it is armed. Another animal of this tribe is furnished only with a single bait, just above the mouth.[9]

We see by this singular contrivance that fertility of expedi-

1 *B. T.* 200.
2 Plate XII. Fig. 2.
3 Robert Martin, Esq. F.Z.S.
4 *Lophius Piscator.*
5 See above, p. 395.
6 Plate XIII. Fig. 1, 3.
7 *Ibid.* Fig 3.
8 *Raie pêcheresse.*
9 *Malthus Vespertilio*, Plate XIII. Fig. 1, 2, *a*.

ent by which the Beneficence, and Wisdom, and Power of the Creator have remedied the seeming defects which appear incident to almost every animal form. If it cannot pursue and overtake and seize its prey, it is enabled, as in the case of the *electric fishes*, the *fly-shooter*, and the *fishing-frogs*, in a way we should not expect, to ensure its subsistence; and, while it is doing this, discharging, if I may so speak, its official duty, and acting that part, on its own theatre, by which it best contributes to the general welfare.

Doubtless the infinite forms of the Class we are considering, that inhabit the, so called, element of water, and of which probably we may still be unacquainted with a very large proportion, all bear the same relation to each other, and are organized with a view to a similar action upon each other, that we see takes place upon the earth. There are predaceous fishes to keep the aquatic population of every description within due limits; there are others whose office it is to remove nuisances arising from putrescent substances, whether animal or vegetable; and lastly, there are others which, like our herds and flocks, are peaceful and gregarious, and graze the herbage of sea-weeds that cover the ocean's bed. All these, in their several stations, and by their several operations, glorify their Almighty Author by fulfilling his will.

## CHAPTER XXII.

### *Functions and Instincts. Reptiles.*

In the whole sphere of animals, there are none, that, from the earliest ages, have been more abhorred and abominated, and more repudiated as unclean and hateful creatures, than the majority of the Class we are next to enter upon,—that of *Reptiles.* One Order[1] of them, indeed, consisting of the turtles and tortoises, and some individuals belonging to another,[2] are exempted from this sentence, and are regarded with more favourable eyes; but the rest either disgust us by their aspect, or terrify us by their supposed or real power of injury.

In Scripture, the *serpent;* the larger *Saurians*, under the names of the *dragon* and *leviathan;* and *frogs* are employed as symbols of the evil spirit, of tyrants and persecutors, and of the false prophets that incite them.[3]

Yet these animals exhibit several extraordinary characters and qualities. They are endued with a degree of vivaciousness that no others possess: they can endure dismemberments and privations which would expel the vital principle from any creature in existence except themselves. Their life is not so concentrated in the brain, which with them is extremely minute, but seems more expanded over the whole of their nervous system: take out their brain or their heart, and cut off their head, yet they can still move, and the heart will even beat many hours after extraction; it is also stated that they can live without food for months, and even years.[4]

But though gifted by their Creator with such a tenacity of *life*, yet is that life often raised a very few degrees above death. Many of them select for their retreats damp and gloomy caverns and vaults, shut out from the access of the light and air. In allusion to this circumstance, Babylon, the imperial city, she, who in ancient times subjected the eastern world to her

1 The *Chelonians.*

2 The *Gecko*, *Monitor*, *Chamæleon*, &c. amongst the *Saurians.*

3 *Job*, xli. 34; *Psl.* xxvii. 1; *Ezek.* xxv. 3; *Rev.* xx. 2, xvi. 13.

4 Cuv. *Règn. An.* ii. 1. 8. Lacep. *Quad. Ovipar.* i. 20.

domination, was forewarned that she should *become* heaps, *and a dwelling-place for* dragons.[1]

Whether the many instances that have been recorded in different countries, of *toads* found incarcerated alive in blocks of stone or marble, or in trunks of trees, are all to be accounted for by supposing a want of accurate observation of the concomitant circumstances in those that witnessed their discovery, I will not take upon me to say; but they are so numerous, as to leave some doubt upon the mind whether some of these creatures may not have been accidentally interred alive, as it were, when in a torpid state, and continued so, till, their grave being opened, and the air admitted to their lungs again, their vital functions have been resumed, to the astonishment of those who witnessed the seeming miracle. Though so given to withdraw themselves into dark and dismal retreats, yet many of them are fond also of basking in the sun-beam, particularly the serpents and the lizards.

Zoologists seem not even yet fully to have made up their minds with regard to the classification of *Reptiles*. Linné placed them in the same Class[2] with the *Cartilaginous* Fishes, of which they form his first and second *Orders*; but subsequent zoologists, with great propriety, have generally considered them as forming a Class by themselves, under their primeval name of Reptiles. This Class M. Brongniart divided into *four* Orders, viz. *Chelonians*, *Saurians*, *Ophidians*, and *Batrachians:* and Baron Cuvier has followed this arrangement in his *Règne Animal*. Latreille, adopting the Group, has divided it into *two* Classes, *Reptiles* and *Amphibians*. The Reptiles he considers as forming two *Sub-classes*, viz. *Cataphracta*, containing the *Chelonians*, and *Crocodiles*, and *Squamosa*, containing the remaining *Saurians* and the *Ophidians*. His second Class, the *Amphibians*, consisting of the *Batrachians* of Brongniart, with the addition of the *Proteus*, *Siren*, &c. he divides into two Tribes, viz. *Caducibranchia*, or the *proper Batrachians*, and *Perennibranchia*, or the *Proteus*, *Siren*, *Axolot*, &c. This classification is adopted by Dr Grant,[3] except that he does not subdivide the Reptiles into two Sub-classes; and Latreille's two *Tribes* of Amphibians he properly denominates *Orders*.

That Reptiles, in the larger sense of the term, form a *natural* Group, will be generally admitted, when it is considered that the *salamanders*, or naked efts, evidently connect the Batrachians with the Saurians, and were formerly considered as

1 *Jerem.* li. 37.

2 *Amphibia.*

3 *Outlines of a Course of Lectures*, &c. 14—16.

a kind of *lizard ;* it seems to me therefore more consistent with nature to consider the Reptiles as forming a *single* Class.

This opinion has received strong confirmation from a circumstance communicated to me by my kind friend Mr Owen, well known as one of our most eminent comparative anatomists. In a letter received from him, since I wrote the preceding paragraph, in reply to some queries I had addressed to him, he says,—"I lose no time in replying to your very welcome letter, because I have a statement to make which justifies your disinclination to regard the *Reptilia* of Cuvier as including two distinct Classes. Not any of the *Batrachia* have a *single* auricle ; for though the venous division of the heart has a simple exterior, it is in reality divided internally into two separate auricles, receiving respectively, the one, the carbonized blood of the general system, the other and smaller, the aërated, or vital, blood from the lungs. This I have found to be the case successively in the frog and toad, the salamader and newt, and lastly, in the lowest of the true Amphibia, the *Siren lacertina,* which in its persistent external branchiæ comes nearest, I apprehend, to the Fishes."

By this statement it appears that those characters, which have been deemed sufficient to warrant the division of the Reptiles into two distinct Classes, exist only in appearance. I shall consider them therefore as forming only *one,* of which the following seem to constitute the principal diagnostics.

## Reptilia. (*Reptiles.*)

*Animal,* vertebrated, oviparous, or ovoviviparous. *Eggs,* hatched without incubation.

*Heart,* really biauriculate, though in some the auricles are not *externally* divided. *Blood,* red, partially oxygenated, cold.

*Brain,* very small ; *vitality,* in some degree, independent of it.

*Integument,* various.

As the two Orders into which the Batrachians of Cuvier are divided by Dr Grant, differ from the rest of the Class not only in their respiratory organs, but also in other important particulars, indicating that they form a group of greater value than the other three Cuverian Orders, I shall therefore consider the Class of Reptiles as further divided into two *Sub-classes,* which I propose to denominate, from the difference of their integument, *Malacoderma* and *Scleroderma.*

*Sub-class* I.—*Reptilia Malacoderma.* (Soft-coated Reptiles.)

*Heart*, with two auricles, externally simple, but internally divided. *Integument*, soft, naked. *Eggs*, impregnated, *after* extrusion.

This Sub-class consists of the two Orders called, by Latreille and Dr Grant, as above stated, *Caducibranchia* and *Perennibranchia;* but considering the Reptiles as forming a single Class, for the sake of concinnity of nomenclature, I think it would be better to restore to the *first* their old name of *Batrachians;* and, as the animals that form the second, as Cuvier observes, are the only true *Amphibians*,[1] to distinguish them by the name that strictly belongs to them alone.

*Sub-class* 2.—*Reptilia Scleroderma.* (Hard-coated Reptiles.) *Heart*, with *two* auricles. *Integument*, hard, often scaly. *Eggs*, impregnated *before* extrusion.

## Orders.

| Sub-class 1. | Sub-class 2. |
|---|---|
| 1. *Amphibians.* | 3. *Ophidians.* |
| 2. *Batrachians.* | 4. *Saurians.* |
| | 5. *Chelonians.* |

*Order* 1.—*Amphibians.* (*Siren, Proteus, Axolot*, &c.)

*Respiration*, double, by gills in the water, and by pulmonary sacs in the air. *Gills*, permanent. Legs, 2—4.

*Order* 2.—*Batrachians.* (*Amphiuma, Triton* or *Water-newt, Salamander, Toad, Frog*, &c.)

*Respiration*, at first by *gills*, and afterwards by *lungs*. *Gills*, temporary. *Ribs*, rudimental. *Legs*, four. Undergoes a *metamorphosis.*

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*Order* 3.—*Ophidians.* (*Snakes* and *Serpents.*)

*Body*, covered with scales, without legs. *Ribs*, movable. *Mouth*, armed with teeth. *Cast* their skin.

*Order* 4.—*Saurians.* (Two-footed and four-footed *Lizards*, of various kinds ; *Crocodiles, Alligators*, &c.)

*Body*, covered with *scales*, or scaly *grains*, terminating in a *tail*. *Ribs*, movable ; *mouth*, armed with teeth. *Legs*, 2—4.

*Order* 5.—*Chelonians.* (*Turtles* and *Tortoises.*)

*Body*, protected above by a *carapace*, or shield, formed by the ribs, and below by a *plastron*, or dilated sternum. *Mouth*, without teeth. *Mandibles*, rostriform. *Legs* or *paddles*, four.

Though the *Malacoderm*, or soft-coated Reptiles, appear the

1 *Règne Anim.* ii. 117.

legitimate successors of the Fishes, yet there are some others in the higher Orders that seem to lead off towards them also, for the *Ophidians* and *Apod* fishes evidently tend towards each other. The *Cœcilia*, or blind serpent, too, is almost uniauriculate, and has only some transverse rows of scales between the wrinkles of its skin.[1]

From this statement, it seems that the Class of Reptiles is connected with the Fishes, not by those at the top of the latter Class, but by those at its base; with the Osseans by the Apods, and with the Cartilagineans by the Cyclostomes; so that they may be almost regarded as forming a parallel line with them, instead of succeeding them in the same series. Even the proper Batrachians seem to tend to the Chelonians, while the Salamanders look to the Saurians.

The great body of the Class are predaceous, subsisting upon various small animals, especially insects, and some Ophidians upon large ones; but the *Chelonians* seem principally to derive their nutriment from marine and other vegetables, though some of these will devour Molluscans, worms, and small reptiles: the *Trionyx ferox* will attack and master even aquatic *birds*. Cuvier says, after Catesby, that the common *Iguana* subsists upon fruit, grain, and leaves. Bosc states that it lives principally upon *insects;* and that it often descends from the trees after earth-worms and small reptiles, which it swallows whole.[2]

*Order* 1.—The *Siren*, or *Mud-iguana*, occupies the first place in this Order, and seems to connect with the Apod and Cyclostomous Fishes, from which it is distinguished by its gills in three tufts, and by having only one pair of legs. It appears to be an animal useful to man, since it is stated to frequent marshes, in Carolina, in which rice is cultivated, where it subsists upon earth-worms, insects, and other similar noxious creatures.

But of all the animals which God hath created to work his will, as far as they are known to us, none is more remarkable, both for its situation and many of its characters, than one to which I have before adverted,[3] as affording some proof, that *the waters under the earth*, and other subterranean cavities, may have their peculiar population. The animal I allude to is the *Proteus*, belonging to the present Order, which was first found thrown up by subterranean waters in Carniola, as we are informed by the late Sir H. Davy,[4] by Baron Zöis. Sir Hum-

1 *Règne Anim.* ii. 99.
2 *Règn. An.* ii 44. *N. D. D'H. N.* xvi. 113.
3 See above, p. 19.
4 *Consolat. in Trav.* 187.

phry himself appears to have found them in the Grotto of the Maddalena, at Adelsburg, several hundred feet below the surface of the earth; he also states that they have been found at Sittich, thirty miles distant, and he supposes that those found in both places might be thrown up by the same subterranean lake.[1] In the year 1833 there were two living specimens in the museum of the Zoological Society, where I had the pleasure of seeing them; and from one of them the accurate figure at the end of this volume,[2] by the kind permission of the Society, was taken by Mr C. M. Curtis.

When we look at these animals, there is something so different in their general aspect from the tribes to which they are most nearly related, that the idea strikes one that we are viewing beings far removed from those that inhabit the surface of our globe, and its waters; which, though accidentally visiting these upper regions, may be the outsetters of a population still further removed from our notice, and dipping deeper into its interior.

The *Proteus* is about a foot in length, or something more, and about an inch in thickness; the body is cylindrical, tapering to the tail; its colour is a pale red; its skin is transparent and slimy, so as easily to elude the grasp. It has four short slender legs, the anterior pair placed just behind the head, having *three*, and the posterior pair, which are shorter, and placed just before the vent, having only *two* toes without claws. The head terminates in a flat, very obtuse muzzle, somewhat resembling the beak of a duck; its maxillæ are armed with teeth; the eyes are extremely minute, and scarcely discernible; they are concealed, and apparently rendered useless by an opaque skin; but as this animal is said to avoid the light, it is evident that it produces some effect upon them; behind the head, on each side, is an opening like those of fishes, over which are the gills, divided into several branches.[3] It has, besides, an internal pneumatic apparatus, consisting of two vesicles, below the heart. The tail is compressed, furnished above and below with a caudal fin, extending to the posterior legs. Its legs, from their having no claws, are, it is probable, principally useful in walking upon the mud, and by means of its caudal fin it can move like an ell or fish in the water. From a small shell-fish being found in the stomach of one, it seems to follow that its food, at least in part, consists of Molluscans inhabiting the same subterranean caves and waters

1 *Consolat. in Trav.* 183—188.

2 Plate XIV. Fig. 1.

3 Plate XIV. Fig. 1, *a*.

with itself, and probably distinct from any of those to which the atmosphere has free access. Sometimes, elevating its head above the water, it makes a hissing noise louder than could be expected from so small an animal.

Before quitting this subject, I may observe that Baron Humboldt has given an account of a wonderful eruption of *subterranean fishes*, which sometimes takes place from the volcanoes of the kingdom of Quito. These fishes are ejected in the intervals of the igneous eruptions, in such quantities as to occasion putrid fevers by the miasmata they produce: they sometimes issued from the crater of the valcano, and sometimes from lateral clefts, but constantly at the elevation of between two and three thousand toises above the level of the sea. In a few hours, millions are seen to descend from Cotopaxi, with great masses of cold and fresh water. As they do not appear to be disfigured or mutilated, they cannot be exposed to the action of great heat. Humboldt thought they were identical with fishes that were found in the rivulets at the foot of the volcanoes. These fishes belong to a genus separated from *Silurus*.[1]

*Order* 2.—This Order begins with two genera, the species of which have been supposed to breathe by lungs only, no traces of gills having yet been discovered in any individual belonging to them. Cuvier thinks that they cast them sooner than the salamanders. One of these is a large animal,[2] being more than a yard in length; it was discovered by Dr Garden, in South Carolina: like the Proteus, its eyes are covered with a thick tunic, and its toes have no claws. The other,[3] found in New York, comes near the salamanders, and has been called by American writers the *giant* salamander. Both are found in fresh-water lakes, and similar places.

I have mentioned, on a former occasion, a salamander that lays her eggs singly on the leaves of *Persicaria*, which she doubles down over them,[4] and which are kept folded by means of the glue that envelopes the egg. Dr Rusconi, to whom we are indebted for this history, observed the whole progress and development of this animal, from its embryo state in the egg. It is at first opaque, formed of a soft homogeneous substance. Almost as soon as it has escaped from its envelope, it becomes gradually transparent, so that the successive developments, both of its internal and external organs, may be discerned—the heart, and its systole and diastole; the stomach, its form and

1 *Pimelodus*. Humboldt names the species in question *P. Cyclopum*. *Zool.* 22.

2 *Amphiuma means*. 3 *Menopoma*. 4 See above, p. 329.

position; the intestinal canal, which at first extends in a straight line, from one end of the abdomen to the other, and then begins to undulate, and ends by forming many convolutions: next may be seen the liver, the development of which keeps pace with that of the stomach and intestines; and lastly appear the lungs, taking their place and form, always filled with air, and so transparent that one might believe the animal has on each side of the trunk a bubble of air gradually dilating and lengthening. When all these organs have acquired the necessary development, the spectator beholds in the little creature the beginning, as it were, of its animal life. Its former life being merely organic, resembling that of a vegetable, but now its motions are become the result of its sensations and will.[1]

We see in this instance how exactly the rudiments, as it were, of the organs of the future animal, are fitted to respond to the action of the elements upon them, how the germ of every organ begins, if I may so speak, to vegetate, and grows till it is fully developed, so as to become either a fit instrument of the will or of the vital powers, and adapted to carry the creature through all its destined operations, and to enable and incline it to fulfil all its prescribed functions. These observations, and this interesting little history, will apply to *man* himself, who, in his embryo state, is the subject of similar developments; and the words of the divine Psalmist are a beautiful comment upon this our embryo life: *For thou hast possessed my reins: thou hast covered me in my mother's womb. My substance was not hid from thee, when I was made in secret, and curiously wrought in the lowest parts of the earth. Thine eyes did see my substance yet being imperfect; and in thy book all my members were written, which in continuance were fashioned, when as yet there was none of them.*[2]

The salamander, as is reported, says Aristotle, if it goes through fire extinguishes it:[3] this is repeated by Pliny, who adds, that it extinguishes it like ice. It never appears, he further observes, except in showery weather, and likewise that it emits a milky saliva, which is depilatory.[4] Salamanders, says Bosc, emit from their skin a lubricating white fluid when they are annoyed, and if they are put into the fire, it sometimes happens that this fluid extinguishes it sufficiently to permit their escape; and again—when one touches the terrestrial

1 Rusconi, in *Edinb. Philos. Journ.* ix. 110—113, on *Salamandra platycauda.*

2 *Ps.* cxxxix. 13—16.

3 *Hist. An.* lib. v. chap. 19.

4 *Hist. Nat.* l. x. 67.

salamander, it causes to transude from its skin a white fluid, which it secretes more copiously than its congeners. This kind of milk is extremely acrid, and produces a very painful sensation upon the tongue. According to Gesner, it is an excellent depilatory. It is sometimes spirted out to the distance of several inches, as Latreille has observed, and diffuses a particularly nauseous scent; it poisons small animals, but does not appear to produce serious effects upon large ones.[1]

I have introduced these ancient and modern statements to show how little they differ, and in confirmation of the truth of them I have a remarkable occurrence to relate, which I give upon the authority of three ladies who witnessed the fact, and upon whose accuracy I can rely. They were residing at Newbury, where their cellars were frequented by frogs, and a kind of newt, or salamander, of a dull black colour. Several of the frogs were caught one day, and put into a pail; and while the ladies were looking at them they were surprised by observing the frogs one after another turn themselves on their backs, and lie with their legs extended quite stiff and dead. Upon examining the pail they found one of these efts, as they called them, running round very quickly amongst the frogs, each of which, when touched by it, died instantaneously, in the manner above stated. They afterwards regarded these efts, as may be supposed, with nearly as much horror as they would a rattlesnake; and a few nights afterwards, finding one in the kitchen, it was seized with the tongs, and thrown into a good fire which was burning in the grate. The reptile, instead of perishing, slipped like lightning through the coals, and ran away under the fireplace apparently unhurt. The house, in which these animals were found, was in a remarkably damp situation.

If our northern salamanders are gifted with such powerful means of offence or defence, we know not how far those powers may be sublimed in the species of warmer climates; and the fire-quenching and death-doing properties of the Grecian or Roman salamanders may approach nearer to the, supposed, fabulous descriptions of Aristotle and Pliny, than modern Herpetologists seem willing to believe.

There appears no small analogy between these properties considered as weapons, and means by which these animals either secure their prey, consisting of earth-worms, insects, and other small game, or disarm and destroy their enemies, and those, related in the last chapter, which distinguish the electric fishes.

1 *N. D. D'H. N.* xxx. 58, 59.

Spallanzani, by numerous experiments, has discovered in this tribe of animals, the power of reproducing lost or mutilated organs; Bonnet and others have confirmed his observations. So that it seems proved, if their legs and tail are cut off, and even their eyes plucked out, that in a few months they will be reproduced; and even a limb thus renewed, if again cut off, will be reproduced again.

In going upwards from the salamanders, at first sight, we feel disposed to proceed next to the other animals of a similar form, the *lizards* and other Saurians, for this way their external form leads us, but their internal organization is nearer that of the frogs and toads. Upon these last I shall not dwell: all know that they begin life in the water like fishes; that they are at first without legs, or any instrument of motion but a tail, which by its undulations from side to side steers the apparently disproportioned body to which it is appended, and makes its way with rapidity through its native element. Few are ignorant that they first acquire a single pair of legs; and lastly, that another pair being also acquired, they leave the water by myriads, and appear, without a tail, as four-footed, and, at certain times, noisy reptiles.

*Order* 3.—The general function of the *Ophidians* seems connected with almost the whole animal kingdom. The insects, frogs, and other reptiles, several birds and beasts, up as high as the *ruminant* and even the *carnivorous* tribes, become the prey of various species. They act the same part with land animals, that their analogues, the eels and other apod and cyclostomous fishes do with respect to those of the water. Some are analogues of the lion and the tiger, as the *Oriental Python* and the *Occidental Boa*, which sometimes exceed thirty feet in length, and are as thick as a man's body; while others compete with the minor predaceous beasts in the destruction they occasion amongst the lesser quadrupeds. But while the predaceous quadrupeds, with the exception of the *Hyena*, leave untouched the skeleton of the animals they devour, the Ophidians swallow the entire animal, flesh and bone and skin, and thus completely remove it from the face of nature; whereas the others, where they abound and are unmolested, make their domain like a charnel house, and deform the earth with the ghastly relics of their cruelty and voracity.

The mechanism of the mouth of these animals is so contrived by Divine Wisdom, and the pieces that form it so put together, as to enable them to twist and distort and dilate it so enormously that they can swallow animals bigger than their

own bodies.[1] The vertebræ of the great Boa are more numerous than those of other serpents, which gives them a greater power of surrounding and strangling their prey with their dreadful voluminous folds, of crushing it, and, with the help of their saliva, rendering it fit for deglutition. With their tail, likewise, they can lay strong hold of a tree, so as to use it as a fulcrum, by which their powers of compression are increased and rendered more available where they have to contend with the struggles of powerful animals.

*Order* 4.—The connection of the *Saurians*, or the animals forming the next Order with the Ophidians, is very intimate. Cuvier says that many serpents under the skin have the vestige of a posterior limb, which in some *shows* its extremity externally, in the form of a little claw.[2] Amongst the lizards is one that has only two *fore-legs*,[3] and another that has only two *hind* ones;[4] and a third,[5] in which the legs are so short and so distant, and the body so slender and serpentiform, that they resemble a snake with four legs rather than a lizard.

This Order is divided into numerous genera and sub-genera. One of the most celebrated is the Chameleon. I have already noticed some of its peculiarities, and its mode of catching the insects that form its food.[6] The ancients were of opinion that it lived upon air, led by the power it has of swelling itself to twice its natural size, by inflating its vast lungs, when its body becomes transparent. Cuvier is of opinion that it is the size of the lungs of these animals that enables them to change their colour, not in order to assume that of the bodies on which they happen to be, but to express their wants and passions. He supposes that the blood, being constrained to approach the skin, more or less, assumes different shades, according to the degree of transparency.[7] The Rev. L. Guilding, however, mentions another genus,[8] the species of which, when in search of prey, adapt their colour to the green tree or dark brown rock on which they lie in ambush.[9] As these animals have the power of inflation, at least partially, by assuming a degree of transparency, they may appear of the colour of the substance they are standing upon, a remark which may also apply to the Chameleon. The object of this may be to conceal themselves from their enemies, as well as from their prey.

1 Cuv. *Anat. Comp.* iii. 90.
2 *Règne Anim.* ii. 71.
3 *Chirotes.*
4 *Bipes.*
5 *Seps.* See Roget, *B. T.* i. 448. *f.* 210.
6 See above, p. 290.
7 *Règne Anim.* ii. 59.
8 *Anolis.*
9 *Zool. Journ.* iv. 165.

The *Guanas*,[1] also, are said to change their colour; they are remarkable, as well as the *Anolis*, for the kind of goitre in their throat, which when irritated or excited they can inflate to a large size. These animals, though their flesh is said to be unwholesome, in the countries they frequent are highly prized for the table, and are often hunted with dogs. Their eggs also are in request.

The *Monitors*, or *safeguards*, as the French call some of them, deserve notice, because one species[2] is said to assist in the diminution of the crocodile, since, like the ichneumon, it devours its eggs, and even the young ones, on which account it is supposed to be sculptured on the monuments of the ancient Egyptians. This name was given them because they were believed to warn people, by hissing, of the approach of the crocodile, or venomous reptiles.

But the most celebrated of the Saurians, from the earliest ages, is the *Crocodile:* its history, however, is so well known that I shall only mention a few circumstances, of less notoriety, connected with it. There has been some difference of opinion as to whether the crocodile can move the upper or lower jaw. Aristotle observes, all animals move the lower jaw, except the crocodile of the river, for this animal only moves the upper.[3] Denon says the same.[4] Lacepede, on the contrary, affirms that the lower jaw is the only movable one.[5] I was assured by Mr Cross, when looking at two alligators in his menagerie, then at Charing-cross, that they moved both their jaws; and my friend Mr Martin has observed the same thing in India. M. Geoffroy St Hilaire and Baron Cuvier nearly reconcile the two opinions. The *head*, says the former, moves on the lower jaw like the lid of a snuff-box, that opens by a hinge. By this mechanism they can elevate their nostrils above the water, which they do with great rapidity for concealment:[6] and the latter observes, that the upper jaw moves only with the whole head.[7] So that the fact seems to be that the lower jaw alone has motion independent of the head, and the upper one can only move with it: but when we consider that the lower one extends beyond the skull, a condyle of which acts in an acetabulum of that jaw, we can easily comprehend that the upper jaw and head forming one piece, may be elevated at any angle, according to the will of the ani-

1 *Iguana vulgaris.*
2 *M. niloticus.*
3 *Hist. An.* lib. i. c. 11.
4 *Voyage*, &c. i. 185.
5 *Hist. Ov.* 194.
6 *An. du Mus.* x. 376.
7 *Règn. An.* ii. 18.

mal; and thus the upper one acquires additional power of action in attacking its prey in the water and securing it.

The nostrils of this animal are at the end of the muzzle, and this structure enables it, by causing the upper jaw to emerge a little, which, as the crocodile cannot remain under water more than ten minutes, enables it to breathe without exposing itself to observation. When on shore it turns itself to the point from which the wind blows, keeping its mouth open. Adanson relates that he once saw in the Senegal more than two hundred of these river monsters swimming together, with their heads only emerging, and resembling so many trees. Were it not for the number of their enemies, great and small, their increase would be so rapid that they would drive man from the vicinity of the great rivers of the torrid zone. The River-horse[1] attacks them and destroys many—Behemoth against Leviathan,—for though the Leviathan of the Psalmist is clearly a marine animal or monster,[2] that of Job[3] is as clearly the crocodile,[4] and they are stated to destroy many of them; even the feline race, in some countries, contrive to make them their prey. Though the scales that cover their back are impervious to a musket ball, those on the belly are softer and more easily penetrated; and here the saw-fish, and other voracious fishes, find them vulnerable, and so destroy them. The *Trionyx*, also, a kind of tortoise, devours them as soon as hatched. Their eggs are the prey not only of the ichneumon and the lizard, before mentioned, but of many kinds of apes; and aquatic birds also devour them, as well as man himself.

The crocodile has no lips, so that when he walks or swims with great calmness, he shows his teeth as if he was in a rage. When extreme hunger presses him, he will swallow stones and pieces of wood to keep his stomach distended. The heron and the pelican are said to take advantage of the terror which the sight of the crocodile produces amongst the fishes—causing them to flee on all sides—to seize and devour them: therefore they are frequently seen in his vicinity.

*Order* 5.—The *Chelonians*, as far as at present known, seem far removed from the Saurians. The turtles, indeed, in their paddles, exhibit an organ which is common to them, and some of the fossil Saurians, as the *Icthyosaurus* and *Plesiosaurus*. Cuvier places the *Trionyx* next above the crocodiles; but it

1 *Hippopotamus*.
2 *Psl.* civ. 26.
3 Chap. xli.
4 See above, p. 16.

agrees with them only in its fierceness and voracity, and the number of its claws.

The importance of the highest tribe of this Order to seamen in long voyages, is universally known and acknowledged, but otherwise there is nothing particularly interesting in their history, or that of the tortoises.

A singular circumstance distinguishes the animals of this Class,—very few of them have teeth formed for mastication. The *guana* is almost the only one amongst the existing tribes that has them. The Chelonians, which seem almost capable of living without food, have none. The teeth of the predaceous tribes are fitted to retain or lacerate their prey, but not to masticate it; so that the function of the great majority appears to be the same with that of the Ophidians before mentioned, the complete deglutition of the animals their instinct compels them to devour. Insects, which, of all minor animals, are the most numerous, and require most to be kept in check, form the principal part of the food of a large proportion of them. Creatures also that frequent dark and damp places, and that take shelter under stones and similar substances, seem to be particularly appropriated to them by the will of their Creator. Of this description are slugs, earth-worms, and several others: these, therefore, they have in charge to keep within due limits. And thus, in their doleful retreats and hiding-places, they fulfil each its individual function, instrumental to the general welfare.

## CHAPTER XXIII.

### *Functions and Instincts. Birds.*

We are now arrived at the highest department of the animal kingdom, the members of which are not only distinguished by a vertebral column, but also by *warm* red blood, and a more ample brain. This department consists of two great Classes, viz. those that are *oviparous*, and do *not* suckle their young; and those that are *viviparous*, which suckle their young till they are able to provide for themselves. The first of these Classes consists of the *Birds*, and the last of the *Quadrupeds*, *Whales* and *Seals*, called from the above circumstance *Mammalians*. Man, though *physically* belonging to the latter Class, *metaphysically* considered, is placed far above the whole animal kingdom, by being made *in the image and after the likeness* of his Creator, receiving from him *immediately* a reasonable and immortal soul; and entrusted by him with *dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth.*

Having, in a former chapter, given some account of those animals, to which the *waters* of this globe are assigned as their habitation and scene of action, I am now to consider those which their Creator has endowed with a power denied to man, and most of the Mammalians—that of moving to and fro in the air as the fishes do in the water, which, on that account, though they move also on the earth, are denominated, in the passage just quoted, the fowl of the *air*.

The animals of this great Class are rendered particularly interesting to man, not only because many of them form a portion of his domestic wealth, look to him as their master, and vary most agreeably his food; but because numbers, also, strike his senses by the eminent beauty and grace of their forms, the brilliancy or variety of the colours of their plumage, and the infinite diversity, according to their kinds, of their motions and modes of flight. But of all their endowments, none is more striking, and ministers more to his pleasure and delight, than their varied song. When *the time of the singing* birds *is come, and the voice of the turtle is heard in our land*, who can be dead

to the goodness which has provided for *all* such an unbought orchestra, tuning the soul not only to joy, but to mutual good-will ; reviving all the best and kindliest feelings of our nature, and calming, at least for a time, those that harmonize less with the scene before us.

I may here offer a few observations upon the *voice* of animals, especially birds. A distinction is made by physiologists between a *voice* and a *sound*, and none but those that breathe by means of *lungs* are reckoned to utter a *voice ;* others, whatever their respiratory organs, only emit a *sound.* The voice also is from the *mouth* alone, the sound from *other* parts of the body.[1] The *vocal* animals, therefore, are confined to the three last classes of vertebrates—the *Reptiles*, the *Birds*, and the *Mammalians.* In most of these, also, the voice partakes, in some degree, of the character of *speech;* it is intended to indicate to another the wishes, emotions, or sufferings of the utterer. The great organ of the voice is the *wind-pipe*, or tracheal artery, as it is often called, and its parts, which by its bronchial ramifications is so intimately connected with the lungs as to form part of their substance.

*Birds*, of all animals, are best organized with regard to their voice. Besides the upper larynx, or throat, which they have in common with Mammalians, at the base of their wind-pipe, where it divides into two branches, rendering to each lobe of the lungs, it has also another larynx, forming a second vocal apparatus. This is produced by a contraction of the organ furnished with muscular fibres, or vocal strings, which by their various tensions and relaxations, modify greatly the tones of the voice ; ascending also in the tube of the wind-pipe to undergo another modification at the upper larynx, which, as it were, adds the tube of the *horn* to that of the *reed.* Thus, if the head of a duck is cut off, it can produce sounds by means of its lower throat, if I may so call it, which no quadruped could do. Besides this, birds can, more or less, shorten or lengthen the tube of their wind-pipe, so as to modify the sounds they emit.

Though the upper larynx, in birds, has no vibratory vocal strings, as in the Mammalians, to modify the sounds, these modificatians taking place at the lower larynx, still they can enlarge or contract it, which may affect the air in its exit, and so produce some diversity.

Besides all this, whoever casts an eye over Dr Latham's and

1 See *Introd. to Ent.* Lett xxiv.

Mr Yarrel's figures of the wind-pipes of various birds,[1] especially wild-fowl, will see that they vary greatly in their relative length and volume ; that some are partially dilated, and others contracted, with other peculiarities that distinguish individual species, especially in male birds. All these, no doubt, modify the voice, and, by the will of Him who formed them, cause them to utter such sounds, and speak such a language, as are required by the circumstances in which they are placed. The cawing of the rook, the croaking of the raven, the cooing of the dove, the warbling of the nightingale and the other singing birds, are all the result of their oganization according to the plan and will of that Supreme Intelligence, infinite Love, Wisdom, and Power, which fabricated and fashioned them with this view as well as others, to give utterance to sounds that, mixed or contrasted, would produce a kind of universal concert, delighting the ear by its very discords.

It is said by a late writer, that the song of the same individual species of birds, in different districts, is differently modified. This, I should think, must be occasioned by a difference in the temperature, and other circumstances connected with the atmosphere.

Of all animals, birds are most penetrated by the element in which they move. Their whole organization is filled with air, as the sponge with water. Their lungs, their bones, their cellular tissue, their feathers—in a word, almost every individual part, admit it into their interstices.[2] Thus giving them a degree of specific levity that no other class of animals is endowed with, which however does not render them the sport of every wind that blows, for, by means of their vigorous wings, formed to take strong hold of the air ; of their muscular force, the agility of their movements, and their powers of steerage by means of the prow and rudder of their little vessel, their head and tail, they can counteract this levity ; and by these also, and by their great buoyancy, they can ascend above the very clouds, as well as descend to the earth ; they can glide motionless through the air, or skim the surface of the waters ; they can sport, at will, in the vast atmospheric ocean ; they can dart forward in a straight line, or like the butterfly, fly in a zig-zag or undulatory one, and with ease take any new direction in their flight that fear or desire may dictate. Enveloped in soft and warm plumage, they can face the cold of the highest regions of the air ; and the denser clad aquatic birds can

1 *Linn. Trans.* iv. *t.* ix.—xv. ; xv. *t.* ix.—xv. ; and xvi. *t.* xvii.—xxi.
2 *N. D. D'Hist. Nat.* xxiii. 352.

also sail over the bosom of the waters, or plunge into them, without being wetted by them. All birds, especially those last mentioned, have a gland secreting an oily fluid, with which they anoint their feathers and repel the moisture.

There is no part of the history of these animals, in which the care of a fatherly Providence is more signally conspicuous than their love of their young, and their tender care of them till they can shift for themselves. But as I have already adverted to this subject,[1] and shall hereafter have occasion to resume it, I shall now say something on the *classification* of the feathered race. It is singular that two Classes should be placed in apposition to each other, seemingly so opposite in their character and most of their qualities, as the Reptiles and the Birds—the one the most torpid and doleful and hateful of animals, symbols of evil demons; the other the most lively and active, and beloved of all the creatures that God has made, symbols of the angelic host, and calling upon us to look upwards, and seek those joys that are above us. But in spite of this apparently striking contrast, still there is a real affinity between the Birds and the Reptiles; and when we recollect that demons are fallen angels, we may apprehend why God has placed their symbols in the same series.

Zoologists are not altogether agreed as to which of the Reptiles come the nearest to the birds: the beak, and some other characters of the *Chelonians*, have been thought to indicate that they are entitled to that distinction;[2] and, by his placing the latter immediately after the Birds, this appears to be Baron Cuvier's opinion. Any one, indeed, that looks either at the common,[3] or the hawk's bill, turtles,[4] or a good figure of them,[5] will see in them a striking resemblance of some sea-bird, especially a penguin; the anterior elongated paddles imitating the *wings*, and the posterior dilated ones the *webbed feet* of such birds. There are other Reptiles, however, that dispute this claim with the Chelonians. Amongst the rest is a remarkable fossil genus, regarded as extinct, which Cuvier has arranged with the *dragon* of modern Herpetologists, under the name of *Pterodactyle*.[6] The carpal and metacarpal bones, and the phalanges of the fourth toe of the anterior leg are excessively elongated, to which it is conjectured a membrane was attached,

1 See above, p. 327—329.
2 Mac Leay, *Hor. Entomol.* 263.
3 *T. Mydas.*
4 *T. Caretta.*
5 *N. D. D'H. N.* xxxiv. *t.* R. 8. *f.* 1. 2.
6 *Pterodactylus. Ornithocephalus.* Sömm.

forming a wing for flight. M. Sömmering classes this remarkable animal with the *Mammalians*, supposing its affinity to be with the *Cheiropterans*, or Bats; and Dr Wagler considers it as forming, with the *Echidna* and *Ornithorhynchus*, an osculant Class, which he distinguishes by the ancient name of *Griffins*.[1] But the wing in its structure appears to approach nearer to that of *birds*, and therefore Blainville seems right in considering it as a Saurian genus leading to them.[2] Professor Goldfuss, in his description of a new species,[3] mentions having found upon it some impressions, looking like those of feathers; and though he thinks it flies like a bird, seems to regard it as between the crocodile and the monitor. The serrated beak of the mergansers is not very unlike that of the common pterodactyle,[4] though that of the species described by Professor Goldfuss has a few very long dispersed teeth, of different lengths, like those of the crocodile.[5] The animals of the last named genus, in the structure of their heart, approximate most nearly to birds, and in their general organization are at the head of the Class of Reptiles.[6]

From these statements, it seems as if the Class just mentioned sent forth several branches towards the Birds; but, all circumstances considered, the pterodactyle, especially if it has feathers, or rather plumiform scales, appears to come the nearest to them, and to prove that the *feathers* of the *Bird* are a transition from the *scales* of the *Reptile*.

## Aves. (*Birds.*)

*Animal*, vertebrated, oviparous, biped.
*Anterior extremities*, organized for flight.
*Integument*, plumose.
*Eggs*, usually hatched by incubation.
*Lungs*, fixed.
*Respiration* and *circulation*, double.
*Blood*, red, warm.

Ornithologists appear at present undecided as to the division

1 *Gryphi.* Gray's *Synops. Rept.* 78.
2 *N. D. D'H. N.* xxviii. 226.
3 *Pt. crassirostris. Isis* Heft. v. 553.
4 *Pt. antiquus.*
5 Isis. *ubi supr. t.* vi. *f.* vii.
6 For these observations, with respect to the crocodile, I am indebted to Mr Owen.

of this great and interesting Class into *Orders*, as the following synoptical table of systems, differing in this respect, will show:

| | | |
|---|---|---|
| Nitzsch and Schoepss have only | 3 | Orders. |
| Vieillot, Vigors, Mac Leay and Swainson | 5 | |
| Linné, Cuvier, Dumeril and Carus | 6 | |
| Illiger | 7 | |
| Scopoli, Latham, Myers and Wolf | 9 | |
| Temminck | 13 | |
| Grant | 16 | |
| Schœffer | 17 | |
| Brisson | 28 | |
| Lacepede | 38 | |

One may truly say here, "the choice perplexes;" and the young Ornithologist must be puzzled to determine which of these systems he ought to adopt, especially since the several authors of them were amongst the most eminent zoologists of their time.

I am indebted to Mr Owen for my knowledge of the first of these systems, of which, as at present it is little known in this country, I will here give an abstract, without entering into its merits, except that its *primary* sections, or Orders, form a very natural division of the Class.

ORDERS.—I. Aërial Birds. *Luftvögeln.*
Sub-Orders.—A. Accipitrines.
B. Passerines.
C. Pies.

— II. Terrestrial Birds. *Erdvögeln.*
A. Columbines.
B. Gallinaceans.
C. Coursers.

— III. Aquatic Birds. *Wasservögeln.*
A. Waders.
B. Anserines.

In this last Order he includes the Bustards,[1] which surely ought to form a separate Sub-order.

On the present occasion I shall follow the system of Linné, as improved by Baron Cuvier, in the last edition of his *Règne Animal*, adopting from Illiger his Order of *Cursores*, or runners, which appears to be osculant between the *gallinaceous* Order and that of the *waders*.

That the series ought to begin with the *web-footed* Birds, as approaching nearest to the Reptiles, there is no doubt; but which should terminate it, seems not satisfactorily determined. The *birds* of *prey* appear naturally to connect with the *beasts* of *prey*, rather than with the Cetaceans, next before which Cuvier has placed them; Carus ends the series with the Gallinaceans,

1 *Otis.*

which Linné *contrasts* with the Ruminants, and Mr W. S. Mac Leay *connects* with the Gnawers,[1] and Illiger and Lacepede end with the Psittaceans, which are analogues of the Quadrumanes, but these are probably mostly analogous forms; there seems a more strict affinity between the web-footed birds and the *Monotremes*, the *Ornithorhynchus*, *Echidna*, &c. which, in some respects, appear to form an osculant *Order*, between the birds and the beasts. In fact the Birds, though united into one group with the Beasts by common characters, may be regarded as forming a *parallel* series with the latter rather than a *continuous* one, several of the members of which, respectively, represent each other, both as to many of their external features, and their functions. Branches, like those of a tree, seem indeed to issue from every natural series, whether vegetable or animal, on all sides, and to run in all directions towards those of other series, so as to form together a perplexing labyrinth, to thread which, although in many places there appears an evident clue, in others it becomes evanescent, and the investigator of nature seems lost. But when we reflect that the Author of Nature is *infinite* in his essence and attributes, we must expect there will be something that indicates their origin from such a Being; though not a real, there will be in them a seeming infinity to finite minds. He who made them sees them all at once, and in their several places, and traces simultaneously every series through all its numberless divarications or convolutions; whereas man sees only a *part* of the ways of his Creator. He can have no simultaneous view of things, and must be contented with adding, here a little and there a little, to his stores of knowledge. To investigate the works of his Creator is a laudable exercise of his powers, and to aim as much as possible to discover the system of things that the God of Nature has established by his Wisdom, and upholds by his Power, is to aim at the discovery of Truth; who will more and more reveal herself to those that, using the proper means, seek her in sincerity.

## Orders.[2]

1. *Swimmers.*
2. *Waders.*
3. *Coursers.*
4. *Scratchers.*
5. *Climbers.*
6. *Perchers.*
7. *Raveners.*

1 *Rodentia.*

2 The Latin names of the Orders are,—

1. *Natatores.*
2. *Grallatores.*
3. *Cursores.*
4. *Rasores.*
5. *Scansores.*
6. *Insessores.*
7. *Raptores.*[*]

[*] *Raptor milvius.* Phædr.

*Order* 1.—*Swimmers.* (*Web-footed*, or *Aquatic Birds.* This Order includes the *Inertes*, *Palmipedes*, and *Pinnatipedes* of Dr Grant's catalogue.)

Body, closely covered with feathers, and coated with a thick down next the skin. *Legs*, placed behind the equilibrium. *Toes*, united by membrane for swimming; *membrane* sometimes divided.

*Order* 2.—*Waders.* (*Flamingo, Coot, Avocet, Woodcock, Snipe, Ibis, Spoonbill, Jabiru, Bittern, Heron, Crane, Stork, Oyster-catcher, Plover, Bustard.—Grallatores.* Grant.)

*Legs* consisting of very long *tarsi*, with the apex of the *tibia* bare; stretched out in flight. *Wings*, long.

*Order* 3.—*Coursers.* (*Apteryx, Ostrich, Emeu, Cassowary, Dodo*, &c.—*Cursores.* Grant.)

Wings, very short, not used for flying. *Legs*, robust. *Toes*, 3—4. *Beak*, depressed or compressed.

*Order* 4.—*Scratchers.* (*Pigeon, Quail, Partridge, Common Poultry, Guinea-fowl, Pheasant, Turkey, Peacock*, &c.—*Alectorides, Gallinæ*, and *Columbæ.* Grant.)

*Upper mandible*, vaulted; *nostrils*, pierced in a membranous space at their base, covered by a cartilaginous scale. *Tail-feathers*, 14—18.

*Order* 5.—*Climbers.* (*Psittaceans, Toucan, Cuckoo, Wryneck, Woodpecker*, &c.—*Chelidones, Alcyones, Anisodactyli, Zygodactyli.* Grant.)

*Feet* with two toes before and two behind.

*Order* 6.—*Perchers.* (*King-fisher, Hoopoe, Humming-bird, Tree-creeper, Nut-hatch, Bird of Paradise, Crow, Magpie, Starling, Cross-beak, Gross-beak, Gold-finch, Linnet, Sparrow, Titmouse, Lark, Goat-sucker, Swallow, Taylor-bird, Nightingale, Red-breast, Fly-catcher, Black-bird, Chatterer, Butcher-bird*, &c.—*Granivoræ, Insectivoræ*, and *Omnivoræ.* Grant.)

*Toes* four: formed for prehension in nidification. *External toe* united at the base to the *internal.* *Three* toes before and *one* behind. All other characters negative.

*Order* 7.—*Raveners.* (*Owl, Secretary-bird, Buzzard, Kite, Sparrow-hawk, Falcon, Harpy, Eagle, Vulture*, &c.—*Rapaces.* Grant.)

*Beak* robust, upper mandible, on each side, armed with a tooth. *Legs* short, robust. *Toes* armed with crooked claws.

*Order* 1.—The *swimmers*, or web-footed birds, form a very important part of the feathered race, both as furnishing man with food, and as ministering greatly to his comfort, by their down and feathers, when he retires to rest; and also by their

action upon the inhabitants of the waters both of the sea and rivers, which form the principal part of their food. Cuvier remarks, that these are the only birds in which the neck exceeds, and sometimes considerably, the length of the legs. Swimming on the surface, they can thus dip deeper to seize their prey. The same remark may be extended to the Saurians, in which, though the majority have a short neck, one fossil animal,[1] which appears to be the analogue of the swan, has a very long one. Other birds, as well as those of the present Order, are distinguished by the length of the neck; as the peacock, the turkey, and several other Gallinaceans, and the Ostrich and its congeners are still more remarkable in that respect. This structure is probably as useful to them as to the web-footed birds, in enabling them to secure articles of food that would otherwise be out of their reach.

The birds at the foot of this Order, and indeed of the whole Class, are the *short-winged swimmers*, particularly the *auk*[2] and the *penguin*;[3] the one having its station in the northern, and the other in the southern seas, reaching to the antartic circle. The *northern* one, the *auk*, seems to rank above the penguin, for its wings have those feathers which, from their office being to propel birds when they fly, are denominated *rowing* feathers,[4] and they can flutter and flap their wings, while the *penguins* have none of these feathers, and cannot use their, so called, *wings* as such. The legs of the auk, also, are not placed quite so near the tail as in the southern bird, in which they are close to it, though both stand nearly in a vertical position. But though of no apparent use as *wings*, their short anterior appendages that go by that name, are not given them by their Creator merely for show, for when under water they use them as *fins*; and when it is recollected that Captain Beechy found them between three and four hundred miles from any land,[5] they seem to have occasion for additional rowing organs. One traveller, D. Pagès, says that they also sometimes use their wings as fore-legs, walking on all fours.[6] Some of them burrow like rabbits, but how they effect this has not been ascertained. In general they are reckoned as the most stupid and foolish animals in the whole Class: in fact most of the web-footed birds exhibit less of the life and spirit and gaiety that distinguish so conspicuously those whose principal theatre of motion is the air: belonging as they do to two elements, they

1 *Plesiosaurus dolichodeirus.*
2 *Alca.*
3 *Aptenodytes.*
4 *Remiges.*
5 Voyage, i. 16.
6 *N. D. D'H. N.* xiii. 306.

may be regarded, in some sense, as half fowl and half fish; and when we call a man, not remarkable for sense, a *goose*, we admit some such degradation in aquatic birds.

But all sea-birds are not of this character; amongst these the *frigate-bird*[1] and the *albatross*[2] are most conspicuous, emulating the eagle and the vulture amongst the terrestrial birds of prey. Of all the oceanic birds, the frigate-bird comes nearest to the *eagle*. Its keen sight, its crooked beak, its short, robust, and plumy legs, its sharp claws, the vast extent of its wings, and its rapid flight, all show that it is the oceanic representative of the king of birds. If the peaceful flying-fish seeks a refuge from the dorados[3] and bonitos,[4] its aquatic enemies, by elevating itself from the water into the air, the frigate-bird darts upon it like a thunder-bolt and devours it. If the booby[5] has caught a fish, like the bald eagle[6] the frigate-bird often compels it to let go its prey, and seizes it before it reaches the water. Its extent of flight is wonderful, and exceeds that of any other marine bird; for it possesses between the tropics a domain of more than four hundred leagues, over which it directs its course by day and by night; for, as the plumage of the under side of its body is not impervious to the water, it cannot continue long upon it, but prefers to brave the wind and the tempest, and to elevate itself above the storm, and for repose retires to lofty rocks and woody islets.

The *albatross* is the analogue of the *vulture*, and the largest of the sea-birds, and his wings expand sometimes to the extent of twenty feet; like his prototype, he is occasionally so gorged with food as to lose the power of flying, and when pursued, his only resource is to disgorge his overloaded stomach. Mr Bennet has given a very interesting account of the mode of flight of this bird, to which I must refer the reader.[7]

I observed, in the last chapter, that one of the short-winged family of this Order, the *merganser*, appears to be connected with the *Saurians* by its serrated beak; but the *penguins*, which are at the foot of the same Family and of the Order, seem connected with the *Chelonians*, their rudimental wings and their legs approaching the paddles and webbed feet of the turtles and some of the tortoises. Their plumage, when not analyzed, resembles very much the fur of a seal, or some quadruped.

1 *Tachypetes Aquila.*
2 *Diomedea exulans.*
3 *Coryphæna hippurus.*
4 *Scomber Pelamis.*
5 *Sula Bassana.*
6 Richardson, *Fn. Boreal. Americ.* ii. 15. Audubon. *Biogr.* 162.
7 *Wanderings*, &c. i. 45—47.

*Order* 2.—I have already noticed several circumstances relative to the birds of this Order;[1] I shall not, therefore, in this place, enlarge much upon them. Their general function is not only to devour the smaller fishes, aquatic Molluscans, and other animals, as well as their spawn, that inhabit the waters of the globe, whether salt or fresh, but also those that are found in their vicinity, as worms, small reptiles, and insects in their different states; and their form is particularly adapted to their function: very long legs and toes; naked knees; a long sharp beak; where they have to dip under water for their food a long neck; and as, on account of their great length, they could not conveniently double their legs in flight, their tail is usually extremely short, so as to permit the legs to be stretched out, and act in some degree as steering organs. The body of these birds, generally speaking, in shape, seems to approach that of the *Scratchers*, but is rather longer, and not so plump. The form of some of them is very elegant and graceful; the plumage of others, especially of some of the scolopaceous tribe, is beautifully mottled, but, generally speaking, their colours are not brilliant.

There is one bird[2] of this Order that is particularly interesting, not only on account of some singularities in its structure, but likewise for its amiable manners: this bird is described and figured by Piso[3] under the name of *Anhyma*, but it is more commonly known by that of *Kamichi*. It is said to be larger than the peacock or even the swan. Its wings are armed with two strong spurs, which point outwards when the wing is folded; but its most remarkable feature is the long, slender, cylindrical, and nearly straight horn which arms its forehead. One would suppose a bird so fitted for combats was the terror of the feathered race, delighting in battle and bloodshed, but this is not the case, for it is one of the most gentle and susceptible of birds. It feeds upon grass, and attacks no birds that approach it: at the time of pairing, however, the males contend fiercely and sometimes fatally for the females; but the victory gained, they become patterns of conjugal fidelity, never parting, and like the turtle, if one outlives the other, the survivor usually is the victim of its grief.[4]

Another South American bird of this Order,[5] if we may credit the accounts that are given of it, is gifted by its Creator with an instinct still more wonderful; it seems to have a natu-

1 See above, pp. 283, 292.
2 *Palamedea cornuta*.
3 *Hist. Nat. et Med. Ind. Occid.* 91.
4 Sonnini, in *N. D. D'H. N.* xvii. 21.
5 *Psophia crepitans*.

ral inclination for the society of man, and seems to occupy the same place amongst birds that the *dog* does amongst quadrupeds. When taken and fed in a house, it becomes attached to the inmates. Like the dog it knows the voice of its master, and will follow or precede him when he goes out, quits him with reluctance, and appears delighted when it sees him again. Sensible of his caresses, it returns them with every mark of affection and gratitude : it seems even jealous of his attentions, for it will peck at the legs of those who come too near to him. It knows and acknowledges also the friends of the family. It sometimes takes a dislike to individuals, and whenever they appear, attacks them, and endeavours to drive them away. Its courage is equal to that of the dog, for it will attack animals bigger and better armed than itself. Sonnini, who relates the preceding anecdotes from his own observation, was also told that in some parts of America, these birds were entrusted with the care of the young poultry, and even of the flocks of sheep, which they conducted to and from their pastures.[1]

The *common Stork*[2] seems equally attached to man, and in return has generally met with protection from him, and in many nations has been accounted a sacred bird that it is a sin to kill or molest ; and they are entitled to these immunities not only on account of their philanthropic instincts, but likewise because they destroy lizards, frogs, serpents, and other noxious reptiles, which are a considerable annoyance in low and marshy districts. The *black Stork*[3] is of a less social turn, and avoids the neighbourhood of man, and frequents solitary marshes and thick woods, where it nidificates on old trees.

*Order* 3.—We seem to enter this order—which from the swiftness of the few animals that compose it, is called the Order of *Coursers*[4]—by one of the most singular birds that is at present known ; I mean the *Apteryx australis* of Dr Shaw. As far as can be judged from the only known specimen, which was brought from New Zealand in 1812, one would think this bird *osculant* between the *Waders* and the present Order. Its legs, indeed, seem those of a gallinaceous bird, with a tendency, as Mr Yarrel remarks, to the spurs of that tribe,[5] but its beak is related to that of the *Ibis*, and the lateral skin of the toes is notched as in the *Phaleropes*. The wings are shorter than in any other known bird, quite concealed by the feathers, and terminate in a *claw ;* a circumstance which seems to indi-

1 *N. D. D'H. N.* i. 190.
2 *Ciconia alba.*
3. *C. nigra.*
4 *Cursores.*
5 See *Zool. Trans.* I. i. t. x. 74.

cate an approximation to some quadruped form. These wings, though useless for flight, were doubtless given by its Creator to this animal to answer some purpose in its economy, either as a weapon or a prehensive organ. With the birds of the Order in which it is placed it agrees in its general form and plumage, but in stature it falls below them, being of the size of a small turkey. It is called by the natives *Kivi.*

There is another insular bird, the *Dodo*, noticed in a former chapter,[1] which though classed with *this*, to judge from its figure seems to connect the Ostrich with the *next* Order, the *Scratchers*;[2] but if we suppose the Order to form a *circle*, these birds will meet, one still being conterminous to the Order above it, and the other to that below it. These two birds have *four* toes. Mr W. S. Mac Leay,[3] as well as several other zoologists, is of opinion that the Ostrich Family, meaning the typical members of it, both in their *internal* as well as their *external* structure, approach the nearest to Mammalians. Of the Ostrich itself it is stated, amongst other characters, that its upper eyelid is movable and ciliated, and that its eyes are more like the eyes of a man than those of a bird, and they are so set as both of them to see the same object at the same time; that it is the only bird that discharges urine,[4] with many circumstances which I have no room to enumerate. Mr Owen, however, whose accuracy as a comparative anatomist can be fully relied on, has observed to me, that the urinary bladder, sternum, and some other parts of these birds, are closer approximations to the *Chelonians* than the *Mammalians.*

The animal of the latter Class, whose external form approaches nearest to the Ostrich is the *Camel*, a resemblance which has been so striking, that from a very early period they have been designated by a name which connects them with this quadruped:[5] in many particular points, besides general form, they also resemble it. The substance and form of their two-toed feet, a callosity on their breast and at the os pubis, their flattened sternum, and their mode of reclining. It is singular that these birds associate with beasts, particularly the quagga and zebra.[6]

The new world, which has a representative of the camel in the *lama*, and of the hippopotamus in the *tapir*, has also a peculiar *ostrich* of its own, which is called the *nandu*;[7] so that in

1 See above, p. 30. 2 Vigors in *Linn. Trans.* xiv. 485.
3 *Hor. Ent.* 266. *Linn. Trans.* xvi. 43.
4 *N. D. D'H. N.* iii. 85, 86. 5 *Struthio-camelus.*
6 Burchell's *Travels in S. Africa*, ii. 315.
7 *Rhea Americana.*

Africa, Asia,[1] Australia,[2] and America, there is a distinct genus of the present Order, each, as at present known, consisting of a single species.

With respect to their *functions*, not much has been observed: they are said to live a good deal upon grain, fruit, and other vegetable substances, and the nandu is fond of insects; probably others of them may also assist in restraining the incessant multiplication of these little creatures. The ostrich may be said almost to graze, though it is very eager after grain; but its history is too well known to require any further enlargement upon it.

*Order* 4.—The birds of this Order are called *Scratchers*, from an action common to many of them, and more particularly observable in our common poultry, that of *scratching* the ground to turn up food, especially when followed by their chicks. Of all the gifts of Providence, there is none that more promotes our comfort and pleasure than the majority of the animals that compose this Order, for it includes almost all our barn-door fowls, and the great majority of the game pursued so eagerly by the sportsman; birds not only valuable for the variety and delicacy of the food, both flesh and eggs, with which they supply our tables, but delighting us by the beauty, the elegance, and stateliness of their forms; the diversity of their plumage, especially the elongated or expansile tail feathers of the males; and the rich variety and splendour of their colours. The gorgeous peacock and the graceful pheasant have scarcely a parallel in the other Orders, except perhaps, as to splendour, in those brilliant little gems, the humming-birds.

I have mentioned, on a former occasion,[3] the numerous varieties of the common fowl, which have probably been produced by climate and cultivation. With regard to size, Sumatra appears to produce both the smallest and the largest kind of poultry, the common feather-legged *Bantam*, and the *Iago* fowl,[4] the cock of which, Marsden says, he has "seen peck off a common dining table; when fatigued, they sit down on the first joint of the leg, and are then taller than the common breed."[5] Colonel Sykes imported them into England in 1831; the hen laid freely, and reared two broods of chickens.

Wild poultry are found both in the old world and the new: the jungle-fowl,[6] from which our breeds are supposed by Sonnerat to have originated, are common in India; and the Span-

1 *Casuarius geleatus.*
2 *Dromaius ater.*
3 See above, p. 36.
4 *Gallus giganteus.*
5 *Sumatra*, 2 Ed. 98.
6 *Gallus Sonneratii.*

iards are said to have found another kind in Peru and Mexico, in which last country they were domesticated, and called *chiacchialacca;* Parmentier states that he heard the crow of the cock of this breed in the wildest forests of Guiana, and that he had seen one of them.[1]

The birds of this order are granivorous, insectivorous, or both, and the Hocco is stated to subsist on buds and fruits. Some are gregarious, as the pigeons; while others, as the partridge, form coveys only for a time; in spring those that survive the sporting season pair off, and are soon at the head of a numerous family.

*Order* 5.—Baron Cuvier has separated the *Climbers* from Mr Vigor's Order of *Perchers*, not only on account of their having two toes behind, as well as before, but also on account of differences in their larynx, sternum, and cœcal appendages. Amongst the Climbers, though there are some armed with beaks of very extraordinary forms and magnitude, as the toucan, there are none so interesting and altogether so remarkable as the Psittacean Family, or the Parrots, Parroquets, Macaws, Cockatoos, &c. They seem complete analogues of the Monkeys and other Quadrumanes, which they exceed, in their faculty of learning to articulate many words, for which their lower larynx is particularly constructed, and thus mimic the *utterance* of man, as the former animals do his *actions;* a circumstance which seems to have induced some ornithologists to place them at the head of their Class,[2] in contrast with the latter animals.

There is a genus, belonging to this Order, found in the southern parts of Africa, the species of which are called *bee-cuckows*,[3] and are remarkable for indicating both to the honey-ratel[4] and the Hottentot the subterranean nests of certain bees, which they do by a particular cry, morning and evening, and by a gradual and slow flight towards the quarter where the swarm of bees have taken up their abode; the beast and the man both attend to the notice, seek the spot, and dig up the

1 *N. D. D'H. N.* vii. 472. Modern ornithologists appear to account all these breeds as well as those mentioned in a former chapter (See above, p. 36) as distinct species. Linne, besides his *Phasianus Gallus* α, or the common breed, has Var. β, *P. G. cristatus*, or the *Polish* breed; γ. *P. G. ecaudatus*, or the *Rumplet;* δ. *P. G. Morio*, or the *black-skinned* breed; ε. *P. G. lanatus*, or the *silk* breed; η. *P. G. crispus*, or the *Friesland* breed; and ζ. *P. G. pusillus*, or the *Bantam* breed. There are several more in Gmelin.

2 Illiger, &c.

3 *Indicator major, minor Vieill.*, &c.

4 *Vivera mellivora.*

nest; and to the share of the bird generally falls, not the part stored with the *honey*, but that in which the *grubs* are contained:[1] so that the bird, though it invites others to partake with it, has its own subsistence, which it could not otherwise readily come at, principally in view. Both this animal and its companion, the ratel, are fitted by Providence for their function, and protected from the danger to which they are exposed from the stings of the irritated bees by a very hard skin. The bees, however, sometimes revenge themselves on the treacherous bird by attacking it about the head and eyes, and so destroying it.[2] It is singular, and affords a most convincing proof of design, that two animals that are so necessary to each other, the one to indicate and the other to excavate their common prey, should each be defended by the same kind of armour, and each seek a different portion of the spoil, suited to its habits.

Amongst the birds most remarkable for their instincts, in the present Order, is the *wryneck*.[3] It is a feathered *ant-eater*, and is organized by its Creator to entrap its prey by the very same means as the quadruped ones. Like them, it can protrude its tongue to a very great length, which is not owing to the structure of this organ itself, but to a peculiar ligamentous sheath in which it usually is contained. Its salivary glands are above an inch long, and shaped somewhat like a tea-spoon. The saliva they secrete is so very viscid as to be capable of being drawn into threads finer than a hair, and several feet in length; so that when the tongue is besmeared with it, no insect that touches it can escape. Like its analogues, it darts its tongue into an ant-hill, or lays it on an ant-track, and draws it back into its mouth laden with prey.[4] It is singular that the functions, in warm climates, given in charge by Providence to *quadrupeds*, in temperate ones, in this instance, devolves upon *birds*, the rapid increase of ants, in tropical countries, probably rendered it necesary that their devourers should be more numerous, and act with a greater momentum.

The general functions of this Order, as they are in most of those of the present Class, are various. The food of some are

1 Sparrmann, *Voyage*, ii. 181, 187.

2 Cuv. *Règn. An.* i. 455. Sparrmann, *Voyage*, ii. 182.

3 *Yunx torquilla.*

4 I owe these observations on the wryneck principally to a medical friend, George Helsham, Esq. of Woodbridge, in Suffolk, a practical ornithologist, not only systematically and anatomically, but knowing birds also in their haunts, and conversant with their habits and instincts.

roots, fruits, and other vegetable substances;[1] of others the grubs of insects;[2] of others, again, principally insects in general under every form;[3] and lastly, some to fruits or insects will add the eggs and the nestlings of other birds.[4]

*Order* 6.—The birds of this Order, the *Perchers*, are distinguished from the last, not only by the characters lately noticed, but likewise by a considerable difference in their habits and manners. Amongst them we find all those that delight us by their varied song; they are truly birds of the *air*, for they seem to have the full command of that element; many of them moving gaily in every direction that their will suggests, rising and falling, flying backwards and forwards, or performing endless evolutions, *pro re nata*, in their flight. These *Perchers* also are the best nest-builders, not usually selecting, like the Climbers, the interior of a hollow tree or similar situations, but most commonly interweaving their nests between the twigs and branches of trees and shrubs, or suspending them from them, or even attaching them to humbler vegetables; some having even exercised arts from the creation, which man has found of the greatest benefit to him, since he discovered them. These birds, indeed, may be called the inventors of the several arts of the weaver, the seamstress, and the tailor, whence some of them have been denominated *weaver* and *tailor-birds*.

The nest of the little Indian *weaver-bird*,[5] though it has neither warp nor woof, being formed by various convolutions of the slender leaves of some grass, so intertwined and entangled as to produce a web sufficiently substantial for the protection of the inhabitants of the nest, is, nevertheless, a very wonderful structure, but as it is well known[6] I shall not further enlarge upon it, but proceed to the *tailor-birds*, whose nests are still more remarkable.

India produces several species that are instructed by their Creator to *sew* together leaves for the protection of their eggs and nestlings from the voracity of serpents and apes; they generally select those at the end of a branch or twig, and sew them with cotton, thread, and fibres. Colonel Sykes has seen some in which the thread was literally knotted at the end.[7] The Indian birds of this description form two genera, separated

1 The *Psittaceans*.
2 The *Pies*.
3 The *Cuckows*.
4 The *Toucan*.
5 *Ploceus Textor*.
6 There are several of these nests in the museum of the Zoological Society.
7 *Catalogue of birds*, &c. 16.

from *Sylvia* by Dr Horsfield.[1] The inside of these nests is lined usually with down and cotton.

But these birds are not confined to India or tropical countries; Italy can boast a species which exercises the same art: and I am indebted to the kindness of one of our most eminent ornithologists[2] for being enabled to give a figure of this pretty and interesting bird, from a specimen in his possession;[3] and to the Zoological Society for their permission to have a drawing made from a nest in their museum.[4] This little creature was originally described and figured by M. Temminck in 1820, but its singular instincts, as to its mode of nidification, were afterwards given in detail by Professor P. Savi. It is called by the Pisans *Becca moschino*, and is a species of the genus *Sylvia*.[5]

In summer and autumn it frequents marshes, but in the spring it seeks the meadows and cornfields; in which, at that season, the marshes being bare of the sedges which cover them in the summer, it is compelled to construct its nest in tussocks of grass on the brink of ditches: but the leaves of these, being weak, easily split, so that it is difficult for our little seamstress to unite them, and so to form the skeleton of her fabric. From this and other circumstances the *vernal* nests of these birds differ so widely from those made in the autumn, that it seems next to impossible that both should be the work of the same artisan.

The latter are constructed in a thick bunch of sedge or reed, they are shaped like a pear, being dilated below and narrowed above,[6] so as to leave an aperture sufficient for the ingress and egress of the bird. The greatest horizontal diameter of the nest is about two inches and a half, and the vertical is five inches or a little more.

The most wonderful thing in the construction of these nests is the method to which the little bird has recourse to keep the living leaves united, of which it is composed. The sole interweaving, more or less delicate, of homogeneous or heterogeneous substances forms the principal adopted by other birds to bind together the parietes of their nests; but this *Sylvia* is no weaver, for the leaves of the sedges or reeds are united by real *stitches*. In the edge of each leaf she makes, probably with her beak, minute apertures, through which she contrives to pass, perhaps by means of the same organ, one or more cords formed of spider's web, particularly of that of their egg-pouches.

1 *Prinia* and *Orthotomus*.
2 Mr Gould.
3 Plate XV. Fig. 1.
4 *Ibid.* Fig. 2.
5 *S. cisticola*.
6 Plate XV. Fig. 2.

These threads are not very long, and are sufficient only to pass two or three times from one leaf to another; they are of unequal thickness, and have knots scattered here and there, which in some places divide into two or three branches.

This is the manner in which the exterior of the nest is formed; the interior consists solely of down, chiefly from plants, a little spider's web being intermixed, which helps to keep the other substances together. In the upper part and sides of the nest, the two walls, that is the external and internal, are in immediate contact; but in the lower part a greater space intervenes, filled with the slender foliage of grasses, the florets of Syngenesious plants, and other materials which render soft and warm the bed in which the eggs are to repose.

This little bird feeds upon insects. Its flight is not rectilinear, but consists of many curves, with their concavity upwards. These curves equal in number the strokes of the wing, and at every stroke its whistle is heard, the intervals of which correspond with the rapidity of its flight.

Perhaps of all the instincts of Birds, those connected with their nidification are most remarkable; and of all these, none are so wonderful as those of the tribe to which the little bird whose proceedings in constructing its nest I have just described, belongs. In the Indian tailor-birds, the object of their sutorial art is stated above; and doubtless, in the case of the Italian, the attack of some enemy is prevented by her mode of fabricating her nest. Situated so near the ground, her eggs, but for this defence, might otherwise become the prey, perhaps, of some small quadruped or reptile. He who created the birds of the air taught every one its own lesson, and how to place and construct its nest as to be most secure from inimical intrusion. I may observe here, that Professor Nitzch's three Orders, or rather Sub-classes, mentioned above, receive some confirmation from the places selected by the individuals composing them, to form their nests and deposit their eggs in. The *aquatic* birds generally select places in the vicinity of *water;* the *terrestrial* make them on the *ground;* and the great body of the *aërial* construct their nests in *trees, shrubs,* and *plants.*

The birds of this Order as to their *food* leave no vegetable or animal substance untouched, and the humming-birds, with their butterfly-tongue, imbibe the nectar of flowers. Of a vast number, insects form the principal part of their food, and they are the chief check to their too great multiplication; and sometimes, as in the case of the locust-eating thrush,[1] they

1 *Turdus gryllivorus.*

devote themselves to a particular tribe of insects, but most of the insectivorous birds will also eat grain.

*Order* 7.—The last Order of Birds, the *Raveners*, includes those that are most perfect in their form, and all are remarkable for their predatory habits. Their power of wing, and talon, and beak, distinguish them from all other birds of the *air;* and though some of the terrestrial birds vie with them in magnitude, and some of the aquatic ones, as we have seen,[1] exceed them in extent of wing and untired flight, yet none can come near them in the union of all those qualities which constitute their claim to the first rank amongst the birds; and the eagle has, as it were, been *consecrated* king over them all, by being placed in the Holy of Holies of the Jewish temple as one of the symbols of those powers that rule under God in nature.[2]

This Order is usually divided into two sections, which might be denominated Sub-orders, the *nocturnal* birds of prey and the *diurnal.* The first of the birds of these sections are distinguished by their large eyes, the enormous pupil of which receives so many rays of light, that they are dazzled by the glare of day; but by it are enabled to see in the night—they fly in the evening and by moonlight. Thus they are fitted best to fulfil their function, and to be very beneficial to man, in keeping within due limits animals that are often extremely detrimental to his property, and commit their ravages more or less in the night; on this account owls are often seen in barns where mice and rats abound, and are most valuable auxiliaries to the cats. The white owl[3] is said to destroy more of the murine race than even these last animals. Had not the provident care of the Father of the universe created these mouse-and-rat-destroying animals, the tiller of the soil would often labour in vain.

The *diurnal* Section of the Raveners contains all the birds of might and power. I have before mentioned the secretary-bird,[4] created to diminish the number of serpents; so similar to some of the *waders*, as to have been classed with them by several ornithologists; but Cuvier says, its whole anatomical structure, as well as its beak and other external characters, vindicate its claim to be placed in the present Order.[5]

Another species belonging to it descends to still lower food, and like the bee-eater,[6] devours bees and wasps and other in-

1 See Introduction.
2 Ezek. i. 10; x. 1.
3 *Strix flammea.*
4 See above, p. 284.
5 *Règne An.* i. 339.
6 *Merops apiaster.*

sects, I allude to the *bee-falcon*;[1] but in general the aquiline race attack vertebrated animals, reptiles, fishes, and birds of every wing, and many quadrupeds, and the giant vultures satiate their ravenous appetites upon any carcasses that their peircing sight, from the great heights to which they ascend, can discover. Humboldt says, that the Condor[2] soars to the height of Chimborazo, an elevation almost six times greater than that at which the clouds that overshadow our plains are suspended.[3]

In the book of Deuteronomy we have a very animated and beautiful allusion to the eagle, and her method of exciting her eaglets to attempt their first flight, in that sublime and highly mystic composition called Moses' Song; in which Jehovah's care of his people, and methods of instructing them how to aim at and attain heavenly objects, is compared to her proceedings upon that occasion. *As an eagle stirreth up her nest, fluttereth over her young, spreadeth abroad her wings, taketh them, beareth them on her wings: so Jehovah alone did lead him.* The Hebrew lawgiver is speaking of their leaving their eyrie. Sir H. Davy had an opportunity of witnessing the proceedings of an eagle after they had left it. He thus describes them.

"I once saw a very interesting sight above one of the crags of Ben Nevis, as I was going on the 20th of August in the pursuit of black game. Two parent eagles were teaching their offspring, two young birds, the manœuvres of flight. They began by rising from the top of a mountain in the eye of the sun; it was about mid-day, and bright for this climate. They at first made small circles, and the young birds imitated them; they paused on their wings, waiting till they had made their first flight, and then took a second and larger gyration, always rising towards the sun, and enlarging their circle of flight so as to make a gradually extending spiral. The young ones still slowly followed, apparently flying better as they mounted; and they continued this sublime kind of exercise, always rising, till they became mere points in the air, and the young ones were lost and afterwards their parents to our aching sight."[4]

What an instructive lesson to Christian parents does this history read! how powerfully does it excite them to teach their children betimes to look toward heaven and the Sun of righteousness, and to elevate their thoughts thither more and more on the wings of faith and love; themselves all the while going before them, and encouraging them by their own axample.

1 *Pternis apivorus.*
2 *Sarcorhamphus Gryphus.*
3 *Zool.* i. 29. See above, p. 272.
4 Salmonia, 99.

## CHAPTER XXIV.

*Functions and Instincts. Mammalians.*

We are now arrived at the last and highest Class of the Animal Kingdom, to which man himself belongs, and of which he forms the summit: but though he may be said to belong to it in some respects, in others he stands aloof from it, as an insulated animal, and one exalted far above it, being created rather to govern its members, than to be the associate of the highest of them.

This Class includes many animals which are of the greatest utility to man, and without which he could scarcely exist, at least not in comfort; and others again that attack him and his property; and though the fear of him, in some degree, still remains upon them, also often excite that passion in his breast. But he of all animals is the only one, that by the exercise of his reasoning powers and faculties, can arm himself with factitious weapons, enabling him to cope with the superior strength, the fierceness, claws, and teeth of the tiger or the lion, and to lay them dead at his feet when in the very act of springing upon him.

The animals of this Class, that are *terrestrial*, are all *quadrupeds*,[1] and are mostly covered with fur or hair, longer or shorter, though in some, these hairs become quills, as in the porcupine, or spines, as in the hedgehog; others, like the serpents and and lizards, are protected by scales, as the *Manis;* and some are incased in a hard coat of armour, often consisting of pieces so united as to form a kind of mosaic, as the armadillo, the *Chlamyphorus*,[2] and probably the *Megatherium.*

In the *aquatic* Mammalians the legs are, more or less, converted into *fins*, or means of natation.[3] The whole body constituting the Class, though sometimes varying in the manner, are all distinguished by *giving suck* to their young, on which

1 Τετραποδα της γης.
2 Plate XVII.
3 See above, p. 256, 265.

account they were denominated by the Swedish naturalist, *Mammalians.*[1]

The situation and number of the, usually protuberant, organs that yield the milk, vary in different tribes and genera. The Creator has distributed them according to the circumstances of each kind. Physiologists divide them into *pectoral*, or those on the *chest; abdominal*, or those on the *abdomen;* and *inguinal*, or those on the *groin.* In the human race, the *Quadrumanes*, and the *bats*, and some others, these organs are placed between the arms. For an erect animal like man, it is evident that this situation for the paps was the only convenient one for suckling an infant, either when sitting or standing; the monkey tribes also, which are always moving about upon trees, and among the branches, could not have exercised this maternal function, had their lactescent organs been placed lower; and the bats, which carry and suckle their young during flight, required that their nipples should be similarly placed, to enable them to keep fast hold. All the species of the above tribes have only a *pair* of the organs in question, with the exception of the lory, or sloth-ape,[2] so called from the excessive slowness of its movements, which has *four*, two of which Cuvier places in his abdominal column, under the name of *epigastric.*

The animals which produce more than two at a birth, as might be expected, have a proportionable number of nipples differently distributed. Thus the *cat* has four pectoral, and four abdominal. The ten nipples of the *swine* are all abdominal, and those of the other Pachyderms, with the exception of the elephant, which has only two pectoral nipples, are similarly situated. The jerboa[3] has both pectoral and inguinal ones, while the lemming[4] has all three kinds; the *Ruminants*, *Solipeds*, *Amphibians*, *Carnivorous Cetaceans*, have only inguinal dugs, with from two to five nipples. This situation is evidently best suited for suckling their limited number of young ones. Amongst the *Marsupians*, whose young, immediately upon their birth, pass into a second matrix as it were, almost the entire skin of the abdomen forms a pocket, inclosing the lactescent organs; those of the opossum are arranged, in Cuvier's table, in the inguinal column; but in the *Kanguroo*, which has four, they appear rather to be abdominal. These variations in the position and number of the organs furnishing

1 Cuvier calls them *Mammifera*, but there seems no reason for altering the original term.

2 *Stenops.* 3 *Dipus Sagitta.* 4 *Lemmus.*

the sole food of the animals of the present Class in their state of infancy, were evidently planned and formed by the hand of a being supreme in Wisdom, Power, and Goodness, who adapted every organ to the circumstances in which it was his will to place the diversified animals that compose it, and to their general structure. To those which produce not more than two at a birth, only two organs for suction were usually given, placed, according to the wants of the animal, either between the anterior or posterior extremities, in which latter case the posture was never erect; but where he decreed an animal should produce a more numerous progeny, he planted them in greater numbers, and so distributed them that all belonging to the same litter could suck at the same time. In the case of the Kanguroo the members of *two* litters are sometimes sucking at the same time, which accounts for their having *four* nipples, a fact which shows how accurately every thing has been foreseen, weighed, and numbered, by a Provident Intellect.

In the whole animal kingdom, except amongst the Mammalians, there is no instance of the young being supported by their parents with nutriment derived from themselves, nothing, therefore, affords a clearer character for a definition of the Class than this most interesting one: the Birds, indeed—with the exception of pigeons which feed their nestlings from their crop—as well as the bees, and several other Hymenopterous insects, provide their progeny with food which they collect for them themselves; but the great majority of invertebrated animals, confine their care for them, to placing their eggs in a situation in which, when hatched, they would meet with their appropriate food, and this appears to be all that is generally done by the two first classes of Vertebrates, the Fishes, and the Reptiles.

## Mammalia. (*Beasts.*)

*Animal* vertebrated, ovoviviparous, or viviparous.

*Extremities* ambulatory, or natatory; in a few organized for flight.

*Integument* pilose; sometimes spinose, or armed with hard scales or plates; and sometimes naked. *Young* not hatched by incubation, but when first extruded from the matrix, receiving their nutriment by suction, till they can support themselves.

*Circulation* double. *Blood* red, warm.

*Respiration* simple. *Lungs* thoracic.

Cuvier seems to have laboured under some difficulty with regard to the *Classification* of Mammalians, and to have regarded the Marsupians and Monotrèmes as forming a *distinct* Class, divisible, for the most part, into Orders analogous to those into which the Class of common Quadrupeds is divisible.[1] Subsequent observations have proved the general correctness of this idea. Mr Owen observes to me, in a letter, "Dissections of most of the genera of *Marsupians* have tended to confirm in my mind the propriety of establishing them as a distinct and parallel group, beginning with the *Monotrèmes*, which I believe to lead from *Reptiles*, not birds. A general simplicity in the structure of the brain; a less perfect condition of the vocal organs; some peculiar dispositions of the great veins and arteries, as the presence of two superior *venæ cavæ*, and the absence of an *inferior mesenteric artery*, are among the circumstances in which they, the Marsupians and Monotrèmes differ from the true viviparous Mammalians, and agree with the oviparous Vertebrates. Recent opportunities of examining the impregnated uterus of the *Kanguroo* and *Ornithorhynchus* have almost determined that they are both ovoviviparous."

Under these impressions, confirmed and illustrated by the observations of so able a comparative anatomist, I shall consider the Class of Mammalians as divisible into two *Sub-classes*, viz. *Ovoviviparous* Mammalians, and *Viviparous* Mammalians.

It may be here observed, with regard to the state of forwardness in which the different tribes of Mammalians leave the matrix, a considerable variation takes place, some requiring a longer time than others, before they can be considered as at all independent of maternal care and protection. The young of the Ruminants, Pachyderms, and Solipeds, come into the world with the organs of the senses, and of locomotion, in a state to be used immediately; they can *see* with their *eyes*, and *hear* with their *ears*, and *walk* with their *legs*, as soon as they are born; whereas the Predaceans and several others, when first born are *blind*, and unable to *walk*, and do not attain to the full use of their eyes and legs till a considerable time after birth. In man, though the infant is born *seeing*, yet a much longer period, and the instruction of the mother or nurse, are required before it can *walk*.

In the first case here noticed, that of the Ruminants and Pachyderms, the young animal requires less care from the mother. She has little to do besides suckling, and watching it in order to protect it if danger threatens. But, in the second

1 *Règn. An.* i. 174.

case, she must prepare a kind of nest, not exposed to the light, and removed from observation, in which she can attend to her young unmolested, till they can see and move about upon their legs. Every one knows how attentive feline animals are to these circumstances, and the Rodents often excavate burrows in which they bring forth and suckle their young. The Marsupian Mammalians probably are exposed to external circumstances, which render it necessary that they should have a kind of nidus formed of the skin of their own body, to receive their young when they leave the matrix, at which period they seem to be in a more helpless state than any of the animals last alluded to.[1]

From this statement we see that the graminivorous and omnivorous animals, whose food is always at hand, come into the world the best prepared for action; while the carnivorous ones, and those that must, if I may so speak, procure their daily bread by the sweat of their brows, require to be in some degree *educated* for their function,[2] before they can duly exercise it. In the instance of the *Ornithorhynchus*, a burrow,[3] seems to supply the place of the marsupial pouch, which indicates some approach to many of the Rodents.

*Sub-class* 1. *Ovoviviparous* Mammalians.

*Chorion*, or external membrane of the egg not rendered vascular by the extension of the fœtal vessels into it. *Embryo* not adhering to the uterus.

Only one *passage* out of the body.

*Marsupial bones* in all.

This Sub-class is divided into two Orders, *Monotremes*, and *Marsupians*.

*Order* 1.—*Monotremes* (*Ornithorhynchus; Echidna.*)

No marsupial *pouch*. *Coracoid bones* extended to the sternum. Young suckled from a *mammary orifice:* brought up in *burrows*. *Animal* predaceous.

*Order* 2.—*Marsupians* (*Wombat; Koala; Kanguroo; Phalangist; Flying* and *Common Opossum*, &c.)

A marsupial *pouch* receiving the young after birth, in which they are suckled, by means of *nipples*. *Animal* herbivorous, predaceous, or carnivorous.

*Sub-class* 2.—*Viviparous* Mammalians.

*Chorion*, or external membrane of the *egg* rendered vascular by the extension of the fœtal vessels into it.

*Embryo* adhering to the uterus.

1 Owen in *Philos.* Tr. 1834. 344.

2 See above, p. 327.

3 Owen, *ubi. supr.* 564.

*Young* when brought forth not received into a pouch; suckled by a nipple.

This sub-class is divided into *eight* Orders thus arranged in an ascending scale,

1. *Cetaceans.*
2. *Pachyderms.*
3. *Ruminants.*
4. *Edentates.*
5. *Rodents.*
6. *Predaceans.*
7. *Cheiropterans.*
8. *Quadrumanes.*

Several of these *Orders* may be further divided into *Sub-orders*, as will appear when I come to treat of them. I have not adhered to Baron Cuvier's arrangement, in placing the *Ruminants* next to the *Cetaceans*, for it always appeared to me incongruous to place at the foot of the scale, animals on every account entitled to rank higher: and I am happy to find my opinion backed by Mr. Owen's judgment, which he informs me is grounded on anatomical considerations. The *Hippopotamus* appears to us both the proper successor of the Cetaceans.

*Order* 1.—*Cetaceans.* This Order may be divided into two *Sub-orders*, the *first* consisting of those that form the great body of the Order, which are *predaceous* in their habits; and the *second* of those that are *herbivorous.* (To the first belong the *Whales;* the *Cachalots;* the *Narwhals;* the *Porpoises;* and the *Dolphins*, &c.: and to the second, the *Manatee;* the *Dugong;* and *Rytina.*)

This Order is principally distinguished from the terrestrial Mammalians by having the *hind legs* converted into a horizontal (so called) fin moving up and down. They have little or no neck, and their anterior extremities are covered with a tendinous membrane, which enables the animal to use them as fins.

The *Predaceous* Cetaceans are distinguished from the *Herbivorous* by having their *mammary* organs *inguinal*, and by their *fins* not being prehensory.

In the *Herbivorous* Sub-order, the *mammary* organs are *pectoral*, and they can use their *anterior* extremities, in some degree, as hands, to carry their young, and in locomotion.[1] They are also armed with *tusks*, a circumstanoe which appears to connect them with the *Morse* or *Walrus*,[2] which is said, by Cuvier, to be both herbivorous and carnivorous, and to differ considerably from the rest of the *Amphibians.*

*Order* 2.—*Pachyderms.* The external characters which distinguish the *Solipeds* from the *typical* Pachyderms are so striking,

1 See above, p. 261.

2 *Trichecus rosmarus.*

that they seem almost entitled to be placed in a separate Order. I shall, however, consider them as forming a Sub-order. (To this Order belong the *Hippopotamus;* the *Tapir;* the *Swine* tribe; the *Rhinoceros;* the *Elephant;* the *Horse;* and the *Ass;* &c.) The principal characters of this Order, are *Feet* armed with *hoofs* incapable of prehension. In the *typical* Pachyderms the hoof is divided more or less, but in the *Solipeds* it is not.

*Order* 3.—*Ruminants.* The *Camel* tribe seems to form another Sub-order in the present Sub-class, distinguished by the remarkable circumstance, mentioned upon a former occasion, that its hoof, though superficially divided, has an entire sole,[1] and the males have no horns. (This Order includes the *Camel; Dromedary; Lama; Giraffe;* the *Ox*, and *Sheep* tribes; the *Goats;* the *Antelopes;* the *Deers;* and the *Elk.*) The principal character of the Order is that which its name indicates, that the animals belonging to it, *chew the cud*, that is, masticate a second time the food that they swallow, which, owing to the structure of their stomachs, they can return to the mouth after the first deglutition.

*Order* 4.—*Edentates.* (This order contains the *Pangolin;* the *Ant-eaters;* the *Armadillos;* and the *Sloths;* &c.) Their distinctive character is to have no fore teeth.

*Order* 5.—*Rodents.* (*Guinea-pigs; Hare* and *Rabbit; Porcupine; Beaver; Mouse; Rat; Dormouse; Jerboa; Marmot; Squirrels;* &c.) The principal character of this order are its *front* or *cutting-teeth;* of these there are *two* in each jaw, separated from the grinders by an *interval*, so that they can neither seize any living prey, or lacerate its flesh; they cannot even cut the aliments which form their subsistence, but they can, as it were, file them, and by constant labour, nibbling and gnawing, reduce them to fragments proper for deglutition. They are connected with the *kanguroo*, the *wombat*, and other *Marsupians*, and the *beaver* exhibits one of the distinctive characters of the *Monotremes*, it has only *one* passage by which the *excrements* are ejected.

*Order* 6.—*Predaceans* or *Zoophagans.* Cuvier's subdivisions of this Order may be regarded, for the most part, as Sub-orders, but there is one tribe included in it by this great man, the *Cheiropterans*, which seems rather to form an Osculant Order, between it and the Quadrumanes. (*Walrus; Seals; Cat; Leopard; Panther; Tiger; Lion; Hyæna; Ichneumon, Civet-cat; Fox; Wolf; Dog; Otter; Martin; Weasel; Glutton; Bear; Mole; Hedgehog; Shrew;* &c.) The animals of this

1 See above, p. 296.

Order have *three* kinds of *teeth*, viz. *cutting-teeth*, *canine* teeth, and *grinders;* their *paws* are armed with *claws;* their muzzle is often set with *whiskers*, usually called smellers; their mammary organs are dispersed; their intestines are less voluminous than those of herbivorous animals, a provision, the object of which is to prevent the flesh which forms their food from putrifying, by remaining too long in the body.

*Order* 7.—*Cheiropterans* (*Bats; Vampyres;* and *Flying-cats*). The animals of this Order are distinguished by real organs for flight, formed of the skin extended between the legs, as described on a former occasion;[1] their mammary organs, as in the Quadrumanes, are pectoral; they are, in some points, connected with the flying opossum, flying squirrels, &c.

*Order* 8.—*Quadrumanes.* (*Monkeys; Apes; Baboons; Oranoutans.*) The great character that distinguishes this order is, a *movable thumb* on their *lower* extremities *opposed* to the *fingers*, so that they can use the *carpus*, *metacarpus*, and *phalanges* of both extremities as *hands.* I have more than once had occasion to observe,[2] that certain tribes in the animal kingdom seem occasionally to form centres from which rays diverge towards different parts. The quadrumanes afford another example of this disposition in nature: the lory, for instance, looks towards the sloths; the baboon, the *Cynocephalus* of the ancients, towards the dogs and bears; the *aye aye*, amongst the Rodents, also might be taken for a quadrumane,[3] and several other instances occur.

*Sub-class* 1. *Order* 1.—The animals of this Order have puzzled Zoologists to ascertain their place and character. At first they were regarded as oviparous instead of mammiferous quadrupeds, and the *Ornythorhynchus* in particular, was thought to be something between bird and beast. The researches of Mr Owen have almost proved that the animal just named does not leave the womb of its mother as an egg, requiring her incubation, to complete its birth; but in the form it is afterwards to maintain, in which case it must necessarily derive its support from her, by some lactescent organ, traces of which have been discovered. Its beak resembling that of a duck, and its webbed feet seem to connect it, in some degree, with the first Order of the *Birds;* but the entire scapular apparatus, the development of the oviduct and uterus in both sides, the absence of the ligamentum teres, its four legs, and reptant motions, show that it is most nearly connected with the *Reptiles.* The

1 See above, p. 272.
2 See above, pp. 148, 199, 206.
3 See above, p. 300.

Echidna, by its extensile tongue, its food, and mode of taking it, approaches the ant-eaters: it also rolls itself up like an armadillo. The functions of the Order seem to be to keep in check the numbers of small animals; the Echidna, the *ants;* and the Ornithorynchus, which frequents the waters, some that are *aquatic.* But we know very little of their habits and history.

*Order* 2.—The animals of this Order are partly herbivorous, and partly carnivorous. The wombat,[1] the koala,[2] the kanguroo,[3] and other New Holland species, are herbivorous; the phalangist[4] of the Moluccas, lives upon the trees, and devours insects as well as fruits. The New Holland opossums[5] are very voracious, and devour carcasses as well as insects: they enter into the houses, where their voracity is very troublesome. That most common in America,[6] like the fox, attacks poultry in the night, and sucks their eggs. It is said to produce often sixteen young ones in one litter, which, when first born, do not weigh more than a *grain* each! though blind and almost shapeless, when placed in the pouch they instinctively find the nipple, and adhere to it till they attain the size of a mouse, which does not take place till they are fifty days old, at which period they begin to see; after this they do not wholly leave the pouch till they are as big as a rat!! This statement is so extraordinary, that, though apparently believed by Cuvier, on the authority of Barton,[7] it seems almost incredible. It is strange, as the animal seems common in America, that Say, or some other Zoologist of that country, has not turned his attention to it.

I have mentioned, on another occasion,[8] several particulars of the history of the kanguroo and koala, which I need not repeat here. Indeed our knowledge of the history and instincts of the Marsupian animals is very limited. Europe produces none. New Holland, some of the Asiatic islands, and North and South America, are their principal habitations. As the young of these animals leave the matrix of their mother at so early a period, and when, if they were exposed to the atmosphere, they must inevitably perish, it is evident that some such protection, as that with which Providence has furnished them, was necessary for the preservation of the race. Doubtless

1 *Phascolomys.*
2 *Lipurus.*
3 *Macropus.*
4 *Phalangista orientalis.*
5 *Dasyurus.*
6 *Didelphis Virginiana.*
7 *Règn. An.* I. 176.
8 See above, pp. 282, 300.

some wise and beneficial end is answered by the seeming premature nativity of these little creatures.

The opossums are peculiar to America, and are remarkable for having a greater number of teeth than any other animal, amounting in all to fifty; they approach the Quadrumanes, by having the thumb of their hind foot opposed to the fingers, whence they have been called Pedimanes, but it is not armed with a nail. They are usually stationed on the trees, where they pursue birds and insects, though, like the monkeys, they often eat fruit, and by this structure of the hind foot they can probably better support themselves on the branches. Many of the animals of this Order tend also to the *Rodents*, and others to the *Predaceans*.

*Sub-class* 2. *Order* 1.—At the foot of the present Class are found the most gigantic animals with which it has pleased God to people the globe that we inhabit.

The destruction, however, at least in the Arctic seas, of these animals, is so great, that it has been supposed, they are not suffered to live long enough to attain their full dimensions; but this has been doubted. Mr Scoresby saw none in those seas that exceeded sixty-eight feet in length; but some are said to reach one hundred and twenty feet. I saw one, which was exhibited two years ago, in the King's Mews, the length of the skeleton of which was more than ninety feet. In the Antartic seas, where the cupidity of mercantile enterprise does not occasion any great destruction of them, some are said even to reach the enormous length of one hundred and sixty feet. God has placed these Leviathans[1] where their enormous bulk can have full play, and their enormous appetite be fully satiated, in the vast and teeming depths of the ocean, where, whether they move horizontally, or, by the aid of that powerful organ, their forked tail, seek the deep waters, there is space, and to spare, even for them.

The carnivorous, or predaceous Cetaceans may very conveniently be divided into sections by characters which distinguish their *maxillary* organs; the common whale,[2] and the fin-whale,[3] have their jaws armed with no real teeth, but only furnished with transverse plates, formed of what is called whalebone, consisting of a fibrous horny substance, sufficient for the mastication of their, for the most part, gelatinous food, which swarms in such infinite myriads in the Arctic and icy seas, that Scoresby calculates it would require eighty thousand persons, constantly

1 See above, p. 418. 2 *Balæna*. 3 *Balænoptera*.

employed from the Creation, to count the number of those existing simultaneously.

Animals of this section are further subdivided into those that have, and those that have not a dorsal fin. To the latter subdivision belongs the animal commonly distinguished as the *whale* by way of eminence,[1] and which is the principal object of the whale fishery. The senses of seeing and hearing in these animals, in the water, are extremely acute; and their eyes are so placed that they can see behind as well as before and above them, and for a great distance; but when the head emerges from the water, this activity of sight and hearing ceases.

Their motions in the water are extremely rapid. They will sometimes assume a perpendicular position, with their head downwards, and rearing aloft their tremendous tail, lash the water with terrific violence, like the Indian god, churning the sea into foam, and filling the air with vapour. Sometimes by the motion of this organ, they produce a thundering noise. They will dive to the bottom of the ocean; and when confined in the shallows, these unwieldly monsters will sometimes leap out of the water. Their brain, compared with that of man, is very small. The weight of the brain of an udult man is often four pounds; that of a whale, nineteen feet long, only three pounds and a half; yet this is large compared with that of some other animals.

The *second* section of Cetaceans consists of those which have teeth only in their *upper* jaw. To this tribe belongs the *sea-unicorn*, or narwhal,[2] distinguished by its long tusk, or tusks, for there are sometimes two, extended in a horizontal direction.

To the *third* section belong those that have teeth only in their *lower* jaw: of this description are the spermaceti whales, or cachalots,[3] remarkable for their enormous head, sometimes occupying half the length of the body. Their teeth are long, and numerous, and all point outwards; opposite to them, in the upper jaw, is an equal number of cavities, in which the ends of the teeth are lodged, when the mouth is closed. These animals are said to grow sometimes to an enormous length; and to be very cruel and dangerous.

The *fourth* and last section of carnivorous Cetaceans consists of those that have teeth in both *upper* and *lower* jaws. To this the porpoise,[4] the grampus,[5] and the long celebrated dolphin[6]

1 *Balæna Mysitcetus.*
2 *Monodon Monoceros.*
3 *Physeter.*
4 *Phocæna.*
5 *Delphinus Orca.*
6 *Delphinus Delphis.*

belong. These animals are more active than the preceding Cetaceans, and have a brain of greater volume. The common dolphin is gregarious, and remarkable for its frolicsome gambols, often fortelling a storm, during which they will leap entirely out of the water. They pursue and devour the gregarious migratory fishes, and will even eat offal and garbage. These animals, in their tooth-armed mouth, often opening wide, seem to exhibit some affinity to the aquatic Saurians, as has been remarked with regard to the Cetaceans in general.[1]

The end for which all these carnivorous Cetaceans were brought into existence by the Creator of the universe, was evidently to keep within due limits, those animals, inhabitants of the northern and southern oceans, which were most given to increase, and which, were it not for some such check, might multiply to such a degree as would interfere with the general welfare.[2]

But the *vegetable* tenants of the ocean require to be kept within due limits, as well as the animal, amongst other creatures to whom this province is assigned, are some Cetaceans; thus preserving the general analogy observable in the animal Kingdom, which, in almost every Order, has its *cattle*, as well as its beasts of *prey*. Only three genera have been hitherto discovered to which this function is assigned, and all of them consisting of animals now in existence.

The Manatees,[3] belong to this Sub-order, on account of their carrying their young with their flappers or fin-like legs, and their breasts, probably gave rise to the fable of the siren, or mermaid.

One of the most remarkable of the herbivorous Cetaceans, is the *Dugong*,[4] which is the only animal yet known that grazes at the bottom of the sea usually in shallow inlets, which it is enabled to accomplish by its power of suspending itself steadily in the water, and by having its jaws bent down at an angle, in such a manner as to bring the mouth into nearly a vertical direction, so that it can feed upon the sea-weeds much in the same manner as a cow does upon the herbage.

Ruppel, a traveller in Africa, discovered a second species of Dugong in the Red Sea; and he is of opinion, that it was the skin of this animal with which the Jews were commanded to cover the tabernacle.[5]

1 See above, p. 16, 17.

2 See above, p. 107—108.

3 *Manatus Americanus.*

4 *Halicore Dugong.*

5 *H. Tabernaculum.* See Exod. xxvi. 14. *Badger's* skins in our Translation.

*Order* 2. Whoever compares the genuine Pachyderms with the Cetaceans, will find many points in which they resemble each other. As the latter Order contains the largest *marine* animals, so does the former the giants that inhabit the *earth.* With respect to their integument, the skin of both is nearly naked, except in the case of the swine, the daman,[1] the mammoth, and some others; a very small eye characterizes all, and a short tail; the blubber of the whale seems to have its analogue in the fat that covers the muscles of the swine. One of the most remarkable animals of this Sub-order, is the fossil one, which, on account of its enormous tusks, is named *Deinotherium.*[2] It is found in the north of Europe, and specimens of its powerful jaws and tusks may be seen in the British Museum. From its lower jaw two powerful tusks rise as in the Hippopotamus, to which Mr Owen regards it as approaching very near, and as forming the link that unites the Cetaceans to the Pachyderms. The herbivorous Cetaceans, in common with the generality of the Pachyderms, are likewise armed with tusks; so that the interval that separates the Hippopotamus and Deinotherium from the Dugong is not very wide.

The grand function of the, for the most part, mighty animals which constitute the tribe I am speaking of, seems to be that of inhabiting and finding their subsistence, in the tropical forests of the old world; both Africa and Asia have each their own rhinoceros, and elephant, which, by their giant bulk, and irresistible strength, can make their way through the thickest forests or jungles. Even the swine, from the thickness of its skin, suffers nothing from pushing through bushes and underwood in search of acorns; and most of these animals, by means of their tusks, muzzle, or horns, can dig up the roots that form their food. The hippopotamus seeks his provender in the African rivers, and by means of the tusks with which the under jaw is armed,—in this differing from the dugong, in which the tusks are in the upper jaw,—is enabled to root up plants growing under the water. The tapir acts the same part nearly in the New World that the hippopotamus does in the old.

By the efforts of the Pachyderms, in general, in pursuit of their own means of subsistence, a way is often made for man more readily to traverse and turn to his purpose forests and woody districts, that would otherwise mock his efforts to penetrate into them. When we consider the vast bulk and armour of the rhinoceros, for instance, and the violence with which he

1 *Hyrax.*

2 From the Gr. δεινος, terrible, and θηριον, wild beast.

endeavours to remove obstacles out of his path, we may in some degree calculate the momemtum by which he is enabled to win his resistless way through the thickest and most entangled underwood.

I need not enlarge on the *second* Sub-order of the Pachyderms, the Solipeds, the well-known equine and asinine tribes; every one must be struck by the contrast that their structure and characters exhibit to those of the *first* Sub-order, or typical ones. A fiery and intelligent eye; a *neck clothed with thunder*, to use the words of inspiration; a graceful form; speed that often outstrips the wind; are the distinctive characters which the highest tribe of them exhibits; while the other, though less beautiful, still has the organs of sight and hearing singularly conspicuous; a long tail; and its integument clothed with a shaggy coarse fur: besides these characters, the undivided hoof of both these tribes forms also a most striking distinction. No animals, indeed, externally present characters more diverse from each other than the soliped and typical Pachyderms. God has given us these animals, evidently, that we may employ them as our *servants*, and their great function is, to carry ourselves and our burthens; they also minister in no small degree to our innocent pleasure and amusements, as well as to our defence and security.

*Order* 3.—Of all the different Orders of the present Class, or indeed of all the Classes of animals, none are of so much importance to their Lord as the *Ruminants*, which we are next to consider; without them, hunger, cold, and nakedness would beset him, or, at least, a large portion of his comforts, with respect to articles of food and clothing, must be cut off.

Cuvier divides this great Order into those that have horns, and those that have none, and we may here adopt his division, considering these two sections as forming two Sub-orders. The first of them, being the beasts of burthen of more than one nation, may be regarded as succeeding the solipeds; these are the camels and dromedaries, the lamas; and perhaps what is called the musk-deer, also wanting horns, may be placed amongst them. So that we have thus before us animals that may be regarded as looking towards the Solipeds, in the *camel* genus; towards the sheep by its fleece, in the *lama;* and towards the antelope tribes in the *musk*.

All the other Ruminants, the males at least, are armed with two horns, either simple or branching; either hollow, or solid; either persistent or deciduous. I feel disposed to consider the giraffe, or camelopard, as an intermediate form between the animals that are horned, and those without horns, for its short,

persistent, solid horns, clothed with a velvet skin, seem almost rudimentary. It may be regarded as connecting, in some degree, the long necked animals, the camel and lama, &c. with the deer tribe.

These last, the most elegant and airy, both in form and limb and motions, of the whole class, placed in contrast with the clumsiness and bulk of the Pachyderms, seem intended as one of the principal ornaments of the globe we inhabit, and originally to be amongst the peculiar favourites of its king and master man. Now, instead of the innocuous animals, he takes into his alliance, as his most intimate associates, those that are best fitted to pursue and destroy, as the dog, and the cheetah; and thus with the help of the horse, he overtakes these beautiful creatures, and, instead of caresses, they receive death at his hands.

The head of these animals, in some, as the rein-deer,[1] in both sexes, but generally only in the males, is ornamented, as it were, with a branching forest,[2] formed by its antlers, or horns, which are solid, covered, as in the camelopard, with a velvet skin, but only during the period of growth, and annually deciduous; these are used by the males in their mutual combats. Amongst these light and airy animals, however, some of a larger and more robust stature are thus fitted for the use of man, as the rein-deer. The elk, or moose,[3] the wapiti,[4] and red deers, emulate the horse in size, and are of great strength, though not yet employed by man.[5] Lastly, come the Ruminants, whose horns are hollow and naked, but persistent. To these belong the Antelopes, one species of which has four horns,[6] the goats, the sheep, and the bovine tribes. The species of the two last of these great families are particularly important to man, and are generally so well known as not to require to be treated of in detail. The bison,[7] with his shaggy mane, presents no slight analogy to the lion, the so called king of beasts; and the gnu, reckoned amongst the antelopes, seems to combine characters borrowed from the ox and the horse.

The function of this great Order of Ruminants, is not only to browse the herbage, and provide, by constantly trimming, and as it were mowing it, for its renewed verdure; many of them are employed also in pruning the trees, by feeding upon their branches; and there is not one that, in its place, does not contribute its part to the general welfare. The cattle *on a*

1 *Cervus Tarandus.* 2 French. *Bois.* 3 *C. alces.*
4 *C. strongyloceras.* 5 See above, p. 285.
6 *A. Chickara.* 7 *Bos Urus.*

*thousand hills* are distributed by their Great Creator according to certain laws, and by their actions in their several spheres, to promote certain ends, which neglected, or imperfectly provided for, would produce derangements that might affect a wide circumference.

*Order* 4.—Having, in a former part of the present volume, given an account of the principal tribes of this Order, I need not here do more than mention it, except by observing, that the members of it are principally inhabitants of the *new* world, the *Manis* and *Orycteropus*, being the only genera it contains that are found in the *old.*

*Order* 5.—The animals included in the Order of *Rodents*, or gnawers and nibblers, as I have before observed,[1] seem to occupy the same station amongst the Mammalians, that the *Hymenoptera* do amongst Insects, since they are the most remarkable of any for the arts which Providence has instructed them to exercise. This, as well as the preceding Order, seems very slightly connected with the great tribe of Ruminants: the Patagonian hare,[2] however, of the Pampas, belonging to the Rodents, seems, in its light and elegant form, to make the nearest approximation to that tribe.

Several of the animals of the Order before us copy the members of the class of insects in one of their most remarkable peculiarities; during the cold or winter season, they become torpid. This is the case with the dormouse,[3] the marmots,[4] the prarie-dog,[5] and many other Rodents, as well as with many predaceous Mammalians, especially the insectivorous ones, as the hedge-hogs.[6] The mole, and the bats, and even some of the largest animals, as the bear, are subject to the same law. When we consider the case of the insectivorous animals of the present class, we see at once the wisdom and goodness of the Lawgiver in this enactment. The reduction of the temperature, and other causes, have driven the insects from the theatre they usually frequent, to remain for a time without motion under the earth and other places of security, where they are safe from these their enemies; it was, therefore a kind and wise provision, that as their accustomed food was beyond their reach, they themselves should also be placed in a state not to require it. Many other animals amongst the Rodents, though they do not pass the winter in a state of absolute torpidity,

1 See above, p. 299.
2 *Cavia patagonica.*
3 *Myoxus avellanarius.*
4 *Arctomys.*
5 *Spermophilus ludovicianus. Faun. Boreal. Americ.* i. 156.
6 *Erinaceus.*

retreat to what may be called their winter quarters, in which they have laid up a store of provisions against the evil days of winter. Of this description are many of the *murine* tribes, particularly the *hamster*,[1] which is furnished with a pouch on each side of its mouth, that it fills with grain to deposit in its burrow, for a winter store. Some will thus carry as much as three ounces at a time. The lemmings[2] also, whose destructive ravages I have before noticed,[3] especially that called the *economist*,[4] have similar habits, storing up roots instead of grain.

Generally speaking, it is the lowering of the temperature that induces Mammalians, as well as cold-blooded animals, to hybernate, and brings on a state of torpidity, or a cessation of the usual stimulus to locomotion and action: in which state, Mr Owen remarks, *warm-blooded* animals become, as it were, *cold-blooded*. As a watch not wound up remains without motion, still retaining the power of resuming it, and when the mainspring recovers its elasticity is again enabled to act upon its wheels: so to animals *heat* is the key that winds up the wheels, and restores to the mainspring its power of reaction. Hybernating animals have supernumerary cells, and generally become very fat in autumn, and it has been said that this fat supports them in their torpid state; it is found, however, that there has been but little of it consumed during the state of torpidity, but that it wastes very fast immediately after that state is ended. The Indians remark, with respect to the black bear, that it comes out in the spring with the same fat which it carries in in the autumn; but after the exercise of only a few days it becomes lean.[5] A state of periodical rest may be necessary to the animals we are speaking of, not only as a means of protection from the effects of a low temperature, and on account of the impossibility of procuring their usual means of subsistence; but since alternate rest and action are necessary to most animals, so a longer period of sleep may be required in some cases, by such cessation of action to keep the machine from wearing out too soon. Excess of heat we know produces the same effect as excess of cold, it disposes to sleep.[6] The tenrec,[7] a Madagascar animal, and the jerboa, fall into a kind of summer lethargy from that cause, which lasts some months.[8]

From the numerous instances of remarkable instincts exhi-

1 *Cricetus.*
2 *Arvicola. Lemmus.*
3 See above, p. 49.
4 *L. œconomus.*
5 *Fn. Boreal. Americ.* i. 20.
6 *N. D. D'H. N.* xxxi. 387—390.
7 *Setiger.*
8 *N. D. D'H. N.* xxxiii. 53.

bited by the animals of this Order, which might be selected, I must confine myself to one or two of the most singular. The hare is only noticed for its extreme timidy and watchfulness, and the rabbit for the burrows which it excavates for its own habitation, and as a nest for its young: but there is an animal related to them, the *rat-hare*,[1] which is gifted by its creator with a very singular instinct, on account of which it ought rather to be called the *hay-maker*, since man may or might have learned that part of the business of the agriculturist, which consists in providing a store of winter provender for his cattle, from this industrious animal. Professor Pallas was the first who described the quadruped exercising this remarkable function and gave an account of it. The Tungusians, who inhabit the country beyond the lake of Baikal, call it Pika, which has been adopted as its Trivial name.

These animals make their abode between the rocks, and during the summer employ themselves in making hay for a winter store. Inhabiting the most northern districts of the old world, the chain of Altaic Mountains, extending from Siberia to the confines of Asia and Kamtschatka,[2] they never appear in the plains, or in places exposed to observation; but always select the rudest and most elevated spots, and often the centre of the most gloomy, and at the same time humid forests, where the herbage is fresh and abundant. They generally hollow out their burrows between the stones and in the clefts of the rocks, and sometimes in the holes of trees. Sometimes they live in solitude and sometimes in small societies, according to the nature of the mountains they inhabit.

About the middle of the month of August these little animals collect with admirable precaution their winter's provender, which is formed of select herbs, which they bring near their habitation and spread out to dry like hay. In September, they form heaps or stacks of the fodder they have collected under the rocks or in other places sheltered from the rain or snow. Where many of them have laboured together their stacks are sometimes as high as a man, and more than eight feet in diameter. A subterranean gallery leads from the burrow, below the mass of hay, so that neither frost nor snow can intercept their communication with it. Pallas had the patience to examine their provision of hay piece by piece, and found it to consist chiefly of the choicest grasses, and the sweetest herbs,

1 *Lagomys.*

2 Mr Daines Barrington presented to the Royal Society an animal resembling the Pika found in Scotland, but probably a different species.

all cut when most vigorous, and dried so slowly as to form a green and succulent fodder; he found in it scarcely any ears, or blossoms, or hard and woody stems, but some mixture of bitter herbs, probably useful to render the rest more wholesome. These stacks of excellent forage are sought out by the sable-hunters to feed their harassed horses, and the (Jakutes) natives of that part of Siberia, pilfer them, if I may so call it, for the subsistence of their cattle. Instead of imitating the foresight and industry of the Pika, they rob it of its means of support, and so devote the animals that set them so good an example to famine and death.[1] How much better would it be if instead of robbing and starving these interesting animals, they learned from them to provide in the proper season a supply of hay for the winter provender of their horses.

But no animals in this, or indeed any other Order of Mammalians, are so admirable for their instincts and their results as the *beavers*.

I have more than once alluded to some proceedings of these, seemingly, half-reasoning animals, and shall now as briefly as possible give some account of those fabrics in which their wonderful instinct is principally manifested. There are two writers who had great opportunities of gaining information concerning them; Samuel Hearne, during his journey to the Northern Ocean, in the years 1769, 1770, 1771, and 1772; and Captain Cartwright, who resided nearly sixteen years on the coast of Labrador. To them I am principally indebted for the particulars of the history here given.

From the breaking up of the frost to the fall of the leaf, the beavers desert their lodges, and roam about unhoused, and unoccupied by their usual labours, except that they have the foresight to begin felling their timber early in the summer. They set about building some time in the month of August. Those that erect their habitations in small rivers or creeks, in which the water is liable to be drained off, with wonderful sagacity provide against that evil by forming a dike across the stream, almost straight where the current is weak, but where it is more rapid, curving more or less, with the convex side opposed to the stream. They construct these dikes or dams of the same materials as they do their lodges, namely, of pieces of wood of any kind, of stones, mud, and sand. These causeways oppose a sufficient barrier to the force, both of water and ice; and as the willows, poplars, &c. employed in constructing them, often strike root in it, it becomes in time a green hedge,

1 *N. D. D'H. N.* xxvi. 407—410.

in which the birds build their nests. Cartwright says that he occasionally used them as bridges, but as they are level with the water, not without wetting his feet. By means of these erections the water is kept at a sufficient height, for it is absolutely necessary that there should be at least three feet of water above the extremity of the entry into their lodges, without which, in the hard frosts, it would be entirely closed. This entry is not on the land side, because such an opening might let in the wolverene, and other fierce beasts, but towards the water.

Cuvier, in his table above alluded to,[1] assigns only *four* pectoral teats to the female beaver; but Dr Richardson states that she has *eight*, and the maxium of her young ones at eight or nine.[2] The number inhabiting one lodge seldom exceeds four old and six or eight young ones; the size of their houses, therefore, is regulated by the number of the family. Though built of the same materials, they are of much ruder structure than their causeways, and the only object of their erection appears to be a dry apartment to repose in, and where they can eat the food they occasionally get out of the water. It frequently happens, says Hearne, that some of the large houses have one or more partitions, but these are merely part of the building left to support the roof. He had seen one beaver lodge that had nearly a dozen apartments under the same roof, and, two or three excepted, none had any communication but by water. Cartwright says, that when they build, their first step is to make choice of a nutural basin, of a certain depth, near the bank where there is no rock; they then begin to excavate under water, at the base of the bank, which they enlarge upwards gradually, and so as to form a declivity, till they reach the surface; and of the earth which comes out of this cavity they form a hillock, with which they mix small pieces of wood, and even stones: they give this hillock the form of a dome, from four to seven feet high, from ten to twelve long, and from eight to nine wide. As they proceed in heightening, they hollow it out below, so as to form the lodge which is to receive the family. At the anterior part of this dwelling, they form a gentle declivity terminating at the water; so that they enter and go out under water. The hunters name this entrance the *angle*. The interior forms only a single chamber resembling an oven. At a little distance is the magazine for provisions. Here they keep in store the roots of the yellow water-lily, and the branches of the black spruce,[3] the

1 See above, p. 442.

2 *Fn. Boreal. Amer.* i. p. 107.

3 *Abies nigra.*

aspin,[1] and birch,[2] which they are careful to plant in the mud. These form their subsistence. Their magazines sometimes contain a cart-load of these articles, and the beavers are so industrious, that they are always adding to their store.

There is a species of beaver found in the great rivers in Europe—the Danube, the Rhine, the Rhone, and the Weser, which has been regarded as synonymous with the beaver of Canada, but which, though it forms burrows or holes in the banks of those rivers which it frequents, does not, like them, erect any lodges, as above described. Does this instinct sleep in them, and require a certain degree of cold to awaken it, or are they a distinct species? Linné mentions one in Lapland, where the cold is sufficiently intense. Cuvier seems uncertain whether they ought to be considered as distinct. Beavers seem formerly to have existed in England; the town of Beverley (*Beaver-field*), in Yorkshire, seems to have taken its name from them, and its arms are three beavers.

Such are the principal operations that these wonderful animals, probably by the mixture of intellect with instinct, are instructed and adapted by their Creator to execute, that man, by studying them and their ways, may acknowledge the Power, Wisdom, and Goodness that formed and guides them.

The functions of the numerous tribes of this Order are various. The great majority may be said to be granivorous, or nucivorous, or even graminivorous; but many live upon dried vegetable substances, and wood. The *aye aye*, which approaches the Quadrumanes, appears to be insectivorous. Though many of them are great plagues to man, yet, by exciting his vigilance, they are useful to him, and they form the food of many of the lesser predaceous animals.

*Order* 6.—The connection between the animals of which this Order consists, and the Rodents, seems not easily made out. The lowest tribe, the Amphibians, which Cuvier has placed immediately before the Marsupians, appears to have no connection with that Order, or any of the Rodents; and the morse, which forms his last genus of the tribe in question, appears evidently to look more towards the herbivorous cetaceans, the manatee,[3] &c. than to any other animals; the seals, indeed, may be regarded as tending towards the feline tribe. Amongst the other Predaceans, the hedgehog and tenrec present, I apprehend, something more than an analogy to the

1 *Populus tremula.* 2 *Betula alba.* 3 *Cheiromys.*

porcupines and some of the rats. The bear seems to look towards the sloth; and the feline race, in their whiskers and feet, look to the hares and rats.

The general functions of this Order are to check the tendency to increase not only in their own Class, the Mammalians, but in most of the other Classes of animals, more particularly those which man has taken into alliance with him, as cattle, and poultry, and game of every description. But where his action is greatest, theirs is usually least; and the most powerful devastators of the animal kinkdom, the lions and the tigers, are found in the warmest climates, where nature is most prolific, and where man has not fully established his dominion, in the trackless and burning deserts of Libya, and in the impenetrable forests and jungles of India.

In more northern regions, the bears, the foxes, and other Mammalians, are employed in this department, though the former also eat roots and other vegetable substances,[1] and thus in the wild countries of the north supply the place of man, and keep the animal population under, and at a certain level, so that one may not encroach upon another. If the matter is closely investigated, we shall find that God has distributed and divided these predaceous animals to every country, in measure and momentum, as every one had need.

The necrophagous Mammalians[2] also, or those that devour dead carcasses, such as the hyænas, dogs, and similar animals, are equally useful in removing infectious substances, which in hot climates soon generate disease, and are always disgusting objects, and exercise a very important and beneficial function, devolved upon them by their Creator; for if all the animals exercising this function were removed from the earth, it would soon be depopulated, and a universal pestilence would destroy man, and all his subject animals.

*Order* 7.—The animals of this Order, though evidently leading towards the Quadrumanes, seems less nearly connected with the insectivorous Predaceans of Cuvier, the hedgehog, mole, &c., and to approach nearer to some Marsupians, as the flying squirrel and the flying opossum. I therefore consider them as forming an Osculant Order, distinguished by their powers and organs of flight before sufficiently noticed.[3] They are nocturnal animals, and live entirely upon insects. In the winter, they become torpid, and suspend themselves by the

1 *Fn. Boreal. Americ.* i. 15, 23, 28.
2 *Carnivora.* Cuv.
3 See above, p. 272.

claw of the thumb of the fore-foot, which is left free for this and other purposes.

*Order* 8.—Linné evidently degraded *man* when he placed him in the same Order with the *monkey*, and even considered his genus *Homo* as consisting of two species, advancing the Ouran Outan[1] to the honour of being his congener, and a second species of man. Cuvier has, with great propriety, separated man, the heir of immortality, and *whose spirit goeth upward*, from the beast that perisheth, and *whose spirit goeth downward*,[2] and placed them in different Orders. Man has employed some animals in almost every Order, or taken them under his care; but there is only a single instance of a Quadrumane being so used. There is a kind of monkey,[3] a native of Madagascar, which, being of a gentle disposition, the natives of the southern part of that island take when they are young, and educate, as we do hounds, for the chase.[4]

The principal function of these animals is to live and move in the trees, amongst the branches in tropical countries, and they subsist upon fruits, roots, the eggs of birds, and insects. One object of their creation seems to be to hold the mirror to man, that he may see how ugly and disgusting an object he becomes when he gives himself up to vice and the slave of his passions. In fact, in every department of the animal kingdom, the moral instruction of his reasonable creature seems to have been one of the objects of Creative Wisdom: and the sloth and the glutton may be added to the mandril and baboon as equally calculated to cause him to view vice with disgust and abhorrence; as the bee, the ant, and the beaver, to excite him to industry, and prudence, and foresight; or the dove to peace and mutual love.

1 Written also *Ourang Outang*, and *Orang Otang*.

2 Eccles. iii. 21.

3 *Indris brevicaudatus.*

4 *N. D. D'H. N*. xvi. 171.

## CHAPTER XXV.

### *Functions and Instincts. Man.*

After traversing the whole Animal Kingdom from its very lowest grades, and having arrived at Man, who confessedly stands at the head, and is the only *visible* king and lord of all the rest, it will be expected that I should devote a few pages to the world's master.

Baron Cuvier, with great propriety, places him by himself in a separate Order, distinguished from that which succeeds it, in his system, by the significant appellation of *Bimane*, indicating that his two hands are the instruments by which he subdues and governs the planet that he inhabits;[1] by which also he is enabled to embody his conceptions, and, as it were, to convert his thoughts into material subsistences.

I shall consider him both physically and metaphysically; physically, as to his actual *position*, and as to his *action* upon his subjects and property, whether vegetable or animal; and metaphysically as to his connection with that world, to which his mind or spirit belongs. When I say that Man stands at the *head* of the creation, I do not mean to affirm that he combines in himself every physical attribute in perfection that is found in all the animals below him; for it is manifest to every one, that many of them far exceed him in the perfection of many of their organs, and in their qualities of various kinds. For *sight*, he cannot compete with the *eagle;* for *scent*, with the *hound*, or the *shark;* for *swiftness*, with the *roe-buck;* for strength and bulk, with the *elephant:* but it is in his *mind* that his superiority lies. There is in him a spirit, an immaterial substance which constitutes him the sole representative here on earth, of the spirit of spirits. He is the only member of the Animal Kingdom that partakes both of a heavenly and of an earthly nature,—that belongs both to a material and an immaterial world: and on this account it was that God, when he had created man, constituted him king over the whole

1 See above, p. 302.

sphere of animals with which he had peopled this globe that we inhabit. When his unhappy *fall* took place, the Divine Image was impaired, and consequently the dominion over those creatures, which formed a part of it, was proportionably weakened, and reduced to its present standard. But still, though weakened, it is not abrogated; his subjects have not universally broken the yoke and burst the bonds of his dominion—a large portion of them still acknowledge him as their king and master; and those that he has not subdued so as to make them do his bidding, still fear him and flee him: and even of these, there is none so fierce and intractable, that he has not found means to tame and subdue. And this is the position in which he now stands with respect to the animal kingdom; he has that within him that enables him to master them, and apply such of them as are of a convertible nature, if I may so speak, to work his will and answer his purpose.

The functions of man, with regard to the world in which he is now placed, are all included in his *action* upon the sphere of animals and vegetables, and in their *re-action* upon him. If we survey all nature, wherever we turn our eyes, or wherever we direct our thoughts, we see the action of antagonist powers, a flux and reflux, by which the Great Builder of the universe supports the vast machine, and maintains all the motions that he has generated in it. The same principle is at work in every description of beings in our own planet; every action of man upon any object of the world, without him, produces a reaction from that object, attended often by important results.

The action of man upon the world without him, is *threefold.* His *first* action upon them is, that of the mind to contemplate them, so as to gain a knowledge of their forms and structure—of their habits and instincts—of their meaning and uses. His *second* action upon them, having studied their natures, and discovered how they may be made profitable to him, is to collect and multiply such species as he finds will, in any way, answer his purpose. His *third* action upon them is to diminish and keep within due limits those species that experience teaches him are noxious and prejudicial either to himself, or those animals that he has taken into alliance with him, which are principal sources of wealth to him, and minister to his daily use, comfort, and enjoyment.

If we consider the predaceous animals, we shall find in them a greater tendency to multiply than in those that content themselves with grazing the herbage; they generally produce more young at a birth; and their period of gestation is often shorter, so as to admit of more than one litter in the year; so that, un-

less some means were used to reduce their numbers within a certain limit, the whole race of herbivorous animals must perish. Hence arose the first kind of *war*. Man armed himself to destroy such of his subjects as had rejected his dominion, and even contended with him for the possession of the earth, and to have license to devour at will its more peaceful inhabitants. A similar cause generated the other and more fearful kind of war, of man with man. *Whence come wars and fightings amongst you,* saith the Apostle ;[1] *come they not hence, even of your lusts that war in your members?*

The highest view that we can take of man is that which looks upon him as belonging to a spiritual as well as a material world. The end of the creation of the earth, says the father and founder of Natural History, is the glory of God, from the works of nature, by man only.[2] And, as the same pious author observes, "How contemptible is man," if he does not aim at this end of his creation, if he does not strive to raise himself above the low pursuits that usually occupy his mind![3] The heavens indeed declare the glory of God, and the firmament showeth the work of his hands. Day unto day uttereth speech, and night unto night showeth knowledge.[4] The beasts of the field honour him, and all creatures that he hath made glorify him. But man must study the book open before him ; and the more he studies it, the more audible to him will be the general voice to his spiritual ear, and he will clearly perceive that every created thing glorifies God in its place, by fulfilling his will, and the great purpose of his providence ; but that he himself alone can give a tongue to every creature, and pronounce for all a general doxology.

But further, in contemplating them, he will not only behold the glory of the Godhead reflected, but, from their several instincts and characters, he may derive much spiritual instruction. Whoever surveys the three kingdoms of nature with any attention, will discover in every department objects that, without any affinity, appear to represent each other. Thus we have minerals that, under certain circumstances, as it were, vegetate, and shoot into various forms, representing trees and plants : there are plants that represent insects, and, vice versa, insects that simulate plants ; and the Zoophytes have received their name from this resemblance.[5] And as we ascend the

1 James, iv. 1.

2 *Finis creationis telluris est gloria Dei exopere naturæ per hominem solum.* Linn. *Syst. Nat.* i. *Introit.* i.

3 *O quam contempta res est homo nisi supra humana se erexerit. Ibid.*

4 Ps. xix. 1, 2.

5 See above, pp. 80, 84, 90.

scale, every where a series of references of one thing to another may be traced, so as to render it very probable that every created thing has its representative somewhere in nature. Nor is this resemblance confined to *forms;* it extends also to *character.* If we begin at the bottom of the scale, and ascend up to man, we shall find *two* descriptions in almost every class, and even tribe of animals: one, ferocious in their aspect, often rapid in their motions, predaceous in their habits, preying upon their fellows, and living by rapine and bloodshed; while the other is quiet and harmless, making no attacks, shedding no blood, and subsisting mostly on a vegetable diet.

Since God created nothing in vain, we may rest assured that this system of *representation* was established with a particular view. The most common mode of instruction is placing certain signs or symbols before the eye of the learner, which represent sounds or ideas; and so the great Instructor of man placed this world before him as an open though mystical book, in which the different objects were the letters and words of a language, from the study of which he might gain wisdom of various kinds, and be instructed in such truths relating to that spiritual world, to which his soul belonged, as God saw fit thus to reveal to him. In the first place, by observing that one object in nature represented another, he would be taught that all things are significant, as well as intended to act a certain part in the general drama; and further, as he proceeded to trace the analogies of character, in its two great branches just alluded to upwards, he would be led to the knowledge of the doctrine thus symbolically revealed—that in the invisible world there are two classes of spirits—one benevolent and beneficent, and the other malevolent and mischievous; characters, which, after his fall, he would find even exemplified in individuals of his own species.

But after the unhappy fall of man, this mode of instruction by natural and other objects used symbolically, though it pervades the whole law of Moses, and the writings of the prophets, as well as several parts of the New Testament, gradually gave place to the clearer light of a Revelation, not by symbols, but by the words and language of man, which *he that runs may* often *read;* yet still it is a very useful and interesting study, and belongs to man as the principal inhabitant of a world stored with symbols, to ascertain what God intended to signify by the objects that he has created and placed before him, as well as to know their natures and uses. When we recollect what the Apostle tells us, that *the invisible things* of God *from the creation of the world are clearly seen, being understood by the things*

*that are made*,[1] and that spiritual truths are reflected as by a mirror, and shown, as it were, enigmatically,[2] we shall be convinced that, in this view, the study of nature, if properly conducted, may be made of the first importance.

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In this enumeration and history of the principal tribes of the Animal Kingdom, we have traced in every page the footsteps of infinite Wisdom, Power, and Goodness. In our ascent from the most minute and least animated parts of that Kingdom to man himself, we have seen in every department that nothing was left to chance, or the rule of circumstances, but every thing was adapted by its structure and organization for the situation in which it was to be placed, and the functions it was to discharge; that though every being, or group of beings, had separate interests, and wants, all were made to subserve to a common purpose, and to promote a common object; and that though there was a general and unceasing conflict between the members of this sphere of beings, introducing apparently death and destruction into every part of it, yet that by this great mass of seeming evil pervading the whole circuit of the animal creation, the renewed health and vigour of the entire system was maintained. A part suffers for the benefit and salvation of the whole; so that the doctrine of the suffering of one creature, by the will of God, being necessary to promote the welfare of another, is irrefragably established by every thing we see in nature; and further, that there is an unseen hand directing all to accomplish this great object, and taking care that the destruction shall in no case exceed the necessity. Well, then, may all finally exclaim, in the words of the Divine Psalmist:—

*O Lord, how manifold are thy works, in WISDOM hast thou made them all; the earth is full of thy riches.*

*So is the great and wide sea also, wherein are things creeping innumerable both small and great beasts.*

*These wait all upon thee: that thou mayest give them meat in due season.*

*When thou givest them they gather it: and when thou openest thy hand they are filled with good.*

*When thou hidest thy face they are troubled: when thou takest away their breath they die, and are turned again to their dust.*

*When thou lettest thy breath go forth they shall be made: and thou shalt renew the face of the earth.*

1 *Rom.* i. 20. 2 1 *Cor.* xiii. 12.

# APPENDIX.

Since the preceding part of this treatise had mostly passed through the press, I have had an opportunity of consulting some recently published works, which contain accounts, illustrated by figures, of many very interesting animals belonging to several of the Classes of which I have there treated; and all of which more or less demonstrate a presiding Intelligence immediately connected with the globe that we inhabit, and who, viewed under every aspect, evidently careth for us, and all the creatures he has made. I shall select a few of these for the consideration of the reader.

I formerly observed[1] that types representing some of the higher forms of the animal kingdom were often to be detected amongst those belonging to its lowest grade: a remarkable instance of this may be seen in one of Ehrenberg's late works,[2] in which is described and figured a singular Polygastric Infusory, which seems to exhibit the first outline of an Arachnidan[3] form; it has eight locomotive organs or bristles, representing the eight legs of those animals.[4] By means of these organs, this animal, which was found by Dr Ehrenberg in the Red Sea, performs a double rotatory movement, one by the rotation of the anterior pair, and the other by the three posterior pairs. The motion of these filamentous legs is so rapid that they appear as if, instead of eight, a hundred were revolving, and so form a kind of natural Phantasmascope. Another infusory genus, *Bacillaria*, seems to prefigure the *Salpes*,[5] the species at first being concatenated in chains or ribands, and afterwards separating.[6] The animalcules forming this genus have sometimes been mistaken for plants, and the quadrangular form of the associated individuals gives them the appearance of the jointed stem of a plant, rather than of an animal chain. On a former occasion, I alluded to other imitations of the vegetable world

1 See above, p. 358.
2 *Symbolæ Physicæ.*
3 *Discocephalus Rotator.*
4 Plate I. A. Fig. 6.
5 See above, p. 307.
6 Plate I. A. Fig. 4, 5.

exhibited by the polypes, particularly to some of them producing seeming blossoms, consisting, as it were, of *many* petals.[1] I shall now notice some that represent *monopetalous* flowers. A genus long known to naturalists, which seems intermediate between the Infusories and the Polypes, named originally by Linné *Vorticella*, exactly simulates a bell flower with a spiral footstalk. They are often found in fresh water, and present no unapt representation of a bunch of the flowers of the Lily of the valley, whence one species has been named *Vorticella Convallaria.* Some of these have branching, and others simple stems,[2] but they are all spiral, and capable of being lengthened or shortened at the will of the animal, which is thus enabled to elevate or depress its little blossoms, the mouths of which are furnished with a double circlet of filamentary tentacles, by the rotation of wnich, like the rest of its tribe, it can produce a food-conveying current to its mouth. Still nearer to the Polypes, with which indeed it is arranged, is another genus representing monopetalous flowers, named by Ehrenberg, who found it in the Red sea, *Zoobotryon*, or *Animal-grape.* This singular animal production will scarcely arrange under any of the Orders mentioned on a former occasion, but it may be regarded as intermediate between the Rotatories and the Polypes. Like the latter it is a compound animal, consisting of a naked branching stem; its lower extremity, as may be seen in the figure,[3] appears as if sending forth numerous little radicles, and the branches terminate in ovate germs, from which issue a multitude of animalcules resembling monopetalous bell-shaped flowers, with the mouth surrounded by a filamentous coronet, each sitting upon a spiral elastic footstalk, by means of which the animalcule can either draw itself close to the stem, or, shooting out, dart on either side after its prey. When the mouth of every individual is open, each germ looks like what botanists call a *raceme* of bell-shaped flowers; and, when they are closed, they resemble a bunch of grapes.[4]

To the class of *Worms*, especially those that have been denominated *Entozoa*, or internal worms, I have a few interesting additions to make, taken from a work of Dr Nordmann's,[5] some of which are so extraordinary and wonderful, both as to their functions and structure, that the great object of the present

1 See above, p. 279.
2 *Ibid.* 277.
3 Plate I. B. Fig. 2. *a.*
4 *Ibid. b.*
5 *Micrographische Beiträge*, &c.

treatise, *Gloria Dei ex opere naturæ*, will receive considerable illustration from some account of them.

Dr Nordmann's first treatise is upon a tribe of these creatures that are interesting from their very singular situation, in the *Eyes*, namely, of the higher animals.

Amongst the personal pests of our own species, enumerated in the chapter above alluded to,[1] I mentioned none that attacked the organs just named; but this learned investigator of parasitic worms has noticed two which have been detected in them; one related to the *Guinea-worm*,[2] which was extracted from the eye of a person affected by a cataract;[3] and another, a *Hydatid*,[4] from the eye of a young woman.

Besides those that infest our own visual organs, quadrupeds, birds, reptiles, and fishes, have each their *eye-worms*. Amongst those to which the will of Providence has assigned their station in the eyes of the latter class of animals, is a remarkable one,[5] which Dr Nordmann discovered in those of several different species of *perch*,[6] sometimes, in such numbers, as must have interfered with that distinct sight of passing objects, which appears necsesary to enable predaceous animals to discover their prey in time to dart upon it and secure it; in a single eye the Doctor detected, in different parts, 360! of these animalcules: when much increased they often produce cataracts in the eye of the fishes they infest. This little animal appears something related to the *Planaria*, or pseudo-leech, and, to judge from Dr Nordmann's figures, seems able, like it, to change its form[7]. Underneath the body, at the anterior extremity, is the mouth; and in the middle are what he denominates two sucking-cups;[8] these are prominent, and viewed laterally form a truncated cone; the anterior one is the smallest and least prominent, and more properly a sucker; the other probably has other functions, since he could never ascertain that it was used for prehension.

A kind of *metamorphosis* seems to take place in these animals, for our author observed that they appeared under *three* different forms.

These little pests, small as they are, have a parasite of their own to avenge the cause of the perch, for Dr Nordmann observed some very minute brown dots or capsules attached to the intestinal canal, which when extracted, by means of a

1 See above, p. 360.
2 *Filaria medinensis.*
3 *F. Oculi humani.*
4 *Cysticercus cellulosæ.*
5 *Diplostomum volvens*, PLATE I. B. FIG. 5.
6 *Ibid.* FIG. 6.
7 See Nordmann's *Micrograph*, i. *t.* ii. *f.* 1—9.
8 Saugnäpfe.

scalpel formed of the thorns of the creeping cereus,[1] and laid upon a piece of talc, the membrane that inclosed them burst, and forth issued living animalcules, belonging to the genus *Monas*, and smaller than *M. Atomus*, which immediately turned round upon their own axis with great velocity, and then jumped a certain distance in a straight line, when they again revolved, and again took a second leap.

Looking over our author's list of eye-worms that infest fishes, we find that five out of seven are attached to different species of perch, and one cannot help feeling some commiseration for these poor animals; but when we recollect that they form the most numerous body of predaceous fishes in our rivers, we may conjecture that thus their organs of vision are rendered less acute, and that thus thousands of roach, dace, carp, and tench may escape destruction. The ever watchful eye of a Father Providence is over all his works, and he has provided means, in every department of the animal kingdom, so to limit the inroads of the predaceous species, that a due proportion and harmonious mixture may every where be maintained, and that with respect to every individual species. The means are various, but the end is one; and the partial evil terminates in the general good and welfare of the whole.

Next to the *eyes*, the *gills* of fishes are subject to annoyance from internal worms; and amongst these there is none more remarkable or wonderful than one first discovered by Dr Nordmann, upon those of the *bream*,[2] and to which, on account of its remarkable structure and conformation, he has given the name of *Diplozoon*, or *Double animal*. In the Classes of Polypes and Tunicaries we have been introduced to many animals that appear to be compound; which, from a common stem or body send forth numerous *oscula* or mouths, in this emulating the members of the vegetable kingdom: but amongst all these plant-animals,[3] there is none can compete with this of Dr Nordmann, which, like the Siamese youths, appears to be formed of two distinct bodies, united in the middle so as to present the appearance of a St Andrew's cross, each half of the animal containing precisely the same organs; namely, an alimentary canal, a system for circulation and generation, and also a nervous system. Müller calls the innumerable and varying cohorts of the animal creation *preachers* of the infinite wisdom and power of the Sovereign of the world;[4] and this is

1 *Cactus flagelliformis.*
2 *Cyprinus Brama.*
3 *Phytozoa.*
4 *Entomostraca.*

one of the most wonderful of them all, which singularly exemplifies those attributes.

At first it might be imagined, that, like the youths just alluded to, this was a monstrous production of nature ; but Dr Nordmann relates that he has found *thirty* specimens, precisely agreeing with each other, all in a similar situation, attached namely, to the gills of the fish mentioned above, and he never found it single, or in any other situation : there can, therefore, remain no doubt on the subject. In order to find these animals, it is necessary to examine all the leaves of the gills separately under water, or to separate the lesser whitish ones with a pointed instrument, when the animal may be detected by its movements : its station is between the leaves or folds of the inner gills.

This singular creature consists of two lobes, or arms, above the point of union, and two below it. The upper pair are the longest and most divergent : they are somewhat lance-shaped, and at the extremity of each, on the under side, is a mouth, with a sucker, divided by a fleshy transverse septum ; by means of these suckers, the mouths of this two-bodied monster are kept steady, so as to suck without intermission. The orifice of the mouth is large, and, when fully open, triangular : there is also an organ within the gullet which seems analogous to a tongue, resembling the sucking organ of the pseudo-leech. The alimentary canal branches out on both sides into numerous blind vessels. The whole of this canal, like the creature itself, is cruciform. The circulation of the blood is very visible : each half of the animal has on both sides two principal blood vessels, which are every where of almost equal diameter, without any enlargement ; in the two exterior ones the blood runs upwards, and in the two interior ones downwards, and its motion is extremely rapid. The generative organs and ovaries are also double. The feces, as in the polypes and other lower animals, pass out at the mouth. The two lowest lobes are somewhat club-shaped, or thickest at the extremity, towards which, in each, are two oval plates, or disks, containimg four oblong *acetabula*, or suckers : the bodies below the plates terminate in a triangular piece, or flapper. In some of their movements it seems as if the two upper lobes had different *wills*, since sometimes one appears inclined to move to the right, and the other to the left, or one to move and the other to remain at rest ; but the lower lobes always move simultaneously, either inwardly or outwardly.

The animals that are found attached to the gills of other fishes are usually at their lower extremity furnished with sev-

eral suckers; thus one genus[1] infesting the gills of the sun[2] and sword fishes[3] has *three;* and another,[4] found in those of the tunny,[5] has *six*, whence Cuvier would rather call it *Hexastoma.* But these are nothing to those of our *Diplozoon,* which, on the four disks just named, has no less than *sixteen* suckers, four on each disk.[6] Under a strong magnifier, these suckers when opened, for they can open and shut, exhibit a complex machinery of hooks and other parts, by which their Creator has enabled them to take firm hold of the gills, so as not to be unfixed by their constant motion in respiration, especially when we consider their structure and substance. A further proof of this *design* is furnished by the form of the animal itself, for the body being divided upwards and downwards into two diverging lobes, it can fix itself at each extremity more firmly than if it was single, not only by having more points of attachment, but also by the divergement of its lobes, especially the lower ones. When a man wishes to stand as firmly and steadily as possible, he separates his legs so as to form a certain angle: and this is what its Creator has fitted our animal to do; and so by all these means it maintains its station on the lubricous, multifid, and constantly moving organs, from which it is commissioned to suck the blood. Probably these Diplozoons may be of the same use to the fishes they infest, as the horse-flies are to the animal from which they take their name.

Dr Nordmann found this creature could exist submerged for three days, during which period its movements became gradually more feeble. One specimen, which he fed twice a day with fresh fishes' blood, lived nine days in water, and appeared to die at last from being too much handled.

What can more evidently illustrate both the power, wisdom, and goodness of the Deity than this most extraordinary animal? How nicely is it formed, in every respect, to fulfil the functions given in charge to it! How admirably is it secured against the mischances to which its singular situation exposes it! When we see so much art and skill put in action to adapt such seemingly insignificant creatures, and so low in the scale of creation, to the circumstances in which they are placed; so many contrivances, exhibiting the deepest intellect, taking the most comprehensive surveys of every possible contingency, and

1 *Tristoma.* 2 *Mola.* 3 *Xiphias.*
4 *Polystoma.* 5 *Scomber Thynnus.*
6 Even this is nothing to those of a genus infesting some Cephalopods, *Hectocotyle*, the different species of which have from sixty to more than one hundred suckers, whence their name.

rearing a structure calculated to stand against every pressure upon it,—we must feel convinced that the attention of the Creator is directed to every *individual* in existence, whether great or small, high or low, spiritual or material. To every thing that he created he gave a law, the law of its nature; a law emanating from Him, enforced by the physical powers acting upon certain structures, and producing certain necessary effects under His *constant* superintendence, direction, and action, on and by those powers.

The intestinal worms, as well as some other parasitic animals, are many of them so remarkable for the situation in which we discover them, that their transport to the spot where they are to exercise their function seems almost miraculous. How a mite should find its way into the human brain seems past our conjecture. We cannot clearly ascertain by what means the eye-worms are conducted to their assigned station, nor how the various species of tape-worm invariably select each its proper pabulum: the same holds good with regard to the cyst-worms,[1] or hydatids. Do they, like the *Infernal Fury*,[2] as fabled by Linné, fall from heaven upon the earth and waters, and instantly bury themselves in their allotted animals? But to speak soberly, all we can safely affirm is, that He who decreed the *end* decrees the *means*, and these probably are physical ones under his direction. He it is who guides the punitive animals that he employs to their several stations. Is there not an omnipresent Deity, whose action is incessant, and co-extensive with his presence? He it is that, as the Prophet speaks, causeth it to rain upon one city, and not to rain upon another city; that employs his instruments, both of benediction and punishment, according to his will. It is He, who by secret paths, and by means that mock our researches, conducts to their assigned station the animals in question. Every power of nature, every physical agent, is at His disposal. His is the earthquake and the volcano; *the lightning of the thunder;* the fire-damp of the mine; the overwhelming violence of the water flood; *the windy storm and tempest:* His is the wide-wasting sword, that destroys myriads, and *the pestilence that walketh in darkness*, and carries off millions; and He gives his commission to all his scourges against individuals as well as against nations, which they unconsciously execute and cannot exceed, for He saith to them, as to the raging sea, Hitherto shall ye come and no further, and here shall the work of destruction cease.

1 *Cysticercus.* 2 *Furia infernalis.* L.

We have a remarkable instance of this special guidance and employment of natural objects in the case of the prophet Jonah, when he disobeyed the word of the Lord. In the first place God *sent out* a great wind into the sea; in the next he *prepared* a great fish to swallow him alive when he should be cast overboard, and at the Lord's *command* the same animal cast him upon the dry land. Next God *prepared* a gourd for a shadow against the heat; after that he *prepared* a worm which destroyed the gourd; and in the last place he *prepared a silent east wind*,[1] or a heat, like the sirocco, without sound. In all these cases the object employed was a physical object, under the immediate direction of the Deity. The wind, the fish, the gourd, the worm, the heat, were not new creations, but well known objects, acted upon to take a particular direction so as to produce particular events.

By what is here said, I by no means assert the doctrine of inevitable fate, for then there would be no use in the employment of means of prevention. Sir H. Davy's safety-lamp would not preserve the life of the miner, nor Dr. Franklin's conductor disarm the thunder cloud; and all the other means that, *non sine Deo*, have been invented to render harmless the action of the physical powers under certain circumstances; but I would merely assert that constant superintendence of the Deity over the world that he has created, and *Who upholdeth all things by the word of his power*, which we call Providence, by which, in general as well as individually, his will has full accomplishment; and every substance or being, whether animate or inanimate, takes the station which he has assigned to it. This is no miraculous interference out of the general course of nature, but the adaptation of that course to answer the wise purposes of Providence, which selects individuals, and distinguishes them from other individuals by events, as to this world, seemingly prosperous or adverse, but which have their ultimate reference to the spiritual world, and to their final destiny. As God willeth not that any should perish, so he withholdeth not from any the means, that, if duly used and improved, will be sufficient for his salvation; and in all his dealings with mankind he hath this great and merciful object in view.

1 רוח קדים הרשית.

# APPENDIX. NOTES.

NOTE 1, p. 2.—*The life and motion.* The word *life* may perhaps here be used, in some sense, improperly; but the original motion caused by the agency of the Spirit, and followed by Light and Expansion, may be called the birth, or beginning, of the life of the world, which followed, under the Divine Guidance, as a consequence of it. I speak only of *animal* life, not of *spiritual*, which resulted from the immediate insufflation, if I may so use the term, of the Deity himself.[1]

I may here be permitted to observe that the Mosaic account of the beginning of creation, especially of the incubation of the Holy Spirit and its consequences, has been transplanted, by many oriental and occidental nations, into their cosmogonies. The circumstances and consequences of it have, in most cases, been altered from their original simplicity; and, in some, it has been assumed as a foundation, on which an Atheistic Philosophy has been erected amongst the Greeks. But when we consider attentively the terms in which these dogmata are delivered, and recollect that the Gods of the Greeks and Romans, especially him who was invocated as the father of gods and men, were really the great elementary powers which under God govern the universe—whence Homer describes him as αιθερα ναιων, and calls him Ζευς νεφεληγερετης, and Ennius appeals to him in these terms,

> Aspice hoc sublime candens quem invocant omnes
> Jovem.

And to live abroad is to live *sub Jove, sub Dio.* It is evident that these Gods were *subsequent* to Chaos, and sprung from that motion of the Spirit which first gave birth to this world as we behold it; besides these, the sun, moon, planets, earth, ocean, &c. made part of the catalogue of false Gods whom the Heathens worshipped and served instead of the Creator. These powers, which were originally reverenced as symbols

1 *Genes.* ii. 7, comp. *John*, xx. 22.

and representatives of the Godhead, and, as it were, his vicegerents in Nature, in process of time were thus regarded and adored as the supreme and only God—the sign instead of the thing signified—the instrument instead of the hand that guided it—the work instead of the workman. They deemed, as the author of the Book of Wisdom observes,[1] *Either fire, or wind, or the swift air, or the circle of the stars, or the violent water, or the lights of heaven, to be the Gods which govern the world.*

Veneration and love to those from whose actions or studies we derive great benefit, and respect for our ancestors, amiable motives when they do not lead us away from God, often induce mankind to throw a kind of Divinity, a ray of glory, around such persons; first, perhaps, they are complimented with the title of *suns* of their people or race, and their wives as *moons*, and next we transform them into what we regarded as their symbol. So the Egyptians, in process of time, added the adjunct *On*, or the *Sun*, to the name of their great ancestor, Ham; whence he was afterwards designated as Hamon, or Ham the sun, and became the Jupiter Ammon of the Greeks.[2]

The idea of the incubation of the Spirit, of its being the principle of love that was in action, and that it produced the first motion, prevails, more or less, in all the cosmogonies.

Aristophanes, in his *Aves*, gives an account of the Grecian cosmogony, which proves that the heathen gods of the Greeks were all subsequent to the original creation of matter, in a passage, of which the following lines are nearly a literal translation:

> Once Chaos was and Night, dark Erebus
> And ample Tartarus; but Earth, and Air,
> And Heaven were not. First black-winged night
> In th' Infinite gulfs of Erebus brought forth
> The wind-nursed egg, from which in circling hours,
> Love the desired, his shoulders golden-winged,
> Sprung like a wind-swift vortex, he who mixed
> With Chaos winged and dark, and Tartarus wide
> Nested our race, and them brought first to light.
> Ere love commingled all, *immortal Gods*
> *Were none*, but from that commixture rose
> Heaven, Sea, and Earth, *and Gods incorruptible.*

*Wind-nursed egg.* Gr. ὑπηνεμιον ωον. Literally, the egg under the wind, alluding to the incubation of the Spirit.

*Love.* This is the motion infused by the Spirit into the chaos which was followed by light and expansion, and the

1 *Wisdom*, xiii. 2. 2 *Cudworth*, I. ii. 338.

whole harmonious circle of creation, in which there was no discord, but all was very good.

*His shoulders golden-winged.* Gr. Στιλβων νωτον πτερυγοιν χρυσαιν. Literally, his back shining with *two* golden wings; these two golden wings were, perhaps, *light* and the *expansion*, which carried love through his whole work.

*Sprung.* G. Εβλαστεν, germinated.

*Wind-swift vortex.* Gr. εικως ανεμωκεσι διναις. Literally, like whirlwinds or whirlpools, swift as the wind.

*He who mixed with Chaos winged and dark.* Gr. Ουλος δε χαιτ πτεροεντι μιγεις νυχιω. This describes *love* or *motion* entering into chaos and beginning to produce order.

*Nested our race.* Gr. Ενεστευσε γενος ἡμετερον. The birds here claim an early origin. The allusion probably is to the mundane egg and the birth of winged love.

*But from that commixture rose heaven, sea, and earth, &c.* Gr. Συμμιγνομενων δ' ἑτερων ἑτεροις, εγενετ' ὠρανος, ωκεανος τε, καὶ γη, παντων τε Θεων μακαρων γενος αφθιτον. Literally, "one thing being mingled with another, heaven, ocean, and earth, and the incorruptible race of all the immortal Gods were produced.

It is evident from this passage that those whom the Greeks accounted their Gods were the elements, the heavenly bodies, and other works of creation. *Thus they changed the truth of God into a lie, and worshipped and served the creature more than the Creator, who is blessed for ever.*

NOTE 2, p. 3.—*Kindred Monsters.* I allude here to the gigantic *Reptiles*, those especially which are now seen only in a fossil state, many of which instead of legs are furnished with paddles; as the *Ichthyosauri* and *Plesiosauri.* These animals seem intermediate between the amphibious Saurians and the Chelonians. Some of them also exhibit several characters in common with some of the Cetaceans, Amphibians, &c.

NOTE 3, p. 5.—*Intermediate, as it were, between matter and spirit.* I find a similar idea in the *Nouveau Dictionnaire D'Histoire Naturelle,*[1] "Le mot de matière porte avec soi l'idée d'un corps lourd et grossier: cependant il est des substances auxquelles on donne le nom de matière, telle que la matière éthérée, et qui sont d'une si inconceivable tenuité, qu'on diroit qu'elles tiennent *le milieu entre l'esprit et la matière.*" Sir Humphry Davy seems to have adopted a similar opinion, which I have given in another part of this work;[2] and Dr Wollaston

1 xix. 449. article *Matières.* Patrin. 2 See above, p. 323.

also, *in his Religion of Nature delineated*, asks—"Might it not be more reasonable to say, *it* (the soul) *is a thinking substance intimately united to some fine material vehicle which has its residence in the brain?*"[1] And again—"If we should suppose the soul to be a being by nature made to inform some body, and that it cannot exist and act in a state of *total separation* from all body; it would not follow from thence, that what we call death, must therefore reduce it to a state of absolute insensibility, and inactivity, which to it would be equal to non-existence. For that body, which is so necessary to it, may be some fine vehicle that dwells with it in the brain, and goes off with it at death.[2] This vehicle, which is so necessary to the soul, dwells with it in the brain, and goes off with it at death, he further supposes, is that by which it acts and is acted upon, by means of the nerves.[3] This vehicle seems not very different from the *vital powers* of modern physiologists, who regard the nervous power as their agent.[4]

The Doctrine of a vehicle for the soul which accompanies her when separated from the body is not a modern hypothesis, but was held by the Platonists and many of the fathers.[5]

Our Lord says to his disciples—*The hairs of your head are all numbered:* upon which we may observe that the head of man is clothed with hair to answer a certain end, an end which has not yet been duly investigated, but which in Scripture has been *intimated* by making it the symbol of *strength* or *power*—by which latter term it is designated by St Paul[6]—as in the case of Sampson, whose superhuman strength seems to have departed from him, when his *seven* locks were shorn off; symbolizing might from the seven spirits of God,[7] or in other words, the sevenfold might of the Spirit. It is well known that the hair is affected by the electric fluid, and it may conduct it to the brain or other organs. Whatever be its function, however, its force will depend upon the quantity, and the quantity upon the number of conductors, and this God regulates in the case of individuals, according to circumstances, so that, though some receive more and some less, *He that receives much has nothing over, and he that receives little has no lack.*[8]

NOTE 4, p. 5.—*For if the instinct of the predaceous ones was*

1 See above, p. 290. 2 *Ibid.* 293. 3 *Ibid.* 293.
4 Dr Wilson Philip, in *Philos. Tr.* 1829, 271, 278.
5 See Dr H. More, *On the Immortality of the Soul*, B. iii. Axiome xxvii. and Cudworth's *Intellectual Syst.* 799.
6 1 *Cor.* xi. 10. 7 *Revel.* i. 4, 5. 8 2 *Cor.* viii. 15.

*not restrained, they would soon have annihilated the herbivorous ones, even if, as Lightfoot supposes, they were at first created by sevens.* If the fall of man, as is generally supposed, happened soon after his creation, the first sacrifice, which as the Lord God clothed the first pair with skins before their expulsion from paradise, must have been offered immediately after the former sad event, would have caused the annihilation of a species; which, in conjunction with the circumstance of Noah being directed to admit *clean* animals into the ark by *sevens the male and his female*, afforded no slight ground for Lightfoot's supposition alluded to in the text. He thus expresses his opinion. "*Bestiæ mundæ creatæ sunt septenæ, tria paria ad prolem, et reliquæ singulæ Adamo in sacrificium post lapsum: at immundæ tantummodo binæ, ad generis propagationem.*"[1] Lightfoot here speaks of *three* pairs and *a half*, and some writers quoted by Poole, seem to think, that the same number were received into the ark, and that the seventh, a male, was intended for sacrifice after the deluge; others think there were *seven pairs.*

NOTE 5, p. 6.—*In the fiercest enmity and opposition to each other.* There was a show-man, who in the year 1831, exhibited on one of the London bridges, as I was informed by a friend upon whose accuracy I could rely, the animals here spoken of in a state of reconciliation. In one cage were *cats*, *rats*, and *mice*, and in another *hawks* and *small birds* living together in the utmost harmony, and without any attempt on the part of the predaceous ones to injure their natural prey.

NOTE 6, p. 9.—*Concerning the kind of which interpreters differ.* The Septuagint renders the Hebrew word כנם, which our translation renders *lice*, by σκνιφες, which is supposed to mean the *mosquito* or gnat, but I cannot help thinking with Bochart,[2] that it rather means the *louse*, not only on account of its derivation from a root, כן, which signifies to fix firmly, which agrees better with the animal just named than with the mosquito, but also because it was produced from the *dust* of the earth like other apterous animals, and not from the *waters*, like the winged ones.[3] The African negroes, as was before observed, have a peculiar louse.[4]

NOTE 7, p. 10.—*Geologists have observed, from the remains of plants and animals embedded in the strata of this and other north-*

1 Lightfoot, *Opera*, Ed. Leusden. i. 154. conf. 2.
2 *Hierozoic*: 574. 3 *Genes.* i. 21. 4 *Fabr. Syst. Antliat.* 340. 2.

*ern countries, that the climate must formerly have been warmer than it now is.* That the inclination of the earth's axis was once different from what it now is was a very ancient opinion; but whatever might be the cause, the fact seems to have been certain, from the existence in very high latitudes of the plants and animals here alluded to, such as various species of palms, of elephants, hippopotami, turtles, and similar tropical forms. Cuvier indeed has conjectured, that the carcass of a mammoth found in Siberia belonged to a cold climate because it was clothed with wool as well as hair. Its hair was stated to consist of three kinds. One being stiff black long bristles, another flexible hair of a reddish brown colour, and the third a reddish brown wool which grew among the roots of the long hair.[1] Now with respect to sheep, there is evidently a difference with regard to their coat in those that live in warm climates, and those that inhabit cold ones, the coat of the former usually consisting chiefly of hairs, and the latter of wool;[2] but Dr Buckland,[3] and Dr Virey[4] have advanced some satisfactory arguments which prove that the Mammoth could not have existed in the countries in which its fossil remains are so abundant, if it had been exposed to a great degree of cold. It is remarked with respect to the remains of fossil elephants, which are so numerous without the tropics, in regions too cold for their existence, that none have been hitherto found in those countries which they actually inhabit at the present time.[5] This throws no small degree of doubt upon that hypothesis which assigns them for their habitation the countries in which their remains are now deposited: but with regard to the remains of coral reefs[6] found in the Arctic seas, no doubt can be entertained that at the period of their formation, those seas were warm enough to suit the temperature of the animals that formed them; but which no longer exist and rear their structures in those latitudes. I met with the following extract in the Literary Gazette for April 7, 1832; it is taken from a work entitled *Six Months in North America*, by G. T. Vigne, Esq.: "The fossil remains of about thirty animals, now supposed to be extinct, have been found at the Big-bone lick; and Mr Bullock conjectures that there are more remaining. That these animals did not perish on the spot, but were carried and deposited by the mighty torrent, which it is evident once spread over

1 Cuvier, *Theory of the Earth*, by Jameson, 275. 2 See above, p. 35.
3 *Supplement to Captain Beechey's Voyage*, ii. 355, 356.
4 *N. D. D'H. N.* x. 162. 5 *Ibid.* 169.
6 Dr Buckland in the *Appendix to Beechey's Voyage*, ii. 355.

the country, is probable from the circumstance of marine shells, plants, and fossil substances having been found not only mixed with the bones, but adhering to them, and tightly wedged in the cavities of the skull—'those holes where eyes did once inhabit,' were often stopped up by shells or pieces of coral forcibly crammed into them." The bones of the *Mastodon* were found by Humboldt at an elevation of more than 7,000 feet above the sea, and in central Asia those of horses and deer have been met with at an elevation of 16,000.[1]

NOTE 8, p. 11.—*Burchel and Campbell appear to have met with more than one new species of rhinoceros in their journey from the Cape of Good Hope into the interior.* Burchel describes one under the name of *Rhinoceros simus.*[2] Campbell's had a straight horn projecting three feet from the forehead, different from any he had seen, and its horn resembled that of the supposed unicorn.[3] There is in the Norwich Museum a horn flattened at the summit, nearly straight, and three feet long, which also seems to belong to another species.

NOTE 9, p. 13.—*The word of God, in many places, speaks of an abyss of waters under the earth. Scientific men in the present day seem to question this.* The passages in Holy Writ, besides those quoted in the text, that appear evidently to affirm that an abyss exists in the earth, are chiefly the following.

In the book of Genesis, in the blessings pronounced, both by Jacob and Moses,[4] previous to their death, upon the tribes of Israel, in that relating to Joseph, amongst others are mentioned—*The blessings of the deep that* lieth *under*, or as the same words are more literally translated in Moses' blessing—*The deep that* coucheth *beneath.*[5] The expression in these passages evidently alludes to an abyss *under* the crust of the earth, from which blessings may be derived: and which is emphatically described as *couching* beneath, as if the mighty waters it contained were lying in repose like a beast at rest, and chewing the cud, in contrast with the incessantly fluctuating and stormy ocean.

When the children of Israel murmured for water in Rephidim, Moses at the Divine command smote the rock in Horeb, and water flowed out of it in a copious stream, which there is reason to believe followed them in all their wanderings through

1 *Quarterly Review*, No. LVII. p. 155.
2 *Travels*, ii. 75. *Bulletin des Sc.* Juin 1817. 96.
3 *Travels*, 295.
4 Comp. *Genes.* xlix. 25 with *Deut.* xxxiii. 13.
5 Heb. רבצת תחת

the wilderness. If we consider the nature of that *dry and thirsty land where no water is*,[1] it is evident that this perennial stream could not be derived from the clouds that hovered round the summits of Mount Sinai, the rocks of that district were washed by no rivers derived from above, and seem not calculated for percolation. But what was the case—the stroke of the wonder-working rod of the Lawgiver of Israel produced a fissure in the rock, which opened a channel through which the waters, before in repose in the great deep, rushed forth in a mighty stream; and therefore the Psalmist says—*He clave the rocks in the wilderness, and he gave them drink, as out of the great abysses.* Alluding evidently to a source of *sweet* waters below.

The prophet Jonah, in the prayer he uttered when incarcerated in the fish's belly, has these words—*I went down to the bottoms of the mountains: the earth with her bars was about me for ever.*[2] A parallel expression is used in Moses' song—*A fire shall burn to the lowest hell—it shall set on fire* the foundations of the mountains.[3] This last passage shows that the *Hades*[4] of Scripture—usually translated *Hell*, but distinct from the *Gehenna* or Hell of the New Testament—is synonymous with the abyss. As is further proved by the following passage of the book of Job. *Hast thou entered into the springs of the sea? Or hast thou walked in the search of the* abyss? *Have the gates of death been opened unto thee, or hast thou seen the gates of the shadow of death?*[5] In this passage the *springs* of the *sea*, the *abyss*, the *gates* of *death*, and the *gates* of the *shadow of death*, seem nearly synonymous, or to indicate, at least, different portions, of the womb of our globe. The *bottomless pit*, or rather the *pit of the abyss* of the apocalypse, also belongs to the same place: the word rendered *pit* means also a *well*. Schleusner, in his lexicon, translates the phrase by *Puteus seu fons abyssi*, so that it seems to indicate a mighty source of waters. But as the terms *abyss* and *great abyss* are applied to the receptacle of waters exposed to the atmosphere, as well as to those which are concealed in the womb of our globe,[6] it is evident that they form one great body of waters in connexion with each other.

NOTE 10, p. 15.—*He who willed the deluge, and the destruction of the primeval earth and heavens by it, &c.* When it is considered that all the knowledge which we have, and can have, of the contents of the globe that we inhabit, is very *superficial;*

1 See 1 *Cor.* x. 4.
2 *Jonah*, ii. 6.
3 *Deut.* xxxii. 22.
4 Heb. שאול.
5 *Job* xxxviii. 16, 17.
6 *Job* xli. 31. *Ps.* cvi. 9. *Isai.* li. 10, &c.

that it is only, as it were, *skin* deep, and consequently very imperfect, it seems as if we stood in great need of some other guide, besides our own reasonings and guesses upon the little that we can explore of the earth's crust, to enable us to form a correct judgment, and to arrive at the truth as to what changes may have taken place in it, and by what means. When we further consider that we are informed by the *highest* authority, that the original earth and its heavens, with all their animal inhabitants—those only excepted, which, by his command, took refuge in a vessel built according to his direction—were destroyed by a universal deluge, which overtopped the highest mountains, and continued in force for nearly a year: when this great catastrophe is duly considered, surely, from the account given of it in Scripture, much may be gleaned that will throw a light upon the subject, that can never be struck out by the unassisted investigations of the Geologist who can penetrate so little below the earth's surface.

My own knowledge of Geology and its principles, as now laid down, is too slight to qualify me to compare them with what has been delivered in Scripture on the subjects here alluded to; but as it appears to me that the scriptural account of the great Cataclysm has not been duly weighed, and its magnitude, duration, momentum, varied agency, and their consequences, sufficiently estimated by geologists, I will endeavour, as briefly as I can, to call their attention, and that of Christian Philosophers in general, to the most striking features exhibited by it, as stated in the seventh and eighth chapters of the book of Genesis, still requesting them to bear in mind these words of the poet, as expressing my own feelings.

*Fungor vice cotis exors ipse secandi.*

My only wish being to excite others better qualified, by their knowledge both of Scripture and Nature, the *Word* and the *Work* of the same Almighty Being, to undertake the task.

It must be borne in mind that the scriptural account is not a *figurative* one, in which the object is to represent one thing by another, but a statement of epochs, and naked facts; of causes and effects; in which all that is requisite is to ascertain the meaning of the terms employed to describe them.

The *cause* of the universal deluge, every one is aware, was, with the exception of one family, the universal corruption of the human race. *All flesh had corrupted his way upon the earth.*[1] In consequence of which God determined to—*Bring a flood of*

1 *Genes.* vi. 12.

*waters upon the earth to destroy all flesh, wherein was the breath of life from under heaven; and every living substance from off the face of the earth.*[1] To accomplish this purpose, it was evidently necessary that the whole globe should be submerged, and the tops of all the mountains covered to such a depth as to prevent any thing in which was the breath of life from making its escape.

Having mentioned the *cause* and *object* of the deluge, we must next consider the *means* by which this universal destruction is stated to have been effected. *Three* only are mentioned. *All the* fountains *of the* great deep *were* broken up, *and the* windows *of* heaven *were opened, and the* rain *was upon the earth forty days and forty nights.*[2]

1. *All the fountains of the great deep were broken up.* The radical idea of the word here rendered *broken up* is that of division or disruption, therefore the meaning is that those fountains by which the waters of the great abyss issued ordinarily upon the earth to water it by numerous streams and rivers, were so cleft, disruptured, and broken up, as to form vast chasms vomiting up the fluid contents of the womb of the earth, and sending forth torrents of incalculable force and volume. The vestiges of such clefts in the earth's crust are still to be traced in many places. Malte Brun, in his *Geography*, observes, with respect to valleys—"Those which are found between high mountains are commonly narrow and long, as if they had originally been only fissures[3] dividing their respective chains, or for the passage of *extensive torrents.* The angles of their direction sometimes exhibit a singular symmetry; we see in the Pyrenees, says M. Raymond, some valleys whose salient and re-entrant angles so perfectly correspond, that if the force that separated them were to act in a contrary direction, and bring their sides together again, they would unite so exactly, that even the fissure would not be perceived."[4]

2. *The windows of heaven were opened*—is stated by Moses to be the *second* cause by which the deluge was effected. The word,[5] which in our translation of the Bible, is here and in other places rendered *windows*, does not mean an opening for the transmission of light, for which another term is usually employed.[6] In the Septuagint and other ancient versions it is supposed to signify water falling from the heavens in large masses, and *cataract* or a corresponding term is used.

1 *Genes.* vi. 17, and vii. 4. 2 *Ibid.* vii. 11.

3 בקעה is Hebrew for a *valley*, and נבקע is the verb used to express the disruption of the fountains of the great abyss.

4 *System of Geography*, I. i. 168. E. Tr. 5 ארבות 6 חלון

The radical idea is that of *lying in wait*, as a wild beast in its den. In other parts of Scripture it is used for dovecots or the holes in rocks that doves frequent;[1] for the sockets of the eyes;[2] for the heavens when shedding copiously blessings or plenty;[3] and for the action of something from above producing earthquakes.[4]

My venerated friend, the late Rev. Wm. Jones, of Nayland—well known for his knowledge of the Hebrew, and the variety and ability of his researches on every subject connected with the interpretation of Scripture—in his *Physiological Disquisitions* thus expresses himself, concerning the term in question. "We suppose then that the air was driven downwards, for this purpose, through those passages which are called *windows of heaven.* These may seem very obscure terms to express such a sense by; but *heaven* is the *firmament*, or expanded substance of the atmosphere; and *windows*, as they are here called, are holes, or channels of any kind. The same word is used for chimneys,[5] through which smoke passes, and for the holes, probably cliffs of a rock, in which the doves of the eastern countries have their habitation."[6]

It strikes me as not very improbable that the term I am speaking of may allude to *volcanoes* and their *craters*, which may be called the *chimneys* of this globe, by which its subterranean fires communicate with the atmosphere, and by which the air rushing into the earth, when circumstances are favourable, may possibly act the part of the fabled Cyclops, and blow them up previous to an eruption: thus they become literally channels or chimneys, through which the matter constituting the expanse or firmament passes, either *from* heaven, or, in an eruption, *towards* heaven. The expression, in Isaiah, quoted above, *The windows from on high*[7] *are opened, and the foundations of the earth do shake*—seems to indicate that *earthquakes* are connected with the opening of the windows of heaven, thus pointing to volcanic action as the result. Still the expression is ambiguous, and requires further elucidation: it may, however, be intended to include both interpretations. The violent disruption of the fountains of the great deep, which appears to have been the first step towards producing the deluge, since God generally employs *means* to effect his purposes, was pro-

1 *Isai.* lx. 8.
2 *Eccles.* xii. 3.
3 2 *Kings*, vii. 2. *Malachi*, iii. 10.
4 *Isai.* xxiv. 18.
5 *Hosea*, xiii. 3.
6 *Isai.* lx. 8. See Jones's *Works*, x. 264. See also Parkhurst, *Heb. Lex.* under ארב II.
7 *Heb.* מסרום.

bably occasioned by the expansive power of *heat*, and the same agent would, as it does at this very time in some countries, send out the waters, and it seems equally probable, that in proportion as the waters rushed out the air would rush in and take their place, and thus form a centre of repulsion, or *vis centrifuga*, to counteract the pressure of the superincumbent waters. It seems not improbable, if this were the case, that in its transit from the surface of the earth, to its centre, the air might bring with it vast cataracts of water attended by thunder and lightning and other electric phenomena.

Heat, the most elastic of all fluids, at the first creation, under the name of the *expansion* or *firmament*, acting in the bosom of the chaotic waters divided them, and therefore it is consistent with the Divine proceedings that the same mighty element should be put in action to bring them again together. And we learn from Scripture, that the same irresistible agent well be employed for the destruction of the present earth and its atmosphere or heavens, which are *reserved unto fire, when the heavens shall pass away with a great noise, and the elements shall melt with fervent* heat; *the earth also and the works that are therein shall be burned up.*[1] As the opening of the windows of the heavens seems the consequence of the breaking up of the fountains of the great deep, it is therefore mentioned in the *second* place.

3. The *third* instrument of Divine Power to produce the deluge was *rain. And the rain was upon the earth forty days and forty nights.*[2] It is a common form of expression,—It rains as if heaven and earth would come together; and this probably was the character of the rain that now fell for forty *Nycthemera*, or entire days of twenty-four hours. A circumstance that does not require further explanation.

By the united operation of these three mighty agents, guided by the Almighty hand of the Deity—*Whose way is in the sea, and whose path is in the great waters, and whose footsteps are not known*[3]—the waters kept gradually rising and prevailing more and more, till they overtopped all the high mountains[4] that were under the whole heavens fifteen cubits,[5] by which the Divine decree to *destroy* the earth with *all* its inhabitants, both rational and irrational, except those in the ark, was fully executed. With respect to the earth itself, when we consider the

1 2 *Pet.* iii. 7, 10. 2 *Genes.* vii. 12. 3 *Ps.* lxxvii. 19.

4 *Genes.* vii. 19. In our translation, ההרים in this verse is rendered *hills*, and in the 20th *mountains*.

5 *Ibid.* 20.

violent action of the ascending and descending waters, and of the firmament rushing downwards; the disruptions, dislocations, introversions, comminutions, deportations here and there of the original strata of the crust of our globe, can scarcely be conceived, and are still more difficult to calculate and explain exactly. In the waters thus again, as at the creation, masters of the whole earth, God had an instrument by which his will with respect to its crust, and the changes to take place in it, might have full accomplishment, especially when we consider the long time during which the waters kept rising or prevailed, till they reached the height necessary to fulfil the Divine decree. It seems not clear whether the forty days during which the rain fell are included in the hundred and fifty days that the waters are stated to have prevailed. If they were included, the period would be five lunar months and ten days; and if they were not, it would extend to six such months and twenty-two days. What a time, even according to the shortest calculation, for the continued action of such a body of fluctuating waters, continually increasing, till they left no peak or pinnacle of the most elevated mountains of the globe visible! Who can calculate the effects of that action?

During this period of the increase and prevalence of the waters, when the mountains were covered, all ingress of the atmosphere into the earth by the chimneys of the volcanoes, if that is the meaning of *stopping the windows* of heaven, would cease; and the abyss, at or before the end of it, no longer vomit forth its waters by its innumerable mouths.

Having considered the *secondary* causes to which the Word of God attributes the *rise* and *prevalence* of the deluge, I must next make a few observations upon the means to which Divine Wisdom, Power, and Goodness had recourse to effect this, and to cause the waters to return to their ancient receptacle. At the first creation, *The Spirit of God moved upon the face of the waters.* The consequence of which was that order arose out of confusion. The *motion* was then begun, by which the *wind*[1] bloweth where it listeth, the *light* shines forth, *heat* expands, the *clouds* are formed, and the physical *cherubim*, under the guidance, and according to the will of Jehovah of Hosts, are in action, and fulfil his purpose, and the consequence is that *The waters under the heaven* are *gathered together into one place and the dry land appears.*[2] Similar steps were taken at the

1 Ανεμος ουδεν εστι πλην αηρ πολυς ῥεων ὁστις ἅμα και πνευμα λεγεται. *Aristot. De Mundo.*

2 *Genes.* i. 9.

deluge. For *God remembered Noah and every living thing, and all the cattle that were with him in the ark: and God made a* wind *to pass over the earth, and the waters assuaged.*[1] It is not here said, as on the occasion just alluded to, that the *Holy Spirit* brooded over the water, but literally that God passed (a) wind (or spirit) over the earth. The action, though not the same, was analogous, *wind* under the *direction* of God was employed to do, in part, what the incubation of the Holy Spirit had before effected, to begin that action by which the globe and its atmosphere would be again placed in statu quo, the water again divided, so that one part should return to the great abyss, its destined abode; and the other be suspended in the atmosphere; and, by the same means, the dislocated crust of the earth be *re*formed; the matter suspended in the water or floating on it deposited, the detritus of the old one being mixed, and often, as it were, intercalated with vegetable and animal substances and remains. This wind from God having passed over the earth, the waters assuaged; that is, their rage and violence ceased; the fountains of the abyss and the windows of heaven being stopped; the one no longer poured forth its waters upon the earth; and the other no longer descended to occupy their place; and the rain had ceased to fall. When the above three causes of the deluge ceased their action, and had given place to the wind from God, the waters of course began to subside.

We are now arrived at the last epoch of this great event, the gradual decrease and final subsidence of the diluvial waters. The period of their increase, if with Lightfoot we add the 40 days to the 150, would be 190 days, or, as was before observed, six lunar months and about three weeks. *In the seventh month* of the deluge, as the same author observes,[2] on the seventeenth day of the month, the ark rested on the mountains of Ararat,[3] from which period the waters returned off the face of the earth, *going and returning*, as it is in the Hebrew,[4] rendered in our translation by the word *continually*, but almost all the ancient versions adhere to the literal sense, which seems to be important, and to indicate a flux and reflux of the waters, which would affect the deposition of the matters floating upon or suspended in them. Whether this flux and reflux partook of the nature of a tide, and was produced by the action of the moon, or whether it was occasioned by the wind, which, as Solomon observes, *Goeth towards the south and turneth about to the north,*[5] does not appear.

1 *Genes.* viii. 1. 2 *Ubi supra.* 3 See above, p. 25.
4 Heb. וישבו המים מעל הארץ הלוך ושוב 5 *Eccles.* i. 6.

After the resting of the ark, more than two months elapsed before the tops of the mountains were seen, and finally, in nearly two months more the waters had universally disappeared; and after their long domination over the earth, lasting nearly eleven months, were confined again within the limits that God had originally assigned to them. Reckoning *to* the day of Noah's going out of the ark, on the twenty-seventh day of the second month, the whole period of his confinement appears to have been one year and ten days. It is evident, from the period that intervened between the resting of the ark, and the subsequent emergence of the tops of the mountains more than two months afterwards,[1] that the subsidence of the waters at first was very gradual; but, in proportion as their volume diminished, it probably became more and more rapid.

The tumult and violence of the *descending* waters, and the effects produced by them, in the new mixture, as it were, of the substances now forming the crust of our globe, and the putting it into its present order—always under the direction and guidance of the Deity, *who sitteth above the water-flood*, employing as his hands those physical agents which rule in nature, to fulfil his purpose—must have been the reverse of those of the *ascending* ones: the object now was not disruption, and dislocation, and destruction, but to form anew the earth and its heavens which had been thus destroyed, and by the addition of a vast body of fresh materials not entering into the composition of the old crust of the former, to render it materially different from it; and that when the attention of mankind was directed to the study of God's works, and of those remains of the former world, a proof might be supplied of the existence of this sad catastrophe, confirmative of the account given in Holy Scripture, and adding to the force of the warning that universal corruption will be a prelude to universal destruction.

When we consider what an infinite host of animals of every description must have perished in the diluvial waters, as well as the incalculable magnitude of the mass of vegetable substances that must have been severed by the violence of the conflicting waters from the earth's surface, or uprooted afterwards in consequence of its being so thoroughly soaked by them, we see immediately that their deposition and sepulture, as well as the putting together again of the dislocated remains of the primeval earth, must have been an important part of the office of the subsiding waters, upon which I shall now offer a few observations.

1 *Genes.* viii. 4, 5.

It has been a matter of surprise that amidst so many fossil animals which are daily brought to light, and those of some of the largest quadrupeds in great numbers,[1] no remains of the *human race* have yet been discovered, except in one or two solitary instances. As the deluge was caused by the wickedness of these old *giants*, as they have been called, but really *apostates*,[2] these *men of renown*, it was evidently a miraculous interference of the Deity for their punishment; it seems, therefore, by no means improbable, that the place of their burial was not left to chance, or the uninfluenced action of physical causes, but, like the burial place of Moses, was decreed by God, and fixed so as to be placed beyond discovery.

It seems to have been the opinion of most modern geologists, that fossil animals in general were *natives* of those districts or countries in which their remains have been discovered. But whoever takes into consideration the account, above detailed, which the sacred writings give us of the universal deluge, and of the prevalence of the waters above the summits of the highest mountains, will see at once, with the exception of those that were overtaken and drowned by the waters in dens or caverns, they must have floated when the waters had reached and flooded all the elevations upon which they had taken their last refuge, and they would have drifted off north or south, or in any other direction the fluctuating element was taking, and if there was an alternate flux and reflux, they would have been carried by it backwards and forwards till they were deposited some here and some there; some upon mountain summits,[3] and others at different heights ruled by the circumstances of the earth's surface and the action of the subsiding waters. Few, indeed, would be imbedded in their *native* country, except those that perished, as above mentioned, in caverns; though probably, in many cases, those of the same species might congregate, and so floating off together might be buried together. It has been remarked that no fossil elephants have been found in the countries that those animals now frequent. It seems, therefore, by no means certain that the gigantic Saurians now found in our southern coasts, or that the Mammoths or other gigantic Pachyderms of Northern Russia or Nova Zembla, were really natives of those regions.

What Geologist, then, however practised, however deeply conversant with his subject, can estimate and exactly calculate

1 See *Reliquiæ Diluv.* 138—182.

2 See Heb.

3 See above, p. 483.

the action and operation of these mighty waters, both during their rise, prevalence, and subsidence for so extended a period; especially when those of an Almighty superintending and directing Cause, upon the whole body of means that he employed to accomplish his purposes, and execute his decrees with regard both to the destruction and renovation of our globe, are duly considered?

By what I have here argued I no not mean to contend that there may not have been many *partial* convulsions which may have produced very important changes in different countries of our globe: it is not moreover at all improbable that while its population was concentrated, many regions when uninhabited, God so willing, by diluvial, volcanic, or other action of the elements, might be materially altered, new mountain ridges might be elevated, mighty disruptions take place, and other changes to which there could be no witnesses, but which can only be conjectured by the features such countries now exhibit.

NOTE 11, p. 22.—*We learn from the Apostle St Peter, that the primeval globe, and its heavens or atmosphere, perished at the deluge.* I shall add a few words here on the passage of St Peter alluded to in the text. Speaking of the scoffers of the last days, and of the deluge, *Whereby*, he says, *the world that then was being overflowed with water perished:* he adds, *But the heavens and earth*, which are now, *by the same word are kept in store*, &c. In this passage it must be observed that the term *world* in the sixth verse is synonymous with the *heavens and the earth* taken together of the fifth and seventh verses, and by it seems to be meant that the earth with its own heavens, or the atmosphere that surrounds it, both *perished* or were *destroyed*,[1] which is rendered further evident by the expression: But the *heavens* and *earth* which *are now*. From which it may be gathered that the heavens and earth *which are now*, are different from the heavens and earth which were destroyed at the deluge; and as the latter has evidently been reconstructed, and vegetable and animal remains have been mixed with the dislocated materials and as it were *detritus* of the original world;[2] so the new atmosphere might be, and probably was differently mixed, so as to be less friendly to health aad longevity, which would account *physically* for the gradual reduction of the former extended period of human life to its present brief standard. Animals as well as man might be affected by this change, their bulk might be di-

1 Gr. απωλετο.

2 See above, p. 490, and Herschel in *Cab. Cyclop.* xiv. 141. No. 135.

minished, and other variations be produced in them which have not been ascertained. When God fixed upon the rainbow as the token of his covenant with Noah, the changes, here alluded to, in the atmosphere might be the cause of the appearance, under certain circumstances, of that phenomenon.

Scientific men have judged it not improbable, without referring to this doctrine of Revelation, that changes in the composition of the atmosphere, according to circumstances, may have taken place.[1]

NOTE 14, p. 29.—*Whoever examines the animals of North America will find a vast number that correspond with* European *species—on the Rocky Mountains, and in the country westward of that range* Asiatic *types are discoverable.* The rein-deer, the fox, the weasel, the rat, the mouse, the golden eagle, the peregrine falcon, and many other birds are of the former description. In the latter paragraph I allude to a fine *Carabus*,[2] which is found in Siberia; and likewise to a new genus[3] related to *Trechus*, of which I possess a specimen, found in India, both taken also in the Rocky Mountains. Mr Sabine informed me that several new Pœonias, and a Laurus that reached the height of sixty feet, were natives of the same country. In Chili, Molina found the green and temporary frogs, the heron, the turtle-dove, and several other old-world animals.

NOTE 15, p. 30.—*But which in their immediate or remote consequences, may be productive of effects that are important to be attended to, and provided for.* When we reflect upon the action of the Deity, we can scarcely avoid taking our ideas of it, in some degree from that of man. Man's attention is usually directed to things that appear to him important, as affecting either his passions or his interests, but he passes by those that appear to him trivial, as having no bearing upon his pain, or pleasure, or welfare. But here there is a great difference, for though some

> By long experience do attain
> To something like prophetic strain,

the generality can trace the chain of causes and effects, but for a very few links; and therefore they disregard some things as trivial, which, in the event, produce effects of the greatest importance. But it is not so with God; he sees the most distant consequences of every thing that happens in his whole universe,

1 *Ann. Des Sc. Nat.* xix. 432.
2 *C. Victinghovii.* Fisch.
3 *Isopleurus.* K. M. S.

and therefore knows exactly in what proportions every thing appertaining to the nature of every creature should be measured out to it in order to produce the effects he intends should take place, if I may so speak, during its ministration ; so combining agents and actions, as may infallibly fulfil his law, and general purpose. He foresees the effect of what are regarded as the most trivial things, as the number of our hairs and the death of a sparrow, as well as of those that are most important: and his general object is to provide for the execution of the laws both physical and metaphysical by which he governs the universe, and so upholds all things, but not so as never to suspend the action of these laws. The following events recorded in Scripture were remarkable instances of such suspension.

1. The *Universal Deluge*, by the means of which the heavens and the earth of the primeval world were destroyed.
2. The *Egyptian* palpable *darkness* for three days and nights.
3. The *passage* of the *Israelites* through the *Red Sea*, the waters standing as a wall on either hand.
4. The *sun* apparently *standing still* in the heavens at the command of *Joshua*, or the earth ceasing to revolve on its axis.
5. The *shadow going back* on the dial of Ahaz three degrees, or the earth retrograding.
6. The *supernatural darkness* that took place at our Saviour's crucifixion.

NOTE 16, p. 46.—*Which will take place in his time and at his word; and by the means and instruments that he empowers and commissions.* Ever since the fall of our first parents a copious harvest of evil and sorrow, the fruit of sin, has been reaped by their descendants, amongst others, that of *slavery* has been one of the bitterest. In the case of Ham it was predicted and decreed by the Deity himself that his son Canaan should be a *servant of servants* or *slave* to his brethren, a prediction which, to judge by the event, affected all the descendants of the offending patriarch, for no races have been so much degraded, in all respects, as the African negroes who derived their origin from him.

Much has of late been done with the view of ameliorating their condition, and most of the European nations have concurred in the benevolent endeavour. In consequence of the exertions of this country, the debasing traffic in slaves, and the miseries and waste of human life that it occasioned, have been very much diminished. But though Christian nations have agreed to relinquish the trade in slaves, and it is to be hoped

that many of the wars that were expressly kindled amongst the Africans themselves, for the purpose of making slaves will cease: still there are markets for slaves that we have no power to close, and therefore it is to be apprehended that the good expected from the abolition, by European states, of the traffic in question, will not be altogether realized: so that it still seems doubtful whether slavery is near its extinction, or whether it ever will be extinguished during the present state of society, and while the nations amongst whom it is practised continue to be apostates from the knowledge and worship of their Creator. While the souls of the sons of Adam are thus enslaved and sold under sin, it seems improbable that God's time for their general emancipation from bodily slavery should be at hand; but when their heart *shall turn to the Lord*, this, and numberless other evils, at his bidding, and by instruments that he appoints, will cease. The best way therefore of accomplishing this object is by providing means, wherever God has made an opening, for the education of the negroes, and for training them to habits of industry and order: to give them freedom before they are qualified to use it for the benefit of society, is giving them not a boon, but a curse.

NOTE 17, p. 46.—*Should another and last cloud of error envelope the world with darkness.* There are many passages of Holy Writ, from which it appears that, before the final triumph of the gospel, there shall be a time of great spiritual darkness upon earth; and it seems also to be intimated that this reign of evil shall be brought on by men that *Despise dominion, and speak evil of dignities,*[1] who shall promise *liberty* to their followers, while they themselves are *the servants of corruption;*[2] who shall resemble Corah, and his companions in rebellion Dathan and Abiram,[3] and rise up against their civil and ecclesiastical rulers; and who shall for a time prevail against them, as seems to be intimated by one of the most ancient prophecies in the Bible. *Dan shall be a serpent by the way, an adder in the path, that biteth the horse-heels, so that his rider shall fall backward.*[4] So says the venerable patriarch, in his valedictory and prophetic address to his twelve sons before his death. These words seem to foretell that serpents, or apostates, symbolized by the tribe of Dan, would, in the *last times*, incite the lower orders to rebel against their governors and reject their authority; and when Jacob adds *I have waited for thy salvation, O Jehovah*, it seems

1 *Jude*, 8.
2 2 *Pet.* ii. 9, 19.
3 *Numb.* xvi. 1—3, 31—35.
4 *Genes.* xlix. 17.

to be further indicated that this event will be followed by the great day of salvation. It was an ancient opinion that Antichrist would be an individual of the tribe of Dan, who, in the last times, to use the words of Irenæus, would leap like a lion upon the human race ;[1] an opinion probably derived from this prophecy, or from that of Moses delivered on a similar occasion, *Dan is a lion's whelp: he shall leap from Bashan ;*[2] and from the exclusion of that tribe from the number of those that were sealed, as recorded in the Apocalypse.[3] St Paul, in his description of the man of sin, describes him as exalting himself above all that is *called God*, or that is *worshipped* or *venerated.*[4] This has been interpreted as meaning *idols*, but in *Scripture* princes and rulers are *called* Gods, as when it is said *Thou shalt not revile the* Gods *nor speak evil of the* ruler *of thy people;*[5] whence it seems as if St Paul meant to indicate a power that was to exalt itself above all authority whether civil or ecclesiastical. Irenæus expected his personal Antichrist to reign three years and a half, interpreting the prophetic period of 1260 days literally ;[6] but this period, if interpreted a year for a day, would only agree with a succession of individuals. The ancient opinion of a personal Antichrist, may be reconciled with the modern one of a succession of individuals entitled to that appellation, by considering St John's prophecy of the two witnesses. They are to prophecy clothed in sackcloth 1260 days.[7] This period synchronizes with the reign of the Antichristian power which *corrupts the gospel*, headed by a succession of individuals. Again, they are to be killed, and their bodies exposed without sepulture in the street of the great city for three days and a half ;[8] this second period synchronizes with the reign of the personal Antichrist, who *denies the gospel*, who is to be a single individual ; and more particularly entitled to the name of Antichrist by his infidelity, and atheistic principles. *He is* the *Antichrist that denieth the Father and the Son.*[9] It may be asked—*When God doeth this, who shall be able to stand?* will any Christian church escape ? We learn from the case of that of Philadelphia,[10] that if any such church holds fast her profession, has kept the word of Christ, and not denied his name, though beset by a host of enemies, she shall be kept from the hour of temptation.

1 *Adv. Hæres.* l. iii. c. 38.
2 *Deut.* xxxiii. 22.
3 *Revel.* xvi. 5—8.
4 Gr. σεβασμα. 2 *Thess.* ii. 4.
5 *Exod.* xxii. 28.
6 *Ubi supr.* l. v. c. 25.
7 *Revel.* xi. 3.
8 *Ibid.* 7—11.
9 1 *John*, ii. 22.
10 *Rev.* iii. 7—10.

NOTE 18, p. 46.—*And be restored to the favour of their God and their own land.* Some Divines have thought that there will be no restoration of the Jews to their own land ; but as it is evident, from what St Paul says, that they will at a period fixed in the Divine counsels be converted to the faith of Christ,[1] so it appears equally clear, from what is foretold in the concluding chapters of Ezekiel and by other prophets,[2] that they shall also again inhabit Judea and Jerusalem. Some interpreters are also of opinion, that the pouring out of the vial of the sixth angel upon the river Euphrates and the drying up of its waters,[3] signify the dissolution of the empire of the Turks ; that, by the Kings of the East therein mentioned, are meant the Jews; and that their return to their own land is indicated, by their way being prepared. Bishop Horsley supposes, likewise, that the eighteenth of Isaiah foretells this event, and that the great commercial nation of the day will be instrumental in bringing it about.[4]

St Paul's conversion is thought to have been a type of the conversion of the Jewish nation in the latter days, and as his zeal und success seem to have exceeded that of the other apostles, and he was the great instrument of the conversion of the gentile world to the faith of Christ, so it has been supposed that the Jews when converted, will be the main instruments of the conversion of the then heathen world.

NOTE 19, p. 48.—*Unless some means can be devised at home, by which the pressure may be lightened, and the suffering classes be enabled to procure the necessaries of life.* There are two mighty nations on our globe in which a system has long been acted upon, enabling them to support a population, never diminished by foreign wars, greatly exceeding that of any other country, whose numbers have only been diminished occasionally by famine, by devastating inundations and unfavourable seasons, from which nothing can altogether insure a people. The nations I allude to are China and Japan. We are informed, in the account of Lord Macartney's Embassy, that in the former of these countries, "Every square mile contains upon an average one third more inhabitants, being upwards of *three hundred*, than are found upon an equal quantity of land, also upon

1 *Rom.* xi. 25, 26.
2 *Ezek.* xxxvii. &c. *Isai.* lx. *Jerem.* xxx. &c.
3 *Rev.* xvi. 12. comp. ix. 14.
4 See also lx. 8, 9, and *Zeph.* iii. 10.

an average, in the most populous country in Europe."[1] The population of the latter is also stated to be prodigious.[2] The encouragement of Agriculture appears to be the sole mean which enables these countries to maintain so vast a mass of population. In China, it is stated, that the whole surface of the country is dedicated to the production of food for man alone, that even the steepest mountains are brought into cultivation; they are cut into terraces, and the water that runs at their feet is raised by chain-pumps, worked each by two men, from terrace to terrace, to irrigate them; and steep and barren places are not suffered to run waste, but are planted with pines and larches.[3] A similar account is given of the state of agriculture in Japan, where attention to it is enjoined by the laws as one of the most essential duties; and if any one leaves his land uncultivated his more active neighbour may take possession of it. In both these countries no article that can possibly be used as manure is wasted, so that the soil and crops have every possible attention of this kind.[4] Malte-Brun has given a very interesting account of the honours paid by the Emperor of China and his court to agriculture: who annually in the beginning of March, after adoring the God of Heaven, and invoking his Blessing on his labour and on that of his whole people, himself, laying aside his imperial robes, holding a plough opens several furrows, and is succeeded by his chief mandarins, who in succession, follow the example of the prince.[5] Some allowance probably must be made for too warm colouring in these statements, as most of them must have been derived from the report of the natives, yet there seems no doubt with respect to their general accuracy. What an example is here set by nations which we are accustomed to consider as far behind ourselves in every art of life: how vast a portion of our own home empire is suffered to lie waste, while all the time hundreds of thousands of our agricultural population are languishing for want of employment, and compelled to live upon a pittance, which, unless they add to it by theft or fraud, is scarcely sufficient to keep body and soul together; and in the mean while the morals of our peasantry are gradually corrupted; they grow daily less industrious; they will often congregate at the beer-shops, and get inveterate habits of intemperance; they lose all respect for

1 Macartney *Embassy* by Sir G. Staunton, iii. 388.
2 Malte-Brun. *Syst. of Geogr. Asia* II. ii. 533. E. T.
3 Macartney *Embassy*, iii. 386. Malte-Brun. *Asia*, 560.
4 Thumb. *Japan*, iv. 82. Malte-Brun. 561.
5 Malte-Brun, 561.

their superiors, and the bonds of union betwixt the upper and lower classes are gradually dissolving; and unless some remedy for this fearful evil is soon discovered, who can say what the consequences may be? When a man once loses his self-esteem, and is degraded from his natural dependence upon himself, under God, and the labour of his hands, for the support of himself and family, being no longer of use to himself or others, he becomes careless of his actions; and being, as it were, rejected by society, becomes the enemy of those above him, and the ready associate of evil men, in evil works.

NOTE 20, p. 84.—*Those that are loricated and covered with some kind of shell.* The varied means by which a provident and beneficent Creator has provided animals with different means of defence ought not to be overlooked. When we see even these invisible atoms as it were provided with armour, to defend them probably from the attack of animals of their own class, we feel confident that he will not neglect us. This distinction of animals into loricated and naked may be traced through most of their Classes; thus the *Coleoptera* stand in contrast with most of the other Orders of insects; the fishes and reptiles that are covered with scales with those that are covered with skin.[1] In birds, however, this distinction does not appear to obtain at all: in quadrupeds the giant *Megatherium*, the *Armadillo*, the *Chlamyphorus*, and the *Manis*, are distinguished from the other Mammalians by the armour that protects them.

NOTE 21, p. 87.—*The first plants and the first animals are scarcely more than animated molecules, and appear analogues of each other; and those above them in each kingdom represent jointed fibrils.* A discovery may here be noticed of one of the most scientific Botanists of the present age, and whose keen eye and philosophic spirit have penetrated into depths and mysteries before unexplored, belonging to the science of which he is so great an ornament. In the investigation of some of these, he discovered that not only vegetable, but even mineral molecules, when placed in a fluid medium, would move about in various directions, but by what cause these motions were generated he offers no conjecture. He very kindly showed me this singular phenomenon, if my memory does not deceive me, with respect to some *mineral* substances. Mr Brown has observed that the motions in question, he was satisfied, arose neither

1 In some fishes the scales are invisible, so that they may be almost reckoned naked: See above, p. 351.

from currents in the fluid, nor from its gradual evaporation, but belonged to the particle itself;[1] and of the spherical molecules mixed with the other oblong particles obtained from *Clarckia pulchella*, that they were in rapid oscillatory motion;[2] in both mineral,[3] vegetable,[4] and animal substances,[5] along with the molecules, he found other corpuscles, like short fibres somewhat moniliform, or having transverse contractions, corresponding in number, as he conjectured, with that of the molecules composing them: and these fibrils, when not consisting of a greater number than four or five molecules, exhibited motion resembling that of the mineral fibrils, while longer ones of the same apparent diameter were at rest.[6] It does not appear clearly from the words of the learned author, whether the motion of the mineral molecules was similar to that of the vegetable ones, which he describes as oscillatory. The motions of the mineral fibrils, when not composed of more than two or three molecules, were at least as vivid as those of the simple molecule, and which from the fibril often changing its position in the fluid, and from its occasional bending, might be said to be somewhat vermicular;[7] now vermicular movement is a kind of progressive oscillation, the anterior extremity going from side to side and being followed by the body. In other mineral bodies, as in white arsenic, which did not exhibit the fibrils, he found oval particles about the size of two molecules, which he conjectures to be primary combinations of them: their motion, which was more vivid than that of the simple molecule, consisted usually in turning on their longer axis, and then often appearing to be flattened.[8] The revolution of a body upon its axis, it may be observed, implies the action upon it of two equal conflicting forces, by the counteraction of which the revolution is produced and maintained: the same action on the longer fibrils[9] would keep them at rest.

My motive for introducing a topic, which, at the first blush, seems to have a very slight connexion with the subject now before me, was a suspicion that sometimes Mr Brown's molecules may have been mistaken for *Infusory Animals*. Comparing the oscillatory motion he observed in them, and Carus's observation that the motions of Infusories occasionally present the appearance of attraction and repulsion,[10] this suspicion seems to merit attention, and to call for more close examination; and it may be observed that the action of these two powers seems

1 *Brief Account of Microscopical Observations, &c.* 4.
2 *Ibid.* 5, 6. 3 *Ibid.* 10. 4 *Ibid.* 11. 5 *Ibid.*
6 *Ibid.* comp. 10, 11. 7 *Ibid.* 10. 8 *Ubi supra.*
9 *Ibid.* 11. 10 *Introd. to Comp. Anat.* E. Tr. i. 45. § 57.

sufficiently to account for the oscillatory motions of the molecules, and takes away all idea of any spontaneity. With regard to the Infusories this has been most satisfactorily established in a former part of this chapter,[1] and this clearly proves their animal nature, as do their modes of motion, &c.[2] but when we recollect that they abound in vegetable infusions, and that the more vegetables are macerated, and as it were decomposed, the more numerous are the animalcula that they appear to give out when infused, it would be nothing extraordinary either that they should be mistaken for moving molecules, or moving molecules for them. Farther we may observe a kind of analogy between the spherical Infusories and the Molecules, and between the filiform ones transversely annulated with a vermicular motion, and the fibrils of Mr Brown.

Another law of nature seems to result from the experiments of this acute naturalist—that all bodies whether organized or inorganized, are formed, as fibrin is in the animal kingdom, by spherical molecules made, as it were, into necklaces, and then adhering in bundles, and that these are the substratum of all substance. In fluids the spherules are not united, and so have free motion inter se.

NOTE 22, p. 106.—*Several of them, for it is not common to them all, when touched cause a sensation similar to that produced by the sting of a nettle.* Aristotle mentions a marine animal, under the name of *Acalephē*,[3] and another, if it be not the same, under that of *Cnidē*,[4] both of which words, according to the Greek lexicographers, are used to designate the same plant, the stinging-nettle;[5] but it seems not quite certain that, in either case, he had the stinging Gelatines or sea-nettles in his eye. Describing his *Acalephē*, he says, "It adheres to the rocks, as do some of the shell-fish, but sometimes it roves at large. It has no shell, but the whole body is fleshy. If the hand is moved to it, it perceives, seizes, and adheres to it, like the Polype, by means of its tentacles,[6] so that the flesh swells. It has its mouth in the middle, and the rock seems to serve it for a shell: if it meets with any of the small fishes, it detains them in the same way that it does the hand. Thus whatever edible thing it meets with, it devours. One kind of them is at large, and devours whatever sea-urchins,[7] or cockles,[8] it meets

1 See above, p. 81. 2 *Ibid.* 82.
3 Gr. Ακαληφη, Aulus Gellius (*Noct. Att.* l. iv. c. 11.) writes it Ακαλυφη.
4 Gr. Κνιδη. 5 Heschius explains Ακαληφαι by Κνιδαι.
6 Gr. πλικταναι. 7 Εχινοι. 8 Gr. κτενες.

with: it appears to have no excrement, in this respect resembling plants. There are *two* kinds of *Acalephēs;* one smaller, and best adapted for the table; the other large and hard, such as are produced about Chalcis. In the winter their flesh is firm—they are therefore caught and eaten at that season—but in summer they dissolve, for they become watery, and when touched they immediately are so damaged as not to be removable.[1] When suffering from the heat they withdraw within the rocks."[2] And again—"It has a mouth in the middle, which is chiefly conspicuous in the large ones; it has, like the bivalve shell-fish, a passage by which the excrements are voided, which is in their upper surface: like them too it has the fleshy part within, but it uses the rock as a shell."[3]

With regard to his *Cnidē*, of which he treats at the same time with the sponges, as inhabiting the caverns of the rocks —he says, "Of the *Cnidēs* there are two kinds, one in the hollows, which adheres to the rocks; others, that range at large, are met with in smooth places,[4] and on the flat shore."[5]

It seems not accordant with the usual accuracy of this great Philosopher and Naturalist, where he is treating formally of the same kind of object, to distinguish it by two different names, nor is it likely that he would have placed them in separate chapters, as if they were distinct things. He would surely not have devoted one whole chapter to the *Tethys* and *Acalephē*, and another to the *Cnidē* and *Sponge*, unless he had meant they should be considered as distinct animals. Still there is one circumstance that seems in one respect to indicate their identity, one species of each appears to be usually fixed, and the other free. But this, by itself, does not furnish a satisfactory proof. With regard to these *Acalephēs* or *Cnidēs* of Aristotle having any right to be considered as belonging to Linne's genus *Medusa*, it seems chiefly based upon their name of *Nettles*, which probably was given them, from a faculty they possessed of stinging, in some measure, like a nettle, a faculty which some of the *Medusas* are known to possess in a re-

1 The word I have rendered watery (μαδαρος) means properly without hairs; but μαδαω is used by Theophrastus to express moisture, and is used here evidently in a similar sense.

2 Aristot. *Hist. Anim.* l. iv. c. 6.

3 *Ibid.* l. viii. c. 2.

4 In the text it is εν τοις μειζοσι, but Athenæus reads εν τοις λειοις, which better agrees with the context.

5 Gr. πλαταμωδεσιν—it may perhaps mean flat rocks. Aristot. *Ibid.* l. v. c. 16.

markable degree.[1] But Aristotle does not appear to intimate that such an effect follows its touch, except that the fixing of its tentacles caused a swelling. If either of his species is entitled to be considered as a Medusa it must be the smaller; the larger or fixed one appears in one respect to resemble the *Amphitrite magnifica*:[2] they are stated to use the rock to which they are fixed as a shell, whence it should seem that they retire occasionally into it, like the above animal. With regard to his second species, though some parts of his description agree with the common jelly-fish, yet their devouring Echini and Cockles seems to indicate some animal furnished with a more powerful apparatus for making their way to the animal inhabiting these shells. Pliny does not in his description merely copy Aristotle; for he speaks of his sea-nettle as producing the same effect as the vegetable nettle. Yet he mentions them and the sponges as being something intermediate between the animal and the plant, which can scarcely apply to our Jelly-fish. It seems, I think, probable, that the term in question was employed by the ancients, to designate more than one group of animals, and more particularly the *Tunicaries* of Lamarck, both those that are fixed and those that are free. Aristotle's fixed species, which he describes as retreating into the rocks, as into a shell, will probably one day be found near the eastern coast of the Black Sea. It is worth while also to inquire whether any animal answering the description of Aristotle's secend species is still eaten, in the winter, by the Greeks, customs of that kind seldom changing.

NOTE 23, p. 130.—*It seems to me most probable that they are the animals, and not the pholads, as is usually supposed, which the Roman naturalists describes under the name of Dactyle.* Pliny says of his *Dactyli* that they are so called, because of their resemblance to the human nail;[3] in the Pholads this resemblance is very slight, but in the razor-shells and some tulip-shells it is much more striking. He also observes that the *Dactylus* when replete with moisture sparkles in the mouth of the eater, and

1 The stinging property of many such Tentacula, for instance, in the *Medusa* and *Holothuria*, likewise deserves notice. This, which, with some modifications, also exists in several plants, appears to be the lowest degree of the, so called, electric power in several fishes, not recurring in the higher orders of animals, and perhaps comparable as regards man, to the magnetic influence alone.—Carus. i. 47. § 60.

2 *Tubularia magnifica*, *Linn. Tr.* v. 228. t. ix.

3 *Hist. Nat.* l. ix. c. 61.

that the falling drops also emit light.[1] If Pliny, in his account of this creature, was really speaking of the pholad, it is singular he should not mention its habit of boring rocks.

NOTE 24, p. 136.—*Their byssus has long been celebrated, for it is mentioned by Aristotle.* Aristotle's mode of expression is singular. Αἱ δὲ πίνναι ὀρθαὶ φύονται ἐκ τῆς βύσσης ἐν τοῖς ἀμμώδεσι καὶ βοβρωδέσιν. He says also when they are deprived of the pinnophylax, they perish.[2] Pliny, who mostly copies Aristotle's account, does not notice the byssus.[3]

1 His natura in tenebris remoto lumine, alio fulgere claro; et quanto magis humorem habeant, lucere in ore mandentium, lucere in manibus, atque etiam in solo et veste decidentibus guttis. *Ibid.*

2 *Hist. Anim.* l. v. c. 10.

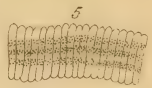
3 *Hist. Nat.* l. ix. c. 42.

# INDEX.

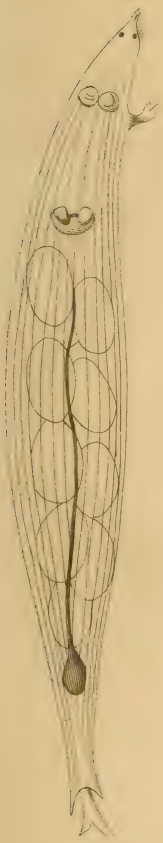
THE END.

A

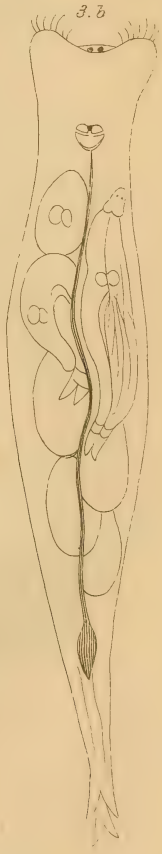


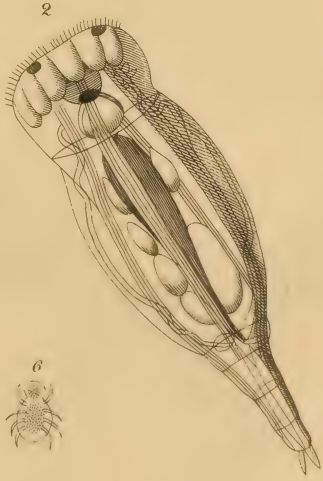















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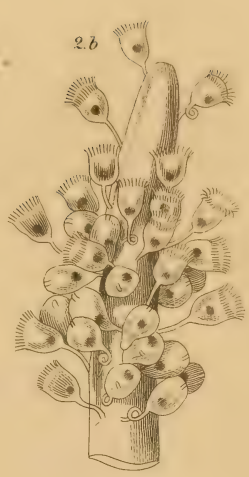


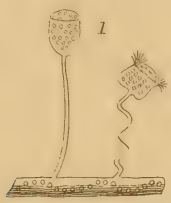


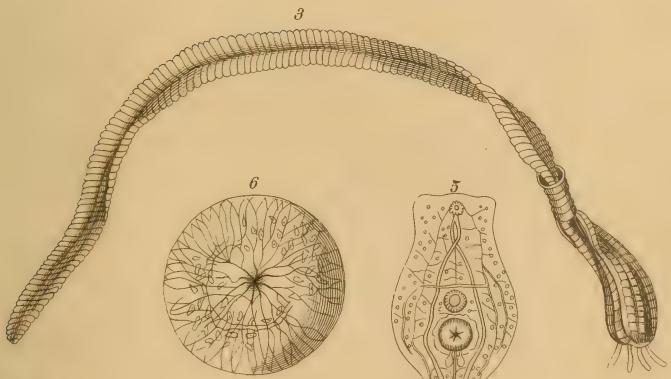






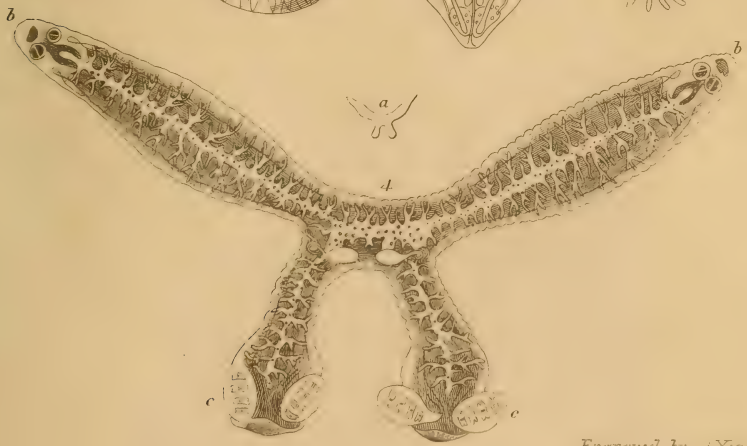


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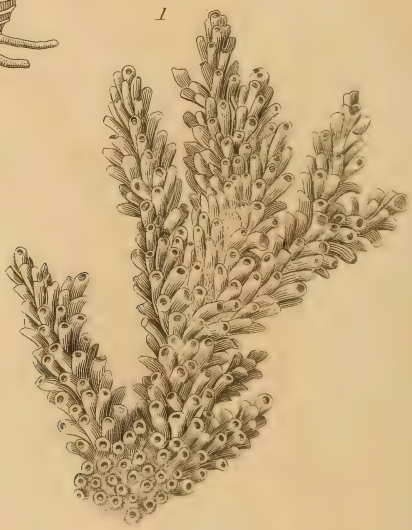


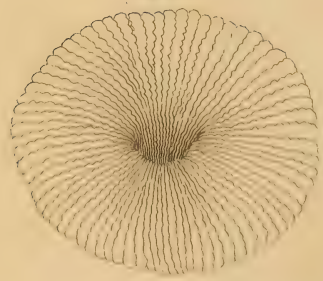


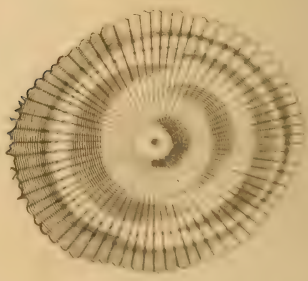


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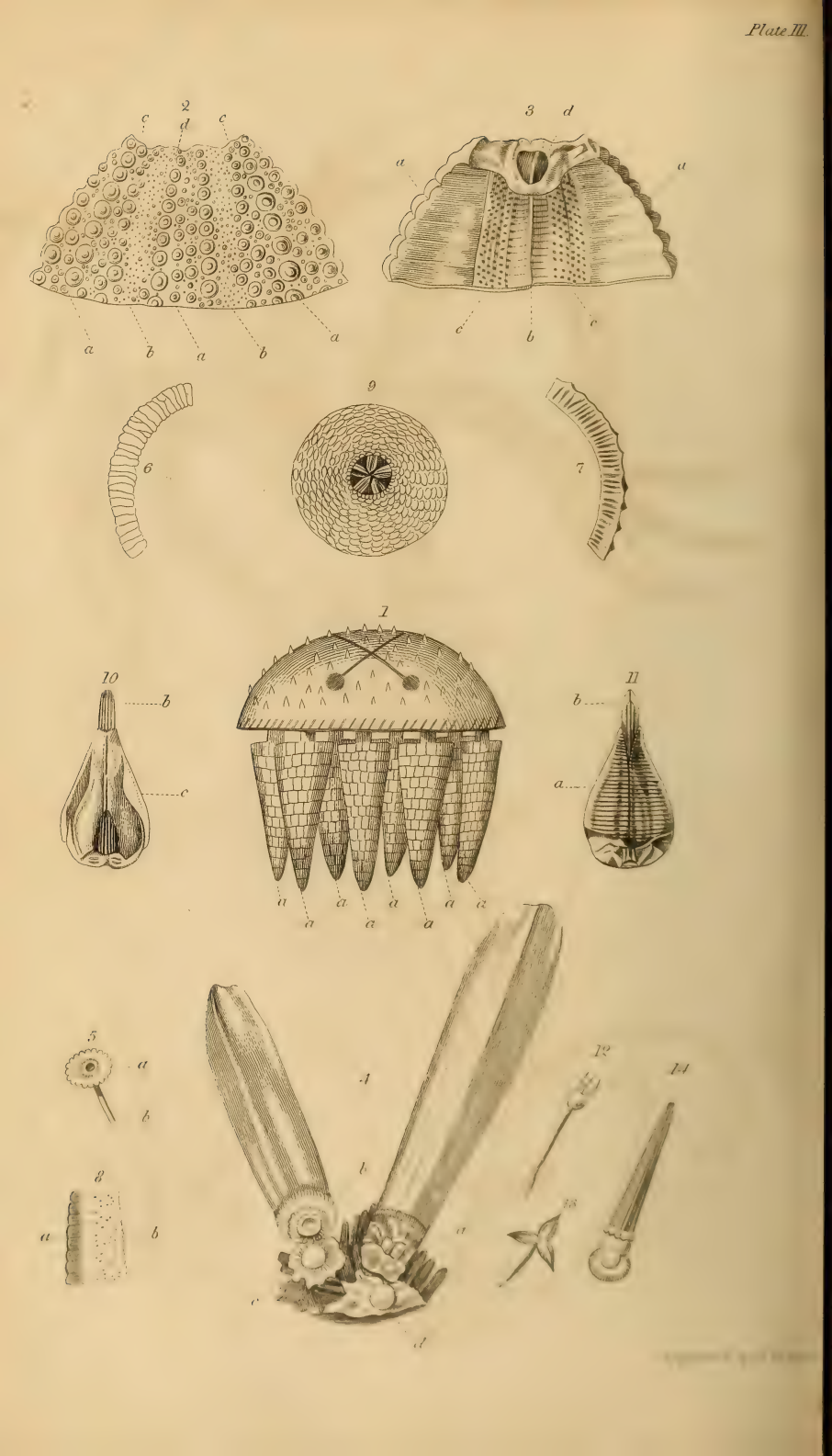
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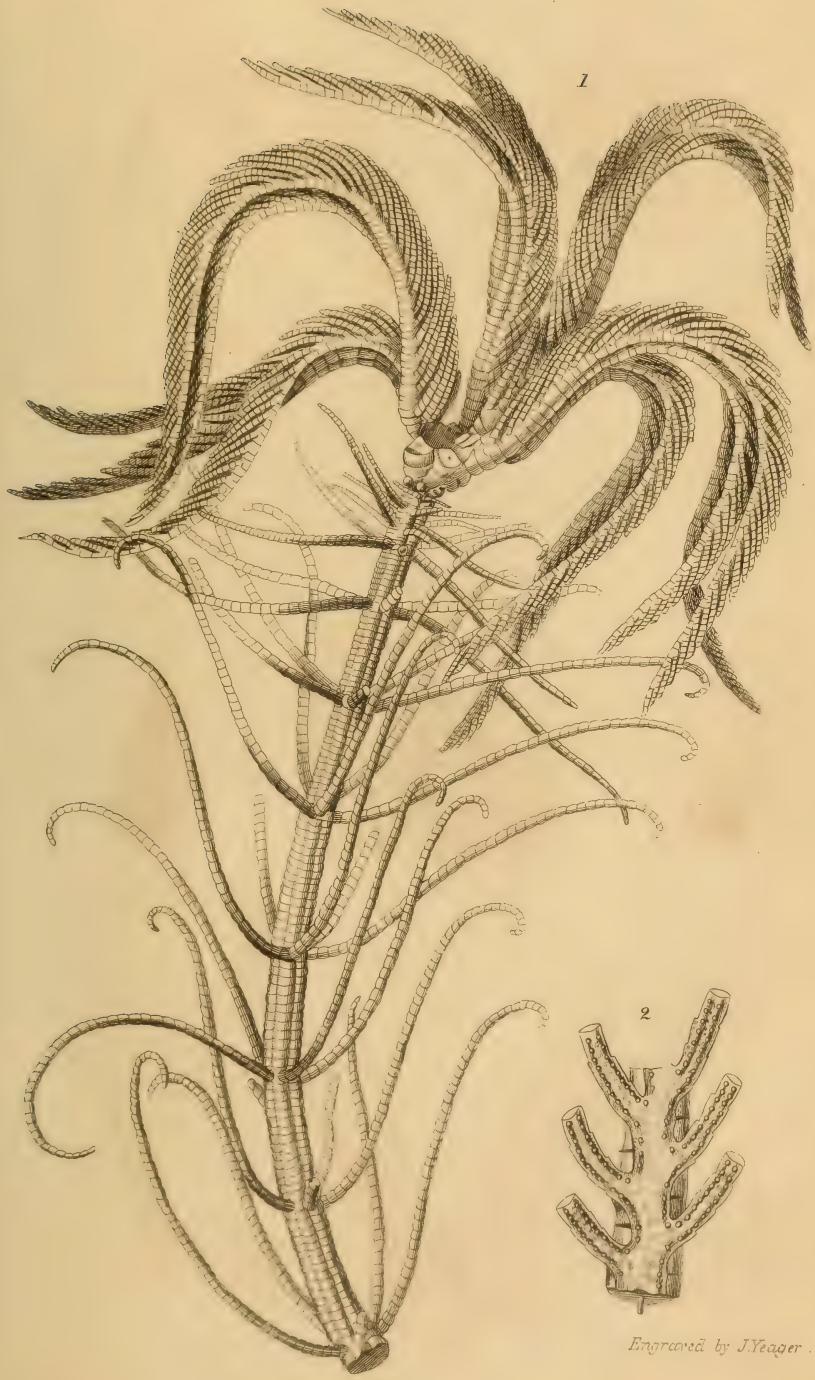


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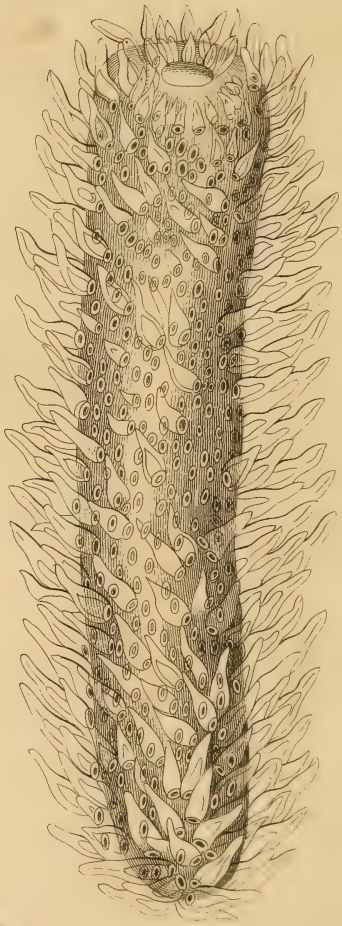

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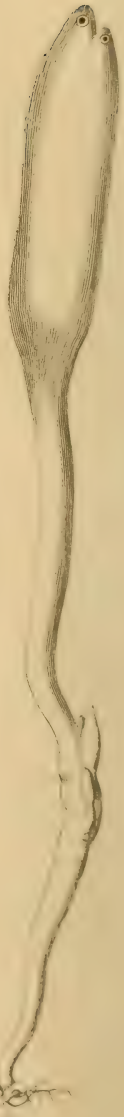

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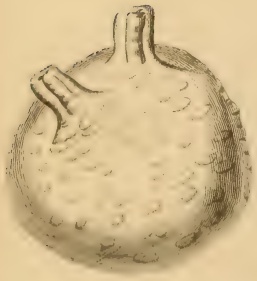

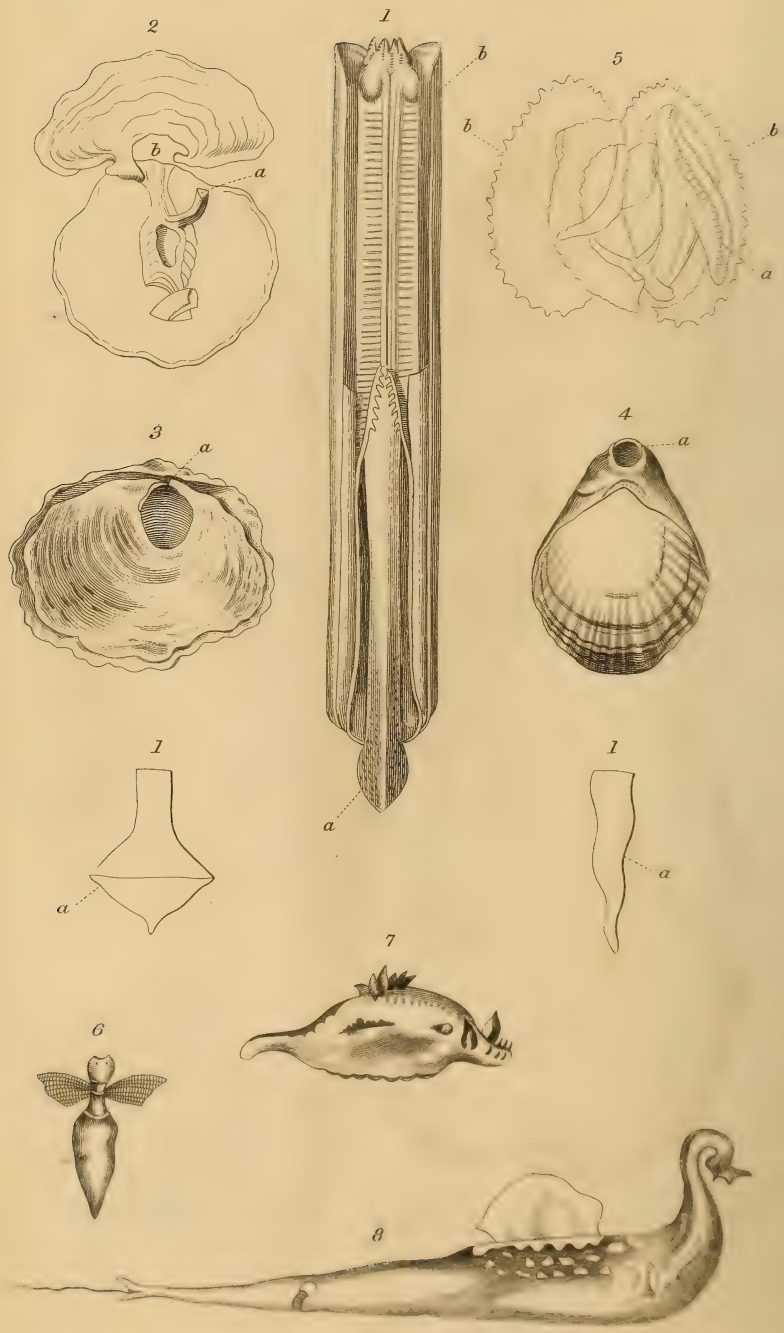


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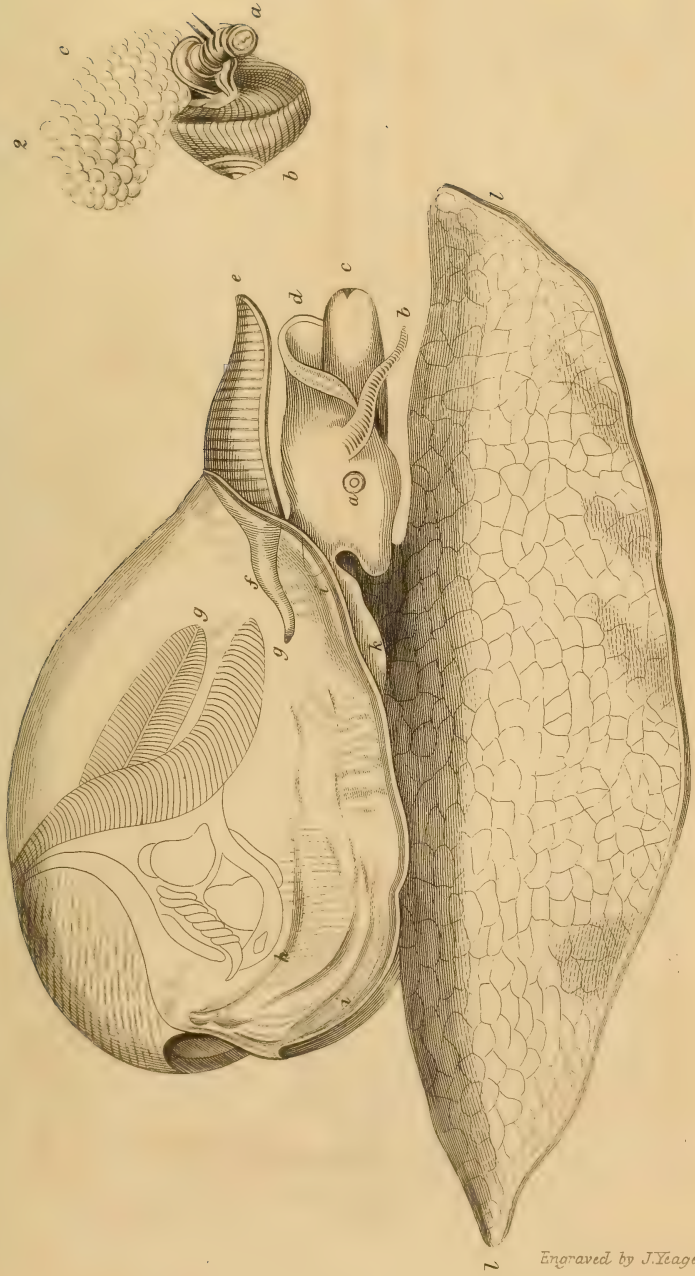


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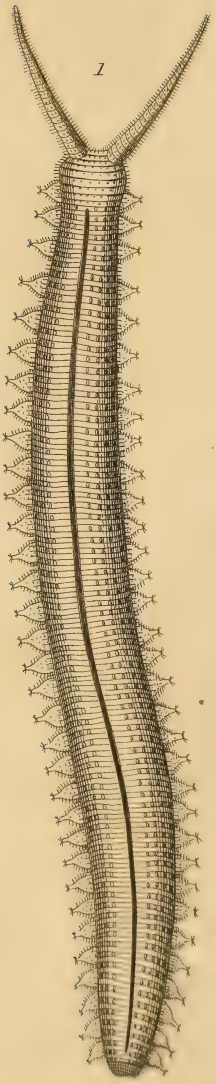
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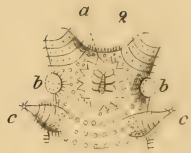
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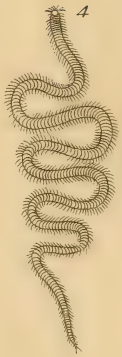
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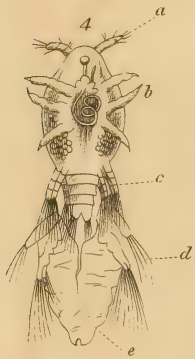


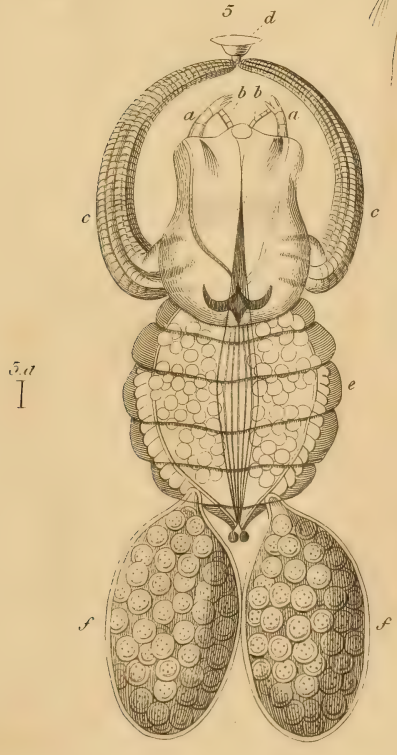


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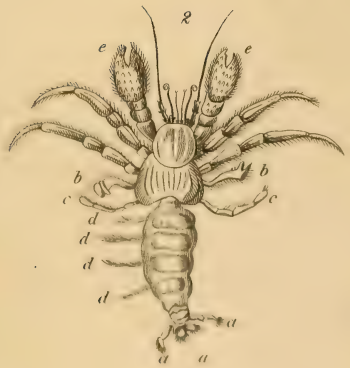
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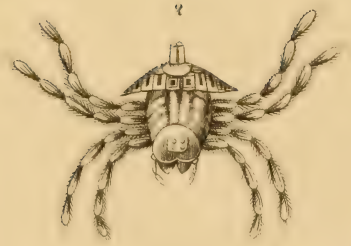

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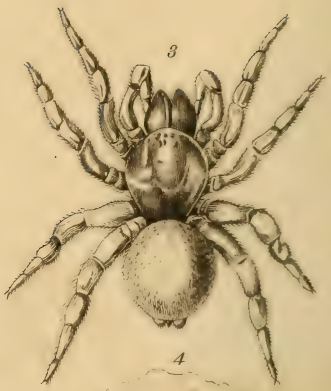
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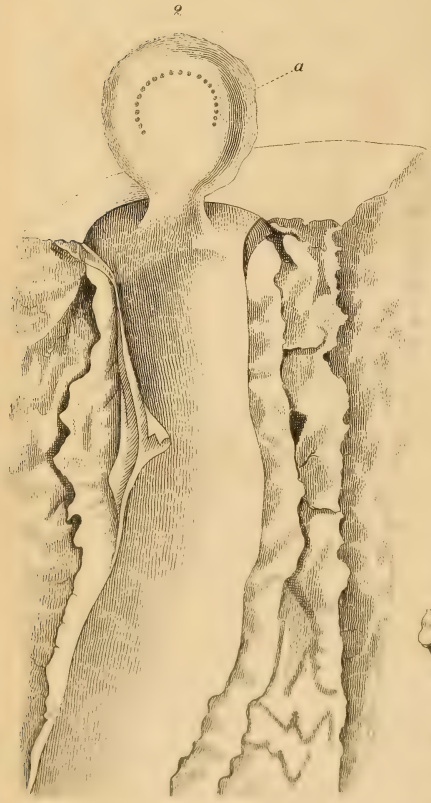
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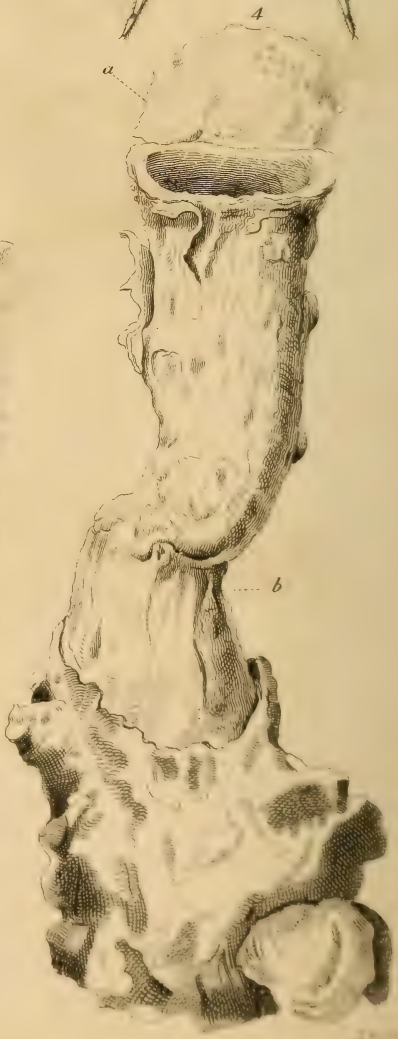
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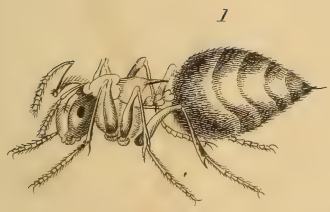
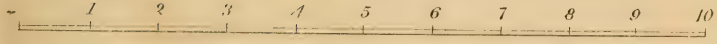




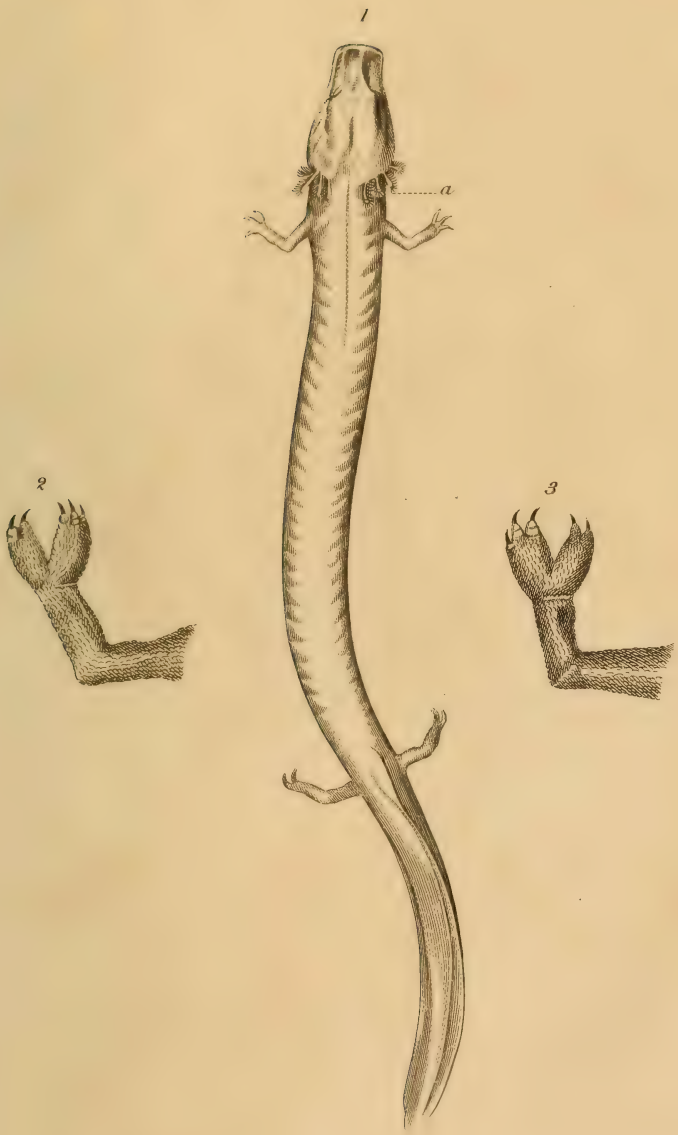

*Myrmica Kirbii Sykes*

*Scale of Inches*




2
1
a


Engraved by J. Yeager.




Engraved by J. Yeager.