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THE EDINBURGH NEW PHILOSOPHICAL JOURNAL,

EXHIBITING A VIEW OF THE

PROGRESSIVE DISCOVERIES AND IMPROVEMENTS

IN THE

SCIENCES AND THE ARTS.

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THE

EDINBURGH NEW

PHILOSOPHICAL JOURNAL.

Mountain Climates considered in a Medical Point of View. By Dr H. C. Lombard.*

What is the effect of a mountain residence on the course of diseases? Such is the question which has often presented itself to me in the course of my medical practice, and on which it has been my wish to collect a few observations, very incomplete it is true, but at the same time very little known. I have been unable, indeed, to find in medical literature any particular work devoted to this subject, and it has appeared to me that some benefit would arise from supplying this want in the science.

In speaking of a residence on elevated situations, the first question that presents itself is, what is a mountain climate, and what are its meteorological characteristics? In order to answer this question I examined works on Meteorology, but not finding there the desired information, I applied to Professor Plantamour, who has had the kindness to furnish me with very valuable particulars.

In the second place, I have availed myself of various sources, in order to study the physiological and pathological modifications impressed on living bodies by a residence on heights.

With regard to influences of a purely physiological nature, I have found all the materials requisite for answering the question in a recent work by Dr Meyer-Ahrens of Zurich

* From the Bibliothèque Universelle de Genève.

The pathological influences of mountain climates, being a subject greatly more complicated, I have found it necessary to undertake numerous researches in reference to them.

On this point, the works of Dr von Tschudi on the diseases usually met with in the very elevated regions of our globe, have furnished me with very valuable information. In regard to countries of inferior elevation to Peru or Bolivia, I have obtained very complete documents, for which I am indebted to the bibliographical researches kindly made for me by Dr Appia. But as there are, notwithstanding, many questions which cannot be answered by means of the works that have been published on this subject, I have availed myself of the knowledge of many of my colleagues, who have readily replied to my inquiries as to the result of their observations on the diseases most extensively diffused among the mountaineers of different countries.

Professor Bertrand of Grenoble, and Dr Albert of Briançon, have made me acquainted with the predominating character of the morbid affections which prevail among the Alps of Dauphiny. Professor Savoyen of Moutiers, and Dr Michon of Chamounix, have rendered me a like service in regard to Tarentaise and the valley of Chamounix. Many practitioners in our vicinity have conferred a similar favour with reference to the diseases most prevalent in the Jura and adjoining districts of Savoy. Lastly, my excellent friend, Dr Lebert, who practised for a long period in the neighbourhood of Bex and Saint Maurice, before being appointed Professor at Zurich, has communicated to me a work in manuscript from which I have derived most valuable information on the subject before us. With the advantage of all these documents, for the most part unpublished, I have been enabled to trace the outlines of the picture of *Alpestrine Pathology*.

Proceeding, after this, to examine the effects produced by a residence among mountains, both in the case of invalids, and of healthy individuals, I have been led to draw some practical conclusions as to the maladies which may be combated by this means, and at the same time as to such as are aggravated by the bracing atmosphere of high lands.

Lastly, after having reviewed the different alpine localities which may be selected for the purpose in question, and explained the hygienic precautions necessary for success in a mountain residence, I have come to some practical conclusions as to making the best choice between different localities, keeping in view the particular disorder which we wish to counteract.

It is thus seen that the medical history of mountain climates touches on many questions in Meteorology, Geography, Physiology, and Pathology. In order to discuss it with advantage, therefore, a great number of facts must be brought under our observation, and even after this has been done, I can regard this work only as the commencement of an investigation, which others, with fuller information, may turn to better account, and render more useful to science than I have succeeded in doing.

I.—*What are the Meteorological characters of Mountain Climates?*

If we compare the great plains of Europe with the countries in the vicinity of the high Alps, we may assign the name of mountain climate to that of the principal valleys of Switzerland, the Tyrol, or the Pyrenees. It is not, in fact, necessary that a country should be in the immediate vicinity of mountains in order to have its climate modified by the presence of snow, the frequency of fogs, and the intensity of aerial currents, for we can recognise even in the climate of our valley some of the characters peculiar to the atmosphere of mountains. We can observe the frequent falls of rain in the districts adjoining the Jura, the accumulation of fogs formed on the heights, and which the north wind gathers in masses over our heads, as they are arrested by Mount Sion in front, the Salève on the one side, and the Jura on the other. Lastly, we may observe the sudden sinking of the temperature when the rains of the plain are converted into snow on the summits of the surrounding mountains. All these meteorological circumstances may be considered as being, in some degree, characteristic of alpestrine climates, if we compare them with the plains of France, Germany, or Lombardy. But it is our wish to confine the subject which now engages us to more elevated localities, and direct attention chiefly to such as are situated at a height more or less considerable above the neighbouring valleys.

Even with this limitation, the question of the meteorological characters of mountain climates is not sufficiently simplified. For, in examining each locality, we must take into account not only the absolute elevation above the sea-level, but also the exposure; recollecting that no comparison can be instituted between the northern and southern declivity of a mountain chain; and that, owing to the disposition of the surrounding hills, two localities situated at the same height may possess an entirely different climate. Such is the case, for example, with Montreux, compared with other villages in the neighbourhood, which have not the same advantage of being completely sheltered from the north wind, and receiving the solar rays during great part of the day. Such, likewise, is the case with Mornex, which, from its position on the eastern and southern slope of the Little Salève, enjoys a very different climate from the surrounding villages, and in particular from Monnetier, whose temperature is much colder, to a degree altogether disproportionate to the difference of level between two localities so near each other.*

With these preliminary reservations, we may now proceed to consider the subject of mountain climates, taking as points of comparison, Geneva and the Hospice of St Bernard, the height of which, according to the recent measurement of Professor Plantamour, is 8230 feet above the level of the sea. Various considerations operate in favour of the choice of these two localities as terms of comparison. The first is, that at both of them numerous meteorological observations have been made according to the most approved method, and with the most trustworthy instruments, so that these two series of observations may be considered as admitting of the most rigorous comparison with each other. A second reason for the selection of the Hospice of St Bernard as a type of this kind of climate is, that it is the most elevated spot in

* The height of Monnetier is 2335 feet; that of Mornex about 820 feet lower.

Europe permanently inhabited, and as such can present us with the most correct observations, and at the same time the most conspicuous features of alpestrine climates. Lastly, a consideration of the utmost importance, in my estimation, is the opinion of Professor Plantamour, who regards the comparison instituted between Geneva and the Hospice of St Bernard as admitting of being applied to all the mountains of the temperate zone, and as capable therefore of deciding the question with which we are occupied. This opinion M. Plantamour has confirmed by investigations, the result of which he has communicated to me in a manuscript note, from which I shall extract the principal conclusions.

"The difference between a mountain climate and that of a plain may be briefly stated as follows:—

"1*st*, *Temperature.*—This diminishes with the height. The decrease between Geneva and St Bernard is one centigrade degree for 616 feet of height; but, as the mean temperature of Geneva is lowered by the vicinity of the lake, this figure indicates a slower decrease than that generally observed in the temperate zone, that is, about one degree in 557 feet. The range of the diurnal variations is less at St Bernard than at Geneva. The maximum comes sooner, the minimum later.

"The range of annual variations diminishes as we ascend.

"2*d*, *Atmospheric Pressure.*—This diminishes with the height, which likewise tends to render the diurnal variations less extensive than in the plain, while the contrary is observed in the annual variations of the barometer.

"3*d*, *Humidity of the Air.*—The absolute quantity of vapour contained in the air naturally diminishes with the temperature. With regard to the relative humidity, or the degree of saturation, the annual mean does not present great differences in the two stations, while the monthly and diurnal variations are much smaller at St Bernard than at Geneva.

"4*th*, *Rain or Snow.*—Of these the annual quantity is one and a half, or twice greater at St Bernard than at Geneva, especially in winter.

"5*th*, *State of the Sky.*—There is little difference with regard to the state of the sky, on comparing it throughout the year in the two stations, but while the summer is the most cloudy season at Geneva, it is winter that is clearest at St Bernard."

From the observations just given, and also from the information contained in the works of meteorologists, we obtain the means of characterizing mountain climates, on comparing them with the neighbouring plains and localities which have the same exposure.

We may affirm that the air of mountains is colder the more elevated they are; but, at the same time, the temperature is more uniform, so that one is much less exposed than in the plain to those sudden variations which frequently take place in the course of a single day.

The atmospheric pressure diminishes with the height, and this difference in the weight sustained by the human body, gives rise to various phenomena to which we shall again recur when treating of the modifications produced on our organs by a residence in an alpestrine climate. At present we may merely mention the rapidity of evaporation, which increases with the diminution of atmospheric pressure. The higher, therefore, a locality is above the sea, the drier will be the air, and the more speedily will it extract moisture from the bodies exposed to it.

This last remark leads us to examine the question of the greater or less degree of dryness in the atmosphere of mountains.

There is, in the first place, a great diversity of opinion among meteorologists, as to the relative humidity or precise degree of saturation. Some, such as De Luc and De Saussure, infer, from their observations on Mont Blanc, that the air of high mountains is much drier than that of the plains. Others, such as Kæmtz and Bravais, have found the air on the Righi and Faulhorn sometimes drier and sometimes moister than in the plain.* Finally, Professor Plantamour has come to the conclusion, from a long series of observations made at Geneva and St Bernard, that if we consider the annual means, there is no very notable difference between the mountain and the

* Cours complet de Meteorologie; translated by Ch. Martins. Paris, 1843.

plain. But if we compare the diurnal or monthly variations, we shall find a much greater degree of uniformity in the elevated situation, We thus definitely ascertain that the inhabitants of elevated regions are not subjected to those changes in the humidity of the atmosphere which are so frequent in lower countries.

Three circumstances should contribute to render the air drier on heights; *first*, the facility of evaporation under diminished atmospheric pressure; *secondly*, the frequency and intensity of aerial currents on the summits and sides of our Alps; *thirdly*, the power of the solar rays, which rapidly dry the earth and organized bodies. Exposure for a few minutes to the heat of the sun, in this rarefied air, is sufficient to dry the face, and cover the unprotected parts of the body with blisters, as we shall afterwards learn. At present we allude to these different phenomena only in as far as they are connected with the dryness of the air.

It is true that the difference of temperature in the different atmospheric strata causes the condensation of the vapours in elevated places; hence, in the latter, there is a more clouded sky, and more abundant rain, as we have seen in regard to St Bernard, where the quantity of rain and snow is nearly double that which falls at Geneva. But, as has been seen, a greater degree of humidity in high districts is not produced by this; and this is no doubt owing to the sloping position of most alpine localities, and the strength of the currents of air, which do not permit the moisture to obtain a lodgment in the soil. As the last property of the atmosphere of elevated regions, I may mention the absence of dew at sunset, a circumstance eminently favourable to invalids and such as are convalescent, as they may remain pretty late in the open air without apprehension of that sensation of damp chillness which is so dangerous in other places.

To recapitulate briefly what has been said; it may be affirmed that we find in elevated situations an atmosphere colder and more steady, both in regard to temperature and humidity, and also more frequently renewed, than in the adjoining plains. With such properties, mountain climates ought to possess great value to such as dread the heats of summer, who are tried by sudden thermometrical or hygrometrical changes, and who stand in need of a more vivifying air than that of the plains. We shall afterwards see where and in what manner the objects sought for may be best attained.

II.—*What is the Physiological and Pathological Influence of Mountain Climates?*

The differences of temperature and humidity which have been indicated between countries situated at different heights, present no character exclusively peculiar to them, and which may not likewise be found in other localities placed at the same level above the sea, although in different latitudes. Such, however, is not the case with atmospheric pressure, which can never have the same character at different heights. We may sometimes observe the barometer descend a certain number of millimetres, but we never notice differences like those which exist between Geneva and St Bernard, or between the sea-shore and the summit of the Righi or Mont Blanc. There exists, therefore, in mountain climates a new element of great importance, that is, a less degree of atmospheric pressure, and consequently air of less density, as well as a decrease in the quantity of oxygen necessary to sustain life by means of respiration. It is to these last two circumstances that we must ascribe, in a great measure, the phenomena observed on high mountains, and to which I wish for a short time to direct the attention of my readers.

On applying to physical science, we shall be informed that the entire weight of the atmosphere represents as many times 300 *kilogrammes* as there are square decimeters on the surface of our bodies; so that, according to the stature of different individuals, the total weight supported by our organs will vary between 15,000 and 20,000 *kilogrammes*. On leaving, therefore, a country more or less nearly on a level with the sea, in order to repair to a higher locality, our bodies will be subjected to less degree of pressure in proportion to the elevation. It is easy to understand what degree of disturbance our organs must undergo when the enormous weight which they habitually bore has been diminished by a sixth part, a quarter, or even a third, as has been observed on the Righi, St Bernard, and the top of Mont Blanc. And if we add to this diminution of pressure the no less important change which takes place in the density of the air, and consequently in the quantity of oxygen, we shall have little difficulty in accounting for the various disturbances which take place in the respiration, circulation, locomotion, and digestive functions, of those who have ascended the lofty peaks of our Alps, and made them for a time their place of abode.

In the appearance of the symptoms just spoken of, it is not easy to say what portion we are to ascribe to the diminished pressure, and the insufficient supply of oxygen. The respiration and circulation should be alike modified under these two influences, and ought to react on the muscular strength. On the other hand, as recent investigations have shown that it is owing to atmospheric pressure that the head of the thigh-bone is kept within the cotyloid cavity, it is evident that the diminished weight of the air must render the movements more difficult. We thus come to the conclusion, that the appearances produced in living bodies, when transported to great heights, are the result of the two meteorological facts in question—a diminished pressure, and a smaller quantity of oxygen.

After these preliminary remarks, bearing on certain theoretical questions necessary for understanding our subject, let us now proceed to consider the modifications in our organs, whether physiological or pathological, occasioned by a more or less prolonged residence among mountains.

With a view to facilitate the study of the phenomena observed in man and animals, we shall divide the localities which form the subject of our observation into two classes; those which are situated *above* 6560 *feet*, and which, for the sake of shortness, we shall call *Alpestrine climates*. We shall then describe the effects produced by *Alpine* or *sub-alpine* climates, that is, such as characterize localities situated *below* 6560 *feet*, and which contain the greater part of the villages or establishments to which patients are sent.

The investigations which follow present themselves under two very distinct aspects. It is found that some of the changes which take place under the influence of mountain climates extend no farther than to modify the play of our organs, without inducing serious or prolonged derangement, and may consequently be termed *Physiological.* Others, which may be nothing else than a continuation or aggravation of the former, exercise an action sufficiently powerful to give origin to some disease, and consequently fall under the domain of Pathology. Let us consider these twofold consequences of an abode in alpestrine and alpine climates.

§ 1. *Physiological and Pathological influence of Alpestrine Climates* (above 6560 feet).

The effects produced by the ascent of high mountains, or by a residence in the elevated regions of our globe, have been frequently studied, both among the Alps and Pyrenees, and also in the chain of the Andes, under circumstances which cannot be realized in Europe. Indeed, notwithstanding the important labours of De Saussure, Bravais, and Martins, on Mont Blanc, at a height of 15,744 feet; those of Desor and Agassiz, on the glaciers of the Aar, at a height of about 13,120 feet; it must be remembered that these observers could remain but a short time in regions so desolate and incapable of furnishing adequate shelter for a lengthened abode. But this is by no means the case in South America, where valleys and plateaux are to be met with in the chain of the Andes permanently inhabited, although their elevation is from 11,840 to 13,120 feet.* One of these, is particular, is the valley of Puna, where our countryman, Dr Tschudi,† resided for a long time, as well as in many other regions of the same nature. He informs us that, in Peru, they use the name *mal de puna* to indicate the effects produced by high situations on those who visit them, or live for a longer or shorter period upon them. The inhabitants of these elevated regions likewise call it *sorroche* or *mareo.* The last of these designations establishes a pretty correct comparison between sea-sickness and the influence of heights on the human body.

* See the list of these various localities in the *Annuaire du Bureau des Longitudes.*

† Reiseskizzen in Perou. Sanct. Gallen, 1846.

A perfect identity has been found to exist among the effects produced on living bodies in whatever part of the world they have been observed, insomuch that all these facts may be united in a single view, and distinguished by the same name, *the mountain sickness* (*le mal de montagne*). This has been done by Dr Meyer-Ahrens of Zurich, in a work lately published at Leipsic.* Considering, with this author, the principal changes produced in our organs by the ascent of high mountains, or a residence in Alpestrine valleys, we shall pass successively in review those which arise in the functions of digestion, locomotion, circulation, respiration, and, finally, such as affect the nervous centres.

The digestive organs undergo considerable modification, indicated by an ardent thirst, with a desire for water and other cooling liquids, and an aversion to wine and other strong liquors. De Saussure, who has often experienced this sensation, has however remarked, that if this repugnance be overcome, the use of spirituous liquors, in moderate quantities, entails no disagreeable consequences, but on the contrary recruits the strength without causing intoxication; he has often observed that a draught which would inebriate in the plains no longer had that effect on the mountains. The appetite is sometimes increased, but for the most part it is destroyed altogether, and the distaste for food is so decided, that in trying to overcome it, nausea and even vomiting supervene. This I have myself experienced after having climbed, without stopping, from the foot to the summit of the Great Salève, which formed an ascent of nearly 3280 feet.

One of the effects of elevation is, that the muscular strength is weakened; the least exertion is attended with great fatigue, even in men of the greatest vigour. Beasts of burden lose their strength even more speedily than men; they become short of breath, and are obliged to stand at every step, and, if forced to continue their journey, they soon sink, and their carcases may be seen lying in the elevated passes of the Andes.

The circulation and respiration are obviously quicker than

* Die Bergkrankheit oder der Einfluss des Ersteigens grosser Höhen auf den thierischen Organismus; in 8vo, 1854.

on the plain; the inspirations are deep and quick or gasping (*saccadées*); the heart beats forcibly, and often with quickness double that of its ordinary state. This was observed by Dr Meyer during his ascent of the Jungfrau. It must not, however, be supposed that this acceleration of the pulse is owing only to the muscular efforts occasioned by the ascent, since Dr Tschudi observed it in his own case, although he was on horseback. It was likewise remarked by Gay-Lussac and Biot, although they were motionless in a balloon, at the height of 8370 feet, the pulse of the one rising 22 beats, that of the other 32.

The nervous system likewise presents some important symptoms, such as vertigo, somnolency, pains in the head, sometimes very severe; frequently, also, a complete and sudden prostration of strength, so as to render all movement impossible; a condition for which even fatigue can in no degree account, and which must be ascribed to a particular state of the nervous system. Some travellers have experienced a feeling of lightness, as if their bodies were no longer in immediate contact with the earth; others have felt a pressure from below upwards under the soles of the feet; often, also, hummings in the ear occur, and the motion of bubbles of air in the Eustachian tube.

Lastly, various other symptoms are observed depending on the dryness and rarefaction of the air, both of which are remarkably promoted by the evaporation. It is under this influence that the ardent thirst of which we have spoken is developed, and which is no doubt caused by the desiccation of the walls of the mouth and the air passages; chaps also make their appearance on the lips and other parts of the skin exposed to the action of the air.

Such is a view of the phenomena usually observed in man when transported to the higher regions of the globe. Animals also present various symptoms, which must not be passed over without notice.

The inhabitants of the Andes, who are of Spanish origin, have been desirous to carry with them their favourite amusement of bull fights into the high valleys of Bolivia, as, for example, to Paz, a town situate 12,234 feet above the level of the sea. But they found themselves quite unable to rouse the combative energies of these animals, now become gentle and peaceable; and, far from tearing each other, they became weak and breathless after a few frail efforts, and were seized with continual vomitings; a grievous disappointment to the spectators who, instead of the sanguinary struggle they expected, found themselves assisting at what may be called a medico-veterinary case.

Cats cannot live at an elevation above 13,000 feet; carried to this height, they invariably sink after being seized with very singular shocks of tetanus. At first they show only irregularity in their movements, as if affected with St Vitus's dance; but these shocks afterwards become more and more severe, they make prodigious leaps, as if they wished to scale the rocks or the walls of the houses; after these violent efforts, they fall exhausted with fatigue and die in convulsions.

Dogs bear up longer than cats, especially if they have been whelped in the country. Conveyed to these regions, they may continue to live there for one or more years, although seized with convulsive movements very like those observed in young dogs, when attacked with the dog-malady.

Rabbits can live at a great elevation, although it is asserted that they then become barren. Gallinaceous birds soon perish. Horses and mules, although they suffer much, at length become acclimated. A great number of them die from the effects of fatigue disproportionate to their muscular strength, in an atmosphere so rarefied as that we are now considering.

After having noticed thc different symptoms which characterize the mountain sickness, it remains for us, before concluding, to say a few words on the circumstances which favour its development, its duration, and appropriate treatment.

The circumstances which appear to favour the development of this morbid affection in those who are seized with it, are, an unusual degree of fatness, a vigorous constitution predisposed to congestions, and birth in a flat country, which renders residence in a different region greatly more difficult. With regard to meteorological considerations—the dryness of the air appears to contribute to its development, as those affected suffer much less in rainy weather, or when the air is charged with moisture.

The various symptoms of the malady in question are not of equal duration. If they are caused by the ascent of a mountain they usually disappear with rest and return to the plain. If the stay on the heights has been prolonged for some time, most of the disturbances in the nervous system and digestive organs commonly disappear at the end of ten or twelve days. But lassitude and dyspnœa last for a longer time; a space of many months, sometimes even of some years, is necessary to make them completely disappear, particularly in those who come from a flat country.

Some travellers allege that a person is attacked by the mountain sickness only once; but this is not strictly correct, although in every case the first attack is always the most severe.

The most suitable treatment to counteract the symptoms in question consists, in the first place, of rest, and the use of some kind of spirits, when they have been occasioned merely by the fatigues of the ascent, as their influence, in that case, does not extend beyond a few hours or days. But when a prolonged visit has been made to the high regions, it is necessary to have recourse to a prophylactic treatment, and a rational use of medicine. Experience has shown that an aromatic infusion is an excellent preservative against the dyspnœa and vomiting. Tea appears to answer this purpose pretty well; but, among the Andes, great importance is attached to an infusion of the leaves of *Erythroxylon Coca.* The Indians always carry some of these with them, sometimes keeping them in their mouths, and sometimes making an infusion of them. Dr Tschudi found much advantage from them when he went to hunt in valleys between 10,000 and 13,000 feet above the sea. The inhabitants of the country likewise employ for the same purpose, and in the same manner, cloves of garlic, with which they rub their mouths and faces. By these means also they restore some degree of strength to the beasts of burden when they are short of breath and exhausted.

With regard to the rational treatment, it must depend on the form the malady assumes. If it is accompanied with faint-ing, paleness of countenance, and vomiting, it is necessary to have recourse to stimulants, which can then be taken in large doses without producing intoxication. But more frequently the disorder takes the form of inflammatory fever, with a tendency to cerebral or pulmonary congestions ; an antiphlogistic treatment is accordingly for the most part recommended. It consists in one or repeated bloodlettings, in the use of fruits, acidulated and purgative draughts, such as cream of tartar and the pulp of tamarinds. Absolute rest in a darkened chamber, kept at a proper temperature, contributes equally to the cure.

Besides the mountain sickness, such as it has been described, other morbid affections are likewise observed in the elevated districts of our globe, which we shall consider in succession, availing ourselves of the researches of various authors, and more especially of those of Dr Tschudi, who has published the result of his medical experience during his residence in Peru and Bolivia.*

One of the most striking features in the pathology of the higher districts, is the frequency and severity of every kind of hæmorrhage. Under the influence of diminished atmospheric pressure, and also in consequence of the dry and essentially tonic state of the air, we meet with frequent cases of hæmoptysis, epistaxis, hæmatemesis, and melænas, so severe as to cause death. In certain regions of Peru there occurs also a kind of purple hæmorrhage, characterized by pustules and boils, which sometimes terminate in suppuration, and sometimes permit the escape of a considerable quantity of blood ; from one of these swellings Dr Tschudi has seen upwards of six pounds of pure blood issue. Along with these local symptoms fever supervenes, with cramps, pains in the joints, dysphagia, and great anxiety. This disease which has received the name of *veruga*, appears to be peculiar to Peru, and even to be confined to certain valleys where it prevails as an endemic.†

After hæmorrhages, inflammatory diseases are those which occur most generally in the high regions of which we are speak-

* Œsterreichische Med. Wochenschrift, 1846. Communicated by Dr Endlicher.

† Le Veruga. Maladie endémique dans le Perou. Archives der Physiologischen Heilkunde, Von Rosas, 1845.

ing. When they affect the nervous centres, they are as rapid in their progress as they are formidable in their consequences. The mountain sickness is often succeeded by an eruption very like urticaria, the phases of which ought to be watched with great care, for if the eruption become pale through cold or from any other want of caution, symptoms of cerebral excitement make their appearance, followed by stupor, coma, and death, in the course of a few hours. Dr Tschudi has often succeeded in arresting this formidable meningitis by means of copious bleedings, and the most energetic antiphlogistic treatment. There is another form of cerebral inflammation (meningitis) of very frequent occurrence among the Peruvian Indians as a consequence of alcoholic intoxication. This disorder is of a very formidable character, since scarcely one out of ten survives it, and it is so frequent that Dr Tschudi assigns to it one-third of the acute diseases of Puna. Nothing equals the rapidity of its progress, for from any excess in drinking, death often follows in the space of six or eight hours. These facts indicate a connection with the meningitis which prevails as an epidemic in the north of Europe, chiefly among soldiers, and which likewise causes death in a few hours.

With regard to pulmonary inflammations, they likewise partake of the acuteness and rapidity which have just been referred to, being almost always accompanied with pleuritic pains, so severe that even the apathetic Indian writhes like a worm under them, and betrays his suffering by the most significant gestures. But while the cerebral inflammations demand an active antiphlogistic treatment, this is not the case with the pleuro-pneumonia of Puna, which cannot be counteracted by bleeding. This method of treatment must indeed be avoided, not only as unavailing to effect a cure, but as even dangerous, for the patient not unfrequently sinks under the loss of blood. The stimulating treatment practised by the Indians ought therefore to be preferred, which consists in the use of strong doses of cayenne pepper (capsicum). Under this treatment copious transpirations take place, which are not long in removing the pulmonary symptoms. Inflammation of the inner parts of the mouth, of the larynx and bronchiæ, are also frequently observed in Puna.

The skin often becomes chapped, particularly in the parts exposed to the contact of the dry air of these regions; a prickling is felt in the face and hands, accompanied by a burning sensation; they then become covered with small cracks, which are followed by a pretty thick scurf. This disorder, which seizes new-comers, is known in Puna by the name of *choun.* It is easily cured by confining oneself for a considerable time to a close apartment, kept at a moderate temperature.

The other diseases of the skin met with in the same circumstances are erysipelas and urticaria.

Along with these, erysipelatous rednesses, and, under the influence of the dried air of these lofty regions, as well as the reflection of the light from the snow, very severe cases of ophthalmia make their appearance; six out of eight of Dr Tschudi's guides were attacked on the same day, and he himself escaped only by great precaution. He compares this ophthalmia with that of Egypt, and regards it as contagious by means of the purulent secretion which falls from the affected eyes. The Indians suffer much more from this disease than the Creoles, who are better acquainted with the means of guarding against it. If it be neglected, and the inflammation become very severe, it often ends in different kinds of chronic affections of the eyes, such as pannus, hæmophthalmia, hypopion, chemosis, ectropion and staphyloma, which often occasion total blindness.

(*To be continued.*)

Notes on the Food of some Fresh-Water Fishes, more particularly the Vendace and Trout. By W. Baird, M.D., F.L.S., &c.

When we consider the immense value of the fisheries of Great Britain, foreign and domestic (calculated some years ago by Mr Barrow* to produce not less than eight millions sterling annually), the investigation into the nature of the food of fishes is

* Encyclopædia Britannica, Art. *Fisheries.*

evidently one of no small importance. The difficulties attending upon a complete knowledge of the subject are no doubt many and great, especially with regard to the marine species, arising chiefly from our want of information as to their feeding-grounds; still something has been done by such men as Mr Yarrell and others, and any new observations tending to further our acquaintance with the food of these useful animals cannot fail to be of some value. The peculiar delicacy of flavour which distinguishes some of our fresh-water fishes has been long known to depend upon the nature of their food, though it is only in a few instances that the exact kind has been ascertained. Mr Yarrell, for instance, in his valuable work upon "British Fishes," informs us, upon the authority of the late Earl of Home, no ordinary observer, that the trout in Berwickshire differ very much, according to the locality in which they are found. The county of Berwick is divided into two districts, a hilly, mountainous region, and a flat, fertile plain. The two principal rivers rising in, and flowing through, the county, are the Blackadder and the Whitadder. This latter stream has its source at an elevation of 900 feet above the level of the sea, and flows over a very rocky and gravelly bed, whilst the former, the Blackadder, rises in deep mosses, and flows for one-half of its course through these mosses, and the other half through a rich and highly-cultivated district. The trout of the rapid, clear, and sparkling Whitadder are fine silvery fish, beautiful to look upon, but very inferior in taste to those of the dark, mossy Blackadder, abounding as it does in a greater variety and quantity of food, and which are of a dark colour, almost black, with bright orange fins. Two other smaller streams, the Eden and the Leet, traverse part of the same county, both flowing through a rich, loamy, and often marly soil, till they empty themselves into the Tweed. The trout of these little rivers, according to the late Lord Home, are of a good size, their bodies beautifully marked with bright red spots, and the sides and fins of an orange colour. The flesh is fully of a deeper red than that of the salmon, and almost as highly flavoured as that prince of fresh-water fishes. The trout of the Tweed, again, into which these two streams run, are very inferior, being in comparison both lean and ill-flavoured; and it is worthy of remark, that as soon as the fine rich trout of the dull and sluggish Eden and Leet enter the rapid, clear waters of the Tweed, they begin to lose their beauty and other good qualities; while, on the other hand, when the comparatively ill-flavoured trout of the Tweed ascend the Eden or the Leet, a change of colour is shortly observed to take place, and they soon assume the richer hues which distinguish those of the tributary streams. These differences in the quality of the trout arise, no doubt, from the nature of the food found in these various rivers. A direct experiment, to ascertain the value of different food upon the growth and development of trout was tried some years ago. For the details we are indebted to Mr Stoddart, who mentions the result in his "Art of Angling, as practised in Scotland." Several fish were taken and placed in three separate tanks of water. The trout in one of these were supplied with worms; those in another were supplied with live minnows; and those in the third were fed upon small dark water-flies. The trout which subsisted upon worms grew slowly, and had a lean appearance; those which were supplied with live minnows became much larger; whilst those which had flies alone given to them attained in a short time prodigious dimensions, weighing twice as much as both the others together. The great lake trout, *Salmo ferox*, is a coarse fish, and of an indifferent flavour. It is exceedingly voracious, and feeds principally upon other fishes smaller than itself, the stomachs of such specimens as have been examined having always been found gorged with fish. The Lochleven trout, *S. fario* var. *levenensis*, on the contrary, is a delicious fish, and, as I have stated in my work on the "British Entomostraca," its food has been found to consist in great part of these minute and delicate little crustaceans. The charr too, *Salmo salvelinus*, is another excellent flavoured fish; and we are informed by Sir W. Jardine, who has examined the stomachs of several, that their food consisted of minute entomostraca. To the kindness of this distinguished naturalist I was indebted last autumn for an opportunity of examining at leisure the nature of the food of another fresh-water fish, of exquisite delicacy and flavour. The Vendace, *Coregonus Willughbii*, Jardine, is a native of several of the small lochs that lie close to the town of Lochmaben in Dumfriesshire. The principal sheet of water is called the Castle Loch, as upon its bank is situated the old ruin known as Bruce's Castle. These fish are more abundant in that loch than in any of the others, and, according to the tradition of the place, were brought thither from the continent by Queen Mary. The vendace is an elegant little fish, of from four to ten inches in length, and of a pale greenish-brown colour on the upper parts, shading gradually into a clear and silvery white. The flesh is white and rich, of a delicate flavour, and highly esteemed as an article of food. It is so delicate, indeed, that it cannot be transported to any distance; and to be duly appreciated must be eaten on the spot. It is well known to sportsmen that this little fish had never been caught with an angle,* and that it could not be taken with any bait, the only way in which it is captured being by means of a net. Some years ago Dr Knox of Edinburgh examined the stomachs of one or two specimens, and found the contents to consist of minute entomostraca. In a paper on the food of the salmon, herring, and vendace, published in the "Transactions of the Royal Society of Edinburgh," in 1832, he mentioned this fact, and gave rough figures of two different species. Mr Yarrell also examined the contents of the stomachs of one or two specimens, and in his valuable work on "British Fishes" has reiterated Dr Knox's statement, and likewise figured the species. Both these gentlemen, however, had only specimens of vendace to examine which had been preserved in spirit, and accordingly the animals found in the stomachs were so much decomposed that their figures are not to be relied upon. Those of Dr Knox (at least one of them) are too indistinct to enable the species to be determined with precision, while those of Mr Yarrell appear to me to be merely copies of specimens figured by Jurine. Having had the pleasure, however, last year, of accompanying Sir W. Jardine to the genial meeting of the Vendace Club, which takes place annually on the 1st day of August, at the Castle Loch at Lochmaben, I had an opportunity

* An instance to the contrary has been mentioned by Dr Davy in the last number of this Journal, p. 348, where he states that he saw a specimen captured in one of the Cumberland lakes—"an uncommon incident."

of examining the stomachs of several specimens immediately upon their being taken from the water. The fish themselves were in excellent condition, fat, and evidently well fed; and, as I had an opportunity afterwards of testing at the Club dinner, exceedingly well-flavoured. The stomachs of those examined I found to be quite full, and containing myriads of a minute Entomostracan new to Great Britain, and which, I believe, has hitherto never been described, though in all probability it is one of those roughly figured by Dr Knox, in his paper alluded to. It belongs to the family *Daphniidæ,* and genus *Bosmina;* and I propose giving it the name of *B. Coregoni.* This genus was founded by me in 1845, in the "Berwickshire Naturalists' Club," to contain those species of the old genus *Daphnia,* which are characterized by having the superior antennæ long, and taking their origin from the extremity of the beak. Only one species has hitherto been described in Great Britain, *B. longirostris*, a minute creature, the anterior portion of the carapace of which terminates at the inferior angle in a sharp point or spine. The present species differs from it in being longer, having the superior antennæ much longer, the carapace greatly more rounded, and the inferior angle not terminating in the sharp spine.

As I have already mentioned, there were myriads of these little creatures in each stomach I opened; and upon examining the mouth of the vendace, a curious and very interesting structure is observable, which appears to be well adapted for enabling this fish to catch its prey. The mouth is small, and is unprovided with teeth, except a few small ones on the tongue, but upon opening it, and looking down, we observe that the arches of the gills are furnished on the inner side with numerous long processes, each of which is barbed on both sides, and project into the cavity of the mouth. Meeting those of the gill-arch on the opposite side, these barbed processes form a complete strainer, arresting even such minute creatures as these entomostraca. The fish, swimming through the midst of a dense shoal of these little crustaceans, must take in thousands along with the water which it imbibes, but instead of being expelled along with this water, which flows over the surface of the gill and escapes from under the gill-covers, they are arrested in their progress, and detained there till a quantity is collected sufficient to be swallowed.*

It is not my intention to enter into the history of the vendace; but a few remarks upon its geographical distribution may not be uninteresting. It was at one time believed to be exclusively confined to the Castle Loch of Lochmaben, but Sir William Jardine, in his paper in the "Journal of Geographical and Physical Science," has shown that this is not the case, as it is found in several of the other lochs in that neighbourhood. An allied species, locally known by the name of *Schelly*, has been long known to inhabit some of the lakes of Cumberland, and Dr Davy has recently proved that the Lochmaben fish is also found in Derwentwater.† This specimen was afterwards transmitted to Sir William Jardine, and in a letter received by me from him on the subject, he says, "I cannot make out a specific difference. At the same time, the fish is of a stouter make, and the proportions of the parts a little stronger. When looked at together there *is* a difference, but if placed before you singly, you would at once say they are one species." The same species, under the name of *Gwyniad*, is well known to exist also in Bala Lake, North Wales. Sir W. Jardine writes to me in the end of November last (1856) that he had then before him a fish from that locality, and upon comparing it with his own specimens of the Lochmaben vendace, he "durst not make it distinct, though very slight variations did exist in the outline of the opercula." In the same letter he adds, "this is an important fact, breaking down the very restricted locality, which I never had much faith in." "When the Lochmaben fish," he continued, "was shown to Agassiz, he said it was undoubtedly different from the Swiss species. I doubt this now, but have not been able to procure specimens." Sir John Richardson, in his valuable article "Ichthyology," in the last edition of the Encyclopædia Britannica, remarks that, according to M. Valenciennes, the

* This curious structure was first pointed out to me by Sir W. Jardine.

† See Dr Davy's paper in last number of this Journal, p. 347. When the present paper was drawn up, and read before the Linnean Society, I was not aware that Dr Davy had communicated his notice to this Journal. Otherwise I should have been glad to have quoted more freely from his interesting notes upon this subject.—W. B.

Coregonus Willughbii, or Lochmaben vendace, is identical with the *Coregonus* (*salmo*) *albula*, Linnæus, of the Fauna Suecica; and that it occurs in Dalecarlia and Lake Miæs, in Silesia, Brandenburg, Pomerania, and Mecklenbourg, and that an extremely similar, if not identical, species has been found even in Kamtschatka. Far from being restricted, therefore, in its habitat, the vendace would appear, on the contrary, to have a wide geographical distribution; and, under whatever name it may ultimately be described, it is now found in the lake district of England and in Wales, and (on the authority of Yarrell) the *C. marœnula*, Jenyns, must now rank only as synonymous with the *Coregonus albula*, Linnæus.* I am indebted to Sir W. Jardine for an opportunity of examining the stomachs of the two fishes mentioned above, as taken in Bala Lake and Derwentwater, but the result has shown a considerable difference in the nature of the food from those of Lochmaben, arising probably from the season of the year in which they were caught, viz., winter. The stomach of the Derwentwater fish was completely empty, while that of the Bala Lake specimen contained the debris of numerous aquatic insects, such as the larvæ of tipulæ, the larvæ of small water-beetles, most probably a species of *Hydroporus*, and the remains of some specimens of the perfect insect itself.

The same friend has also kindly supplied me with the stomachs of two specimens of the common trout from Galloway. Though the fact has long been known that great part of the food of these fish consists of entomostraca, I believe none of the species found in their stomachs have ever been properly ascertained. One of these trout was caught in a small loch in Galloway, and the water at the time was observed to be peculiarly prolific in small insects, &c. Upon examining the stomach, I found that it contained a mass of entomostraca in all states of decomposition. Many specimens, however, were quite perfect, and I was delighted to find that the species upon which this trout had been feasting was one hitherto unknown to naturalists. The specimens, as far as I could judge, were

* See also, upon this subject, Sir W. Jardine's note to Dr Davy's paper, in last number of this Journal, p. 350.

all of the same species. This little entomostracan belongs to the family *Daphniidæ*, and forms a species of the genus *Daphnia*, or water-flea. I propose the name for it of *Daphnia Jardinii.* Its distinguishing characters, and which separate it from all other species known to me, are, 1*st*, The shape of the head, which in some respects resembles that of *Daphnia mucronata*, Müller; and, 2*d*, The lengthened form of the body and terminal spine of the carapace, which corresponds pretty nearly with the *D. longispina* of the same author. These two characters, united in the same species, separate it from all others belonging to the genus.

The other trout was taken at Barn Hourie, and its stomach contained a mass of entomostraca of a totally different species. Unfortunately, however, the process of digestion had advanced farther in this trout than in the other, and I was unable to determine the species to which it could be referred. The specimens were numerous, and appeared to be confined to one species alone. It belongs to the family *Cyprididæ*, or those entomostraca in which the body of the animal is contained within a carapace of two valves, exactly resembling a small bivalve shell. The carapace, however, from which the specific characters are chiefly taken, was so completely digested that no trace of it was left, the only parts remaining being the harder portions of the body of the animal, as its maxillæ, natatory organs, or antennæ, and its feet. From these I was able merely to ascertain that the species belonged to the genus *Cypris;* but I hope some future time to have an opportunity of examining a trout from the same water before its dinner has been so far digested.

Description of Species of Entomostraca.

1. *Bosmina Coregoni.*—Carapax sphæricus, valvulæ, in parte inferiore, rotundatæ; antennæ superiores perlongæ, longitudinis corporis toti. *Long.* ⅓ linea. *Hab.* in ventriculo Coregoni Willughbii, in lacu "Lochmaben."

2. *Daphnia Jardinii.*—Caput triangulare, vertice mucronato; valvulæ carapacis, in dorso, rotundatæ, pars inferior mucrone longo terminata; pars anterior arcuata. *Long.* ½ linea. *Hab.* in ventriculo Salmonis farionis in comitatu Kircudbright.

On the Influence of Magnetism on Chemical Action—(continued.) By H. F. Baxter, Esq.

Having already treated of the influence of *magnetism* in its *static* or quiescent condition on *chemical action*,* we shall now speak of its influence in its *dynamic* condition, or when in *motion*, and this will form the second part of our inquiry.

Part II.—*The Influence of Magnetism in its dynamic condition, or when in motion, on Chemical Action.*

We need scarcely remark, that the subject of our present paper necessarily involves the following question, *Can magneto-electric induction occur in fluids (in electrolytes?)* and we shall of necessity have to refer to experiments bearing upon this point.

In speaking of the results obtained by Fresnel and others, Ampère, according to Becquerel, "à avancé que les effets chimiques que l'on à attribués, dans quelques cas, à l'action des aimants, pourraient bien provenir des courants que ces mêmes aimants développent par influence. Il à fait l'application de son principe à la décomposition de l'eau que Fresnel avait cru un instant avoir produite avec des aimants. Il dit que les courants par induction étant instantanés, ne peuvent produire de décompositions; mais les variations d'intensité du magnétisme des barreaux, qui ont lieu en raison des changements continuels de température, peuvent produire un effet semblable à celui que l'on obtient quand l'on approche et que l'on éloigne successivement un aimant des fils de métal. Voilà comment il explique la continuité du courant et celle de l'action chimique qu'il produit."†

Faraday, in several of his researches on magneto-electric induction, has endeavoured to ascertain whether a *current* might not be induced in other liquid conductors besides mercury. "The relation," he says, "of the induced current to

* Edinburgh New Philosophical Journal, New Series, vol. v. p. 235.

† Becquerel "Traité de l'Electricité," t. i. p. 384.

the electro-conducting power of the substance, amongst the metals (3152), leads to the presumption, that with other bodies, as water, wax, glass, &c., it is absent only in consequence of the great deficiency of conducting power. . . . . I thought that processes analogous to those employed with the metals might, in such non-conductors as shell-lac, sulphur, &c., yield some results of static electricity (181, 191); and have made many experiments with this view in the intense magnetic field, but without any distinct result."*

It is not without great diffidence that we enter upon the present investigation, or even suppose that any attempt on our part could lead to a successful result in elucidating this question. The strong conviction, however, which appears to exist, that the absence of the current is due solely to the want of conducting power in the solutions, led us to hope, that by perseverance we might ultimately obtain some evidence of its existence: how far our attempts have been successful remains to be seen.

We shall not enter into any detail of the general facts of magneto-electric induction, as made known by Arago, Faraday, Ampère, Nobili, and a host of other philosophers, as these are to be found in the treatises of Becquerel† and of De la

* "Experimental Researches," series xxviii., *para.* 3171. Since this paper was drawn up, we find that we have committed a great oversight in not having become acquainted until now with a letter by Faraday to Professor De la Rive, "On Electro-dynamic Induction in Liquids" and inserted in the Phil. Mag. for April 1854. We are glad in having the opportunity of referring to this paper, and only wish we had been aware of it before. Professor Faraday's experiments were different from those we have related; and we cannot do better than to refer to the letter itself. He concludes by stating, "I consider the excitement of induction-currents in liquids not metallic as proved; and, as far as I can judge, they are proportionate in strength to the conducting power of the body in which they are generated. Whether the conduction, by virtue of which they occur, is electrolytic in character or conduction proper, I cannot say. The present phenomena do not aid to settle that question; because the induced current may exist by either the one or the other process. I believe conduction proper exists; and that a very weak induction-current may pass altogether by it, exerting for the time only a tendency to electrolysis, whilst a stronger current may pass partly by it, and partly by full electrolytic action."

† Traité de l'Electricité et du Magnétisme.

Rive;* but it may not perhaps be considered unnecessary to state the general principle, as deduced by Faraday,† from his investigations:—"If a continuous circuit of conducting matter be traced out, or conceived of, either in a solid or fluid mass of metal, or conducting matter, or in wires or bars of metal, arranged in non-conducting matter or space; which, being moved, crosses lines of magnetic force, or, being still, is, by the translation of a magnet, crossed by such lines of force; and further, if, by inequality of angular motion, or by contrary motion of different parts of the circuit, or by inequality of the motion in the same direction, one part crosses either more or fewer lines than the other, then a current will exist round it due to the differential relation of the two or more intersecting parts during the time of the motion; the direction of which current will be determined (with lines having a given direction of polarity) by the direction of the intersection, combined with the relative amount of the intersection in the two or more efficient and determining (or intersecting) parts of the circuit."

Our first experiments were conducted in the following manner:—The large electro-magnet (Professor Wheatstone's), which we have already described in our former paper, was placed about six feet from the galvanometer, the line of the magnetic poles being in the same line as that of the needles of the galvanometer. A thick glass tube, half an inch in internal diameter, and six inches in length, contained the solution (either a saturated solution of common salt, or an acid solution, consisting of 1 part strong sulphuric acid and 6 of water); into each end a platinum wire, eleven inches in length and $\frac{1}{12}$th of an inch thick, was inserted by means of a cork, about half an inch of the wire being immersed in the solution, and the projecting part bent at right angles; the other extremities of the platinum wire were attached by means of binding-screws to two copper wires, each about six feet in length,

* Treatise on Electricity.

† "Experimental Researches," series xxviii., *para.* 3087. We may also refer to the principle, as established by Lenz. *Vide* "Treatise on Electricity," by De la Rive, vol. ii. p. 15.

and $\frac{1}{10}$th of an inch thick, by which they were connected with the galvanometer. A piece of wood was attached across the wires at the point where the binding-screws were connected, so as to keep the wires firm and steady, and in the centre a string was fastened, which passed through a pulley above; to the under part a brass weight was tied; and by these means the wires could be raised or lowered at pleasure, while standing at the galvanometer. Near the galvanometer the wires were firmly fastened down by means of string, so as to prevent any motion of the whole instrument.

The *Galvanometer* consisted of but few coils; and upon bringing the electro-magnet into action scarcely any effect was produced upon the instrument.

The *Electro-magnet* was excited by six of Grove's middling-sized cells, and to concentrate the power, one of the soft-iron armatures was employed, leaving a space of about an inch between the poles.

We shall not detail each experiment, but give the general results.

When the circuit was first completed, whichever solution was employed, an effect occurred upon the needle. The circuit was kept closed, and after some time the tube was raised and lowered between the poles before the electro-magnet was excited; a slight tremulous motion of the needle was generally produced. Upon exciting the electro-magnet, and then repeating the experiment, a slight effect appeared to be produced, and continued for some time, but ultimately subsided. Upon passing a loop of single wire between the poles we could always obtain an effect, constant and definite, the direction of the current depending upon the pole; but with the solution, the effect upon the needle gave satisfactory indications, although trifling, for a short time, and the results would then become perplexing, and this with either of the solutions. To whatever cause the effects were due, whether to chemical action on the electrodes, or to the wires intersecting the lines of magnetic force arising from the earth, or those from the magnet, or to the effects of magneto-electric induction which we were seeking, they could, at any rate, traverse the solution.

To avoid the effect, if any, due to the motion of the wires forming the circuit, in our next experiments the electro-magnet was arranged in the following manner. The poles, instead of looking upwards, looked towards the north, the magnet resting on one of its sides, the two poles being in the same perpendicular plane.

Thicker copper wires, $\frac{1}{8}$th of an inch thick, were connected with the galvanometer, their free extremities dipping either into two mercurial cups, or being connected with the platinum electrodes by means of binding-screws. A glass tube, $\frac{2}{8}$ths of an inch in internal diameter and 10 inches in length, was bent at each extremity at right angles, at one extremity to the extent of an inch, and at the other to the extent of an inch and a half, and in the same direction. Into the former the platinum wire was inserted by means of a cork, and also bent at right angles to the extent of an inch, the other extremity was connected by means of the binding-screw, or mercurial cup, with the copper wire; but this platinum wire was fastened firmly on to a piece of wood, so that the glass tube could rotate upon that portion which formed its axis. A piece of membrane was tied over the other end of the glass tube, to confine the solution, and this dipped into a shallow dish containing the same solution, and which was placed between the poles of the electro-magnet. Into this basin the other platinum electrode, formed of a piece of platinum foil four inches long and two broad, being connected with the other copper wire by means of a copper clamp, dipped. By this arrangement we had the opportunity of passing the tube between the poles of the electro-magnet without moving the wires; but to effect this, whilst standing at the galvanometer, a long piece of wood, which worked upon a pivot, just over the axis of the tube was used, and to this end the tube was fastened, the other extremity, the long end, serving as a handle; this served also as a means of support to the tube during the rotation, and in order to obtain, occasionally, as great amount of rotation as we could, a piece of string was attached to the handle.

Upon the first completion of the circuit, as in the former experiments, an effect occurred upon the needle; and rotating the tube to and fro occasioned a constant current; but this in a great measure subsided, although there was a constant effect. When the tube was placed directly in front of the poles, the magnet being excited, so that three inches should pass between the poles, then, upon rotating the tube, no effect beyond that of mere rotation appeared to occur. When an inch and a half only passed between the poles more decided effects appeared. Generally speaking, the platinum electrode in the dish was *positive*. When the upper pole of the electro-magnet corresponded to the marked pole, and the rotation of the tube was from left to right, a greater effect appeared upon the needle than when the rotation was from right to left; or when the poles were reversed, similar effects appeared upon reversing the rotation. It was very seldom however that we could obtain such definite results as we could wish. If the *current* consequent upon the arrangement of the circuit were powerful, no definite result could be obtained; it was only when the circuit *current* was trifling that the effects appeared.

The tube was arranged so as to pass between the sides of the poles, but this made no difference. There was one circumstance, however, which appeared worthy of notice, viz., that the effects did not appear so striking when nearly the whole of the tube was between the poles as when a small portion—two inches—alone was introduced.

Instead of making the extremity of the tube dip into the solution, mercury was employed as the conductor, in the following manner :—the membrane was removed, and a cork, with a piece of platinum wire, two inches long, inserted into it, closed the tube, about an inch of the wire protruding. Some mercury was placed in a shallow plate, about six inches in diameter, and the platinum foil served as the electrode, as before. With this arrangement the results obtained were similar to those in the last experiments; there was no decided increase in the effect upon the galvanometer as we expected. When the upper pole was the marked pole, the electrode in contact with the mercury was *positive*, upon rotating the tube from left to right, or from east to west. We could not obtain those reversed effects as we could have wished; they occurred occasionally, but were not permanent.

The effects were only obtained with the solutions, and were not observed when distilled water alone was used.

As the results are so masked by the effects that might arise from electro-chemical actions, and a constant effect being continually produced upon the needle during the motion of the tube, we were as much perplexed in these experiments by the results that might arise during the motion of the fluid portion of the circuit in the present instance as we were before, from the effects that might arise from the motion of the wires. We were now led to the experiments in which the *magnet* was the moving part.

The soft-iron bar and helix employed has been already described in our former paper. The bar was suspended vertically to the axis of a wheel moving horizontally, and which was fixed on the upper part of a stand, the centre of the board being cut out. The stand was four feet high, and supported upon four legs. By means of a vertical wheel with a handle, which was attached to the side of the stand by a cross-beam, and by pulleys fixed on the upper part of the stand,—a string surrounding the two wheels,—motion could be given to the upper wheel. The helix was suspended, and firmly fixed by cords, having the iron bar within. The lower end of the bar was placed in a small glass jar, heavy, and a little larger in diameter than that of the bar, so as to avoid any motion of the fluid during its rotation, and likewise any chemical action from occurring upon it.

A shallow basin, six inches in diameter and an inch and a half in depth, contained the solution. A piece of platinum foil three inches and a quarter in length, and an inch and a quarter in breadth, was placed upon the bottom of the basin, the small glass jar containing the pole of the electro-magnet being upon it; this formed the lower electrode. The upper electrode consisted of a similar piece of platinum foil, or sometimes two narrow strips, so as to pass on each side of the jar horizontally or vertically. The electrodes communicated with two wooden cups containing mercury, the lower one by means of a platinum wire, bent so as to dip into the fluid and press upon the platinum foil, being coated with sealing-wax for two inches, leaving about a quarter of an inch bare at the extremity, so as to prevent any current being conducted from the other electrode, which communicated with the mercury by means of a copper clamp.

The *Galvanometer* was placed about 3 feet from the pole of the magnet, and on a level with it. The communication between it and the mercurial cups was formed by pieces of copper wire ⅛th of an inch thick and 3 feet in length. At this distance, when the electro-magnet was excited, no sensible effect was produced upon the needle, and when the bar was made to rotate, a slight tremulous motion sometimes occurred.

We need scarcely add, that great care was required to have the contacts perfect, and the platinum electrodes thoroughly cleansed.

The electrodes being rather more than an inch apart, the basin was filled with the *acid* solution, so as just to cover the surface of the upper electrode. The circuit being completed, an effect occurred upon the needle, varying as to amount; this soon subsided; but it generally happened that one of the electrodes continued positive throughout the experiment. Upon rotating the bar, the magnet being excited, a slight motion was observed upon the needle, and, by catching the vibrations of the needle at proper times an effect of 3° or 4° could be ultimately obtained; and by reversing the rotation of the bar, an effect upon the needle was obtained in the opposite direction, amounting perhaps to as many degrees. When the lower pole was north, or corresponding to the marked end of the needle, and the bar rotated like the hands of a watch, the face looking downwards, the lower electrode was *positive*, *i.e.*, coincided with the platinum plate of a simple voltaic circle. When it rotated in the *opposite* direction the upper electrode was then *positive.**

* Mr Hunt records an experiment (*Phil. Mag.*, April 1848), in which he placed a helix, surrounding an iron wire, in an electrolyte, and upon completing the circuit of the helix to magnetize the wire, an effect occurred upon the needle. "In every instance," he says, "upon either making or breaking con-

There was something peculiar in the motion of the needle, for it was very steady or slow in its movement, acting as if time was required, and it was difficult to know when to catch the vibrations. There was not that sharp, quick motion usually observed when studying electro-chemical effects; and it was only when a quick and sharp rotatory movement was impressed upon the bar that it became quickened.

One or two other circumstances were observed which appear deserving of notice. Upon rotating the bar in one direction, it sometimes happened that no effect was produced, but upon rotating it in the contrary direction, the current was easily procured, and in the normal direction. Again, upon rotating the bar in either direction the normal effect was produced, viz., 3° or 4° in both directions; but occasionally the needle would suddenly move 10° or 15°, or more, as if a sudden impulse had been given to it; and whenever the rotation coincided with that direction, this increased amount would continue. Now, these effects, we are inclined to believe, are due, the first to the current which existed in the circuit, and which may be called the *circuit-current*, being too powerful to allow the normal current to travel in the opposite direction; and the second, to the circumstance that a sudden chemical effect was produced coinciding with the normal current. Upon breaking the circuit, and uniting the wires afterwards, indications of a *reversed* current were obtained; but these have been frequently observed under other circumstances, when there was no rea-

nection, the needle of the galvanometer vibrated from 3° to 5°, but steadily returned to its permanent deflection. . . . . The transient disturbance of the needle arose from the passage of an induced current through the electrolyte, and by the wires to the galvanometer." But the case he considers as "precisely similar to one recorded by Faraday," which he quotes. This is a voltaic circle in an *induced* circuit. We could never understand how the effects could be referred to those as recorded by Faraday, provided the wires were well insulated. The action upon the needle in Mr Hunt's experiment was not *constant*, but *temporary*; and if the motion of the needle could not be referred to the direct influence of the magnetism of the helix or wire, we are more inclined to consider it as an effect of *magneto-electric induction*, a temporary current being formed either in the metallic conductor or solution, and able to *traverse* the electrolyte.

son to suppose that chemical action had occurred, unless we must consider this fact as evidence of its having taken place. We are now led to inquire whether a solution (an electrolyte) can conduct a current without undergoing decomposition? But before discussing this question, we must refer to a circumstance which was at first rather perplexing, as well as to some other experiments.

Upon repeating these experiments on other occasions, it occasionally happened that no effect could be obtained, or the results were doubtful, the current passing at one time in one direction, and then in the opposite direction. The reason of this we shall be able to point out afterwards.

When a *saturated solution of common salt* was employed, instead of the *acid solution*, effects similar to those already described were obtained. With *water* alone no effect was obtained.

Instead of *platinum* two *amalgamated zinc* plates were used as the electrodes, each about five inches and a half in length, and two inches broad; in the upper one a notch was made, so as to admit of the glass jar containing the pole. With these plates, using *water* as the liquid, the chemical action was too powerful to obtain any decisive result. The slightest motion of the fluid in the basin caused an action upon the needle, and the effects sought for were completely masked by those resulting from chemical action.

With *copper* plates of the same size as the zinc, and using copper wires instead of the platinum wires, with a *concentrated solution of sulphate of copper* as the interposed liquid, more satisfactory results were obtained. The amount of effect upon the needle was not greater than 3° or 4°. If the circuit current was in one direction, the induced current was readily obtained in that direction. With the *acid* solution the chemical effect was too powerful, the effects being similar to those obtained with the zinc plates. With *water* alone no effect was obtained.

Returning to those experiments in which the *platinum* electrodes were used, and which appeared to give the most decisive results, and reflecting upon the *direction* the *current* took, viz., the lower electrode being *positive;* it seemed possible, after all, that the current might not be *induced* in the *liquid*, but that it merely traversed it. The following experiment was now performed :—

A large glass tube, two inches in diameter, and six inches in length, had a piece of membrane tied over the lower end, and was then filled with the *acid* solution, and placed upon the lower platinum electrode as before, the basin containing some of the same solution. The upper electrode was placed sometimes horizontally, at other times vertically, at the upper portion of the fluid in the tube. The lower pole of the electro-magnet was now outside of the tube, but close to it, and extended about two inches down from the top. Upon rotating the bar, an effect was obtained upon the needle, and by catching the vibrations of the needle at proper times, by rotating in the reverse direction, it was made to increase; the effects being similar to those we had already obtained. But the current was now *reversed*, or the *upper* electrode was now *positive.* So here we had the current *induced* in the fluid, unless we suppose it to have been due entirely to the platinum electrode, or to the metallic part of the circuit.* The bar was rotated within the deep jar as before, in the centre of the fluid, but the effects did not appear to be increased. The experiment was repeated with shorter tubes with similar results, but with this exception,—when the lower electrode was brought up to within an inch of the pole, the effects upon the needle began to vary, and the nearer it was brought to the pole it then became *positive* as in former experiments.

When we consider the arrangement of the *lines of force* of a magnet, it is reasonable to suppose that the situation and position of the two electrodes, in reference to the course of these lines, must be of some, if not of great importance; one being *positive* or *negative* to the other, according to circum-

* We can scarcely suppose that the current was induced in the glass rather than in the solution or fluid conductor, yet Mr Harris found that the rotation observed in Arago's experiment could be obtained with annealed glass, but not with sulphuric acid and saturated solution of sulphate of iron. *Vide* Faraday's "Experimental Researches," series i., *par.* 130.

stances. That such is the case, we may infer from the principle established by Faraday, and which we have quoted at the commencement of the present paper. In these latter experiments, the lower electrode was placed out of *the lines of force*, or at any rate in such a position relative to the lines that it was ineffectual in originating the current, or acting as the *cathode*, thus becoming *negative* to the other, and we now obtain a clue to the circumstance that was formerly perplexing to us, viz., the current traversing the galvanometer sometimes in one direction, at other times in another. There can be no doubt that the bar in those instances might have been raised, and again, as the magnetic power of the bar began to sink so would *the lines of force* fall in upon the magnet. So here we have three important circumstances to attend to, and to take into consideration in these experiments, *First*, The *position* of the electrodes, whether *axial*, *radial*, or *equatorial*, in reference to *the lines of force; Secondly*, Their *distance* from each other, whether *both* or only *one* of the electrodes are within *the lines of force* or *sphondyloid;* and *Thirdly*, The *strength* of the magnet, or magnetic *sphondyloid.*

We may add, that when using the platinum wires alone as electrodes, instead of the foil, effects, though perhaps not to the same amount, were obtained upon the needle; but we have never been able to keep the needle deflected to a certain distance by rotating the magnet in one constant direction; it always appeared to be in a continual state of vibration. This may, however, arise from the bar, as from its mode of suspension, it did not revolve freely within the helix, and occasionally stopped in consequence of the friction against the sides.

We tried several times to obtain signs of *polar decomposition*, and for this purpose we placed some *concentrated solution of iodide of potassium and starch* in a tube, using the platinum electrodes, either wires or foil, and rotating the bar in one constant direction, but have not as yet been able to obtain as definite evidence as could have been wished, although the galvanometer, in these experiments, was affected. The change of colour that did appear was too general, and not confined to the *anode*.

The experiments were repeated with the *osmometer*, viz., by rotating the electro-magnet in one constant direction, the septum being either *horizontal* or *perpendicular* to the *lines of magnetic force;* but in these instances no definite result was obtained.

We endeavoured to ascertain whether the *rotatory* motion, which occurs when a solution acts chemically upon a metallic cylinder inclosing a pole of the magnet, is affected upon rotating the pole. When zinc or copper cylinders were used some effect appeared; but it was too slight, and the results might have been due to the unsteady motion of the bar, or to other causes than to the mere rotation of the pole. When a cylinder of soft iron, however, was employed, no effect occurred.

Concluding Remarks.

In bringing this imperfect inquiry to a close, we shall add one or two observations upon the question originally proposed, viz., "The influence of *Magnetism* in its *dynamic* condition, or when in *motion*, on *chemical action.*"

The only positive conclusion that we can deduce from the foregoing experiments is the following:—*That the currents consequent upon magneto-electric induction may be excited in fluid conductors, such as electrolytes.* The question, however, whether an electrolyte can conduct an electric current, without undergoing decomposition? may be considered a disputed point, but the evidence that has been adduced in favour of the supposition that it can do so appears to us to preponderate, and we can only refer to a valuable lecture* by Professor Faraday, "On Electric Conduction," in which he considers that a liquid (an electrolyte) may possess "*conduction proper*" as well as "*electrolytic conduction,*" and that the former does not necessarily imply the latter. Although an electrolyte may possess "*conduction proper,*" it is reasonable to suppose, that if the forces by which the elements of the

* Journal of Royal Institution. May 25, 1855.

electrolyte are held together be feeble, then, according to the *intensity* of the current, so would decomposition occur. Some results observed in the foregoing experiments would lead to the conclusion that this might have been the case, for, when using the acid solution and the platinum electrodes, and rotating the bar in one constant direction, the needle was sometimes suddenly deflected several degrees. In this case, the current, although weak, might have induced a tendency to, which ultimately resulted in, chemical action. In other instances, whenever conditions exist so as to render the chemical forces so equally balanced that a slight circumstance might be capable of overthrowing this equilibrium, we might then expect that the weakest current would be able to effect this. Our failures in obtaining *polar decomposition* were evidently due to the want of *intensity* in the current, and as we have every reason to believe that this may be increased by more powerful means, so may more decided chemical effects be produced. Hence we may arrive at the conclusion, *that magnetism (in its dynamic condition, or when in motion), may excite or originate, and increase chemical action.*

On the Occultation of Rivers. By Thomas S. Traill, M.D., Professor of Medical Jurisprudence in the University of Edinburgh.

The disappearance of some rivers into chasms in the earth, and their reappearance at the surface, has attracted attention from very ancient times; and several instances of this curious phenomenon are alluded to by both Greek and Roman authors. This has chiefly been observed among strata of limestone or of gypsum; and has been more frequently noticed in the Peloponnesus than in any other part of the world. The fervid imaginations of the ancient Greeks generally clothed such occultations with mythological fiction, and adorned them with the graces of poetic imagery. That temperament, which led them to people every grove, and animate every stream with presiding deities, could easily imagine subterranean rivers traversing extensive regions, and with little difficulty reconcile itself to the fabled loves of Alpheius and Arethusa; which led the enamoured river god to pursue his coy nymph from the mountains of Peloponnesus, even in ocean's bed, to the shores of Sicily.

The best account ever given of the occultations of Grecian rivers is contained in the valuable travels of Colonel Martin Leake, in *The Morea;* a work in which he has admirably illustrated the descriptions of Pausanias, the notices of Strabo and of the Greek historians.

He justly remarks, that the disappearance of the Peloponnesian streams is better known than their emissories. The former, in the language of Greece, are termed *βερεθρα,* or in the Arcadian dialect *ζερεθρα*, and often, in the common language of the present inhabitants *καταβοθρα* (pronounced *katavóthra*).

Either from tradition, received from their forefathers, or from observation, the modern Greeks are no less persuaded of the reappearance of the engulfed streams than were their celebrated ancestors. But it is to be regretted, that in modern times no experiments have been made on this curious subject, to corroborate this opinion, especially in a country so abounding in instances of *occultation;* and one of the objects of this paper is to point out a simple method of determining the true emissories of such subterranean streams, after I have given a brief account of the best knowǹ ζερεθρα of Peloponnesus, which are chiefly in Arcadia, its central province, and of a few in Western Europe.

The valleys of Arcadia, which have no other exit for their running waters but *zerethra*, are those of Tegea, Mantineia, Asea, Orchomenos, Alea, Stymphalus, and Phineus. Of their zerethra the following is believed to be the distribution :—

1. In the Tegeatice there are two zerethra; one at Taki, which discharges its engulfed waters into the valley Asea; the other disappears at Persová, and has its emissory, it is said, in the sea, on the coast of Argolis, at the place called Δεῖνη (*Deine*) by the ancients.

2. In the Mantinice there is one, which disappears near the ruins of Mantineia, and is stated to have its emissory in the valley of the Helisson, near Daviá.

3. In the Asæa there is one, perhaps two zerethra; the emissory of the first is in the pegæ of Megalopolis; and the other is believed to be one of the sources of the Eurotas, near Belemina.

4. The river of Orchomenos is engulfed in the zerethra of Caphyæ, and reappears at Rheunus, near the modern Tara, whence it falls into the river Ladon.

5. That in the Alæa is near the modern town of Skotiní, and is considered as having its emissory in the fountain of Teneiæ, near Orchomenos.

6. The river which enters the zerethra of Stamphylus is said to reappear near Argos; but Colonel Leake thinks that this emissory is that of a river which is engulfed in the Valley of Késari.

7. In the Pheneatice there are two zerethra; one of which engulfs the river Aroanius, which reappears in the sources of the Ladon, below Lycuria. Leake was unable to ascertain the emissory of the other. The same traveller believes that there are several smaller zerethra, of which no account has yet been given by any writer.

The most noted of all these is the alleged commingling of the waters of the Alpheius and Eurotas. Pausanias describes the two rivers as arising not far from each other, then mingling their waters for a distance of about 20 stadia, when they pour into a chasm in a mountain, within the bowels of which the waters separate, to form two distinct rivers; one of which, reappearing in the Laconice, forms the Eurotas; the other, the Alpheius, reappearing in the pegæ of the Megalopolis. The story recorded by Strabo, to show their subterranean separation, is evidently fabulous, viz., that if a garland were consecrated to each river, and both simultaneously thrown into their zerethra, each would make its appearance in the river to which it was dedicated.

In western Europe, the most celebrated instance of the occultation of a river *was* that of the Rhone, near Bellegarde, on the confines of France and Savoy, about 18 miles from Geneva; but, alas, on visiting this interesting spot in the autumn of 1855, I found that the *Perte du Rhone* no longer exists; for the Sardinian Government, in which territory it was, had blown up the rocky roof, beneath which it had been engulfed, in order to facilitate the conveyance of timber on the river. At that point the Rhone had contracted to a narrow but deep stream, and disappeared below the rocky strata, for a distance of 180 feet in length. The deep chasm is now open to the day, and the traveller crosses the river on an artificial bridge, instead of the grand one of nature's masonry.

In Spain, there is another remarkable occultation, that of the considerable river, the Guadiana, in New Castile. It disappears in a chasm near the village of Castillo de Cervera; and, after a subterranean course of about 15 or 16 English miles, it issues into day, near the high road from the Sierra Morena to Madrid, at a place named *Los ochos de Guadiana* (the eyes of the Guadiana), between Manzanares and Villaharta. At the Venta de Quesad, about three leagues north of Manzanares, I found a well, which happened to be dug on the concealed river that flows here at the depth of 38 varas, or 114 feet.

In Britain we have a few minor instances of river occultation, particularly in the limestone of the counties of Derby and York.

The small streams named the Manifold and the Hamps sink into a chasm on a common near Ashburn, and reappear about three miles below, in Ilam grounds. The stream which issues from the cavern of the *Peak* is that which disappears near the high road from Chapel-le-Frith to Castleton, about three miles from the latter town. Similar instances occur in the streams in Weathercote and Yordas caves, on the western borders of Yorkshire.

With regard to the method of investigating the course of subterranean streams, it occurred to me, when gazing on the grand emissory of the Guadiana, that the usual modes were not satisfactory. It is generally recommended, to throw into the zerethra light floating bodies, such as leaves, chips of wood, or chaff, and noticing their reappearance. When the subterranean course is long and tortuous, the time of waiting for their reappearance will not suit the traveller; especially as such bodies, from their extreme lightness, and angular form, will be very apt to be detained by projections of the channel; or where the water entirely fills it, to be left behind: besides which, such common objects are not easily identified as the individual articles committed to the waters of the zerethra.

It seems to me, that it would be preferable to employ a number of turned balls of wood, from $\frac{1}{2}$ to $\frac{3}{4}$ of an inch in diameter, which, for identification, might be stamped by a hot iron with a particular mark or letter. Such should not be very much lighter than water, that they might be less likely to be stopped by inequalities in the roof of the subterranean channel, or its sinuosities. Turned spheres of beech or of ash, which have a specific gravity of 0·845 and 0·840 respectively, would be preferable to balls of fir or cork, with a specific gravity of 0·540 and 0·240; while the softness of the two last would render them more liable to chafing by friction in their passage, and therefore to detention.

A handful or two of such spheres, thrown into any chasm engulfing a stream, would seem a more certain mode of ascertaining the emissory than employing substances so easily to be mistaken as leaves, chips, or chaff.

Chronological Remarks on the River Wye. By CHARLES RICHARDSON, Ross, Herefordshire.

All along the river, as well as in the small district near Ross to which our attention is now more particularly confined, the Wye runs through level alluvial land, varying in width from 100 yards or less, in localities where the rock is hard and the hills high, to a mile and a half in places where the material is softer and the country more level; and this alluvial land is bounded by cliffs which follow the "general course"* of the river.

Let us consider, in the first place, what evidences we have to prove that this alluvial land and these cliffs have, in the course of time, been formed by the river itself.

With regard to the alluvial land, it is to be noticed that the river runs across it from cliff to cliff, in bends of a peculiar form, and of an average length, in this district, of about a mile; there being six such bends in the six miles of the small district alluded to. At each of these bends, the water constantly wears away the bank on the *convex* side, while the opposite bank is made up at an equal rate by deposition of the sediment, so that the river always preserves its average width; and this wearing away of the one bank, and forming on the other side, is sufficiently rapid to be notoriously observable by all living in the vicinity, many persons recollecting *acres* gained on one side, in a single field, and lost on the opposite side, during their lifetimes.

The cause of the wearing away on the convex side of the bend, and of the deposition on the concave side, is sufficiently obvious; it occurs during "freshes," when the river is "bank full," (the water is usually about ten feet below the surface of the alluvial land), and the water runs at the rate of about five miles an hour, and is loaded with sediment.

If the stream, at such a time, be attentively observed where there is a bend in its course, it will be at once seen that the

* When the term "general course" of the river is used, the direction of the alluvial land between the cliffs is meant.

current sets against the convex bank,* which it consequently wears away; but that on the other side, the speed of the current gradually diminishes in proportion to the distance from the main stream. Now, where the stream is at its full force, its tendency is to detach and carry away fresh particles, which it does from the convex bank; but as the speed becomes slower, towards the concave side, the coarser and heavier particles are first deposited, while the finer are carried farther in-shore, into quieter water, and there deposited, and so on; the fineness of the particles deposited bearing an exact proportion to the speed of the current at each successive point; and, as the great bulk of the particles are nearly of equal weight, it follows that the greatest amount of deposition will occur in a certain *zone*, somewhere intermediate between the first commencement of deposition and comparative rest.

We see evidences of this all along the river; for, as in some seasons the banks are worn away much more than in others, or from some such cause, a wide margin for deposition is suddenly opened, then the chief amount of deposition takes place at a certain distance from the main current, while further in-shore the deposition is less, so that the land rises in the form of a bank or ridge near the water's edge, leaving a strip of much lower land further in-shore, which is only very slowly, in comparison, raised by deposition. These ridges, which show a former course of the river, may be traced here and there in all parts of the more recent alluvial land. A conspicuous example of this occurs where the "Ross oak" stands, as will be noticed presently.

If the way in which the land is formed by the river be observed at any favourable spot, of which we have good examples at the Backney, Ross, and Wearend bends, it will be seen that first a bank of coarse gravel is formed on the rock bottom of the river, and on that is deposited a fine gravel or coarse sand, and then mud and substances not much differing

* At the bends in the river, the terms *convex* and *concave* are applied with reference to the stream itself; thus the bank on the convex side of the *stream* is called the convex bank, though its form, as regards itself individually, is concave; the expression, which should be "the bank on the convex side of the river," is used for the sake of brevity.

in specific gravity from water, such as water-logged timber, &c., and shells of some fresh-water molluscs indigenous to the river; and lastly, on this, a thickness of from six to nine feet of earth, hardly distinguishable in appearance from the mould of this country.

Now, if the formation or structure of the alluvial land be examined at any point,—either away from the present course of the river, by digging (as I have had the opportunity in many places where trial pits have been dug, and where the foundations of the railway bridges and viaducts were put in), or at those places where the bank is being washed away by the river,—the same evidences of river deposition will invariably be found. At one place near the Wearend, where the bank has been rapidly washed away, trunks of large trees have been gradually exposed, and even layers of leaves and hazel nuts have been found, all, of course, quite black and much decomposed.

Then, as respects the formation of the cliffs. If all the surrounding country be examined, the surface will be found to be of a gently undulating and rounded character, and without any instance of an abrupt cliff occurring anywhere excepting only those by the river; while, on the other hand, these cliffs are to be found of a greater or less elevation on both sides, and along the entire course of the river, intersecting in all ways the regular contour of the hills, but always following the general course of the stream. Now, if, in a district such as this, where all the hills are of a gently rounded outline, we saw one hill abruptly cut away on one side, so as to form a cliff, we should naturally look around for a cause for so singular an effect; but when we see that cliff conformable to the course of the river, and not only that one hill, but every hill all along the course of the stream similarly cut away, and always with equal conformity to the river's course; and when, in addition to this, it is seen that where the general course of the river makes a bend the hills on the convex side are much worn away, while those on the concave side are much less worn, the conclusion is irresistible that the cliffs and alluvial land must be due to the action of the river.

That these cliffs did not exist immediately after the diluvial period, or, in other words, were not coeval with the adjoining surface of the hill, we have clear proof in the fact, that the "surface-softening," presently to be alluded to, has not sensibly affected the beds of rock exposed at the bottom of the cliffs.

We may presume that the river first commenced running down its course immediately after the land had been lifted to its present elevation, when the waters of course sought the lowest channel.

We have in this country strong evidences of great diluvial action or "denudation" immediately preceding this period, during which the undulating and rounded character was given to the surface. A striking instance of this may be seen on the higher hills, skirting the Forest of Dean, where a very thick and strong bed of old red conglomerate occurs, underlying the lowest beds of the mountain limestone formation 320 feet, as ascertained by measurement in the Little Doward Hill. This "great sandstone bed," usually about 20 feet in thickness, is seen cropping out on the north-western slopes of the undermentioned hills:—Penyard, Warm Hill, Lea Bailey, Bishops' Wood, Copped Wood, Huntsham, Great and Little Doward, and at Staunton, where it forms the ridge or summit of the Buckstone Hill (one of the highest in the Forest of Dean), the old Buckstone, or rocking-stone, itself being a piece of it.

Now, wherever this "great bed" occurs, the rounded contour of the hill is broken, and we have a twenty feet cliff, as might be expected, from diluvial action, and great masses, many as large as a cottage, that have fallen from this bed during the process of denudation, lie scattered below; a very remarkable circumstance (as may be well observed in Copped Wood Common) being, that many of these great blocks have stopped, hanging in singular and fantastic attitudes, half-way down the steep hill-side, where it is not very easy for a man to stand; others have reached the bottom, but none have rolled many yards on the level, affording clear and unmistakeable proof of submersion at the time of their fall; for, if such masses of rock had not been checked in their descent by water, it is evident that they must have rolled, not only to the bottom of the hill, but a long way on the level beyond.

One other peculiarity may also be noticed in this district, that no firm and hard sandstone rock is to be met with until at a depth of 15 or 20 feet below the surface, excepting *only* the "great bed" just alluded to. Abundant opportunities of observing this occur all over the country, and, recently, more particularly in the railway cuttings; the beds can be followed from a depth of 40 or 50 feet to the surface, where they crop out. From some of these beds was obtained as good building stone as any used in this country, but always from a depth of more than 20 feet below the soil; and if these same beds be followed towards their out-crop, they gradually become softer as they approach the surface, until, when within 10 feet of it, they are found to be what is, in the language of this country, expressively called "Dunstone," a kind of indurated sand, in the *form* of rock, neither sand nor stone, and which may be broken between the fingers.

Now, as this surface-softening invariably affects *all* beds in *every hill* in this district (save the one already mentioned), and as the "dunstone" is to be found only near the surface, it must be attributed to atmospheric action, subsequent to denudation continued through a vast period of time. That no surface-softening took place *during* the diluvial period, we may infer from the fact that such beds as are still under water remain hard and firm, although near the surface. This may readily be observed in any part of the river at low water, when the hard rock bottom is seldom more than 3 or 4 feet under water. A noticeable fact, also, is, that the hardest and best beds in a quarry are usually found just beneath a bed of marl, which would naturally be less pervious to atmospheric influences.

It may here be remarked, that the "great bed" is the only one that has really resisted the atmospheric action, and is consequently (speaking of this district) the only bed of sandstone truly adapted to the building of important national structures, such as cathedrals, &c. The truth of this remark may be ascertained by an inspection of Hereford Cathedral, or any old structure built of the ordinary stone of this country.

It has been stated, that the river runs across the alluvial land from cliff to cliff, in bends averaging a mile in length in this district. Now, wherever the river arrives at the cliff, a portion of it, certainly not exceeding 107 yards on an average, is exposed and undergoing "wear" (this length of 107 yards is a very *full* average, and is the result of careful measurement of the most decided cases) ;* while along the remaining distance, 1653 yards, measured in the direction of the cliff, and not along the river channel, the alluvial land alone is exposed to the action of the current. The *rate* at which the river wears away this alluvial land has now to be considered.

There is still in existence an old survey of the Guy's Hospital estates near Ross,† made by John Green in 1756, just 100 years ago, and by comparing the present position of the river with that shown on this survey, the alteration in its course is at once apparent. There is also a celebrated old oak tree, called the "Ross oak," growing near the Ross bend of the river, which was, at the date of that map, thought worthy of record. The distance of this tree from the present river bank is 170 yards, but on J. Green's survey it is only 118 yards; the river must consequently have made 52 yards of land at that place in the century; and supposing the land to have been made at the same rate, about 327 years ago it must have run close under the bank on which the old oak grows, from whence, as has been before stated, the old river bank can be distinctly traced all the way to the cliff at Wilton Castle. This old oak has been noted for many years; it is 29 feet in circumference at 3 feet from the ground, and when it was set on fire in the winter of 1849–50, notices of it were inserted in the London papers; in many, its age was put down at 900 years, and in some at a much larger figure. Now

* The bends in the river channel do not *all* reach the cliffs, and the exceptions are of two kinds; the first those where the wearing of the banks has been (of comparatively late years) impeded by "cribbs," or walling built purposely to stop the encroachment of the river; and the second those in which the river, in its natural course, does not arrive at the margin of the alluvial land; these latter occur chiefly on the *concave* side of a bend in the general course of the river. We have, however, in the subsequent calculation, assumed that the cliffs were always and invariably subjected to their usual "wear" at each epoch.

† For a copy of this survey I am indebted to the kindness of J. S. Taylor, solicitor to the governors of Guy's Hospital.

it happens that we have the means of arriving very nearly at its true age; at the time of the fire the hollow trunk was burnt so thin that the enormous limb which formed the top of the tree, fell, and when sawn through was discovered to be solid at a height of what had been rather more than 30 feet from the ground, and was ascertained, by counting the concentric rings, to be 278 years old. Now, if 40 years be added for the time required for an oak to attain the height of about 30 feet, we shall have $40 + 278 + 7 = 325$ years for the age of the tree, which, supposing the oak to have been a sapling on the bank of the river of that day, agrees remarkably with the former estimate of the rate of wear and deposition obtained from the old survey. It may also be added that on examining the shell of the hollow trunk at the time of the fire it was found that it had grown $5\frac{4}{8}$ inches in the last 50 years; now it must have grown much more rapidly when a younger tree; if we suppose at double the rate just mentioned, that will make an average of half as fast again during the whole term, and, as the entire growth or radius of the trunk is 55 inches, we shall have the age of the tree 316 years; agreeing as nearly as could be expected with the more precise calculation above.

At the Wearend, the rate at which the alluvial land has been worn away, as obtained from J. Green's survey, appears to have been nearly 60 yards during the century; but as we have the opportunity of estimating the rate of wear for 327 years at the Ross bend, that rate has been assumed as the basis of the subjoined calculation.

Now in 327 years, the Ross bend in the river has progressed downwards (towards the sea) a distance of 170 yards, and, supposing the process to continue at the same rate, it would reach the present site of the bend at the Wearend, just a mile below, in about 3384 years; therefore, as the distance between these bends is exactly the average distance from bend to bend all along this part of the river, we may call that period of 3384 years an "epoch" in the age of the river; and during this "epoch" the bounding cliffs would have undergone their usual process of wear all along the course of the river.

We will now proceed to consider the *length of time* required by the river to wear away the cliffs to their present form.

Sections of the surface of the ground have been made in several places across the general course of the river, showing the manner in which the cliff at that point intersects the rounded contour of the surface, and enabling us to form a tolerable idea of what the surface was before the river had worn it away.

This surface, as it may be supposed to have existed when the river first ran down its course, has been marked on these sections with a dotted line; and by measurement, the amount of land (or cliff) worn away cannot have been *less* than 400 yards.

As regards the *rate* at which these cliffs are worn away, we have a very good example at the Wilton Bridge. That bridge was built in 1599, 257 years ago; the masonry of the western abutment was founded on an exposed ledge of rock which stands high enough to be dry whenever the water is low, and yet low enough to be under water on the occurrence of the least "fresh" down the river; it is, in fact, just about the elevation that would subject it to the alternations of being wet and dry most frequently, or, in other words, to the greatest amount of wear. Now this bed is by no means composed of the best and firmest quality of stone in this district, for it is comparatively thin, and what is here called "shelly," or composed of laminæ of about half an inch in thickness, and it is only 15 or 16 feet below the original surface, but it is certainly a very hard bed considering that circumstance.

The whole surface of this bed has, in the course of the 257 years, been worn away $3\frac{3}{4}$ inches, and we may fairly assume that the rocks forming the general cliff were certainly not worn away at a more rapid rate, for they contain, everywhere, decidedly better and stronger beds of rock than this at Wilton Bridge.

Now what must have been the process by which the cliffs were formed from the commencement? When the river first ran down its course, it sought the lowest ground, and must there have gradually worn for itself a channel; then would begin its "meandering," as it may be called, between its bounding cliffs, and the formation of the alluvial land. These bounding cliffs would, of course, be but a short distance apart at first, and the *bends* would consequently pass from cliff to cliff in a shorter distance than when the breadth of the alluvial land became greater; in other words, the duration of what has been called the "epoch" would, at first, have been zero, and would gradually have increased as the width of the alluvial land extended, until it became what we now find it. From this it might have been supposed, on first thoughts, that the duration of the epoch has been, on an average, and reckoning from the commencement, *one-half* what it is now; the common arithmetical mean, however, is not correct in this case, as will be at once perceived when it is considered what the length of the epoch would be when the alluvial land was only a few yards in width, say five for example; for the average of one-half to be correct, the river, after wearing the cliff for a distance of 107 yards, must have left it, gone 5 yards away, and returned to it again in a distance of about 20 yards. This is clearly incompatible with the *curvature* of the river channel; and, judging by that curvature as at present existing, the river could not have left the cliff and returned to it again, after going 5 yards from it, in a less distance than 180 yards.

As our object is now to ascertain, as nearly as possible, the true average duration of the epoch from the commencement to the present time, it must be borne in mind, in the first place, that the distance from bend to bend is made up of two quantities, first, the part where the cliff is supposed to be in "wear," namely, the invariable length of 107 yards, a constant quantity; and, secondly, the part of the cliff *not* exposed, a quantity varying with the width of the alluvial land. For the sake of brevity, let us call this second quantity the "length," and the corresponding width of alluvial land the "breadth."

We have one fact that will help us to arrive at a correct average; at a part of the river where the "breadth" is about 50 yards, the "length" is as nearly as possible 1000 yards; and, assuming our estimated "length" to be tolerably correct where the "breadth" is 5 yards, we have these figures—

"Breadth"	5	"Length"	180
,,	150	,,	1000
,,	400	,,	1653

From these figures it appears that the "breadth" varies directly as the square of the "length;" and consequently, that if the "lengths" be taken along a horizontal line, and the corresponding "breadths" perpendicular to that line, the points so obtained will be in a parabolic curve; therefore, from a property of this curve, the average "length" will be just two-thirds of what it is now, or 1102 yards.* We have, therefore 107 yards as the length undergoing wear, and 1102 the average "length" exempted, making together 1209, the *average* distance from bend to bend from the commencement, which, at the rate of 52 yards in the century, makes the average "epoch" 2325 years.

Now at the rate of 52 yards in 100 years, the 107 yards of cliff would be subject to wear for a period of 206 years, and would, at the rate obtained from the bed at Wilton Bridge, be worn back three inches during that time, when that portion of cliff would be exempted from wear for the remainder of that epoch, namely, according to the average just obtained, for the rest of the 2325 years.

* That the "breadths" are as the square of the "lengths" appears from these figures $\overline{1653}|^2 : 400 = \overline{1000}|^2 : 150 = \overline{180}|^2 : 5$, very nearly, the true figures being $\overline{1653}|^2 : 400 = \overline{1012}|^2 : 150 = \overline{185}|^2 : 5$.

By this proportion we can ascertain the "lengths" where the "breadths" are 300, 50, and 20 yards, and putting them into a tabular form we have

"Breadth"	400	"Length"	1653
,,	300	,,	1432
,,	150	,,	1012
,,	50	,,	584
,,	20	,,	370
,,	5	,,	185

Taking common arithmetical averages between these figures and then reducing such averages, each in proportion to its length, to a *common* average, we have 1091 for the result, which is only 11 less than two-thirds of 1653, the present "length." And if a greater number of co-ordinates had been employed, the result would have approached still more nearly to the two-thirds, which may therefore be taken as the limit or true average."

Therefore, as we find that the cliffs have been worn back 400 yards in all, and 3 inches at each epoch, there must have been 4800 epochs; and, as the average length of the epoch is 2325 years, the river must have first begun to wear its banks 4800×2325, or more than 11,000,000 years ago.

This result may be obtained otherwise, thus: At the rate of the bed at Wilton Bridge, rock would wear when *constantly* exposed to the action of the river, $3\frac{3}{4}$ inches in 257 years, or a yard in 2467 years; but as only 107 yards out of 1209 are in wear at any one time, the time it must have taken to wear a yard was $2467 \times \frac{1209}{107} = 27,877$ years, and as 400 yards have been so worn away in the whole, it must have taken $400 \times 27,877$, or about 11,150,000 years.

The circumstances that make the river Wye, in this district peculiarly eligible for this argument are:—

Firstly, it is a large stream, uninfluenced by tides, and having, for so considerable a stream, a great fall, as much as $2\frac{1}{2}$ feet in a mile along the "general course," and consequently a rapid current.

Secondly, it flows through a geological formation admirably suited to the purpose; for the beds of the Old Red sandstone are here comparatively level, firm and regular, slowly but surely wearing away under atmospheric influences, at a rate peculiarly adapted to the calculation;* for, if the rock had been much harder, the rate of wear could not have been so well estimated, and if it had been much softer, such a breadth of land would have been worn away that an approximate calculation could hardly have been made.

And, thirdly, the gently-undulating character of the surface of the country enables us to estimate the *amount* of that wear as easily and correctly as could well be.

The chance of error, in the foregoing calculation, can only exist, to any amount worth noticing, in one item, namely, the

* From all that I have observed, *frost* has little or no effect on the sandstone rock of this country. I have never seen the face of the stone "spalled" or splintered off after frost, as is the case with the rocks of the Oolitic and some other formations, but the wear appears to proceed from a gradual and slow, but certain disintegration of the exposed surface under atmospheric action.

rate at which the rock of this country is worn away by the river; to determine this, no better example than the one on which the calculation has been made, now exists; although, doubtless, *very exact* observations, carried on for a term of not less than forty or fifty years, on a number of different portions of the beds of rock exposed to the action of the river, might give a more reliable result. I have, however, reason to think that the rate of wear would certainly not be found to be *more*, probably considerably *less* rapid than that of the bed at Wilton Bridge.

The two other items which form the basis of the calculation, namely, the proportion of cliff exposed to the action of the river at one time, and the whole amount worn away, are open to more precise observation at the present time, and can only be rendered more correct by increasing the number of facts; those however already in my possession are more numerous than are here brought forward, and I am confident that a multiplication of them will only tend to corroborate those given in this paper.

On the Occurrence of Natro-Boro-Calcite with Glauber Salt in the Gypsum of Nova Scotia. By HENRY HOW, Professor of Chemistry and Natural History, King's College, Windsor, Nova Scotia.

The Natro-Boro-Calcite, to which the following communication chiefly refers, must be ranked among the least common of minerals, inasmuch as it has hitherto been found in but one locality, and is not yet fully described in the manuals of mineralogy. The circumstances under which I have lately met with it will add not a little, I think, to the interest it already possesses, as it has been obtained in a new geological position, and in a state of greater purity, than the specimens as yet examined seem to have had; so that I have been enabled to make out its true constitution, which, I believe, for reasons presently to be mentioned, has not till now been arrived at.

The brief history of the mineral is this. It was originally sent, a few years since, to Dr Hayes of Boston, U.S., from Tarapaca, in Peru, where it had been found in the nitrate of soda beds. From the analysis of this chemist, it seemed to be composed of water, lime, and boracic acid, and he called it Hydro-Boro-Calcite. Ulex, however, examined a specimen from the same locality, and finding it mixed with the nitrate and sulphate of soda, he boiled the whole with water for the extraction of these, and, analysing the residue, he expressed his results in this formula,

$$NaO\ 2\,BO_3 + 2\,CaO,\ 3\,BO_3 + 10\,HO,$$

and he named the mineral Natro-Boro-Calcite.

Professor Anderson of Glasgow afterwards analysed a specimen from the same locality, which, though somewhat mixed with foreign matter, he showed to consist essentially of the mineral of Ulex. A few remarks, extracted from the paper containing these results,* will sufficiently mark the characters of the Peruvian mineral, and what is known of the geological nature of its till now unique locality.

"The Natro-Boro-Calcite is found in the nitrate of soda beds of the province of Tarapaca, in Peru, and is known to the natives by the name of Tiza. It occurs in rounded masses, varying from the size of a hazel-nut to that of an egg. Externally these have a dull and dirty appearance, but when broken across, they are found to be formed of a series of interlaced needles of a brilliant white colour, and silky lustre. These crystals were extremely minute in all the pieces I examined, but the specimen analysed by Hayes was composed of prisms a quarter of an inch in length.

The qualitative analysis indicated the presence of boracic and sulphuric acids, lime, soda, water, siliceous sand, and traces of chlorine. Ulex found also traces of nitric acid, but that I examined contained none.

The quantitative analysis gave results according very closely with those of Ulex, excepting that, previous to his analysis, he boiled the mineral with water to extract the nitrate and sul-

* Proc. Phil. Soc. Glasgow, Feb. 1853.

phate of soda which he had detected, and which are obviously a mechanical admixture. This was not done in my case, as the analysis was made for commercial purposes, and I was desirous of ascertaining its exact composition as it occurs. Ulex obtained—

	Experiment.	Calculation.
Water, . . .	26·0	25·60
Lime, . . .	15·7	15·93
Soda, . . .	8·8	8·82
Boracic acid, . .	49·5	49·64
	100·00	100·00

which numbers agree very closely with the formula,

$$Na\,O\;2\,BO_3 + 2\,Ca\,O,\;3\,BO_3 + 10\,HO.$$

"The conditions under which this substance is found in loose masses in the nitrate of soda beds, give it a peculiar interest in a scientific point of view, and render it highly desirable that we should have full details of the whole circumstances of its occurrence. The district of Tarapaca has been as yet but little explored, but it would appear that it is chiefly volcanic; and it is remarkable that, up to the present moment, boracic acid has never been found abundantly except in volcanic districts."

The rock in which I met with the mineral, in March last, is part of a very extensive formation of gypsum in the western centre of Nova Scotia, and the precise locality or bed of it at Windsor, on the Clifton estate, lately the property of Judge Haliburton. My attention was first drawn to the other mineral I have named at the head of this paper—the Glauber salt—as a curious "stuff," which had attracted the notice of the quarrymen, and which they called "salts." Upon the specimens of "salts" shown to me I at once saw that at least two distinct minerals were present; and procuring sufficient of both from the spot myself, I submitted them to examination. I give the chemical analysis in the first place, and afterwards the description of the minerals and locality.

The Glauber salt was easily separated in a pure condition, and its analysis in the fresh state gave,

Sulphate of soda,	44·54
Water,	55·46
	100·00

showing that it was the ordinary mineral,

$$\text{Na O SO}_3 + 10\ \text{HO}.$$

The second mineral reminded me of the Tiza which I had seen in the hands of Dr Anderson, in Glasgow; and a careful selection of pieces being made, it was proved by the following results to be identical with that curious substance. The water was found by gentle ignition; the soda, estimated as sulphate, in a portion of the anhydrous residue from which the boracic acid was expelled as fluoride of boron; the other ingredients in a separate quantity; the boracic acid by deficiency. The whole results were calculated upon the air-dry mineral, which was always employed for analysis, and I obtained from the substance as it occurred,

Soda,	8·36
Lime,	13·95
Boracic acid,	41·97
Water,	34·39
Sulphuric acid,	1·29
Magnesia,	0·04
	100·00

numbers which, notwithstanding the high percentage of water, showed me that I really had to do with Natro-Boro-Calcite. Considering the last-mentioned two ingredients as accidental, I treated a portion of selected mineral with *cold water*, washed well with the same, allowed the residue to dry in the air, and, after about ten days' exposure, analysed it. It was perfectly free from sulphuric acid, and gave of the other constituents,

	Experiment.	Calculation.
Soda,	7·21	7·82
Lime,	14·20	14·12
Boracic acid,	44·10	44·02
Water,	34·49	34·04
	100·00	100·00

The recurrence of the high percentage of water, and the accordance of my experimental numbers, both from the actual and the purified mineral, with the calculated figures, are ample warrant, I think, for the formula which I propose as the true expression for the air-dry Natro-Boro-Calcite, viz. :—

$$NaO\ 2\ BO_3 + 2\ CaO,\ 3\ BO_3 + 15\ HO,$$

which differs from that of Ulex, before given, by five additional atoms of water, which I think it probable were removed, in his case, by the manipulations with boiling water, and possibly by desiccation at 212°. Indeed, I found that when the air-dry mineral was placed in the air-bath at this temperature, it lost, upon separate occasions,

	I.	II.	Mean.
Water =	8·25	7·58	7·91 per cent.,

which, deducted from my total loss above, leaves 26·49 for the amount retained, a number so close to that really obtained by Ulex, 26 per cent., as to leave me little doubt that mine is the true expression. I find also that Hayes* originally gave 35 per cent. as the result of his analysis.

The minerals just described were found in the closest association in narrow cavities partially filled, perhaps two inches deep, forming a kind of interrupted vein in the body of the solid gypsum rock, exposed by blasting, about thirty feet below the surface, and extending horizontally some few feet. The more abundant mineral of the two was the Glauber salt, so far as I observed personally, but the quarrymen told me that at first the other came out in "bowlfuls," but they threw it away. I obtained only a few ounces of the Natro-Boro-Calcite, and perhaps not more than a pound in all was preserved by those who obtained it on this occasion.

The Glauber salt was perfectly transparent on the first exposure, and afforded a remarkably fine instance of the crystalline forms of the mineral. Some crystals which I saw partially effloresced, were at least an inch and a-half in length and breadth. Many masses were penetrated by the most perfect crystals of selenite, of various sizes, separate and in marls.

The Natro-Boro-Calcite was for the most part along with and among the crystals of the Glauber salt; and in some in-

* Liebig und Kopp's Jahresbericht, 1849, p. 780.

stances the latter seemed to be crystallized on the former as upon a nucleus; or possibly they were in definite combination as a totally distinct mineral; for crystals, which at first were beautifully transparent, would effloresce after a day's exposure or less, become opaque, and, upon being placed in water, show the silky lustre peculiar to the Tiza, while plenty of sulphate of soda was to be found in the water. In other specimens the Natro-Boro-Calcite was alone, in rounded mammillated masses, in the substance of the gypsum; and these, which were of all sizes up to that of a pigeon's egg or larger, on being broken, presented the appearance of a finely-fibrous, silky lustrous mass, brilliantly white in colour.

The purest pieces had a specific gravity of 1·65; hardness = 1; were tough between the teeth, tasteless, scarcely soluble in water; before the blowpipe melted with ease to a transparent head.

On comparing the circumstances of this occurrence with those referred to in the remarks of Professor Anderson, before quoted, and some other facts, I think they are very interesting. In the gypsum of Nova Scotia, we have a new and distinct locality for the rare mineral Natro-Boro-Calcite, which is analogous with that of a species chemically allied,* boracite, *e.g.*, $Mg\ O\ BO_3$, being found in the gypsum of Holstein, and a compact boracite forming beds with rock salt and gypsum at Starsfurth in Northern Germany.

With these exceptions, boracic acid is found, as is well known, either in directly volcanic regions, most abundantly as such, or as borax; and a recent well-marked case of actual sublimation of the acid from a volcano in the Island of Vulcano, near Sicily, has been studied by Warrington,† or in smaller amount in minerals the products of recent or extinct volcanoes, as Humboldtite,‡ from ejected blocks of Vesuvius and Zeolites, and Datholite from trap of Salisbury Crags, New Jersey, and other places, or in minerals of purely plutonic or metamorphic rocks, as Tourmalines, the Rhodizite of Rose, and Axinite; the species which contain it at all being few in num-

* Nicol's Mineralogy, p. 305.
† Well's Annual, 1856, p. 232.
‡ Nicol's Mineralogy, p. 307.

ber. It may be noticed, also, that traces have lately been met with* in the Kochbrunnen of Wiesbaden and the Kaiserquelle of Aachen.

If, now, we may reason from the character of the majority of its situations, we may almost consider the volcanic or at least igneous origin of boracic acid so well established as to be led, by its occurrence in the saliferous strata, to seek for some volcanic agency as the cause of their production.

Such an origin, I find, has already been assigned to the gypsum of Nova Scotia by Mr Dawson.† This formation has been shown to be a member of the lower carboniferous series, and is assumed to have been produced by the action of rivers of sulphuric acid, more or less dilute, such as are known to exist‡ in various parts of the world, issuing from these active volcanoes, and flowing over the calcareous reefs and bed of the sea. "In accordance with this view, the gypsum is found only in association with the marine limestones, though, as might have been anticipated, these last sometimes occur without any gypsum."§

Gypsum, which is geologically of various ages in different countries, was supposed by the writer just quoted to be peculiar to the lower carboniferous series in Nova Scotia alone, but it has been recently shown by Professor W. B. Rogers‖ that a bed of this substance, with rock salt, occurs in a thick deposit in limestone of the same period near New River, in Virginia, in the Appalachian belt.

I think the occurrence of Natro-Boro-Calcite in the gypsum of Nova Scotia cannot but lend support to the theory of Dawson as to the origin of this rock, when all the circumstances above mentioned are taken into consideration, and that a search for it, or some equivalent in similar situations, might lead to more conclusive evidence as to the geological causes of the saliferous systems in general, and furnish additional links of union between the sciences of geology and mineralogy.

* Liebig und Kopp's Jahresbericht, 1852, p. 328.

† Acadian Geology, p. 223.

‡ Lyell's Elements, chap. xvi.

§ Acadian Geology, p. 224.

‖ Edin. New Phil. Jour., April 1857, p. 360.

On the Cause of the Pyramidal Form of the Outline of the Southern Extremities of the great Continents and Peninsulas of the Globe. By W. L. Green, Esq. of Honolulu, in the Island of Woahoo, Sandwich Islands.

Humboldt, in his "Cosmos," remarks: "The pyramidal configuration of all the southern extremities of continents belongs to the *similitudines physicæ in configuratione mundi*, to which Bacon already called attention in his "Novum Organum;" and again he observes, "The pyramidal terminations of the great continents are variously repeated on a smaller scale, not only in the Indian Ocean, and in the peninsulas of Arabia, Hindustan, and Malacca, but also, as was remarked by Eratosthenes and Polybius, in the Mediterranean, where these writers had ingeniously compared together the forms of the Iberian, Italian, and Hellenic peninsulas."

A glance at the map of the world renders the truth of the above obvious; indeed, it will be seen that there is no considerable portion of land throughout the whole globe but what does terminate towards the south in one or more pyramidal forms.

The cause of this fact may be expressed (as I would suggest) in a few words, viz., that when an arched or conical surface enters the water at an angle, in the direction of the length, the water line must always describe a conical figure thereon, with the apex pointed to the deflected end.

In the application of this fact to the case in point, it will readily be perceived that, as a rule, the surface of every continent or peninsula partakes more or less of an arched or a conical form,—that is to say (independently of its arched form as a portion of a spheroid), it is higher towards the centre than at the sides, and the incline from the interior towards the sea-coast is moderately regular.

There is no fact in geology better established than that vast portions of the earth's crust are constantly undergoing a change of level. The great area in the Pacific Ocean occupied by atols and coral islands is perhaps the grandest and best proved instance of this fact. These atols also prove, as has been ably demonstrated by Darwin and Dana, that the nature of the subsidence or upheaval is not necessarily a simultaneous ascent or descent of the whole area, but rather that a large segment of the earth's crust remains stationary, or nearly so, at one end, and rises or falls at the other.

It is self-evident that the largest and deepest oceans are the areas of greatest subsidence, and that the southern hemisphere, consisting as it does of nearly all ocean, has been the grand area of subsidence. If, then, the axis of this area of subsidence (or of these several areas of subsidence) has been anywhere to the northward of the pyramidal extremities of South America, Africa, Arabia, Hindustan, and Malacca, that form of coast line follows as a necessary consequence ; for they are arched or conical surfaces, entering the ocean at an angle in the direction of their length ;* and they have their apices pointing to the deflected end.

What the Southern and Indian Oceans are to these countries, the Mediterranean is to the peninsulas projecting into it ; the Atlantic to Greenland, Newfoundland, and the south-west of England ; and perhaps North America may owe its form to the same principle.

It is immaterial to the truth of this principle whether any of these particular countries be at present rising or falling, all that is necessary is, that an area of the earth's surface, of more or less arched or conical superficies, enters the sea, or emerges from it at an angle.

A simple practical exemplification of the principle is obtained by taking in the hand a common playing card, and arching it slightly by pressing the two sides ; insert it in a basin of water with the arch uppermost, and the lower edges just below the surface, the greater part of the arch being above ; then depress one end just below the surface, and the water line will form a good representation of the southern extremities of South America, Africa, or Hindustan, according to the angle of depression. By bending the card along the middle, thus

* It is hardly necessary to call attention to the fact, that all the main mountain chains of the portions of continents where the pyramidal form exists run north and south, or nearly so,—that is to say, the arched or conical superficies enter the ocean at an angle in the direction of their length.

forming a ridge in the centre with straight sloping sides, and depressing one end in the water as above, similar figures are produced; or, bending the card parallel to its length, about three-fourths of an inch from one side (the ridge thus formed representing the position of the Andes to South America), and depressing one end below the surface of the water at a certain angle, an exact representation of the southern extremity of that country is formed by the water line.

The smaller the angle at which such a surface enters the water, the more acute will be the conical figure, and *vice versa.* This agrees with the facts as shown in the three countries just named; inasmuch as where we find most ocean, there we should expect the greatest depression, and the surface of the land to enter the ocean at the greatest angle. Thus to the southward of Hindustan there is more ocean than to the southward of Africa, and the angle of the conical figure of the former is consequently more obtuse than that of the latter; whilst to the southward of Africa there is more ocean (and probably, therefore, more depression) than to the southward of South America, and the angle of the coast lines is more obtuse than those of the last-named country, which are the most acute of the three, and, having the least area of ocean to the southward, may be expected to be inclined to the ocean at the smallest angle.

The bluff point of Africa is evidently a local result, arising from the circumstance of there being a table-land there, and is rather a corroboration of the truth of the principle now advanced than otherwise, for this is just the effect a table-land would have under the circumstances supposed.

It is of course not to be expected that we should find perfectly conical or pyramidal coast lines in these countries, as local elevations, subsidences, and degradations destroy the regularity of the surface, which has a corresponding effect on the regularity of the coast lines.

The general average height of the land above the sea-level should, on this principle, decrease not only from the central portion towards the sides or coasts, but also from the direction of the supposed highest end of the area towards the lower, —from the northern base of the pyramid to the apex at the south; and this seems to be actually the case. The extensive and high table-lands appear to be where they should be in South America, Africa, and Hindustan. Volcanic peaks must not be accounted in estimating these relative heights; and even mountain ranges not volcanic, which may have been raised subsidiary as it were to the grand movement, can only be expected to show a partial agreement with the principle.

The general course of the rivers should show a tendency to flow towards the deflected end of the area, besides running east and west from the crown of the arch or ridge; and in accordance with this, we find a marked southerly trend of the rivers in the conical portions of South America, Africa, Hindustan, and in the great track to the southward of China, ending in the peninsula of Malacca.

It may be observed, that when a table land of unusual height extends across an area, thus entering the ocean at an angle, the coast line would necessarily make a sudden curve in at the point where it ended. This may perhaps account for the deep bights on each side of South America, and on one side of Africa.

The subsidence exhibited by the ocean at the north polar regions, being a comparatively small circular area of depression in a mass of land of somewhat even character of surface, would necessarily not admit of larger pyramidal outlines of land than capes and promontories.

Although the proved nature of the subsidence over the large area of atols in the Pacific Ocean,—that is, stationary at one end and depressed at the other,—is brought forward to show the probability that this may be the nature of all the subsidences and upheavals of the earth's crust on a grand scale; the certainty of the fact, that a conical or arched superficies entering the sea-level at an angle must present a conical or pyramidal outline where the water cuts it, ought rather, in view of the phenomenon that all the great continents or peninsulas (being conical or arched surfaces) point with their apices to areas of subsidences, be the proof that such is the mode of that subsidence or upheaval.

General Considerations relating to the Earth's Crust, which seem to occur from the nature of its Subsidences, as exhibited by the form of the Southern Extremities of Continents; also their probable connection with Volcanoes, illustrated by Kilanea.*

Confining our view, for the present, to the southern half of the globe, as divided by the equator, it will be evident (if the cause of the form of the southern extremities of continents be considered as demonstrated) that the whole solid crust of the southern hemisphere is inclined at an angle to the surface of the true spheroidal form of the earth; or, at any rate, it is so from the equator to some parallel of latitude to the southward of Cape Horn, say at least to 60° south.

But besides this inclination, there is another general form, which the surface of the solid crust in this hemisphere must have (between the equator and 60° south), judging from the facts as we find them.

If we commence from a point on the equator where longitude 25° west cuts it (being about the centre of the North and South Atlantic Oceans,) and draw a straight line (on the globe) to a point in latitude 60° south and 35° east longitude, that is to say, 60° south and 60° to the eastward; from this point another line to a point on the equator, 60° northward and 60° eastward; thence 60° southward and 60° eastward again, and so on round the globe, till we arrive at the point from which we started; we have in the spaces included in these lines six regular triangular areas, each of 120 degrees base. In three of these spaces we find nothing but ocean, and in the other three all the land in this portion of the globe pretty equally divided; the sea spaces and land spaces being also alternate, that is to say, there is an area of all ocean between each triangular area containing the land. And further, if we include in our view Madagascar with Africa, and New Zealand with Australia, we find the apices of the cones formed by the coast lines point to about the southern angle of the three imagined trian-

* Some of these considerations are merely speculative; and although they depend mainly on the truth of the view taken of the form of the southern extremities of continents, they may be wrong; but the truth of that view is in nowise dependent upon these speculations.

gular areas containing the land; or, in other words, we ought to look for the central ridge of the conical superficies in or near the line drawn through the centre of our land areas. The three meridian lines, which in fact equally divide our triangles containing the land, pass within three degrees of the Northern Andes, through the great north and south chain of Southern Africa, and within three degrees of the New South Wales and Van Diemen's Land range of mountains. That is to say, they pass close to the three, and the only three, great north and south ranges of the southern hemisphere. Or, taking the six meridian lines at equal distances of 60° each, which divide our six triangular areas, it may be affirmed, speaking generally, that three pass along the highest ridges of land, and three along the central or deepest portions of the ocean, in the southern hemisphere; a line of ridge and a line of hollow being alternate and at equal distances.

It is easy to perceive, by inspection of the accompanying sketch (Pl. I., fig. No. 1) of the Southern Hemisphere, showing these triangular areas, that a section of the globe taken through any parallel of latitude between the equator and 60° south would exhibit on the surface-line of the solid crust a figure approaching that in fig. No. 2 (Pl. I.), which is supposed to be a section taken through the tropic of Capricorn, exaggerated in proportions to be rendered more clear and sensible.

It seems hardly necessary to observe, that this general view of the facts of the form of the earth's crust in the southern hemisphere is more compatible with the hypothesis of a solid crust, shrinking on to a contracting fluid interior than with any other hypothesis advanced. It must be left to mathematicians to say whether a supposed equal force, acting upon every point of a hemispherical crust of supposed equal strength, would not be resolved into three directions, and tend to cause six rents, as supposed in fig. No. 2 (Pl. I.); and whether the irregular hexagonal form, that is with the alternate angles interior, is not the form that ought to exist under the circumstances supposed.

There is one result of an equal pressure on the hardened crust of a spheroid which does not require a mathematical calculation to be perceived to be a necessary one,—that is, that the flattened poles must, other things being equal, be the first to yield. Is there evidence that the poles of the earth have so yielded first, and now exhibit the greatest depression? The circular space of ocean existing as far as we can penetrate at the North Pole, shows, at any rate, a certain amount, and a regular amount, of depression there.

The Antarctic continent at the south is as yet no evidence that the depression of the solid crust, now assumed to be proved to exist in an increasing degree from the equator to 60° south, is not still greater between this parallel and the South Pole, inasmuch as all that land is, as far as known, purely *volcanic.* It is a part of the view now advanced of the nature of the depression of the earth's crust, that there will probably be an outbreak of the molten interior at the central portion of the line of depression. It is to be expected (as an inspection of fig. No. 2 (Pl. I.) will explain), that a rent will be formed in the solid crust at the points or lines of the resolution of the depressing forces. The molten interior, then, may flow out to the height due to the pressure (modified by accompanying accidental circumstances), it may solidify, thicken the crust about that region, and show above the ocean as land; but is no proof whatever of the bodily rise or non-depression of the mass of the solid crust of the earth,

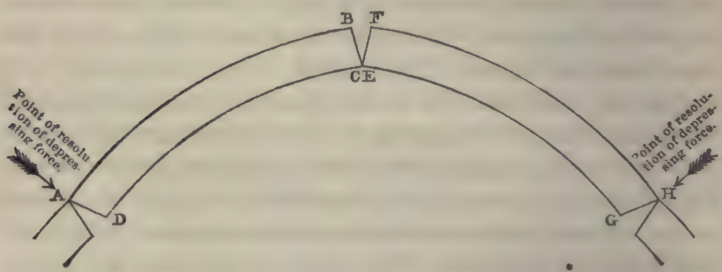
A notable instance of a line of purely volcanic matter, and no other land whatever, along a line of depression (in accordance with this view), is exhibited by Iceland, the Azores, Cape de Verde, Trinidad, and Sandwich Land, extending from the Arctic to the Antarctic circle, and all included within about ten degrees of longitude. The central meridian of this space, 25° west, was the starting-place for our six lines, and goes through the centre of the first of our areas of subsidence in the southern hemisphere.

Whatever laws have governed the form of the solid surface of the southern hemisphere must, we may be satisfied, have also governed those of the northern; and if we cannot equally well apply the same to both, it is because some modifying cause, not understood, has altered or complicated the effects. The simplicity of the observed facts of the case in the southern hemisphere, and their comparative complexity in the northern, ought to induce us to confine our attention to the former first, resting assured that, when these are brought under law, the facts of the northern hemisphere must some day be included.

It has been shown, principally through the admirable expositions of Darwin, that lines of active volcanoes are generally found on areas of upheaval, or at least that, where volcanoes are active, there the land is rising: that on areas of known subsidence, active volcanoes are not found. This is principally exemplified in the Pacific Ocean, where perhaps an equally correct statement of the case might be expressed as follows, viz.: —that active volcanoes, and narrow areas and lines of moderate upheaval, in the Pacific Ocean, are found on the borders of areas of subsidence, and no active volcanoes within them.

On the principle now advanced, of subsidences of large areas of the earth's crust at one end, from a comparatively stationary axis at the opposite end, the above circumstances would seem to result as a matter of necessity. Referring again to a portion of the earth's crust, in the form supposed to exist in the section through the tropic of Capricorn (fig. 3), it will be

Fig. 3.



seen that the effect of the mutual pressure which must exist amongst the segments is to cause an upheaval at the sides opposite to the depressed sides. Suppose A, B, C, D, and E, F, G, H to be any two of such six segments, or any two of any number of segments extending round the earth, with their sides mutually resting on each other, it will be evident, on inspection, that any force which acted so as to depress the segments at A and H would tend to raise them at B and F. The rents between all these segments would, we might expect, be filled with the molten interior, and volcanoes or eruptions of trap might exist along the lines of rent. The volcanoes along the rents of upheaval might well be active; for we can perceive no reason why they should not be; those along the rent of depression would be extinct; because this would be the natural effect of submerging an active volcano for centuries in the depths of the ocean. The water would have access to cool and solidify the molten matter in the rent. Were the greatest active volcano in the world, Kilanea on Hawaii, to be submerged, together with the whole island, to the depth of one mile below the surface, we can imagine the effect a few thousand years might have upon it; but with Kilanea one mile below the surface, Mannakea would still exist above it, an extinct volcanic island 4000 feet high. Such extinct volcanic islands are commonly found in the central portions of oceans, or in the central lines of areas of depression.

The low line of volcanoes, active and extinct, in the Sandwich Islands, is situated upon a line of upheaval between two areas, one of known subsidence (the old region), and one of deep sea (assumed subsidence). The principal active volcano, Kilanea, is unique in the phenomena it presents; nor can they be accounted for on any theory hitherto advanced as to the moving cause in volcanoes generally. The only supposition approximating to probability, in the case of other volcanoes, viz., that of the waters of the ocean obtaining access to the molten interior, here fails. There is no outburst of steam, vapours, or gases whatever. The greatest amount of vapour that is ever seen or noticed in any way may be fully accounted for by the rills of fresh water which may percolate amongst the heated rocks. Nothing is seen but a comparatively quiet unfathomable lake of liquid stone. This great lake has its tides, which rise or fall hundreds of feet with fearful calmness. The greatest eruptions are the quietest; thousands of acres of land may be covered hundreds of feet thick with the molten lava, and the inhabitants a few miles off know nothing at all about it. If the rise of such enormous masses were caused by expanding vapours, we ought to see or hear something of them now and then. The roar of the escape of the steam which could produce such tremendous mechanical effects as are constantly produced on Manua Loa, would be heard over the whole group; and it would surely sometimes escape after doing its work. No such instance has ever been recorded. I do not hesitate to say that steam, vapour, or gases, are no more the cause of the great movements of the lavas on Hawaii than the dust which accompanies the movement of an army is the cause of its march. In this, as probably in other volcanoes, and as in thousands of other instances, cause and effect have been confounded.

The great rises and falls of molten matter in the rents of the earth which are or may be open to the surface on Manua Loa, may perhaps be looked upon as simply the varying height of a column of liquid matter connected with the liquid interior, depending on the pressure of the nearest segments of the earth's crust on that interior, modified by the temperature, and constant liquidity or viscidity, by the varying amount of the pressure of the atmosphere, and by the form, perhaps a varying one, of the communicating rent or orifice. As we find a steady succession of outpourings have occurred for many ages past, and as we know that a steady subsidence of an adjoining area of the earth's crust has also being going on during the same time, may not a succession of minute subsidences of a segment, as above supposed, have been the primary cause of corresponding small rises in the column of lava and of the consequent regular overflows ?

As J. D. Dana, the Geologist to the United States Exploring Expedition, and the last person who, I believe, has scientifically inquired into the causes and phenomena of this volcano, advances with considerable detail and ingenuity the opposite opinion to this; that is, he argues that the rise of the lavas is due to the steam, vapours, or gases arising from the access of fresh water to the column of lava in the rent or conduit; it may be necessary for me to state my view of the causes of the principal phenomena which he attributes to the action of expanding vapours.

And first, with respect to the " boiling motion" in the great lake; " the flow of the lavas in an unceasing current to the south-west," he observes of it, " the steam is seen to move on at a rate which has been estimated at three and a half miles per hour." This motion he agrees with Mr I. Coan in comparing to that of a boiling cauldron; for he says " it can be nothing else." That there may be a certain amount of vapour escaping from this lava, arising from the access of fresh water to portions of the column near the surface particularly, is not improbable; but that this constant, regular, and steady motion in one direction is caused by such escaping vapours may well be doubted.

I would suggest, whether the cooling of the exposed surface of this molten lake would not cause the cooled, and consequently heavier, portions to descend (as in water), to be replaced by the hotter and therefore specifically lighter portions, from the comparatively inexhaustible supply of the molten interior. This action might, and probably would, assume the form of a current, the direction of which would depend upon the form of the sides of the conduit. The different angle of inclination of the sides, for instance, might easily be supposed to produce a surface current.

The other remarkable phenomenon, for which it seems at first sight extremely difficult to account, is this; that whilst the probability is, that the conduits of Kilanea and of Mokuweoweo (the summit crater of Manua Loa) must unite at some depth beneath the surface, both being filled with a liquid, the column of lava in the latter often stands nearly ten thousand feet above that of the former, without even sensibly affecting its height or action.

Dana supposes that the lava in one column may be more inflated with vapours and gases than that in the other; and therefore being, on the whole, specifically lighter, a longer column would balance a shorter one.

Without pretending to say that this inflation may not exist to a certain extent in the upper portions of the column, and therefore have some partial effect, I would suggest another cause, which seems to require no supposition, but what must be a necessary result of the facts of the case.

The sketch given in Dana's work represents a section of Manua Loa, showing the proportionate slopes and distances on the surface, and the width of the craters of the two volcanoes, all according to scale, as determined by the officers of the Expedition. The lines representing the sections of the conduits are of course imaginary, but may fairly be expected to give a probable representation of their form.

There can be little doubt that the conduit of the summit crater (being the main and the largest crater, and the effects resulting from it having vastly exceeded those of Kilanea), is also much the larger of the two. Now, in two conduits supposed to be connected, with the same heated liquid mass of fixed temperature, the temperature in the wider one would, other things being equal, be higher than in that of the other, in proportion to the squares of their diameters, or in the proportion of the mass to the amount of cooling surface.

The rest follows of necessity from this fact, which is also a necessity. A column of cold water will balance a longer column of hot water where the difference in temperature is only perhaps 150°, how much more, then, must we expect a column of molten lava of certain temperature to balance a longer one of a temperature higher perhaps by 1000°. But besides the actual difference in specific gravity which must exist in the lava of the two columns, we must in this case take into account the increased viscidity of the lava as the temperature is lower; that is to say, a pressure on the base of the cooler and more viscid column, that would not sensibly affect its height, on account of this comparative viscidity, might raise the hotter and more liquid one a considerable height. According as a liquid loses the theoretical properties of a liquid, or becomes viscid, so it is less amenable to the theoretical laws of liquids. Water itself is not a theoretically perfect liquid, and in many practical cases, from the cohesion of its particles, is not governed by the theoretical rules. How much less, then, may we expect lava to be so. The difference in the friction of the ascending hotter currents in two conduits of different diameter, must be an important effect to be added to the two already mentioned in causing a greater relative reduction in the temperature of the lava in the narrower one.

These principles, as it appears to me, explain easily and naturally this the most anomalous phenomenon in the eruptions of Kilanea and Manua Loa.

It will be seen, first, that the column of lava in the summit crater conduit may *always* stand many thousand feet higher than in that of Kilanea, and yet never be visible, or its effects be apparent, either in the crater or on any part of the mountain. An outbreak, therefore, may occur through the sides of the mountain, far above the level of Kilanea, without having any other effect on the latter than perhaps *lowering it.* It is "the last hair that breaks the camel's back;" and a very slight rise in the column may rend the mountain, already and for some time in a state of tension. Still, as before explained, a considerable rise may take place in the lighter and more fluid column of the greater conduit without sensibly affecting that in the smaller. There can be no doubt that there ought to exist a certain amount of correspondence between the movement of the lava in the two columns, however different the actual height; but how are we able to detect it? The surface level of the summit column is always far out of our sight, except in a few fitful moments, when it rises to the bottom of the crater. Or if, judging from an outburst through the sides of the summit, we suppose the level to have risen, and hasten to Kilanea to observe the effect, we find it lower than when we last saw it. The outburst at the summit of Manua Loa has lowered the column in that conduit, and that in Kilanea may have fallen in consequence. The nature of the case supposed —the lava in one column being invisible—renders it all but impracticable to detect the correspondence of movement in the two conduits.

The eruptions in this mountain are far less noisy, and accompanied with fewer circumstances to astonish the senses, than in most instances, because, no doubt, as Dana says, the lavas are far more liquid, and the vents are open. *There are no means of confining or entangling elastic vapours*,—effects which probably are merely incidental to, and the results of, the rise or overflow of vast masses of molten rock in all volcanoes, not their causes.

Dana asks, Why are the lavas of Hawaii more liquid than those of most other volcanoes? He tries the fusibility, and finds it no greater (if so great) than that of other lavas, and leaves the question unanswered. The conduits, from the source of the lava, are wider, judging from all the observed circumstances than those of any other known volcano. I have already, shown that, under such circumstances, the temperature would necessarily be higher, and consequently (*cæteris paribus*) the liquidity greater than in any volcano with a conduit of less diameter.

Were we at a loss to account for the great rises of the lavas on Hawaii, without having recourse to the supposition of elastic vapours, it will be pretty evident, from what has been said, that any cause which produced a change in the relative temperature of the two columns might produce a considerable amount of variation in their height. That elastic vapours are not the cause of these great rises, as supposed by Dana, I have already offered some considerations; and, in conclusion, I may recapitulate :—There are no evidences or appearances of the escape of any such amount of elastic vapours as would be at all commensurable with the tremendous effects produced. No violent escapes, or explosions of steam on a large scale, are noticed. The lavas that overflow are usually found to cool compact and solid; few or no vesicles of entangled gases occur, except in the mere scum of the lakes or pools, or in the agitated surfaces of streams subject to varied and irregular mechanical forces. All the most important phenomena and motions can be better accounted for in other ways.

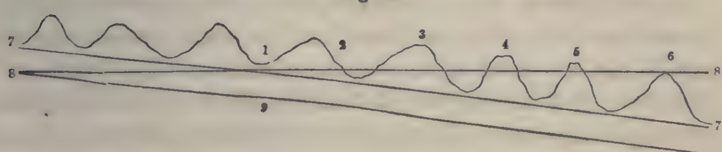
It may be observed, that Dana expressly excludes the waters of the ocean from being considered the probable source of the vapours; and in this we agree. The vapours from the water of the rills derived from rain, are the only ones he brings forward as likely to have any connection with the lavas of the volcano. Now, it is probably far within the truth to say (and an approximate calculation within certain limits may be made), that the whole annual rain-fall over one hundred square miles on Manua Loa might easily be evaporated from the heated surface of rock round the circumference of the conduit of Kilanea, from the top down to the sea-level, only in one fortnight. Further, were it all by some means accumulated, and let on at once, around the sides of the conduit, it is difficult to imagine how the resulting steam could affect, become entangled with, or exert an efficient pressure on, the column of lava. By whatever orifices the water entered, the steam could escape; and supposing, in the worst case, that all these orifices were filled with water, the elastic vapour would have a column of lava on one side, and a column of water on the other. *A column of water double the height of that of the lava would be blown into the air before affecting the height of the column of lava one inch.* This consideration may also help to dispose of the effects of a percolation of water from the ocean on a column of lava standing far above its level.

The most important feature in this view of volcanoes appears to be, that they may be the results of the movement of the crust of the earth rather than the causes of it—the latter being an idea which seems to influence too powerfully many geologists.

It is not difficult to perceive that, taking into view the general shape of the crust of the southern hemisphere, as here assumed to exist, that a powerful lateral pressure must be the result of, and coexist with, the downward pressure in each segment, and that other mountain chains *might be formed in each, by this lateral pressure* (*besides the central ones*). And, further, as the subsidiary forces or effects would tend to be developed in the same relative portions of each segment; in accordance with this we find the summits of smaller mountain chains, bearing a very similar relative position and distance to the main ones, in three relatively similar segments, viz.,—in the Falkland Islands to the Andes, Madagascar to the ranges in Africa, and New Zealand to that in Australia.

The straits between and about Tierra del Fuego and the main land, and between Australia and Van Diemen's Land, are the necessary results of the first hypothesis advanced; that is to say, a chain of mountains entering the ocean, or emerging from it, at an angle, must leave the last one or two peaks surrounded by water, thus :—

Fig. 4.



1. Passes lowering. 2. Promontory. 3 and 4. Islands. 5. Rock. 6. Shoal. 7. Sloping Plain. 8. Sea-level, giving a conical form to the coast-line of plain land. 9. Inclination of the whole surface of crust.

A similar effect is visible at the points of pyramidal outlines of land all over the world.

It follows also on this view of the movement of segments of the crust of the earth, that upheaval and depression might, and probably would, coexist; that is to say, that whilst, for instance, the chain of the Andes was being raised by lateral pressure, the portion of the segment on which the Andes are situated, may be falling at the southern end. The actual rise or fall, then, of any particular spot would depend on the rate of upheaval arising from lateral pressure, compared with the rate of depression at one end, and the distance from the stationary axis.

It will thus be seen that one simple force gives rise to two comparatively simple movements; but the visible effects of these two simple movements may often appear extremely complicated from one point of view,—that is, judging as we do from former ocean-beds or shores. Within a comparatively small area a varied rate of upheaval, a varied rate of depression, and stationary land, might exist, all caused by one force and two movements.

Another effect, which must always complicate appearances in our inquiries into the actual motion of the earth's crust, is the alteration of actual sea-level which every rise or subsidence throughout the whole globe must produce. And this must in many cases be important in amount. Suppose, for the sake of illustration, that the enormous subsidence of the Pacific area, pointed out by Darwin and Dana, had been the only grand movement of the earth's crust in recent times, or since the tertiary epoch, it must have lowered the level of the ocean over the whole globe between 400 and 500 feet. This would have been alone sufficient to drain the waters of the sea from off a large portion of all the tertiary basins in the world, without these areas having undergone any upheaval whatever. It is not pretended that this has been the case, but is brought forward to show how such evidences of subsidence and upheaval must necessarily be complicated and uncertain.

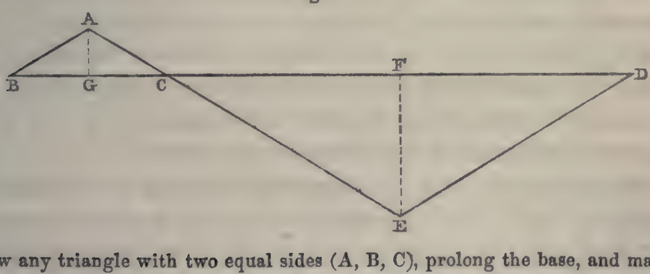
It seems probable, from a due consideration of the form and direction of different areas of the earth's crust, as here supposed to exist, that the greatest depth of the ocean may have been under-estimated; for, taking the double slope (that is to the southward, and also east or west) from the highest tablelands of South America or Africa, to the level of the sea, and imagining the same slope continued under the ocean, as far as we can go south-eastward or south-westward towards the central line of the ocean without coming upon the base of the volcanic land, 40,000 to 50,000 feet seems to come within the bounds of the probable depth. Somewhere in the Southern Ocean, between latitudes 45° and 60°, at about equal distances between Cape Horn and the Cape of Good Hope, that and Van Diemen's Land, or the latter and Cape Horn, will probably be found to be the deepest portions of the ocean. In sounding for greatest depths, care should be taken not to get in the line of the volcanic islands.*

Although only indirectly connected with this subject, it may be well to call the attention of ethnologists to the corresponding circumstances of the correspondingly peculiar tribes which exist at the southern extremities of the continents of America and Africa, and perhaps of Australia or Van Diemen's Land, and that the anomalous circumstances may be connected with, or perhaps accounted for, by the subsidence (in one case, or upheaval in another) of their end of the continents.

Darwin, in his "Voyage of a Naturalist," speaking of the Fuegians, says, "Whilst beholding these savages, one asks, Whence have they come? What could have tempted, or what change compelled, a tribe of men to leave the fine regions of the north, to travel down the Cordillera or back-bone of Ame-

* A fair view to take in estimating generally the probable greatest depth of the sea, all other means failing, seems to be, as explained in the following sketch.

Fig. 5.



Draw any triangle with two equal sides (A, B, C), prolong the base, and make the line C D bear the same relation to B C that the area of the sea does to the area of the land (say three times the length). Bisect C D in E, and draw F E perpendicularly to C D. Extend A C to E, and join E D, F E will represent the probable proportion of the deepest depth of the sea to A G, the greatest height of the land. Call the highest table-lands (before degradation), 15,000 feet, the depth of the sea (after allowing for sediment), would be 45,000 feet.

rica, to invent and build canoes, which are not used by the tribes of Chili, Peru, and Brazil, and then to enter on one of the most inhospitable countries within the limits of the globe?"

Well may he ask this question; and perhaps the answer may be—They have never done so. But rather, being once, when the southern extremity of this continent was at a less angle, the inhabitants of a plain region at the base of the chain of the Andes, a rising ridge on a falling area, when broad lands may have existed on each side of them, and when, consequently, the climate was drier and warmer, the soil better, and its productions abundant; their dwelling-place has, through the course of unmarked ages, gradually, and to them insensibly, subsided into the ocean. Their descendants are left at last, on the narrow bases of the ridge, in a raw, moist climate, barren soil, and with a deep and stormy strait between them and the main land, now contracted and fully occupied by its own tribes; the necessity of the case compels them to invent canoes, and obtain their subsistence by fishing. The alteration and inferiority of circumstances induces a corresponding alteration in their physical appearance and condition. Thus, although at the present day they are classed amongst the lowest grade of savages, "their features indicate relation to the Araucans," a far superior tribe, "whose neighbours they are."*

As the subsidence of vast archipelagoes will account for otherwise inexplicable circumstances in the existing facts of the Polynesian race,† so may the subsidence of continents account for anomalies in races of men in all regions of the globe. No study is more likely to throw light on some of the most notable phenomena of organized beings than that of the latest movements of the crust of the earth, and the relation of the sea to the land. In this instance, the peculiar cause, the peculiar food, and the degraded state of the Fuegians, may be necessities imposed upon them by the laws of the cooling of the planet on which they reside.

HONOLULU, *January* 16, 1857.

* Prichard's Natural History of Man, 447, Ed. 3.

† See Sandwich Island Magazine, No. I., Art. 2.

Observations on British Zoophytes. By THOMAS STRETHILL WRIGHT, M.D., Fellow of the Royal College of Physicians, Edinburgh.*

Description of Plates II. & III.

Clava.

Fig. 1. Corallum and polyps of *Clava repens* (magnified three diameters).

2. Clava membranacea (natural size).
3. Corallum or polypidom of *Clava membranacea* after removal of polyps by maceration (enlarged).
4. Portion of corallum of *Clava cornea* (from Professor Goodsir's specimen; enlarged).
5. Diagram of reproductive capsules or polyps on female polypary of Clava—*a* ectoderm—*c* endoderm—*ac* generative cavity—*d* nutritive cavity of pedicle and capsules—*e* ova changing to (*f*) ciliated planarioid larvæ.
6. Free swimming larvæ.
7. Reproductive capsule of female *Coryne glandulosa*, lettered as fig. 5, and showing the origin of the ova (*c*) from the external surface of the endoderm.

Eudendrium.

8. *Eudendrium pusillum* with Medusa-buds (eight diameters).
9. Medusoid of do. with tentacles relaxed.

11 & 12. Ideal figure of Hydractinia as a Gymnopthalmatous Medusa, and figure of ideal Gymnopthalmatous Medusa—*a* alimentary—*b* reproductive—and *c* tentacular organs or polyps—*d* visual, and *e* auditory organs.

13. Gemmation of Medusa from alimentary polyp.
14. Do. from reproductive polyp.
15. Do. from tentacular polyp.
16. Eudendrium sessile, with Medusa-buds (eight diameters).
17. Single polyp of do.

On Clava.

1. The genus Clava has been hitherto defined by writers on systematic Zoophytology as a single but gregarious polyp, destitute of a polypidom or corallum. Pallas, who, according to Johnston, first described this animal, writes, "Etiam hæc Tubulariis adnumerari debent Zoophytæ, quamvis ne quidem ramescent ut Coryne, et *tubulo corneo* plane destituta sint." Van Beneden remarks, "The individuals are not united to each

* Communicated to the Royal Physical Society, Jan. 28, 1857.

other," "at least I have not seen, as in Hydractinia, a common substance which unites all the individuals." Johnston, making no mention of a corallum, says that the polyps are "single," and "fixed by a narrow disc." And the latest writer, Gosse, in his "Manual of Marine Zoology," states that the polyps are naked, and is evidently not aware of the existence of a polypary or common connecting base between them. A similar ignorance of the existence of a polypary and corallum in Clava is also betrayed by Van der Hoeven in his "Handbook of Zoology." If the descriptions given by these writers were correct, Clava would stand alone among all the marine hydroidæ as a naked and single polyp. One species only of this zoophyte has been hitherto described, under the names of *Clava parasitica* (Gmelin), *Hydra multicornis* (Forskal), *Coryne squamata* (Müller), and *Clava multicornis* (Johnston).

2. In a note on Diœcious Reproduction in Zoophytes, contained in the "Edinburgh New Philosophical Journal," vol. iv., p. 313, I mentioned that I had noticed two species of Clava, and that the polyps were not separate, as hitherto described, but were attached together by a fleshy basis, investing a horny polypidom, somewhat similar to that of Hydractinia, or by a creeping thread inclosed in a membranous sheath. In the same month of July, I found a third species at South Queensferry, when examining the shore there with my friend Mr Murray. These three species I propose to designate by the names of *Clava cornea*, *Clava repens*, and *Clava membranacea*.

3. *Clava repens* (Plate II., fig. 1) occurs plentifully on the friable sandstone of the Scougall rocks near Tantallon Castle. Its polyps are joined together by a polypary or cœnosarc, a fleshy fibre inclosed in a thin tubular corallum, which creeps along, and adheres to the stone. This polypary is readily overlooked, as the "colletoderm" or glutinous envelope of its corallum is generally coated with the detritus of the rock and other foreign matters. The polyps have therefore the appearance of being solitary, and ranged in irregular lines, as shown in Van Beneden's drawing.* These polyps are about five or

* Recherches sur L' Embryogénie des Tubulaires, 1844.

six lines in length, white, or coloured with tints of rose or flesh colour, and they sometimes exceed the polypary greatly in thickness. About a half line of their attached extremity is covered by a very delicate extension of the brown corallum, which remains as a cup when the polyp is removed by long maceration in fresh water. The tentacles, from four to about forty in number, according to the age of the polyp, are arranged spirally in several rows round the buccal papillæ. Thick at their insertion, they decrease in diameter towards their extremity, and are extended, with a tendency to droop at the points. Immediately beneath the lower tentacles, the reproductive capsules hang in many-pedicled clusters, so that this graceful zoophyte presents a resemblance to a miniature forest of cocoa-palms heavily laden with fruit.

4. *Clava membranacea* (Figs. 2 and 3).—In this species, found at Queensferry, the polyps are closely massed together in clusters, each cluster being either a male or female zoophyte. The animal was found adherent to fronds of *Fucus vesiculosus*, but so slightly, that the whole cluster could be readily detached by peeling it off with the point of a scalpel. The polyps had a rich aurora tint, and were larger and more slender than those of *Clava repens*, some of them being more than an inch long. The upper surface of the corallum, examined after the removal of the polyps by maceration, presented the appearance of a favoid aggregation of cells, closely cemented together by an excessive development of the "colletoderm." The cement between the cells included several species of diatomaceæ and microscopic algæ. The lower surface of the corallum consisted of a mat of parallel and anastomosing tubes of soft membrane. These tubes also passed beyond the cluster of cells which they supported, and crept along the surface of the fucus in irregular lines, to furnish, as it were, other colonies of polyps.

5. *Clava cornea* is a clustered and diœcious zoophyte, resembling in appearance the species last described. The specimen which I place on the table was kindly lent me, for this evening, by my friend Mr Goodsir, and is one of the results of his trip to the Orkneys with the late Professor Edward Forbes. The polyps are long and slender, like those of *Clava mem-*

branacea. The corallum apparently consists of a thin chitinous plate attached to the fucus. Over part of this plate the chitine rises in low, smooth ridges, running either parallel to each other in winding lines (fig. 4), or meeting at various angles. These ridges have a double contour under the microscope. The polypary lies between the ridges, and consists of fleshy fibres, from which the polyps spring. I believe a thin ring or cup incloses the base of each polyp, and that a membrane also passes from the summit of each ridge to that of the one next it; but I have not been able to satisfy myself on these points. In other parts of the same polypidom the ridges assume the aspect of an intricate net-work, or even a spongy mass, in which the chitinous and fleshy elements are intimately blended together. The whole mass of the polypary, corallum, and polyps, is readily detached from the fucus. [Since writing the above description, I have convinced myself, by the examination of Mr Goodsir's specimen, that the corallum of *Clava cornea* is formed of tubes cemented together, either laterally in sub-parallel lines, or in a more complicated mass. The surface of the corallum of this zoophyte, in fact, has a strong resemblance to the stem of the corallum of *Halecium halecinum*, which consists of a bundle of sub-parallel and anastomosing tubes, more or less closely cemented together, a structure which becomes beautifully apparent in transverse section.]

6. *Reproduction of Clava.*—All the three species of this zoophyte which have come under my observation are unisexual or diœcious; that is to say, the polyps connected by the same polypary have either spermsacs or ovisacs, but not both. The reproductive capsules are amassed together, like bunches of grapes, in one or more thick pedicles, which arise from beneath the lower range of tentacles of the polyp.

In my communication on Hydractinia,* I stated (after Allman and Huxley) that the polyps of all the hydroid zoophytes consisted of three elements:—1*st*, *The ectoderm or outer layer*, the seat of sensation and other external relation, furnished with tactile processes, and with apparatus of offence or defence. 2*d*, *The muscular or middle coat*, specialized for motor function; and, 3*dly*, *The endoderm or inner coat*, of which last,

* Edinburgh New Phil. Journal, New Series, April 1857.

again, the *inner surface* is endowed with the nutritive function, while its *outer surface* subserves to that of reproduction. It is necessary to remember the relation and function of these layers when describing the reproductive apparatus of Clava.

7. The Ovisacs of the female of this zoophyte, of which fig. 5 shows a section of five *in situ*, are found to consist of ectoderm (*a*), muscular coat, and endoderm (*c*), and their nutritive cavity is continuous with that of the pedicle, which, again, is a diverticulum of the alimentary canal of the polyp. In each of the ovisacs at an early period, one, or more generally, two transparent ova appear, consisting of a vitellus and germinal vesicle, inclosed in an envelope, and situated in the generative cavity (*ac*), between the endoderm and the other coats, as in the ovisac of Hydractinia. In the reproductive capsule of *Coryne glandulosa* (Dalyell) the secretion, if I may so call it, of the ova, from the outer surface of the endoderm (as shown in fig. 7), is a fact beyond doubt, but in Hydractinia and Clava their appearance takes place at so early a period of the development of the ovisac, that the seat of their origin can only be inferred from observations in other zoophytes. The ova, after becoming opaque and almost black by the granulation of the yoke, gradually assume a transparent pink tint, and are developed into ciliated planarioid larvæ, which are discharged from the distal extremity of the ovisac, and after gliding over the bottom of the vessel in which they are contained for a few days, become fixed, and changed into minute polyps. In this zoophyte the reproductive process differs from that I have described in Hydractinia, inasmuch as the young arrive at their larval or planarioid stage of development before leaving the ovisac, and the endodermic layer of the ovisac is gradually withdrawn into the pedicle, while in Hydractinia the contents of the ovary are discharged as ova, and the endodermic layer occupies the interior of the ovary to the last, although reduced in volume by absorption.

8. The Spermsacs of the male Clava resemble the reproductive capsules of the female in external appearance and arrangement. The development of spermatozoa in their interior is similar to that I have described as occurring in Hydractinia. We have the same secretion of gelatinous matter from

the external surface of the endoderm; the same development in this matter of minute cells, and the production from these cells of spermatozoa. But while, in Hydractinia, the endoderm of the spermatic capsule is reduced, towards the last stage of the process, to a mere line of brown granular matter occupying the axis of the capsule, in Clava the endoderm is gradually withdrawn from the capsule altogether, and the cavity of the latter at last contains spermatozoa alone. The spermatozoa of Clava, which are very large and active, are discharged from the summit of the spermsac. The ectoderm of both ovaries and spermsacs contains the larger thread-cells in great numbers.

9. The existence of spermatozoa in the reproductive capsules of Clava, a fact unnoticed by Johnston, was discovered by Ratke in 1844, that of ova by Rudolf Wagner in 1836, but neither of these philosophers fully recognised the diœcious character of this animal. Van Beneden also described Clava in 1844, and figured the male capsule, which he mistook for an entire ovum. Van der Hoeven, in his recent work already cited, rather loosely states that the propagation of this zoophyte is effected by buds which contain ova or spermatozoa, and which occasionally detach themselves from the stem on which they are developed, swim freely about, and resemble small medusæ. He gives no authority for such an opinion, and he has probably classed with Clava a number of small clavate polyps with filiform tentacles, such as the *Podocoryne* of Sars, the *Coryne fritillaria* of Steenstrup, and the Zoophyte described at a late meeting of this Society by Mr Peach. There also exist a number of undescribed Tubularian Zoophytes, some exceedingly minute, passing upwards through Clava, Coryne, and Eudendrium, to Tubularia, some of which give off free Medusæ.

Eudendrium.

10. The two new species of this Zoophyte I now describe can lay claim to none of the arborescent beauty which has gained for this genus the name of Eudendrium. So insignificant are they, indeed, that they are easily overlooked, even when carefully sought for. The first species, to which I have given the name of *Eudendrium pusillum*, is found growing on many Ser-

tularians and on the back and legs of the Spider-crab, in which last situation it sometimes occurs in great profusion. It is adherent to these bodies by a creeping tubular corallum inclosing a filiform polypary. From this creeping fibre stems arise at frequent intervals, from about one-eighth to a quarter of an inch in height, and bearing at their summit small white club-shaped polyps. The polyp is capable of partially retreating into the upper part of the tube, which is dilated at this point so as to form an imperfect cell. The filiform tentacles vary in number from four to twelve, according to the age of the polyp, and are held in two rows, the one (generally consisting of four) elevated, the other depressed or horizontal.

At almost all seasons of the year we notice *on the polyp-bearing stems* of this Zoophyte small protuberances, which rapidly increase in size, and become Medusæ or "jelly-fish" of the naked-eyed type.

The Medusa-bud first appears as a diverticulum or sac of the endodermic and ectodermic layers of the polypary, covered by an extension of the corallum. After a short period the diverticular sac becomes depressed at its summit, and at the bottom of the depression a slight elevation may be observed. This depression and elevation are the rudiments of the umbrellas and peduncle of the future medusa or acaleph. The depression rapidly deepens, until the sac becomes folded in upon itself, so as to form a deep bell with the peduncle rising like a thick clapper from the bottom of its concavity. In the mean time the endoderm of the bell (now become very opaque by the deposit of red granular matter within it) has slightly separated from the outer layer of ectoderm, and has become divided into four thick tubular lobes, communicating with each other by a circular canal at their summits, and with the peduncle at their bases, and connected together laterally by the inflected ectoderm, within which a transparent muscular membrane is developed. The ectoderm now forms the umbrella and the endodermic lobes, with their uniting membrane, form the lateral canals, and the sub-umbrella of the Acaleph or Medusa. A constant interchange of circulating particles takes place between the cavity of the parent polypary and the cavities of the peduncle and the endodermic lobes. The process of development goes on, the peduncular sac is changed into a quadrangular polyp, the endodermic lobes into slender canals, bearing at their extremities polyps of a peculiar form, systolic contractions commence in the muscular tissue of the sub-umbrella, and the bud has become a perfect Acaleph, (fig. 9), although still joined by a narrow pedicle to the polypary of the Eudendrium. This pedicle is, however, soon absorbed, the thin covering of the corallum bursts, and the living bubble dashes away through the water, with powerful strokes, a formidable little tyrant of the sea.

When first separated from the Zoophyte, the Acaleph seeks the surface of the water with long zig-zag bounds, carrying its tentacles closely coiled in spirals. Having remained swimming there for a short time, it begins to sink slowly with the mouth of its bell uppermost, and the tentacles, uncoiling themselves, stream behind, to a distance of more than twenty times the length of the bell, in straight lines or graceful curves, sweeping the water in search of prey. In most of the naked-eyed medusæ, the umbrella is so thick and solid, that the shape of the upper part of the bell is but slightly altered by the contractions of the sub-umbrella; but in the species I am now describing the umbrella is thin and soft, so that the whole parietes of the bell contract together at each stroke, forming a curve similar to the wave-line of Scott Russell, and admirably adapted for rapid passage through the water.

A jar of these lively creatures, some swimming rapidly about like small frogs, with their half-coiled tentacles jerking backwards at each stroke, others descending headlong in flocks, like the falling train of a rocket, and all glittering under oblique illumination in the dark water, forms one of not the least interesting of those scenes of beauty which are of daily occurrence to the naturalist.

12. In the Anatomy of the Acaleph of Eudendrium four distinct parts claim our notice.

(1.) The umbrella.
(2.) The sub-umbrella.
(3.) The lateral and circular canals.
(4.) The alimentary polyp or peduncle ; and
(5.) The tentacular polyps.

13. In the description of these parts, I shall consider the animal, not as *a sexual polyp*, with Ehrenberg, Allman, Carpenter, and others, but as a free and independent extension of the *polypary* of Eudendrium; not as the product of the alternate generation of Steenstrup, in which the parent is a zoophyte, the child an acaleph, the grandchild a polyp again, and so on in endless succession; but as a new phase in the continued development of the Zoophyte, in which the humble, fixed, and thread-like polypary attains, as it were, a higher life of beauty and motion, and an organization adapted to its changed existence.

14. At our last meeting, I described to the Society that, in the case of Hydractinia (a Zoophyte intermediate in its form and structure between the trne Zoophyte and the Acaleph) we had a polypary consisting of a fleshy expansion permeated by a net-work of tubes, and furnished with organs of reproduction, digestion, and prehension, in the form of reproductive, alimentary, and tentacular polyps. A homologous structure obtains in the Acaleph now under our notice. Instead of a *flat expanded* polypary, we have that body bell-shaped, and represented by the umbrella, the sub-umbrella, and the lateral canals. In the peduncle, we have a single alimentary polyp. While the long tentacles, with their bulbs, form the homologues of the tentacular polyps of Hydractinia.

It is not, perhaps, incorrect to consider, with Allman, the ovaries and spermaries of Cordylophora, or those of Clava or Hydractinia, as sexual polyps; but, as to the naked-eyed Acalephs, produced by gemmation from various hydroid Zoophytes, a knowledge of the anatomy of Hydractinia teaches us that they are something more. They are independent polyparies, having polyps endowed with various functions; some species of them possessing, indeed, differentiated organs of sight and hearing, and being capable, like Hydractinia, of producing other polyparies, similar to themselves, by gemmation.

In fig. 11 I have given an ideal sketch of Hydractinia as a Gymnopthalmatous Medusa, and at fig. 12, having its organs indicated by the same letters, a sketch of an ideal Acaleph or free-swimming polypary, and I have furnished this last with *the alimentary polyp* of Lizzia (*a*), *the reproductive polyps* of

Thaumantias (*b*), *the tentacular polyps* of Sarsia (*c*), with their eye-specks, and the auditory capsules containing otolithes common to the Campanularian and many other Acalephs. Such an animal would be endowed with the power and special apparatus for the exercise of the faculties of motion, sight, hearing, prehension, digestion, and reproduction. It will further have the power of propagating animals similar to itself by gemmation, *from its alimentary polyps*, as in Lizzia (fig. 13), from *its reproductive polyp*, as in Thaumantias (fig. 14), and *from its tentacular polyps*, as in Sarsia (fig. 15); and, lastly, in these budding Acalephs, even while still attached, preparation will have commenced for a still further exercise of the propagative function.

The ovaries or spermaries of Cordylophora and Clava are the germens or anthers of the animal plant, while these Acalephs must be considered as the fruit-bearing branches, leading an independent life. They are the divided parts, paradoxically speaking, of an individual existence.

15. *The umbrella* (of the acaleph of *Eudendrium pusilla*) is homologous with, and developed from, the ectoderm of the polypary. It is a clear, structureless tissue, containing, on its external surface, numerous large thread-cells, each occupying its own sac. It is continuous with the ectodermic layer of the tentacular polyps, and exists as a delicate membrane passing within the bell and partly forming the sub-umbrella, and covering the alimentary polyp.

16. *The lateral canals* (homologous with tubes of the endoderm in the fixed polypary) are situated immediately beneath, and are adherent to, the umbrella. At the summit of the bell they join together to form a quadrangular cavity, and they communicate below with a circular canal, which passes within and around the mouth of the bell. This system of canals is at first lined with red granular matter, which is afterwards absorbed, and it is constantly traversed by streams of nutritive fluid, impelled by ciliary action, and changing the direction of their course at short intervals of time.

17. The *sub-umbrella* is a thin muscular membrane attached to the exterior of the lateral canals on their inner aspect, and along their whole length, and also to the umbrella along four

lines running mid-way between the canals. Its function is that of motion; it also acts as an organ of circulation and respiration by enlarging the calibre of the lateral tubes at each of its systolic contractions, and constantly refilling the bell with freshly aerated water. Its structure has a finely dotted or crapy appearance. The dots show a tendency to arrange themselves in transverse lines during the contraction of the membrane, but no true muscular fibres exist. Numerous transparent corpuscles may also be observed scattered with some regularity in the tissue of the sub-umbrella, which, from observations in other classes of zoophytes, I am led to consider as the rudiments of a ganglionic nervous element. Similar bodies, of a fusiform shape, may also be detected along the sides and inner aspect of the lateral canals. The sub-umbrella passes across the mouth of the bell to form the veil, which is perforated in the centre by a wide circular opening. This apparatus, by contracting the jet of fluid ejected from the bell, increases its propulsive force; at the same time, by its projection outwards at each stroke of the sub-umbrella, it renders the *stern*, also, of our little vessel conical, and facilitates its passage through the water.

18. *The alimentary polyp or peduncle* (the digestive organ of the Acaleph) rises from, and communicates with, the confluence of the lateral tubes at the summit of the umbrella. In shape it is short, quadrangular, and without tentacles, differing in this respect from the acalephs of other species of Eudendrium described by Dalyell and Van Beneden. Its structure consists of a layer of highly vacuolated endoderm, covered by a delicate ectodermic investment, containing a fringe of thread-cells round the mouth.

19. *The tentacular polyps* (or prehensile organs) are placed one at each confluence of the circular with the lateral canals. They consist of two parts,—the hollow bulb and the tentacle. In two of these polyps the tentacle is very short, while in the other two, opposite to each other, it is excessively developed, and, when not in use, coiled in a tight spiral. The ectoderm or outer edge of the tentacle, or that which, when coiled, forms the periphery of the spiral, is loaded with small thread-cells, while its inner edge is destitute of those bodies.

No eye-specks or otolithes can be detected in this Acaleph with the microscope, but when a taper is brought close to the side of the vessel in which it is swimming, a brilliant star of light appears at each of the bulbs of the tentacular polyps, reflected from some tissue which I have not been able to detect.

The reproductive organs, which, in the Acalephs of some zoophytes are developed before the separation from the parent polypary, have not appeared during the seven or eight days which the Acalephs of *Eudendrium pusillum* lived in my possession.

Eudendrium Sessile.

19. This species (figs. 16 and 17) is found growing on shells in deep water in the Firth of Forth, and on rocks at the shore about Granton. The red or white polyp is sessile, or united by a very short ringed stem, on a creeping polypary, and it is inclosed up to the tentacles in a membranous tube, which bends with every movement of the body. The filiform tentacles are from two to eight in number, of equal lengths, and carried in two rows, the upper one elevated, the lower one depressed. The Acaleph buds in this species are sessile, and are produced from the creeping polypary, close to each of the polyps, often in pairs. They differ in no respect of either size or form from the Acalephs of *Eudendrium pusillum* already described in this paper.

On the Prehensile Apparatus of Spio seticornis. By THOMAS STRETHILL WRIGHT, M.D., &c.*

Description of Plate III.

Fig. 18. Section of tip of tentacle of Spio seticornis—*a* wall of tentacle—*b* vessel—*c* spine-bearing papillæ.

19. Enlarged sketch of one of the papillæ.

20. Tricho-cysts—*a* entire—*b* ruptured, and discharging spicules.

1. Old shells taken from the sea are frequently found studded with small tubes, composed of mud and sand, cemented together by slime. These tubes are the habitation of the An-

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nelid *Spio seticornis.* When they are placed in water, we presently see a pair of long glassy tentacles protruded from each opening, which are tossed about with such an incessant and violent motion that we are tempted to believe their concealed owners have taken leave of their senses. If a small piece of oyster is thrown amongst them, it is instantly seized by the waving arms around, and pulled hither and thither, until it is torn to pieces and devoured by the black-eyed and wicked-looking little Annelids, which, forgetting their usual coyness, protrude their heads from the tubes. We observe that the tentacles, when seizing the oyster, attach themselves to it not by winding themselves round it, but by simple adhesion, as if they were studded with numerous suckers and hooks, like the arms of the cuttle-fish. Anxious to examine their microscopic structure, we make many attempts, by rapid clips of our spring scissors, to possess ourselves of a pair of the delicate white arms, but in vain. The Spio, who has all her senses about her, twitches them in, and darts back deep into the substance of the shell, from the mouth of which her tube projects only a little distance. At last we make a successful snip, and a tentacle is placed on the stage of the microscope, still continuing its writhing motions, and gliding through the water as though possessed of independent life.

The tentacle of Spio, the tip of which is shown in fig. 18, is a hollow tube of dense granular parenchyma, covered by a thin layer of transparent tissue. Its interior is occupied by a sinuous vessel, which, in the living animal, is constantly traversed by an ebbing and flowing tide of crimson fluid. The tentacle is thus enabled to discharge the additional function of a branchial organ, and for that purpose is furnished with a ciliated band running from the tip to the base.

The prehensile apparatus of Spio consists of numerous large papillæ, thickly crowded together along the borders of the tentacles. The microscopic structure of these papillæ is exceedingly interesting. They are composed of a prolongation of the granular parenchyma, covered by the transparent layer. At the summit of each papilla, the parenchymic substance is produced through the external layer, as an acuminated soft cilium or spine.

I have already noticed the extensive occurrence of these soft spines, which I have called Palpocils, in the lower classes of animals, as instruments of adhesion or tact. We find them occurring, in an exaggerated state, in some of the protozoa, as in *Actinophrys*, *Podophyra*, and *Acineta;* on the tentacles of *Hydroid* and *Helianthoid Polyps*, accompanied generally, but not invariably, by thread or sting cells. In the polyzoa, situated on the small papillæ, concealed within the jaws of the avicularia, or bird's-head processes of *Cellularia ciliata* and others. In the Mollusca, as in the adhesive tentacular fringes of Lima and others, and on the dorsal papillæ of the Eolidæ. In the Turbellaria; and in the Annelidæ, as in the tentacles of Terebella and others. Probably the long motionless Cilia which grace the tentacles of some of the Rotiferæ, as in Stephanoceros and Floscularia, are of the same nature as these processes.

On forcibly pressing the tentacle of Spio, the spine-bearing papillæ burst, and there issues from each of them a body of a very peculiar kind. This body is a pear-shaped capsule (fig. 20, *a*), which issues from the papilla in which it lies concealed, with its broad end in advance. Under stronger pressure the capsule also bursts, and discharges its contents (*b*), —a multitude of acicular spicules, sharp at each end.

It is impossible to resist the conviction that these sacs are analogous to the thread-cells of the polyp, although their structure differs very considerably from that of the latter organs. They approach more nearly to the tricho-cysts discovered by Allman in *Bursaria leucas*, a protozoan animacule, which consist of fusiform capsules, having a single spicule in their interior, or to the globular thread-cells of Cydippe, described by myself, which contain a simple coiled thread, unaccompanied by the usual invaginated sac which occupies the thread-capsules of the Hydroid Zoophytes.

We cannot, I think, doubt that the tricho-cysts of the subject of this communication are instruments of offence, like the thread-cells of zoophytes. If so, woe to the unlucky inhabitant of "the broad sea wolds" who shall be clasped by the white and blushing arms of Spio, once a powerful Nereid and grand-daughter of Oceanus and Terra, to whom the piety of mankind made offerings of the choicest of milk, oil, and honey, now degraded to the form of a cruel and voracious little worm, and fed by dilettante naturalists on morsels of native oyster. His fate will be like that of the unfortunate whom we have all read of, who, drawn gently into the arms of what seemed a beautiful maiden, suddenly found himself transfixed by a hundred hidden blades projecting through the rich silk that covered her breast.

The Distribution of Rain in the Temperate Latitudes of North America. By LORIN BLODGET, U. S.

The general questions relating to the supply of moisture to the continental areas of the Northern Hemisphere are at present the most difficult in climatology, and, for their solution, an ample collection of facts, from widely distributed sources, is indispensable. The military posts of the United States have recently been extended to nearly every part of the interior and Pacific districts, and the observations required to be made at these posts have supplied some very desirable elements, though the periods of observation are yet very short. An approximation sufficiently near to the true quantities, for many purposes of generalization, may be afforded by four or five years of observation, however, and most of these posts now furnish records for three or five years. Not only the new districts of this continent, but much of the interior of Europe and Asia, assist to furnish this new material, particularly for the belt not yet illustrated, which stretches from the Black Sea northeastward across the Caspian, and over the great areas of Southern Siberia.

To understand the distribution of rain in the United States clearly, it is quite necessary to make some exterior or general comparison of the temperate latitudes, and to do this, if possible, in a systematic manner, or as a whole. The measurements recorded at many new points require such a comparison for the purpose of verification, and without it, it is often difficult to decide on their accuracy. If a comparison discloses symmetrical relations, these may at once decide whether the records are accurate, and whether the collection is sufficient to permit the investigation of exterior questions or those relating to the sources of supply of moisture to land areas. It is still preferable to confine attention to the simple facts of distribution as shown by actual measurements, and to discuss general questions only for the purpose of verifying these.

In this simple distribution there are some noticeable points, both of conformity to the distribution on the eastern continent, as far as we know what that is, and of contrast with it. The most prominent of these, from the European point of view, or, as respects European analogies, is the great quantity of rain falling on the Mississippi plain of the interior; and at distances so great from the coasts, and under such circumstances of atmospheric circulation, as to preclude the idea of direct derivation from the sea. The quantities are not graduated according to the proximity of bodies of water, either at the borders of the Gulf of Mexico or at the Great Lakes. The quantity falling on the area between the 35th and the 40th parallels is immense, and the hypothesis of direct transmission in the surface atmosphere would require a constant and strong sea-wind from the south for most of the year. Without doubt a large quantity of water is so transmitted from the Gulf inland, but the leading relation is that of *capacity for moisture* simply, which capacity may be supplied from a superior current or atmospheric movement as readily as from one at the surface merely. Where the heat is greatest on this plain, and the resulting capacity for sustaining aqueous vapour therefore greatest, there is, on the whole, the heaviest precipitation in the regular recurrence of rains. At Cincinnati the temperature is often equal to that at New Orleans, and the high measure of capacity is fully supplied, producing excessive humidity, and a profusion of rain corresponding to such conditions. This point is 630 miles from the sea, yet it has a mean annual quantity of 48 inches of rain, or more than double that of London or Paris.

At the mouth of the Mississippi both the quantity and the forms of precipitation become, in a great degree, tropical; in the warmer months they are fully so, and it is singular that, from this point northward, the diminished quantity of rain has direct relations to the diminution of heat and the increase of altitude,—this last point again reversing the analogies of the west of Europe. In confirmation of this view, it is found that the upper plateaux or valleys on both sides of the mountain ridges in Virginia receive a quantity much less than that falling in the Ohio valley at the same latitude, differing from that more widely, indeed, than from the quantity on the plains of the Atlantic coast. From Cincinnati the mean of 48 inches is extended nearly to Portsmouth, and it is still 42 inches at Marietta, much nearer the base of the mountains; while at Lewisburg, White Sulphur Springs, Staunton, Winchester, and other places in the various parts of the upper valleys, the quantity cannot exceed 36 inches. All accessible measurements place it lower, indeed, and the general drainage of the region implies only a moderate quantity, with none of the profuse floods so frequent on the Ohio, and on the entire extent of the Atlantic slope.

The western part of the continent differs radically from the condition that has just been described. It is apparent that the different latitudes there reproduce, in succession, the various generic distinctions belonging to Africa, Europe, and Asia in like latitudes. The absence of rain marks a desert belt in both cases; and in each it begins at low latitudes of the coast, to extend over a large share of each continent north-eastward. Sahara, from the 27th to the 32d parallel on the coast of Africa, has a corresponding area at the same latitudes in California; and though there are many local differences between the two, and a much larger development on the eastern continent, the substantial identity of the two cannot fail to be recognised in an illustrative chart.

In all parts of the dry areas this correspondence in leading features, while wide differences of degree, with many local peculiarities, exist, may be traced without difficulty. The transition belt of the Old World occupies a very large space, yet it is here so much compressed as to obscure the points of identity in many cases. The characteristic autumn rains of the north shore of the Mediterranean have been thought to be wanting here, yet they appear very decidedly on the Gulf coast at the mouth of the Rio Grande; and it has been recently shown by the surveying officers who have traversed the west of Texas and New Mexico, that a large area there is characterized by an autumnal rainy season, though the quantity falling is small. It is but little removed from the summer rainy season of Chihuahua and other parts of the north of Mexico, and at the north it merges into the equally distributed rains of the higher latitudes in the extreme north of New Mexico. This is nearly the geographical position the autumn rains of Europe have, and the difference which places these in lower latitudes is due to the greater width of the European belt, since that belongs, in part at least, to the south shore of the Mediterranean.

The next in the order northward is a narrow area having the dry summer of Spain, and moderate winter rains. But for the peculiar cold coast of the summer at San Francisco, this belt of light rains—which fall wholly in winter—would perhaps be wider; but it is now much circumscribed, both in latitude and longitude, bordering closely on deserts inland. The summer rains also extend farther northward in the interior than on the coast, as they are abundant on many parts of the high mountains north, as well as south, of the Gila river, while they are unknown as far south as observations have been made along the peninsula of California.

At the latitude of San Francisco the two divisions of the year become more distinctly defined; and though the quantity for the year is not larger than in France, it falls profusely during the rainy season. The warmer months have none, and this complete interruption belongs to a relatively larger area than on the old continent; the statistics for the belt to which the Mediterranean is central showing a decided contrast with those we have for California. At the 42d parallel the summer rains begin on the Pacific coast in small quantity, and from this point northward they increase rapidly and regularly, so far as known. At Sitka they become profuse and almost constant, and it is probable that they are more abundant above the 50th parallel than in like latitudes of the west of Europe.

For these higher latitudes the Pacific coast has a larger quantity for the whole year than the west of Europe, though the belt of profuse rains is not wide, and in the interior, east of the Rocky Mountains, the quantities are much the same as on the Russian plains north of the Black Sea. The dry transition belt there borders the Black Sea, and extends to the northern extremity of the Caspian, while it ceases here at the plains of the Columbia west of the mountains, and at the northerly bend of the Missouri east of them,—both points nearly at the same latitudes as the dry Caspian basin. The plains of British America are as well supplied with rain as those of the Volga, and apparently better than the high plains or steppes of Siberia. At least they have a supply adequate to the purposes of cultivation, and show no deficiency on the eastern slopes of the Rocky Mountains, at the sources of the Saskatchawan, Athabasca, &c.

This decided abundance on the plains of British America may be taken as strong evidence that the dry plains at the south find their origin in general causes affecting continental distribution, and are not to be attributed to the Rocky Mountains alone. The greater area of the dry belt of the eastern continent is beyond the influence of important mountain ranges, and it clearly is not chargeable to such influences. Though the configuration here may favour the view that all such contrasts are due to configuration simply,—since the mountain ranges near the Pacific are all high, and formidable as atmospheric barriers,—the comparison of the two continents, as a whole, furnishes an analogy so clear that we are not disposed to look farther for the solution of the arid belts. What the ultimate causes of this continental aridity are is not clear; but it is not necessary to enter on that inquiry in order to admit conclusions adverse to those which attribute all these distinctions to the influence of mountain ranges.

In the central area east of the Rocky Mountains there are many interesting anomalies and contrasts which cannot belong to vertical configuration, since the whole is a plain. On the lower Rio Grande there is an autumnal rainy season, which at New Orleans passes into a district having a summer and a winter rainy season, with a small comparative deficiency in both spring and autumn. Here the quantity is nearly twice as great as that at the mouth of the Rio Grande. Further east, April and September exhibit a decided deficiency. This is particularly the case from Pensacola to Charleston, and on the upper part of the Peninsula of Florida. But in Florida the winter is a dry season, and the summer excessively rainy in the southern part. In summer the quantity in Florida is similar to that falling at New Orleans, though perhaps somewhat greater; but in winter there is a quantity three times as great on the lower Mississippi, as in Florida—the quantities being 18 and 6 inches respectively.

Northward in the Mississippi valley or plain the rains for the warmer season increase rapidly in their percentage on the amount for the year,—those for the three months of summer becoming fifty per cent. on the yearly quantity at Fort Snelling. From this last point northward the condition is similar to that on the plains beyond the Volga, though the summer quantity is evidently greater in actual measurement than where it constitutes fifty per cent. of the yearly quantity near the Ural Mountains.

The district of the great lakes is peculiar, repelling the summer profusion as it does, and thus diminishing the yearly sum very much in comparison with the country near it on the south. This influence is most clearly shown at Lake Michigan, around which the quantities for the warmer months increase in all directions. A portion of the high lands in New York, and probably also at the north of Lake Huron and Lake Superior, arrest a larger quantity in summer and autumn, because of the presence of these bodies of water; but this water surface, as well as that of the plains in their vicinity, certainly receives less than the plain of the Mississippi at a distance from them in the same latitudes. Iowa is much more profusely watered than Michigan, and more profusely also than the plain north of Lake Erie, which extends eastward through New York at the south of Lake Ontario.

The valley of the St Lawrence at Montreal and northward is now less known than most other localities. In that part of this valley which lies in New York the quantity of rain is small,—somewhat singularly so near Ogdensburg. But at Montreal it is much larger, according to the two or three years of recent observation, and it appears to be large also at

Quebec. For this area, and its extension northward to Hudson's Bay and Labrador, there is yet too little known to decide whether it has analogies with other districts of similar position on the eastern continent.

It does not appear that any part of the Alleghanies is characterized by the profusion which is directly due to altitude, as on the high lands of the British Islands, and on the various ranges of the Alps. In some parts of New England and New York this increased quantity appears to a certain degree, but never largely; and in Pennsylvania the hills or mountains first begin to produce a diminution, instead of an increase of quantity. In Virginia this is still more decidedly the case,—the whole mountain region being comparatively deficient in the quantity of water falling in rain for every season. Still further south the profuse humidity of the lower Mississippi may add something to the quantity falling on the Cumberland Mountains, and on the southern prolongation of the Alleghanies proper. In Georgia, South Carolina, and North Carolina, the slope approaching the mountains has decidedly less rain on attaining an altitude of 1000 feet, and none of the ridges, or even of the higher ranges, have any marked excess. The *immediate* coast, however, has again a diminution of quantity, the islands and exposed points of the mainland showing less rain-fall, as they show a less excessive saturation, at the extreme intervals; the heavier rains falling at a sufficient distance inland to avoid the cooling sea breezes. This excess at the *inland border of the alluvial plain* characterizes all the southern states on both the Atlantic and the Gulf of Mexico.

The full sea exposures diminish the quantity on the whole coast south and east, at least to the 42d parallel. At Nantucket, and on the eastern end of Long Island, long series of accurate observations afford the same result. At Whitemash Island, near Savannah, Georgia, and at St Augustine, Key West, the same influence is apparent, and great reduction of the adjacent inland measurements appears. The solution of all these facts is undoubtedly the same as in the case previously noticed, where the great lakes are found to reduce the quantity, particularly for the summer, by preventing the high temperature, and consequent excessive local saturation, which prevails at times over land areas.

It is remarkable, that in the United States generally, the sensible moisture should present conditions in marked contrast with the measured precipitation in rain, according to the standard of mutual relations which exists in Europe. At the 38th parallel in the Mississippi valley this is more remarkable than elsewhere, and it is next conspicuous on the Atlantic slope from Massachusetts to Georgia, or most decidedly from Maryland to Georgia. In the lake district the sensible humidity is greater than in the districts just named, while the quantity of water falling in rain is much less. There is something European in the atmosphere of the lake district for parts of the year, though the summer has much of the extreme aridity and elasticity which belong to the climate of the United States as a whole.

There are interesting features of this elasticity and absence of sensible moisture over all parts of the great interior. One of the most noticeable localities is the line which separates the rains and clouds of Upper Texas from the intense aridity of the atmosphere of New Mexico ; this line is near the eastern border of the *Llano Estacado* or Staked Plain. The phenomena of violent storms called *northers*, which prevail from Vera Cruz to Galveston, are abruptly changed here, the whole being confined to the area where saturation becomes excessive, and where violent displacements of the local atmosphere attend the precipitation of this moisture in rain.

At the northern border of the summer rains of Mexico, along the mountains near the Gila River on the south, a similarly abrupt transition from a local humidity to an intense aridity occurs ; the clouds coming up from the south-east, and wasting suddenly at that limit. At the eastern side of the Sierra Nevada the same transformation of the west winds occurs at the latitude of Los Angelos (35°) in the rainy season, or at its commencement and close.

A local phenomenon of condensation, still more striking as a peculiarity, is found in the fogs of the coast of California from Monterey to Fort Orford. This is intensified at San

Francisco, and it is there clearly seen to be but the simple condensation of the moisture of the heated air of the interior when reduced in temperature by the intrusion of the cold coast wind. This is usually at 57° nearly, while the valleys of the Sacramento and San Joaquin may be at an average of from 85° to 90° for many days, or even months. When this dry wind rises, as the result of the contrasted densities of the air over the cold sea, and of the heated interior, the moisture is condensed by the sudden refrigeration simply, and it often falls or settles slowly in its vesicular form until the surface is wet as from a rain. At sea it does not exist; and it constantly remains along the line separating the sea and interior but a few miles in width. Though rolling its volumes constantly inland, the movement only diminishes the humidity of the interior, instead of adding to it. When the rains commence, the clouds depositing them are high, and with a regular movement from the west. The relations of the local and sensible humidity to the quantity of rain, and to its sources of supply, are similar in some respects over the whole area of the United States to those just described at San Francisco, or they are similarly disconnected and remote.

It may be said of the sources and laws of supply of moisture to this continent, that the entire weight of the leading facts bears against the hypothesis of direct transmission from the sea in the surface atmosphere. With the whole movement of winds, when reduced to a resultant, from west, at the latitudes of 30° to 50° north, we find a *much heavier rain-fall on the eastern half of the continent*, and over areas like the Ohio and Mississippi plain, and the Atlantic plain from Maryland northward. If the Mississippi plain may be supposed to be supplied by the southerly winds of the lower portion from the Gulf of Mexico, it is still difficult to suppose that supply very great at and above Cincinnati, and equally great in Iowa. The relation of the plain of the lakes to those two first named has great force, as proof that a wholly different law of supply exists.

Dove has recently* attributed the quantity of rain for the

* "Annalen du Physik." Translated for American Manual of Science, 1855-56.

continental areas more directly to the surface-winds than at any former period, and in support of this view has cited at length the local peculiarities of the transition-belt of the eastern continent. Here this transition-belt is narrower, and its peculiarities are less likely to be taken as the type for other latitudes.

The force of the evidence afforded by the chart in favour of the view taken here as to the sources of supply for the great quantities of rain falling in the eastern United States, depends upon the recognition of the westerly winds as a strong exterior circulation—a circulation not admitted by Dove. But on this point the subject opens too widely for the limits of this paper, and it can only be said that the evidences of this exterior circulation furnished by American observation appear overwhelming.

The accompanying chart (Pl. IV.) shows some of the more prominent features of the distribution of rain in North America, though larger areas of observation are wanting. The greatest want is at sea, however, and it is impossible to say what the graduation seaward is anywhere except on the Atlantic coast. There it is unknown beyond a few miles; and whether the Gulf stream has a belt of excess can only be inferred from the general path it appears to furnish for the greater storms.

On the scale of the map, the areas of small quantity appear large, and if the extreme latitudes were included, the proportions would be yet greater. The belt of excessive rains at the north-west is also large, and what the shading seaward should be cannot now be defined. The belt of excess is narrow, though it occupies a long line of coast. The number of 80 inches at Sitka is somewhat less than the actual measurement, and the other quantities are derived from this point alone for all the coast above Puget's Sound.

The quantity on the mountains near the Pacific is of course but a rude approximation, since measurements are impossible, and there is little local uniformity. Portions of the Sierra Nevada have more than 35 inches, and other portions clearly much less. The coast-ranges are also very variable for localities varying little in position or altitude. The mountains of New Mexico are equally variable, and sometimes a great profusion occurs in close proximity to localities having very little, or none. Whether this variability belongs to the ranges southward in the interior of Mexico is not known; but there is some reason to believe that they are more uniformly watered when rains fall, since the temperature is much less variable, and the change of seasons affects them less.

Some minor distinctions, which are elsewhere given on charts of a larger scale, do not appear on this, though this may suffice to give some general view of the distribution of quantities.

On the Composition of the Phosphate of Lime existing in Sea-Water. By AUG. A. HAYES, M.D., Assayer to State of Massachusetts, U.S.A.

The presence of phosphate of lime, as one of the constituents of sea-water, was long since pointed out, and from time to time its proportion, relatively to other substances forming deposits from the water by evaporation, has been the subject of special researches.

In the past state of our knowledge it had been supposed that the phosphate of lime found in the analysis had the composition of $3\,CaO\,PO^5$, or bone phosphate, dissolved in virtue of the solvent power of saline water.

Some experimental results, which I have lately obtained, have led me to doubt the accuracy of our knowledge on this subject, and may be of interest to chemists and geologists, as this almost universally distributed salt seems to have had an influence in the formation of secondary rocks, as a cement and otherwise.

When bones, with adhering muscles and tissues, are immersed in water, either pure or saline, in a temperature of 60° or 80° Fahrenheit, a fermentative decomposition takes place, and continues for some time. The fat cells of the tissues become broken, fatty acids and oils are separated, while a superficial breaking up of the structures of the bone occurs. Translucent bones and fish bones are rendered opaque; and the appearance of amorphous products indicates that an important change of chemical composition goes on in their masses. The water becomes covered with a film, and deposits adhere to the sides and bottom of the containing vessel, while suspended matter gives a grayish hue to the fluid. Several of the acids formed in the decomposition of organic matter, in presence of azotized compounds, such as the lactic, crenic, and more rarely the acetic, are recognised early; in the later stages, the butyric appears. The mere solution of the juices of flesh are slightly acid in their secretion; but the most remarkable condition which follows the first stage in the decomposition of the bone, is that of the *alkaline* reaction of the fluid. It can be demonstrated that *no ammonia has been formed;* and a number of observations indicate that a solution of a small quantity of carbonate of lime in carbonic acid and water is not the cause of alkaline reaction.

By heat cautiously applied, the albuminous matter of the solution may be coagulated without destroying the alkaline action of the fluid, and the separation of suspended substances being effected, a clear alkaline fluid may be obtained, in which the acids appear to be united to protein compounds, derived from the tissues.

On adding to the clear fluid some solution of ammonia, a precipitate of phosphate of lime and phosphate of ammonia and magnesia, mixed with some organic salts of lime, falls. There is nothing here presented, unlike the ordinary solution of bone phosphate of lime in gelatinous solutions by heat, and, without further examination, the case might be passed as one presenting only the usual results. By boiling the fluid a few moments, and allowing it to cool,—an excess of ammonia being present,—the phosphates and other compounds of earths and oxide of iron may be removed, and the filtered liquid obtained clear and nearly colourless. On adding to the clear filtrate a solution of wine and ammonia and water, *an abundant precipitation of bone phosphate of lime occurs;* an excess of the lime solution being present, the whole of the phosphate of lime falls, and may be washed on a filter, as usual. Without insisting on the accuracy of this mode of separating the phosphate of lime, still it offers great facility of application, in studying the progress of the decomposition of the bone, and solution in water of phosphate of lime; enabling us to prove, that in the presence of decomposing animal matter, some bone phosphate of lime, or $3\,CaO\,PO^5$, is only slightly soluble in water.

As the second precipitation of phosphate of lime caused by the lime solution proves the existence in the liquor of an excess of phosphoric acid, the character of *alkalinity* noticed in the liquor from bones becomes the more remarkable; and in further elucidation of this point, it was found that phosphorus, oxidizing in contact with animal tissues, would produce its oxygen acids in union with protein compounds possessed of marked alkalinity.

Adopting the more accurate processes for determining the proportion of phosphoric acid, it has been demonstrated that the decomposition of bone may give to the fluid in which it is immersed a phosphate of lime no more basic than $CaO\,PO^5$, and even more acid solutions have been formed by a continued action.

The known composition of bone requires, for the production of the monobasic phosphate of lime, the withdrawal of not only the two equivalents of lime, but also the carbonate of lime, forming about ten per cent. of the mineral matter, by *acids engendered from the animal substances decomposing with it.* The deposition taking place in the fluid consists of crenate, stearate, oleate, and carbonate of lime: there are present, also, some undetermined salts, or compounds of lime and animal matter; and no one can pursue these inquiries into the products of decomposition without having the suggestion arise, that the chemical constitution of bone may be very different from that which our analyses show. Early in the progress of decomposition we notice the solution of the bibasic phosphate and the appearance of a protein compound of lime, the separation, as it were, of two constituents of bone by a proximate analysis. Later, the presence of salts formed by acids renders the problem more complex, though not less interesting in character.

In the description of the decomposition of bone and tissues in water pure or saline, here briefly given, I have confined the expression to the case of complete immersion. When bone, with the adhering tissues and muscle, is exposed so that part is immersed in water and part remains in the atmosphere, the decomposition proceeds with other phenomena. The acids of animal decomposition, with their attendant ethers, appear, and the solution is always acid; while the separation of the lime from the basic phosphate takes place through the affinity of the acids with which it combines. It is well known that recently formed phosphate of lime is decomposed in part by carbonic acid in solution, or by a current of the acid gas; and this acid is one resulting from the changes which the crenic acid suffers when exposed to air. In this double exposure there is therefore less of novelty attending the changes, although the results are equally important; for the tribasic phosphate may thus become converted into the monobasic phosphate of lime, in presence of, and in contact with, recently precipitated carbonate of lime. We may even displace phosphoric acid from bone-ash by sulphuric acid, in presence of protein compounds, and an excess of carbonate of lime, without combining the phosphoric acid of the bibasic phosphate with the lime of the carbonate. On varying the circumstances, so that after a double exposure the decomposing matter may be immersed wholly in the fluid, *the acid state disappears*, and is succeeded, after the lapse of some time, by the alkaline state described above. Where bone decomposes naturally, this double exposure is doubtless that most commonly observed; but the changes taking place in dead organisms immersed in the ocean belong to the conditions productive of alkalinity, and lead to the conclusion that, under these conditions, either the monobasic or bibasic phosphate exists in sea-water. In this view, the phosphate of lime in sea-water cannot be the tribasic or bone phosphate, because its most obvious and abundant source is found in the presence of decomposing organisms, constantly undergoing the earlier as well as final changes.

If the bones of organisms in their natural transformations give rise to mono and bibasic compounds of phosphoric acid and lime, which, either natural or alkaline, from the presence of organic matter, dissolve in sea-water, then it follows that one or both of these salts may be that best adapted to the formation of new bony structures of the animals assimilating them. It is not necessary here to name the many secretions and fluids of the animal system, known to every chemist, in which the phosphoric acid present is in too large a proportion to form bone phosphate with the lime also engaged, nor to refer to the composition of the phosphate of lime found in the stomach during healthy digestion, for evidence in support of the conclusion I have presented. Indeed, it appears probable that we have often overlooked this bibasic composition of the phosphate of lime, solely in consequence of its apparent incompatibility with alkaline reaction in the fluids under examination.

Although the subject, as here presented, was one of special research, yet it is connected with one of a more general character, in which, under a new aspect, we have a striking illustration of bone decomposition, as afforded by its final results.

On the Composition of the so-called Guanos of the Atlantic Islands. By Aug. A. Hayes, M.D., Assayer to State of Massachusetts, U.S.A.

The deposits formed on islands frequented by sea-fowl, and exposed to tropical rains and winds, have within the last few years become an article of commerce in the United States, chiefly as a source of phosphate of lime. Unfrequented islands have consequently been stripped of their coverings, and large quantities of various compounds, containing phosphoric acid, have become well known to those chemists who have engaged in the analysis of them.

These guanos have generally been supposed to differ from the Peruvian guano, in the particular, that the ammonia salts have been washed out of them, leaving the earthy salts behind; but no evidence has been adduced proving that ammonia compounds have been formed during decomposition.

In the following description, it is my intention to include under two heads all the varieties that have been abundantly found :—

1*st, Arenaceous Guano.*—This variety, where it has been freely exposed, is generally white, with some shade of yellowish-brown. It is a somewhat coarse sand, resembling coral sand, and we find in it remains of bones of fish, those of other marine animals, and the shells of shell-fish, reduced to a coarse powder.

The deposit on the Aves Island is thus characterized, while that from the Cuba Keys, and other points, is more finely divided, and still contains humus of flesh. These seldom afford more than sixty parts of bone phosphate, from one-hundred pints of the dry sand; the remainder being nearly all carbonate of lime. Where the food of the fowls has been almost exclusively fish, and the droppings have been protected, we find a larger percentage of bone phosphate of lime.

2d, Rock Guano.—The mineral I have named rock guano is in the form generally of an irregular incrustation, from one inch to two feet in thickness, pale yellowish-brown, or nearly white in colour, its fracture showing a deeper shade in bands, alternating with those of a lighter colour. Like compact calcareous concretions, the exposed surface presents rounded elevations, while within, the mass is full of cavities and air-passages. Its fracture, generally splintery, sometimes assumes a conchoidal form, and its hardness, greater than that of fluor-spar, is next to that of feldspar; average sp. gr. 2·440.

Varieties are numerous, referable generally to a kind of secondary action, in which the matter of comminuted bones has mixed with beds of recent shells, and not only consolidating them, but decomposing the carbonate of lime in their structures, has converted it into phosphate of lime.

By far the most remarkable form of rock guano is of recent discovery. It is a rock much resembling some trachytes, having natural cleavage planes, which divide it into rhomboidal masses of various sizes. The recent fracture discloses grains disseminated, which, partly resembling feldspar, might be mistaken for this mineral; with light and dark-coloured sandy grains, coloured by iron oxides, cemented as it were by a yellowish-green mineral, might at once be pronounced to be epidote.

I have been informed that the island from which this rock was brought has been surveyed, and was supposed to be of *volcanic origin*, in consequence of its basis rock being pronounced recent trachyte, while it is truly consolidated bones, of altered composition, the lime base replaced by iron and in part by oxide of manganese.

In stating the composition of rock guano, as no two specimens are alike, I purposely omit several constituents which occur in minute quantity, and keep in view the phosphate of lime and organic matter as the prominent constituents. The composition of the arenaceous guano—found on the same spot below the rock guano—on Monk's Island, is also given for comparison.

100 *Parts of Rock Guano.*		100 *Parts of Arenaceous Guano.*	
Moisture,	0·80	Moisture,	6·84
Dry organic acids, humus, &c.	11·00	Dry organic acids, humus, &c.	1·80
Sulphate of lime,	7·90	Sulphate of lime,	7·00
Bone phos. lime & magnesia,	110·20	Bone phos. lime & magnesia,	114·40
Sand,	0·80	Sand,	0·60
	130·70		130·64

The bone phosphate here stated is the proportion obtained by adding sufficient lime to combine with the phosphoric acid present. My own analysis of the vertebra of the halibut gave 86·8 parts of bone phosphate of lime in one hundred parts of the gently-calcined ash, while so much of the fresh bone and tissues as afforded 100 of ash, after treatment with carbonate of ammonia, decomposed by acids, gave 92 parts. The food of fowls we know to consist of shell-fish in part, and consequently the bone phosphate originally present could not have contained so much as 86 parts of phosphate of lime; while the really existing phosphate in the rock guano produces more than 125 parts. This composition offers the clue to the explanation of the secondary origin of the guano as a rock presenting varied physical characters, and leads us to inquire into the chemical influences exerted, while the excrement of birds mixed with more or less of other animal remains, undergoes decomposition at temperature not below 85° Fahrenheit; both water and moisture, being present as aids.

Experiments show that, under these conditions, putrefaction proceeds with the production of acids. The first effect observed on the recent droppings is the removal of the urates, and other soluble excretions which are ammonia producers, by rains. Then the crenic, humic, carbonic, stearic, and oleic acids begin to combine with lime as they form or are separated from the animal matter; and these lime salts being in turn carried off by rains, the phosphate of lime of the divided bones becomes less and less basic in composition. Halibut bones, even after they have been long boiled in pure water, to remove animal tissues, give to sea-water lime salts abundantly as they decompose, and the quantity of fatty acid salts formed is very large. The salts of fatty acids are among the most permanent products of decomposition, and we find them in the composition of most of the remaining forms of the organic matter. The breaking-up of bone, in a limited quantity of water, proceeds until the presence of mono and bibasic phosphate, crenates, stearates, &c., establish a balance; but where rains are frequent, this limit is not reached, as the removal of the lime salts allows the *phosphoric acid* to be actually disengaged, and to act on carbonate of lime. Thousands of tons of both arenaceous and rock guano have been imported in which the phosphate of lime of the mass was bibasic; while the varieties which are formed by the conversion of beds of shells into phosphate of lime show that a higher state—even that of acid reaction —must have been attained in the mass.

In the composition of the rock guano, we see that the proportion of organic acids and salts is much larger than exists in the arenaceous guano from which it has been derived. The presence, to a greater or less amount, of this matter alters the physical characters of rock guano; and it often is almost entirely abstracted, apparently subsequently to consolidation. When the organic matter passes to the state of carbonic acid, the removal of the excess of lime by the ready solubility of the bicarbonate of lime formed may proceed rapidly, and we always observe in the older rock, thus deprived of organic matter, innumerable channels through which the solution has passed apparently.

The cementation of the sandy grains into rock is one of the most interesting features of this subject, as it throws light upon many similar operations constantly progressing. In point of size, the grains of the sandy guano vary from that of fragments of bone and vertebra to minutely-divided processes, in which infusoria shells abound mixed with the seeds of grasses. The first stage of the change into rock is the aggregation of these grains to form a kind of sandstone, in which the individual particles are seen, and this aggregation may take place in the beds. In the guano rock this individuality is entirely lost to the eye, which detects nothing in the close-grained and compact banded mass, to indicate its origin. Mineralogically these bodies are diverse, and some specimens, containing converted shells, are puzzling problems to be solved with the knowledge already obtained.

Rock guano, wherever it has been observed, with one exception, occupies the highest part of the island surface, or covers the arenaceous form; we cannot, therefore, explain its aggregation by the usual effect of infiltration of earthy salts dissolved, but must give great weight to local phenomena of evaporation. The small islands on which it is found are swept by the constant currents of the trade-wind, and the evaporation of water from their surfaces exceeds in amount that received as rains; it being well known that none but saline water is found in the soil. When water holding saline matter in solution evaporates from the surface of the earth, pure water arises in vapour, while saline compounds remain at or near the surface. In accordance with this law, the solution formed by rains permeating a bed of decomposing bone remains of bird droppings, rises to the surface of the bed, and then becomes concentrated. Any acid ingredient would act on the grains it wets, while suspended matters would fill the interstices; and so long as capillarity existed, finely-divided and saline parts would thus increase at or near the surface, and be deposited in the porous portions, gradually filling the pores, and consolidating into mass the granular remains. Doubtless while one part of this process was proceeding, rains carried down a part, which subsequently was raised anew, until finally the surface rock, no longer pervious to rain, became cemented into the compact state it now presents by the conjoined forces acting. The exceptional case referred to, when remarking on the relative positions of the compact and sandy guanos, is that of the new discovery of the trachyte-like form of guano rock.

So far as can be judged from the chemical composition of this rock, which is hydrous, and its mineralogical characters and positions, it was originally formed in the way described above, when its place was the upper surface of the island. But its iron and manganese constituents, the existence of crystalline phosphates, as well as the silicate of alumina and iron, in the form of clay from volcanic rocks, lead to the opinion that it has been long submerged below the waters of the ocean, and there gained its close resemblance in its larger features to trachytes and basalts.

As the materials of the minerals here described have been at one time organized, and may now be considered strictly mineralized, the specimens present fine illustrations of the important action of minor chemical forces in changing the physical conditions of matter, by which the bones, once the food of fowls, have become converted into rock. On the other hand, we find, in the products of the decomposition of bones added to sea-water, the phosphoric and organic salts of lime essential to the continuance and multiplication of animal life there in its various exhibitions.

On the Chemical Composition of some Norwegian Minerals.

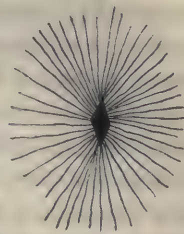
By David Forbes, F.G.S., A.I.C.E., F.C.S. Part III.

VI.—*Orthite.*

This mineral is of very frequent occurrence in the granite veins which traverse the metamorphic schists of the south-west coast of Norway.

It is so constantly present in one variety of granite, that its appearance may be regarded as characteristic of this rock, which, when Orthite is associated with it, appears to be a compound consisting of quartz, mica, and two feldspars, apparently orthoklase, with a much smaller proportion of oligoklase. As far as my investigations have extended, Orthite does not appear to occur in the other varieties of granite.

The crystals of orthite are almost invariably surrounded by a peculiar radial development of fine lines running into the matrix, whether this be quartz or feldspar.



The annexed woodcut shows this appearance, which is as peculiar as it is difficult of explanation.

The lines themselves are true cracks, and appear to increase in length and general development with the size of the crystal from which they radiate; so that in some of the largest crystals of orthite, which occasionally are found so large as to weigh several pounds, these cracks may extend as far as several feet from the crystal. They are rarely if ever altogether absent, even when the crystals of orthite are very minute.*

The orthite here analysed is from a granite vein at the Naes Grube, about ten English miles east of Arendal, and was surrounded by dark-red orthoklase.

It was but very indistinctly crystallized, and had only traces of cleavage planes. The fracture was subconchoidal, and hardness$=6$.

Colour greenish-black; streak greenish-gray; opaque, with a faint resinous lustre.

The specific gravity of two pieces taken at 60° Fahrenheit, was found to be respectively 2·86 and 2·93.

Before the blow-pipe on charcoal it swells, becomes brownish-yellow, and fuses to a black glass; with borax in the oxidating flame it dissolves to a reddish-yellow glass, which, on cooling, assumes a faint yellow colour. In the reducing flame the glass shows the same colour, but with a faint greenish tinge.

With phosphate of soda and ammonia it leaves a skeleton of silica, and in the reducing flame affords a glass, which when warm is green, but colourless on cooling. In the oxidating

* I have noticed that this radial development occurs also with some other minerals associated in this granite, as Gadolinite, Malakon, Tachyaphaltite, Alvite, Tyrite, Ytterspath, Oerstedite. Also in the following minerals peculiar to the Zircon syenite of Brevig, as Thorite, Tritomite, Orangite, and a zircon-like mineral not yet analysed. It, however, appears to be most particularly characteristic of Orthite.

flame the glass is brownish-yellow when warm, and colourless when cold; affords indications of manganese when treated with soda; heated in a tube it swells up, evolves water, and becomes lighter in colour. It is completely decomposed by hydrochloric acid, and gelatinizes; the solution affords traces of metals precipitable by sulphuretted hydrogen.

A preliminary analysis of this orthite was published by me in a paper in the Norse Magazin for Naturvidenskaberne,* some years back—the results tabulated as follows:

Silica, ...	31·03
Alumina, ...	9·29
Glucina, ...	3·71
Sesquioxide of iron, . . .	22·98
" of cerium, . .	7·24
Protoxide of lanthanum with didymium,	4·35
Yttria, ...	1·02
Lime, ...	6·39
Water, ...	12·24
Alkali and loss, . . .	1·75
	100·00

The alkalies, magnesia, and oxides of copper and manganese present were not determined.

Very shortly afterwards an analysis of precisely the same orthite† was published by H. Strecker, with the following results.‡

Silica, ...	31·85
Alumina, ...	10·28
Protoxide of iron, . . .	19·27
" of cerium, . .	12·76
Lime, ...	9·12
Magnesia, ...	1·86
Oxide of copper, . . .	0·54
Water and carbonic acid, . .	13·37
	99·05

In my analysis the cerium and iron existing in the orthite are tabulated as sesquioxides, whereas in the other they are

* Mineralogiske Iagttagelser omkring Arendal og Kragerœ af D. Forbes og T. Dahll, in Nyt Magazin for Naturvidenskaberne, vol. viii. part 3. 1854.

† Taken simultaneously at Naes Grube from same mass of orthite.

‡ Christiania Universitets Programme for 1854.

calculated as protoxides. It is most probable that both protoxides and sesquioxides are present; and the fact that chlorine is not evolved when the orthite is dissolved in hydrochloric acid, is not sufficient to decide that the cerium present is in the state of protoxide; for if the iron in the mineral existed as protoxide, as the greater part assuredly is, the chlorine eliminated by the action of the hydrochloric acid on the sesquioxide of cerium would not be evolved, but at once be converted into hydrochloric acid, with peroxidation of the protoxide of iron.

Rammelsberg has shown that in the orthite of Hitteroe the oxide of iron present is a compound of the protoxide and sesquioxide in nearly equal amounts. He, in conjunction with nearly all the chemists, look upon the cerium as present as protoxide, which, if accepted, must cause the foregoing analysis to be corrected as to amount of oxygen.

Since the publication of the above analysis, I have again examined this orthite, and am now enabled to bring forward results which I believe to be still more accurate; but it was not considered that the present methods for separating compounds likely to contain protoxides and sesquioxides, both of cerium and iron, were sufficiently correct to enable the respective state of oxidation of these oxides to be determined with accuracy, and therefore they are noted in the results as protoxides, although there is much reason to suppose that some sesquioxide is present.

The analysis was conducted as follows:—A weighed amount was decomposed by hydrochloric acid, and, after adding a little nitric acid, the whole was evaporated to dryness, and then redissolved in water containing some hydrochloric acid. The silica thus left insoluble was collected and determined. Its purity was ascertained by solution in hydrofluoric acid and evaporation.

The solution was now neutralized by ammonia, and precipitated by oxalic acid, so that it reacted, now slightly acid. This precipitate was filtered off after standing twenty-four hours, and collected; then ignited and dissolved in hydrochloric acid, precipitated by ammonia and filtered. The filtrate now contained the lime which was precipitated as oxalate, and determined as carbonate, after ignition, with the usual precautions.

The precipitate by ammonia now contained the cerium, yttria, and oxides of lanthanum and didymium. The yttria was separated from the other oxides by dissolving them in a little dilute sulphuric acid, and treating the solution by a concentrated solution of sulphate of potash; it was then precipitated from the filtrate of potash, washed well, redissolved in hydrochloric acid, reprecipitated by ammonia, and determined. The cerium compound precipitate was dissolved in water, acidulated with hydrochloric acid, and precipitated by ammonia, well washed, ignited, moistened with some nitric acid, again ignited, and then boiled in a solution of chloride of ammonium, which dissolved the protoxide of lanthanum, and probably some didymium, leaving the sesquioxide of cerium insoluble, and, from its brown colour, evidently containing didymium. These were both determined as usual, the oxide of lanthanum being precipitated by ammonia.

The original solution from which the oxalates had been separated was now precipitated by hydrosulphide of ammonium, and collected, then redissolved in nitro-hydrochloric acid, and precipitated by ammonia. This precipitate, which now contained sesquioxide of iron, alumina, and glucina, was treated whilst moist with a solution of carbonate of ammonia, which dissolves the glucina, which was then separated by filtration, and determined.

The alumina was then separated by boiling in potash, and both it and the iron determined as usual.

Another portion of the mineral was employed to determine the amount of oxide of copper present. It was dissolved in hydrochloric acid, filtered, and sulphuretted hydrogen passed through it; only a minute amount of sulphuret of copper was found, which was neglected; and it appeared that the presence of copper was due to some particles of copper pyrites mechanically entangled in the orthite, so that in the specimen here analysed, which was carefully selected, then broken up and carefully picked, only a trace was found.

A third portion of the orthite was reserved for determining the alkalies and magnesia, also to verify the lime determination.

This was decomposed by hydrochloric acid, some nitric acid added, evaporated to dryness, redissolved in water, acidulated with hydrochloric acid, and precipitated by ammonia in excess, filtered, washed, and the filtrate* precipitated by oxalate of ammonia, and the lime determined as carbonate, after ignition with some carbonate of ammonia: it was found to contain a little oxide of manganese, which was separated by dilute acetic acid, and estimated, its weight being subsequently deducted from that of the carbonate of lime.

The solution, after separating the lime, was evaporated to dryness in a platinum capsule, and ignited, to drive off all ammoniacal salts, after which the residual alkaline and magnesian chlorides were weighed, and then redissolved in water, and the magnesia separated by caustic barytes: the filtrate was acidified by sulphuric acid, and the resulting sulphate of baryta separated by filtration: the alkalies were then estimated as sulphates, after evaporation to dryness, and heating.

The relative amounts of potash and soda were estimated indirectly by determining the amount of sulphuric acid contained in the mixed sulphates, and calculating therefrom. By subsequently calculating the amount of chlorides equivalent to the potash and soda thus found, and deducting this from the total weight of the mixed chlorides the amount of chloride of magnesium was obtained from which the magnesia was calculated.

The water contained in the mineral was determined from the loss sustained in heating a known weight of the purest orthite for some time. No carbonic acid was detected when perfectly unweathered fragments of orthite were examined.

The obtained amounts were as follows: 23·46 gr. afforded—water 2·87 gr., 7·28 gr. silica, 0·87 gr. glucina, 5·39 gr. sesquioxide of iron, 2·18 gr. alumina, 1·69 gr. of sesquioxide of cerium, 2·68 gr. carbonate of lime, 0·24 gr. yttria, 1·34 gr. oxide of lanthanum. 50·35 gr. afforded 6·02 gr. carbonate of lime, containing 0·04 gr. oxide of manganese, also 3·71 gr. alkaline and magnesian chlorides, from which 1·49 gr. alkaline

* The filtrate, after having been acidified by hydrochloric acid, was now tested by sulphuretted hydrogen for copper, but only gave a very faint trace; it was, therefore, again neutralized by ammonia.

sulphates were obtained, which subsequently produced 2·54 gr. sulphate of baryta.

From these data the following percentage composition was deduced.

		Oxygen.		
Silica,	31·03	16·42		
Alumina,	9·29	4·51	6·85	16·28
Glucina,	3·71	2·34		
Protoxide of iron,	20·68	4·59	9·43	
,, manganese,	0·07	0·01		
,, cerium,*	6·74	0·97		
,, lanthanum,*	4·35	0·63		
,, copper,	trace.	——		
Yttria,	1·02	0·22		
Lime,	6·68	1·90		
Magnesia,	2·06	0·82		
Potash,	0·90	0·15		
Soda,	0·56	0·14		
Water,	12·24	10·88		
	99·33			

It is worthy of remark, that this orthite which contains so large an amount of water does not present any appearances which would have been produced had the water been subsequently introduced by infiltration; it is hard, and possesses a clear and brilliant fracture, and shows no signs of alteration from weathering or otherwise; it must therefore be supposed that the water here present is due to the chemical constitution of the mineral, and not that it is an allanite (or anhydrous orthite) altered subsequently. The formula deduced from the above analysis is

$$3\ RO\ Si\ O_3 + 2\ R_2O_3\ Si\ O_3 + 10\ HO.$$

or otherwise expressed,

$$(\tfrac{3}{5}\ \dot{R} + \tfrac{2}{5}\ \dddot{R})\ \dddot{Si} + 2\ HO.$$

which upon calculation will yield the following percentage composition.

* Probably both these oxides contain more or less didymium, which however will probably be in greater part associated with the cerium from the method employed in the analysis.

Silica, ...	30·49
Alumina, (&c.) . . .	13·82
Protoxide of iron, (&c.) .	43·55
Water, ...	12·14
	10·000

VII.—*Calcite.*

Crystals of calcite from Gamle Mjurfjær Iron-mine, at Naeskül near Arendal, were found lining fissures in a granite vein which cuts through the vein of magnetic iron ore.

As the crystals had a very peculiar rather dark brown colour, they were thought worthy of examination. They were well defined and often large crystals, being scalenohedrons, and possessed a specific gravity of 2·75 at 60° Fahrenheit.

They were analysed by the ordinary methods, and a separate portion was examined by means of molybdate of ammonia for phosphoric acid, which was found present in small amount hardly sufficient for quantitative estimation. Magnesia was sought for, but no trace was found present. The results obtained, when tabulated, give the following percentage compositions:—

Carbonate of lime, . . .	98·39
„ iron, . . .	0·79
„ manganese, .	0·23
Alumina, ...	0·38
Phosphoric acid, . .	trace.
Insoluble, ...	0·21
	100·00

The crystals, therefore, notwithstanding their dark brown colour, contained but a much smaller amount of iron and manganese than might have been expected.

On Insect-Vision and Blind Insects. By ANDREW MURRAY, Edinburgh.*

By far the greater majority of insects are born blind—not blind like a litter of pups, because they cannot see—but blind because they have got no eyes to see with. Almost the whole of the Hymenoptera and Diptera, and two-thirds of the Coleoptera, are in this predicament. In fact, all those species which pass their larval state in darkness are thus unprovided. To what purpose would it be, for instance, to furnish the larva of the bee with eyes. It passes its larval life in a dark cell, where it is nourished without trouble or exertion of its own; all it has to do is to open its mouth to receive the food which its kind nurses place in it.† Or what purpose would eyes serve to the nut beetle (*Balaninus nucum*), which wakens to existence in the interior of a hazel nut, where its parent had deposited the egg. Its food is beside it. It has only to eat; and by the time it has finished the kernel its larval life is finished too, and it passes into the chrysalid state. Eyes, therefore, to these, and such as these, would be useless, and they are dispensed with at that period of their existence. On the other hand, those caterpillars which have to seek their food in the light of day, as the larvæ of Lepidoptera and of the predaceous beetles, are provided with eyes, but they are not eyes like the compound eyes of the perfect insect; they are minute specks, termed ocelli, and are placed in varying numbers and varying positions on each side of the head. These are the eyes which we find in the spider, and in some crustaceans; and sometimes insects in the perfect state are provided with two or three of them in addition to

* Read before the Royal Society of Edinburgh, April 6, 1857.

† The larva of the bee has a minute conical tubercule on each side of the head, which was supposed by Swammerdan and Walkenaer to be the rudimental eyes of the perfect insect; and Müller (probably on their authority) states it broadly, that "the larvæ of Hymenoptera are for the most part destitute of eyes, but the larvæ of bees have two simple eyes" (Müller's *Physiology*, vol. i., p. 115); but Mr Westwood correctly points out that these tubercules must rather represent the antennæ, as they appear to be articulated near the base and the tip (Westwood's *Introduction to Entomology*, vol. ii., p. 25), and therefore the bees form no exception to the general rule found in the Hymenoptera.

their compound eyes. The structure of these simple eyes, or ocelli, seems to be somewhat various. In the eye of the *Salticus æneus* (one of those spiders which have the singular property of running backwards or forwards, or in any direction, without turning) we find a nearly spherical lens, covered by or passing into the chitonous structure of the integument, behind which are found the ends of the nerves, with a black pigment or choroid passing round them, terminating behind in the retina. The eye of the scorpion is somewhat different. In it we have a spherical lens behind the cornea, or integument, behind it a lenticular vitreous body, lying in the cup-shaped retina, and the black pigment or choroid surrounding the lens. The optic nerve which supplies these simple eyes runs from the cephalic ganglion in a bundle or united mass of filaments for a certain distance, and then breaks up into a separate nerve or filament for each simple eye, as exhibited in figure 1, which shows the nerves of the head of the larva of *Dytiscus marginalis*.* In the caterpillar without eyes no nerve or filament given off from the cephalic ganglion towards the place where the eye should be. It will only be developed from it when it is required; and it would appear that in one particular anomalous group the optic nerve must be at one time developed, afterwards lost, and finally restored. Erichson, in his last work, "Naturgeschicht der Insecten Deutschland," vol. iii., records the observation, that in the Cerambycidæ the larva in its youngest state possesses eyes, but loses them as it becomes older, and after passing through the chrysalid state acquires perfect compound eyes; thus apparently contradicting the statement made by Blanchard ("Annales des Sciences Naturelles," 1846, p. 283), that the organs of insects do not modify themselves sensibly during the life of the larva, but only grow. What the reason of this strange anomaly may be it is difficult to say; possibly—(the Ceramby-

Fig. 1.

* Copied from Blanchard's figure in "Annales des Sciences Naturelles, 1846."

cidæ being wood-feeders)—that the eggs are laid on the bark, outside of the tree, and the young larva may have need of eyes till it has eaten its way into its heart, when of course they would cease to be useful, and might be dispensed with.

After the larva (whether eyeless or not) has passed into the chrysalis and undergone the mysterious change which then takes place, it emerges (except in a few rare cases to be presently noticed) well provided with compound eyes. What the change is which then takes place, or how it is effected, we only know imperfectly. The best observations on the subject are those of the late Dr Newport, in his paper on the "Nervous System of the *Sphinx Ligustri*," published in the London Philosophical Transactions for 1834. In the larva of the *Sphinx Ligustri* he found that the optic nerves were only two diminutive trunks extending from the sides of the cerebral ganglia, and dividing each into eight filaments, given to the eight minute eyes on each side of the head. "At the period of changing to the pupa state," he says, "there is a deposit of dark pigment very slightly organized at the base of each nerve. As the changes of the insect advance, the optic nerves gradually enlarge at their base; and, when this enlargement has gone on to a considerable extent, the dark pigment is carried forward from the base of the nerves, and exhibits a corrugated appearance around its interior margin. When the changes have farther advanced, the optic nerves are extended of a pear-like form, from the sides of the cerebral ganglia, which they then equal in diameter. The enlargement of the nerves seems to be occasioned by the shortening of the cords which connect the cerebral, with the subœsophageal ganglia and the extension forwards of the nervous substance of the cords within the investing theca, the effect of which is, not to enlarge the cerebral ganglia in a corresponding degree, but to develop the optic nerves by the gradual extension and expansion of the nervous substance within them in the form of successive series of purse-like layers of fibres one within the other.

"When the outer layer has arrived at its maximum of extension, it seems to become perforated at a point corresponding to the central part of the membrane, which is carried forward to become the choroid. The next layer advances, and then the next in succession from within outward, so that the central part of the nerve is the last part developed. The fibres of each series, from being bent like the segment of an arc, gradually assume a more lineal direction, and diverging from the axis of the eye, the whole nerve, when completed, forms a series of flattened pear-shaped cones, one within the other, the apices of which constitute the base or origin of the nerve next the cerebral ganglia."

This is the process which was observed by Newport in the case of a larva possessing simple eyes, and from it we can form an idea how the process is conducted in the larva which has no eyes at all, although observation of their changes has not yet been extended to them.

The appearance of the nerve in the perfect insect is shown in the following figure of the nerves of the *Creophilus maxillosus*; and it will be observed that it is now one solid large compacted nerve, applied to the back part of the eye. There is, however, one curious exception to this state of it in the perfect insect. Many insects pass their lives in dark and secluded places, avoiding the light; as, for instance, the *Blapsidæ*, *Tenebrionidæ*, and one or two species of other families (*Pristonychus elegans*, Dej., *P. elongatus*, Dej., *Homolata spelea*, Erich., &c.) which are found pretty far in in the caves of Carniola, though not so far as the eyeless insects of which I shall presently speak. Now, in these the eyes are not only very small, but also very slightly raised above the surrounding surface, in marked contradistinction to those species which affect the glaring and brightest sunlight, as the Cicindelidæ, which have the eyes excessively prominent; and on examining the optic nerves in these lucifugous species, we find that it is not a solid compacted nerve, but that it is like the nerve leading to the simple eyes in the larva,—solid at the base, but afterwards broken up into a number of separate filaments,—as shown in this figure of the optic nerves of the perfect *Blaps mortisaga*, or churchyard beetle.

Fig. 2.*

* Copied from Blanchard, *loc. cit.*

The effect of this must undoubtedly be to diminish the vision of the insect; though why it should be diminished because the animal lives in dark places, does not at first sight very well appear. It would rather appear to us that it had need of a larger eye than of a smaller one, to make up for the loss of light. If the animal were to live in total darkness, we can understand why eyes should be dispensed with altogether; but, if eyes are necessary for it at all, would we not say that the greater the darkness the greater the power of the eye should be. Such would appear to be the inference which any analogies we can draw from the vertebrate kingdom would present. There the eye is enlarged, and endowed with greater power, when the animal has to pass its active hours in the dark. The owl, the tiger, and its congeners, are familiar instances. To be sure we have the mole, which may be cited as an example in the opposed sense; but it is scarcely a fair example, inasmuch as its manner of life necessarily requires the complete protection of the eye; and we do not know to what extent it is gifted with the sense of sight, its eyes being supplied by the fifth pair of nerves instead of the optic nerves. The explanation which I am disposed to give of the peculiarity in this class of insects is, that the sense of sight is not less acute in the one than the other insect, but merely more limited. Each filament of the optic nerve will doubtless perform its duty as well when separate as when tied up in a bundle; and what the churchyard beetle does see it will see as well as another, only its points of sight are circumscribed; for what use to it would an extended field of vision be where the whole prospect is mere obscurity. I therefore look upon the small and flattened eye, supplied with few nerves, of these twilight insects less as a provision or adaptation to the place and mode of life of the insects (though it may be that too), than as an instance of nature's aversion to anything like waste or unnecessary work.

Fig. 3.*

The structure of the compound eyes themselves with which the insect in the perfect state has now become provided, seems

* Copied from Blanchard, *loc. cit.*

wholly different from that of the simple eye, or ocellus, which I have already described. Viewed externally they seem divided into an immense number of facets, of greater or less size, in different insects, and of greater or less size in different parts of the same eye. These facets are not entirely hexagonal, as is generally supposed (or rather taken for granted), but are of various forms, apparently assuming whatever form the position of the neighbouring facets, combined with the curve of the eye, impose upon it, being hexagonal in some parts, pentagonal or quadrangular in others, and frequently of an irregular angular form. The prevailing form differs in different insects,—being, for instance, oblong or square, with the corners very slightly filled up or cut off, in the dragon-fly; hexagonal in the butterfly; and so on. These facets are sometimes so small as to be scarcely perceptible. In many of the larger Dynastidæ they are so minute as to make the globe of the eye appear quite smooth and homogeneous; others are coarse and well marked; and these variations occur to such an extent, and are so constant in different families, that they have been successfully used by Professor Lacordaire in his monograph of the Erotylidæ as generic distinctions. It would be long to tell of the different modifications the exterior of these eyes assumes; how some, as the common hive-bee, have the eyes pilose, the hairs being inserted in the corners between each facet (acting possibly as eye-lashes, or rather eye-protectors); how some, as in the dragon-fly, have their structure deep, while others are shallow; how some have their eyes resplendent with golden or silver lustre, while others are opaque. It will be sufficient to say, that these facets are numerous in all, but perfectly surprising in number in some, varying from 50 up to 25,000.

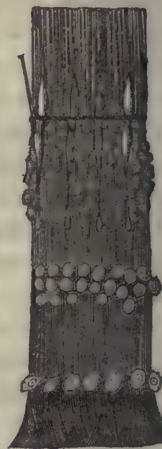
A transverse section of a compound eye shows that it is composed of transparent cones, each terminating in one of the facets of which I have been speaking, having very much the appearance of a multitude of telescopes, pointed outwards in every direction. M. Leydig, however, gives a better view than any we have previously had of the intimate structure of these telescopes, in his recent work on Histology, from which I have taken the following figure showing two of the eye-tubules of the eye of the *Procrustes coriaceus* highly magnified. The cornea or chitonous integument is outermost; in it can be traced indicationsof the layers of the chitonous substance of the integument; behind this is a long tube surrounded with pigment, terminating in the retina, behind which, again, lie the bundles of filaments of the optic nerve; from the retina proceeds forwards up the tube a ganglionic structure, having two ganglionic enlargements, and inclosing filaments of nerves. A muscle lies on each side of it, and it ends in a quadrangular cone-shaped body, having its base applied to the facet, and its apex towards the interior of the eye. At first sight there does not appear much resemblance between this eye and the human eye; but physiologists were determined to find analogies and homologies, and of course such were laid down. It is only recently, however, that discoveries have been made which would seem to furnish a clue to the true homologies of the eye in insects. Hitherto the analogy has always been attempted to be drawn between the entire eye of the vertebrata and the eye tubules, or so-called individual eye, in the compound eye of insects; and the generally received opinion is that which is stated by Professor Owen in his "Comparative Anatomy of Invertebrate Animals," (edition 1855); that the conical body was the equivalent of the crystalline lens and vitreous humours. Dr Carpenter has carried the attempt to find analogies farther, having in his "Comparative Physiology," (edition 1854,) pointed out the equivalents of the iris and the aqueous humour, as well as the crystalline lens. The recent microscopic researches of various eminent physiologists give us reason to doubt that these analogies or homologies are founded in fact. The error has arisen wholly from comparing each of these small portions of the compound eye of insects, with the entire eye in the vertebrate animal. If instead of com-

Fig. 5.

paring a portion of the one with the whole of the other, we compare the entire compound eye with the entire eye of the vertebrata, we shall at once see that the analogies so long drawn must be abandoned. The eye of the vertebrate animal is a hollow globe, with only one small aperture for the admission of the visual rays; and as not merely one minute point exactly opposite to the aperture is to be impressed on one point of the sensorium of vision, but a large extent of view on every side is to be impressed over a large extent of sensorium, special optical apparatus and contrivances are required for this purpose;—we have the iris to regulate the admission of light, the crystalline lens to converge the visual rays, the ciliary ligaments to adjust its focus, the vitreous humours to disperse the rays,—all necessary (in consequence of the form of the eye to which I have alluded) to produce on the sensorium the correct impression of the object seen, but none of them, as I understand it, necessary for any other purpose than to overcome the difficulties arising from the cave-like form of the eye. Had the eye been retroverted, for instance,—turned inside out like a glove,—the sensorium would then be exposed to the direct impression of the visual rays all round, and would need neither pupil nor iris, crystalline lens nor vitreous humour. It is not my business here to show why the eye is better as it is, any more than it is to show in what respects the eye of the vertebrata is superior to the eye of the insect. It is sufficient for my purpose to show that the above inverted position of the eye corresponds to the position of the so-called compound eyes of insects. Looked at in this view, we must,—if we are to seek the homologues of the eyes of insects in the eyes of the vertebrata,—put aside all these accidental parts (if I may so call them), and prosecute our search in the parts deeper seated, and forming what may be called the ultimate portions of the eye; and the microscopic researches to which I have alluded have revealed a structure which appears at last to give us their true homologues. Professor Goodsir brought these discoveries before the physiologists of Edinburgh in an interesting lecture which he gave on the structure of the retina about two years ago (and of which an abstract will be found in the "Edinburgh Medical Journal," Oct. 1855. See also Proc. Royal Soc. in present number of this Journal, p. 156).

I shall not occupy the time of the reader in recapitulating these discoveries further than simply to say, that what used to be called the retina has been proved to be composed of several layers, which have been distinguished as the bacillary (fig. 6, *a*), the white cellular, in three strata (*b*), the grey cellular (*c*), the filamentary (*d*), and limitary layers (*e*), reckoning from behind forwards. These structures are shown in fig. 6.

Fig. 6.



The layer which interests us the most is the bacillary, which is composed of rods and cones, and which Kölliker ascertained, by process of exhaustion, to be in all probability the structure on which objective light first impresses itself.

It will at once be seen that there is a great resemblance between the bacillary layer, containing rods and cones, and the conical-shaped bodies arranged behind the facet of the eye in insects (fig. 5, *b*). The arrangement of the rest of the structure furnishes also other points of resemblance—the prolonged filaments in the white cellular layer remind us of the prolonged stalk on which the conical bodies rest; and the filamentary layer, which is composed essentially of the ultimate filaments of the optic nerve, seems to correspond to what Leydig calls the retina in the insect. On all these points there seems a resemblance; but there is one awkward circumstance, which at first sight would seem to upset all our conclusions. I have placed the figures with the rods and conical bodies both looking outwards, in order that the resemblance between them may be more apparent; but in nature they are not so placed. There their position is reversed. The conical bodies are next the light in the insect—in the vertebrate animal they are farthest away from it. If placed as they really stand, one of the figures should be turned upside down. Here is a difficulty which makes us pause upon the very threshhold. But we are relieved from our dilemma by a happy conception of Brücke and Hannover, made apparently without any reference to the eyes of insects (and therefore more trustworthy for our purpose), and suggested rather by the difficulty of accounting for the portion of the retina on which objective light first impressed itself being placed farthest away from the light. They conceive that the light passes through the whole coats or layers of the retina, which are all perfectly transparent, and is reflected back again by the rods and cones of the bacillary layer. Professor Goodsir improves upon and extends this idea. He suggests that "the divergent pencil of light which proceeds from any visible point to the eye, becoming convergent after having entered the refractive media, passing through the perfectly transparent retina, is probably brought to a point at the surface of the choroid or outer part of the bacillary layer of the retina, and is not entirely absorbed there, but is reflected as a divergent pencil." In other words, that the eye is looking backwards, and sees images reflected as in a mirror; and if we suppose the structure which we see in the front of the eye of an insect to be continued all round to the back, and then the front part to be removed or absorbed, we have exactly the structure which we find in man, merely substituting the cones and rods of the latter for the conical bodies in the former. The arrangement is the same in both, only the insect is, as it were, looking at the landscape out of a window, while man has his back turned to the window, and is looking at the landscape in a mirror. In the insect the visual ray enters each facet; in man it impinges on the truncated ends of each of the rods in the bacillary layer. The effect of this is, as Professor Goodsir puts it, that "the human sensorium receives from the retina the impression of a picture which is not continuous, but made up of detached points; as in the vision of the insect which only sees an object by as many points as can transmit rays along the axis of its eye-tubules." Thus it would appear that both see by what Müller called "mosaic vision."

The foregoing is the structure which almost universally prevails in insects. But there are a certain number of anomalous insects which live in the dark, and which are altogether unprovided with eyes. Some of these are found in ants' nests; others in subterranean places, under leaves, bark, and decaying vegetable matter; and others, again, only far in the interior of caves. A rapid glance thrown over them will not be without interest.

It is only within the last few years that ants' nests have been searched for other insects than the ants themselves. But it is now found that many such pass their whole lives in these nests; and various species hitherto unknown have been found by searching these. Ants' nests are therefore popular at present; and not the less so, that some of the new species which have been found in them are blind. These, and all species which live entirely in ants' nests, wear the same livery as their hosts, and not only so, but very often assume much of their form. The commonest of the blind insects found in ants' nests is the *Claviger testaceus*, Preyss., which is found throughout Europe. Two other species have been described: one, *C. longicornis*, Müll., also found in Europe; and *C. colchidicus*, Motsch., from the Caucasus. This genus is represented in North America by an insect named *Adranes cæcus*, described by Leconte, and it also lives in ants' nests.

Another group of blind insects are found under ground or under stones, &c. The first which I shall mention is a small beetle belonging to the predaceous group, the Bembidii. It was recently discovered near Bordeaux and Toulouse, and described by M. Jacquelin du Val under the name of *Anillus cæcus*. M. du Val's specimen was taken under large stones which lay buried beneath a dunghill, or rather a large bed of decaying straw. Notwithstanding its want of eyes, M. du Val describes it as very agile, which is the character of all the Bembidii. Besides this, there have been found under ground a number of minute Clavicornes without eyes,—*Aglenus brunneus*, Gyll.; *Anommatus 12-striatus*, Müll.; *Clinidium Guildingii*, Kirby, and *sculptilis* of Newm.; *Langelandia anophthalmica*, Aubé. The latter is specially found on stumps of stakes or posts which have stood long in the ground. This is perhaps the place to take in two species recently described by Fairmaire, of whose habits we as yet are ignorant,—the *Amaurops Aubei* from Sicily, and the *Leptomastax Coquereli*—a very singularly formed species, allied to the Scydmænidæ, taken on the sands of the Bay of Beikos during last campaign.

Another group of blind insects are found under leaves and decaying vegetable matter. They are confined to two or three genera. The first (*Ptilium*) is curious as containing the smallest species of beetle known, and as having some of its species blind and others provided with eyes; and yet, so far as we know, there is no difference in the habits of life of those with eyes and those without them. When the eyes are awanting, they are replaced by a small tubercle, from which springs a long hair, which may possibly serve something of the same purpose as the tiger's or cat's whiskers, which are understood to be serviceable to these animals in moving in the dark,—a provision which we shall see strikingly reproduced in one of the genera of cave insects. The blind species of Ptilium are *Ptilium aptera*, Guer., and *microscopica* and *angustata* of Gillmeister, who has published a very careful monograph of this minute genus. The remaining blind genera which have been found under leaves and in forests, are *Leptinus*, the single species of which, *L. testaceus*, Müll., has been found in Britain, though very rarely; and *Adelops*, a number of species of which (all blind) are now known, and which possesses an interest peculiar to itself, from containing species which are found in the caves, as well as species which are found under leaves in forests. The species found in the latter localities are *Adclops Schiodtei*, *Aubei*, and *ovata*, Keis., and *meridionalis*, Fairm., all found in the Pyrenees and south of France; *Khevenhulleri*, Müll., near Vienna; besides a new species which Mr Jansen last year discovered near London.

I now come to the troglodytes, or cave insects. It is a long time (nearly a century) since the curious blind reptile, the *Proteus* (now *Hypochthon*) *anguinus* was discovered in the caves of Carniola; but although the occurrence of one animal so singularly adapted to its condition of life, might naturally have suggested the idea that others with a like structure would be found there also, if sought for, still it is only within a comparatively recent period that it has been ascertained that various eyeless insects and crustaceans also inhabit these vast subterranean solitudes.

The first insects which were found were a small crustacean of the Oniscus tribe, described by Kock in 1840 under the name of *Pherusa alba*, and a beetle, described by Sturm in 1844 under the name of *Anophthalmus Schmidtii.* Schiodte next visited the caves, and discovered eight new animals, and in 1851 published a very interesting account of his researches, and of the animals which were found in the caves. About the same time similar discoveries were made in America in the great Mammoth Caves of Kentucky. In 1842 the blind fish *Amblyopsis spelæus* was discovered, and afterwards blind insects also. Subsequent researches in Europe have also successively brought to light other species. Besides the *Anophthalmus Schmidtii*, we have now four other European species; and, it is to be observed, that so far as our information yet goes, they appear to be confined each species to its own cavern, or rather district of caverns;—*Anophthalmus Schmidtii* from the cavern of Luege, near Adelsberg, in Carniola; *A. Bilimekii* from the Sele Grotto; *Scopolii* from the Grotto of Setz, in Carinthia; and *Hacquetii* and *hirtus* from the Grotto of Kirmberg, near Oberiggdorf. Each district would appear thus to have its own species,—a circumstance (if confirmed) interesting, in relation to the theory of single centres of creation. The *Pherusa alba*, no doubt, is found in all the caverns of Carniola; the *Leptodirus Hohenwartii* in several; and so on; but these caverns are close together, and probably connected with each other by internal passages. It is curious that these creatures are only found far in the interior of the caverns, and never approach the garish light of day, which would appear to be as effectual a barrier to the dispersion of the species from one unconnected cavern to another as the highest mountain or widest ocean is found to be in the upper world. One does not well see why these blind animals might not, as it were, lose their way, and occasionally stammer upwards into broad daylight. Had they had sight, however feeble, the light might have been painful to them, and kept them in their native darkness; but if they have no perception of light, such a check would not operate. But I shall recur to this point when I come to speak of the structure of the places where the eyes should be.

But if the specific distinctness of the species peculiar to each cavern strikes us with interest, their generic identity is not less wonderful. Here in each cave we have a species so like those in the others (though still distinct), that we involuntarily ask ourselves what is the peculiar virtue of this form, as adapted to its condition of life, that the changes should be thus rung upon it in every cavern in Europe; and while we puzzle over it, lo! the caves of Kentucky are examined, and another new species is brought from them,—an *Anophthalmus* too, and as close in form to the European species as those of the one cave are to those of the next. I cannot suggest any plausible explanation why this particular form should be selected as most suitable for the condition of life of these insects (for that it is most suitable, cannot, I think, be doubted,—Nature not only always doing everything well, but everything best). To our finite perception, not only is the purpose of the form of the insect undiscernible, but its existence in its sphere of life at all would almost seem to be a mistake. It is one of the predaceous carnivorous Coleoptera coming in our arrangement next the agile group of *Trechus;* and unless we assume that it is provided with some special sense which compensates for the want of light and want of sight, it does not need much consideration to satisfy us that its hunt after its prey will be the pursuit of food under difficulties; and that it does not live on very full commons may be inferred from the state in which we find it,—the whole of the inside, in any I have seen, being shrivelled up into almost nothing. Still they live; therefore must be fed, and must, I think, be possessed of some additional instinct or increased power in the other senses, to enable them to procure the wherewithal. What is that additional or increased sense? Is it that of smell? Entomologists are not yet of accord as to the seat of that sense, some maintaining that the antennæ are its organs, while others maintain that they are the organs of touch, and others again the organs of hearing; and most striking evidence has been brought forward by the advocates of each in support of their particular view,—evidence so conclusive, that I acknowledge I have been convinced by all three, and I do most potently believe that the antennæ are the seat of all three senses, so that we may not only say that, like a Scotchman, the insect *feels* a smell, but it also hears a smell, and smells a sound. How does the structure of the antennæ of the *Anophthalmus* affect the question? They are considerably longer than usual in the group to which they belong, but are not thickened or expanded, which is the form we see adopted in those insects where the sense of smell is to be specially developed, as in those which have to smell out putrid or fetid matters on which to feed. It would not appear, therefore, that they hunt by the sense of smell. The sense of hearing is the sense which, among our own blind, becomes most useful, and I think we may reasonably infer that the same is the case among these blind insects. Sensitiveness of touch will no doubt be increased; and we see on the *Anophthalmus* that there are several excessively long, stiff hairs projecting on each side of its body, which may be used for the purpose I have indicated in speaking of similar hairs on the blind *Ptilium*. This can, however, only be a very subordinate assistance; for we have two other blind predaceous animals, two Arachnideæ, which are not furnished with such long hairs (the *Stalita tæniaria* and *Blothrus spelæus* of Schiodte, *Obisium troglodytes*, Sturm.) The remaining troglodytes belong chiefly to the family of Clavicornes. The cave species of the genus *Adelops*, which I have already spoken of as possessing some species which are found under leaves in the forests in the Pyrenees, are *Adelops byssina* and *montana*, Schiodte, from the caves of Carinthia; and *Adelops hirtus*, Tellkampf, from the Mammoth Cave of Kentucky; another instance of the same form, though not the same species, being reproduced in both countries. Another genus, *Leptodirus*, is interesting from its form, which has little affinity with any other genus, although it approaches most nearly to *Mastigus*. Three species of this genus are known,—*Leptodirus Hohenwartii*, from the Grotto of Adelsberg, *angustatus* from the Grotto of Volija Jama, and *sericeus* from the Grotto of Cuba Dol. The *Adelops* are extremely agile, notwithstanding their want of eyes. The *Leptodirus* are less so. The still more recent discovery of a blind Curculionidous species, allied to *Otiorhynchus* and described under the name of *Troglorhynchus* (Verhandl. des Wiener Zool.-bot. Vereins, Bd. iv. S. 62), and of a Brachelytrous species (allied to *Oxyporus*, according to H. Müller (its discoverer), and to *Pæderus*, according to Kraatz), and named *Glyptomerus cavicola*, Müll., completes, I think, the tale of blind cave beetles.

The food of these insects remains to be considered. So far as regards the carnivorous species, there is no difficulty in guessing what their food is. It must be the other smaller and less powerful species which live beside them; but what do these, in their turn, feed upon. Schiodte supposes them to feed on a Byssus which clothes part of the walls of the grottos. But H. Müller of Lippstadt, in an account of his researches after them last summer, published in the "Stettiner Etom. Zeitung," xviii. (March 1857), narrates that he found the *Leptodirus Hohenwartii* in stalactitic chambers, constantly wet and dripping, which would not furnish much nourishment; but he found that there were numerous morsels of corrupted and blackened wood lying on the ground, and he believes that it was upon these that they fed. Schiodte and Müller both consider water in the caves to be essential to their life; and it may be that it is by means of water that such fragments of wood have been, and are still deposited in the caverns. The *Troglorhynchus* also was found in caves whose bottom was covered with humid earth.

Besides the species already mentioned, there is a species of Thysanoura found in these caves—*Anurophorus Stillicidii*, Schiodte; and there are several blind crustaceans both in the caves of Carniola and those of Kentucky, as well as a number recently found in deep wells in this and other countries. These, however, do not fall within the scope of this paper, so I shall not occupy the time of the reader in enumerating them.

At one time it occurred to me that we might have some blind species in our own caves; and about two years ago, I took advantage of being on a visit in Derbyshire to make a thorough search through one of the largest natural caves in that porous county, viz., that known as the Blue John Mine, from which is extracted the beautiful purple fluorspar, of which the so-called Derbyshire spar ornaments are formed. The mine is a natural cavern, in parts of which the spar is wrought for. It descends obliquely, by rifts and crevices, for a very considerable distance, occasionally opening up into lofty caves or halls, as the manner of such places is. After passing the part of the cavern where the path has been smoothed and made practicable for the visitor, the wildest confusion reigns. Great angular blocks of stone, slippery with slime and clay, lie piled up in continued streams; here and there all access appeared barred, and we only prosecuted our way by creeping on our bellies through little narrow holes in the clayey barriers, such as only a vision of an *Anophthalmus* on the other side would ever have tempted me to risk sticking in. Sometimes up, sometimes down; now trying a rift running to one side, then a crevice to the other; every nook and every alley was faithfully explored; but alas! nothing blind found but the alleys. I mention these particulars to let any one who has a fancy for the same adventure see that "the gambol has been shown"—that I did not limit my exploration to the ground usually viewed by tourists, and that it will be better for any one who wishes to repeat such an examination to select a different cave for the purpose. Indeed, we can scarcely expect to find any troglodytes in this cavern, for, as I have already mentioned, the species in the Carniolan caves do not occur within two miles of the mouth, while here I do not suppose, that at the very farthest, we penetrated more than half a mile into the bowels of the land.

I am afraid I have already exceeded the space allotted to me; but I feel that any paper treating of blind insects would be imperfect if it took no notice of the peculiar structure in which their chief interest lies, viz., their want of eyes. I am not aware that anything has yet been done by others in relation to this. I believe not; the extreme rarity and value of these minute creatures operates as an obstacle. I have, however, sacrificed one of my specimens of *Anophthalmus Bilimekii*, in order to see if anything could be gathered from an examination of the interior of the head; and I think that, notwithstanding the disadvantages arising from the *dryness* of the *subject* (if I may use the words both in their literal and anatomical sense), I have observed something which it may be worth while to notice. The head of the *Anophthalmus* consists of two great lobes engrossing almost the entire surface of the head. Simple inspection, I think, shows that these occupy the space which was intended for the eyes.* On looking into the inside of the head, I find, of course, all the soft parts desiccated and undecipherable; but the inner

* The eye-space is not always thus well marked out. It is so in all the *Anophthalmi*. Kirby, in his description of *Clinidius Guildingii* in the "Zoological Journal," 1832, dwells upon it in that species; but in others, as *Adelops*, *Claviger*, *Aglenus*, &c., there appears no eye-space at all, but the whole of the head is of one uniform surface and texture.

surface of the chitonous integument showed this interesting peculiarity. Under a high power of the microscope, I found the thorax to be wrinkled transversely, with an immense number of angular elongate cells, like the cells in vegetable structure, which I believe to be the normal structure of all

Fig. 6.

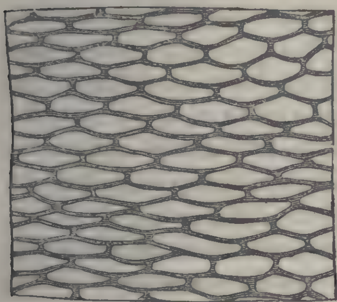
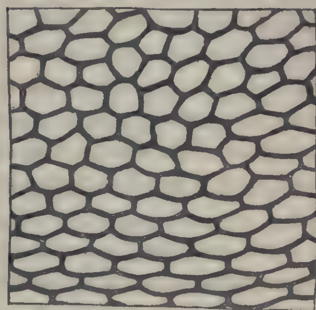


Fig. 7.



chitonous substances. This structure is shown in fig. 6, which represents a portion of the inner surface of the thorax. Bringing the interior of the ocular space under the microscope, I find the same cells, but greatly more developed (fig. 7). The power which shows the cells in the head very distinctly does not allow us to see the structure of the thorax at all. Dr Greville has been kind enough to execute the drawings of figs. 6 and 7, so that there can be no doubt as to their accuracy. The scale only is some whatdifferent, fig. 7 being on a smaller scale than fig. 6.

It will be observed, also, that on the thorax and at the back part of the ocular space, the chitonous cells are long and transverse; as we approach the centre of the ocular space, they begin to assume more of the usual hexagonal form of the facets of the eye, till in the centre we see some facets which are almost of the normal shape. This may possibly arise partly from the necessities of the rounded form of the eye space; and Dr Greville thinks he sees a tendency to an approach to the hexagonal form even in some parts of the thorax. I do not pretend to say positively that the structure on the ocular spaces of the head of the *Anophthalmus* is an atrophied or abortive eye; but I may at least say it looks very like it; and supposing it to be so, it gives us an instructive insight into the mode of development of the outer surface of the eye. We see that it is only a slight modification of the normal structure of the integument, and the tendency seen by Dr Greville towards a similar structure in other parts than the eye-space, is peculiarly interesting, as showing, that so far as the integument is concerned, there is no particular condition necessary for its development into the cornea, but that it might be equally easily constructed upon the thorax as upon the head. And this is in entire accordance with what is already known regarding the development of the eye in the vertebrata. In them the eye has been satisfactorily proved to be merely a part of the skin altered and added to ; for instance, the state of the eye of man in its earliest stage is simply a fold of the skin.

In all this, and indeed throughout the whole of this paper, I have been proceeding on the assumption that these insects are destitute of the power of vision. But this is merely an assumption, which may be only partially true. We know that the *Proteus anguinus* has an eye under the skin, and a not wholly atrophied optic nerve ; and we are told that when flambeaux are brought near it, and an attempt made to catch it, it usually darts off for some distance, where it rests, and is more easily caught the second attempt. In like manner, Schiodte says of the *Leptodirus*,—" The animal moves slowly and cautiously, supported on its long legs as if on stilts ; it stands still the instant that light, or rather the sound of approach, reaches it, when it crouches down and remains immoveable, with erect antennæ and stretched out legs, unless it is touched." No doubt the above incidents may be explained without supposing light to have any effect upon them. The noise of the visitors, the disturbance of the air by their presence, and torches, &c., may sufficiently advertise them of the intrusion of foes ; or if light has any effect upon them, it may be that the structure of the ocular space in the Anophthalmus is of a parallel nature to the eye and optic nerve of the Proteus ; or, failing this, it may be that, like plants and zoophytes, they are sensible of the influence of light without possessing eyes. Notwithstanding this, I imagine there can be little doubt that their powers of vision must be so feeble as to justify us in looking upon them and calling them blind.

REVIEWS AND NOTICES OF BOOKS.

Encyclopædia Britannica: Dissertation Sixth, exhibiting a General View of the Progress of Mathematical and Physical Science, principally from 1775 *to* 1850. By JAMES DAVID FORBES, D.C.L., F.R.S., Sec. R.S., Ed., Professor of Natural Philosophy in the University of Edinburgh, and Corresponding Member of the Institute of France.

The rarest of all the productions of nature we take to be a competent historian of science. The very elements which go to his composition are of necessity paradoxical, and, unless wonderfully blended and tempered, are likely, from man's natural anxiety for self-elevation, to lead their possessor to aim at discovering, rather than at recording discoveries. That he may appreciate genius—that he may be able to distinguish between originality and an aptness to assimilate and work out the conceptions of others, it can hardly be doubted that the historian should be himself a man of original power—should, indeed, have exhibited that power by his own contributions to the progress of science; and yet how generally does it happen, that a consciousness of the position of his own name on the page, draws, with unjust force, his pen towards the spot whence that name may be descried, as though he were writing an introduction which the next generation should complete by the addition of his own biography. The recent life of Newton may, to some extent, explain our meaning. Valuable as it is in reference to Newton himself, we cannot help feeling, when we are reading the account of his optical discoveries, that we are touching also on those of Sir David Brewster. A similar remark will apply to the same author's account of the stereoscope. The very fact of Sir David's high eminence as a discoverer, mixed up as his discoveries have been with those of others, aided too, perhaps, by some little impatience of criticism, renders him, unconsciously, a special pleader when he should be a simple narrator, and thus disqualifies him from being altogether an unexceptionable historian of science. The recorder will, under all circumstances, be blended with the record; and if the topic has engaged him in previous controversy, his judgment will not be wholly unbiassed.

At the same time, physical science, in its present progressive form can hardly be mastered by any but those who partake, to some extent, in its discoveries. A mere compiler will probably be a superficial examiner. Even if he possessed the power, we doubt if any would have the patience to climb to the requisite height, unless he started from a platform created by his own genius.

The author of the work before us belongs to the class of original discoverers—to that of men of genius of the highest order. Happily his range of research has been too wide—embracing every region, from the scattering of the stars in the heavens to the pulsations of heat in the arteries of the earth—to suffer his sympathies to be nailed down to any one or two branches of his subject. Happily, too, his discoveries have generally come before the world in a form so clear, complete, and convincing, that he has been little, if at all, involved in the meshes of controversy. Happily, moreover, he seems to have got scent of what we intended to say about the liability of men of genius to err in recounting discoveries in which they themselves have borne a part; for, on turning to the subject of polarization of heat, we find him commencing that portion of his history with an apology. "The length to which this chapter has already extended must be my apology for bringing concisely to a conclusion what remains to be stated regarding the progress of the subject of radiant heat." (Art. 707.) The length of the chapter! Why, the next chapter is considerably longer. We must return to this subject before we have done.

Spite of all these encouraging considerations, we confess we opened the present Dissertation with some little anxiety. We think the existing generation is not favourable to the production of durable impartial history. Ours is an age of discovery; we do not now mean scientific discovery. For a century or so the habit had prevailed of receiving implicitly the traditions and records of past times, assuming them to have been substantiated at the date of their publication. This style of constructing history consisted merely in breaking up and rearranging stereotype blocks. Recently, the worthlessness of such a mode of proceeding has become apparent, and now the opposite error has come strongly into vogue—that of leaping back to contemporaneous neglected documents, and, on their evidence, reversing the settled deliberate verdict of past centuries. Thus Cromwell and Mary of Scotland, and George of England (we don't mean him of the Dragon) get new characters;—nay, to such an extent is this carried, that, following the example of a learned prelate, we have a worthy man presenting us with "historic doubts" relative to the existence of Shakspeare—a writer of plays. Now, this style of thing is creeping into science. In a work lying before us, entitled "Specimens of the Table Talk of the late Samuel Taylor Coleridge," we read, under the date October 8, 1830, the following judgment:—"It would take two or three Galileos and Newtons to make one Kepler." Coleridge, with all his knowledge, probably knew very little of any one of the three—Galileo, Kepler, Newton; but, had he not seen the famous frescos in the hall of the University of Bonn? and with German spectacles too? Speaking of Kepler, we believe it is the fashion now to attribute more to him than was the custom with our ancestors. We had, some two or three years ago, a life of that eminent searcher after laws thrust into our hands, in which he appears in glorious colours; and almost whilst we write, a contemporary, after the manner of Horrox, commits himself to the following judgment:—"Before all astronomers, we think Keppler* deserves the title of Legislator of the Heavens," (a title frequently, and with justice, given to him). "Besides his three laws, he certainly did as much in the discovery of gravitation as Newton did; some think more." We do not know whether this writer, too, gets his information from German pictures or not, but, if he will consult the works of Kepler, he will perhaps admire him more and exalt him less. The untiring energy which could grapple with such apparently hopeless masses of materials, and build them up into goodly symmetrical structures—the faith in the existence of simplicity, amidst infinite complexity which could impel him to devote his life to search it out, proclaim that great man to be a true philosopher: but there was a point beyond which his mind could not penetrate; in optics, in astronomy, he looked for harmonies, for correlations, rather than for laws. Like the bee, he constructed

* Terpander, we think it was, immortalized himself by adding a seventh string to the lyre: modern biographers and editors may immortalize themselves by adding a seventh letter to the name of Kepler. He is himself immortal, without the aid of the additional *p*. There are, it is true, some of his works in which the seventh letter is employed, no matter whether correctly or not. But, as *Joannes Keplerus*, he was accustomed to build castles with the letters of his name, just as he did with the distances and periods of the planets; and consequently, under that name he should be suffered to rest in peace. The following passage from the life of Kepler, in the Library of Useful Knowledge, made a powerful impression on our imagination thirty years ago. It may be regarded as a mind-portrait of Kepler, painted by himself. "When I was a youth," he says, "with plenty of time on my hands, I was much taken with the vanity, of which some grown men are not ashamed, of making anagrams, by transposing the letters of my name, written in Greek, so as to make another sentence; out of Ιωάννης Κεπλῆρος, I made Σειρήνων κάπηλος; in Latin, out of *Joannes Keplerus* came *Serpens in akuleo*. But not being satisfied with the meaning of these words, and being unable to make another, I trusted the thing to chance, and taking out of a pack of playing cards as many as there were letters in the name, I wrote one upon each, and then began to shuffle them, and at each shuffle to read them in the order they came, to see if any meaning came of it. Now, may all the Epicurean gods and goddesses confound this same chance, which, although I spent a good deal of time over it, never showed me any thing like sense, even from a distance. So I gave up my cards to the Epicurean eternity to be carried away into infinity; and it is said they are still flying about there, in the utmost confusion, among the atoms, and have never yet come to any meaning. . . . . . . Yesterday, when weary with writing, and my mind quite dusty with considering these atoms, I was called to supper, and a salad I had asked for was set before me. It seems, then, said I aloud, that if pewter dishes, leaves of lettuce, grains of salt, drops of water, vinegar and oil, and slices of eggs, had been flying about in the air from all eternity, it might at last happen by chance that there would come a salad. "Yes,' says my wife, 'but not so nice and well-dressed as this of mine is.'"

his fabric with wonderful and accurate symmetry, such as his eye loved to look on, but in that symmetry other eyes, aided by other intellects, have discovered an economical adaptation which neither Kepler nor the bee dreamt of. We are digressing, though possibly our digression may have helped us to strengthen the second of the positions with which we set out, viz., that the historian of science, if he be not also a discoverer, is likely to be only a superficial examiner, and therefore subject to be misled by the tendencies of the age in which he lives.

We say we approached the Dissertation with some little anxiety. The subjects which it embraces are numerous, widely ramifying and difficult. When we assert that we have read the work, we do not mean it to be inferred that we have weighed each sentence, and considered both its exact import and the grounds on which the author set it down. In this sense, it is reading, not of a day or of a year, but almost of a life. As the record of the discoveries of three-quarters of a century, terminating with the present time, it can scarcely be believed that any man but the author himself, and two or three others, whose range of reading has been as wide as his own, can speak decidedly on every point—can even venture to speak on some points at all. That the work has many blemishes, many oversights, some manifestations of undue leaning to this side or to the other, may be safely admitted—it is a human production, and to err is human. That its blemishes will be carefully sought out, we may venture to predict. Indeed, the very first remark in reference to it, which met our ears, was a complaint of the treatment which Mr Fairbairn has received in the matter of the tubular bridge. We had intended to judge of the merits of this question by reading through Mr Fairbairn's own statement. We went so far, indeed, as to read the title-page, and we give the reader the benefit of our researches. "An account of the Construction of the Britannia and Conway Tubular Bridges, &c. &c., By William Fairbairn, C.E." But here we paused, and finally resolved that here we would pause. What have we to do with Mr Fairbairn and Mr Stephenson? True, had we found on examining those parts of the work with which we have most right to be familiar, that a general tone of one sidedness, a tendency to exalt this man and to depress that, to pass hastily over important branches of science that others less important might be brought into prominent notice—had we found such to be its tone and tendency, we should have raised our voice against this Dissertation being received as the exposition of the progress of Mathematical and Physical Science. But we find nothing of the kind; we are, on the contrary, impressed with the clear, healthy spirit which pervades the whole work. The author's scientific attainments place him in an atmosphere above the current where the straws and motes of the present day are floating, which an ordinary writer would have greedily caught at; and from this height he has looked on the past century with the broad and kindly gaze of one who himself awaits the judgment of succeeding ages.

The Dissertation is divided into seven chapters—the first introductory; the second and third on astronomy; the fourth on mechanics with its applications; the fifth on optics; the sixth on heat, including some topics of chemical philosophy, and the seventh on electricity and its cognates.

The introductory chapter is a very admirable inquiry into the limits of the science of natural philosophy, and the relations which exist between it and mathematics on the one hand, and the mechanical arts on the other. The following passage will give the reader a just idea of the spirit in which the work has been conceived and executed:

"It seems to me impossible to exclude from a review, however slight, of contemporary progress in the exact sciences, the advantages which have accrued to them, both directly, and as it were reflexively, by the astonishing progress of the mechanical arts. The causes, indeed, which called them forth are somewhat different from those which are active in more abstract, though scarcely more difficult, studies. Increasing national wealth, numbers, and enterprise, are stimulants unlike the laurels, or even the golden medals, of academies, and the quiet applause of a few studious men. But the result is not less real, and the advance of knowledge scarcely more indirect. The masterpieces of civil engineering—the steam-engine, the locomotive-engine, and the tubular bridge—are only experiments on the powers of nature on a gigantic scale, and are not to be compassed without inductive skill, as remarkable and as truly philosophic as any effort which the man of science exerts, save only the origination of great theories, of which one or two in a hundred years may be considered as a liberal allowance. Whilst, then, we claim for Watt a place amongst the eminent contributors to the progress of science in the eighteenth century, we must reserve a similar claim for the Stevensons and the Brunels of the present; and whilst we are proud of the changes wrought by the increase of knowledge during the last twenty-five years on the face of society, we must recollect that these very changes, and the inventions which have occasioned them, have stamped perhaps the most characteristic feature—its intense practicalness—on the science itself of the same period." (Art. 11).

In treating his subject, it has been the author's aim to blend the personal with the scientific. Accordingly, in the subdivision of the work into sections, he has allowed the biographical principle to predominate, thus giving as much as possible a historical character to the whole, and endeavouring to introduce the reader to the intellectual acquaintance of the eminent men who are selected for notice. (Art. 23). We regret that our limits do not permit of our extracting one of these biographies in full as a specimen. We shall content ourselves with giving a few passages from the combined notices of Leverrier and Adams in reference to the planet Neptune.

"We have now to chronicle a discovery, which, by general consent, stands first in the achievements of science, not only in the period now under review, but even in the long and eventful series of years which have elapsed since Newton established the doctrine of universal gravitation.

"The discovery of which we speak was no less than the proof of the existence of a planet beyond the recognised boundary of our system, merely as an inference from the perturbed motion of the outmost planet Uranus; a proof, not general or abstract, but particular and specific: 'Look, on such a night, and in such a direction, and there you will see by the telescope a star, small, indeed, but with a distinguishable disk,—*that* is the planet which has made Uranus move so unsteadily in its orbit,'—so spoke the mathematician; and the zealous astronomer to whom the call was especially addressed, pointing his glass to the sky, discovered at once, that is, the same evening, a body answering, *almost precisely*, in position as well as in brilliancy, to the oracular announcement. * * * *

"M. Leverrier is, we believe, a native of St Lo in Normandy, a province which has been singularly productive of eminent men (Laplace and Fresnel were of the number). With no advantages, but the reverse, he won a high position at entering the polytechnic school, which he constantly maintained. He at first, we believe, attached himself to chemistry, but his taste for physical astronomy was soon developed, and was advanced entirely by his private efforts. It is a peculiarity of the mode of cultivating the sciences in Paris, that such abstruse and difficult studies are not merely engaged in temporarily for purposes of academical distinction, but that they actually become a 'carrière' or *calling*, and are pursued in that methodical manner for which the French are distinguished. In 1845, when he commenced the careful examination of the theory of Uranus, M. Leverrier was already favourably known by his researches on comets, and on the orbit of Mercury, but especially by immense calculations connected with the secular inequalities of the planets, by which his ability and hardihood in computation had been thoroughly exercised. * * * *

"On the 1st of June 1846 he announced to the Academy of Sciences that the true longitude of the expected planet, for 1st January 1847, was 325°, with a probable error of 10° This result was immediately published in the *Comptes Rendus*.

"Between the 1st June and 31st August 1846, when his third memoir on the perturbations of Uranus appeared, M. Leverrier busied himself in obtaining a farther approximation to the elements and place of the suspected planet. He now assumed the correction of the mean distance amongst the other quantities to be sought. By a fresh calculation he deduced a complete list of elements as regards longitude; and diminished the mean distance considerably.

* * * *

"No one who read at the time the abstract of this remarkable paper in the *Comptes Rendus* failed to be struck with it, not only as regarded the weighty matter thus publicly announced, but also on occount of the calm and well-founded conviction which the author manifested in the truth of his bold conclusions, and the definite manner in which he gives the challenge to practical astronomers to verify or disprove them. * * * *

"So ardent a conviction in a manner compelled the proof which the geometer claimed, and M. Galle, whose intelligence and zeal are well known, pointed his telescope to the sky the very evening that M. Leverrier's letter reached him. Fortunately provided with a newly published star-map, by Bremicker, of that region of the heavens, which was not at that time diffused generally amongst European observatories, he detected that same night (the 23d Sept. 1846,) a star-like body of the eighth magnitude, not noted in the star-chart, therefore a wandering body, having a manifest disc from $2\frac{1}{2}''$ to $3''$ in diameter, and distant only *fifty-four minutes of a degree* from the predicted place.

"It will be remarked that the discovery in question was anticipated and completed in France and Germany alone; England had no direct participation. We must now, however, state briefly what occurred there of a similar character, at the same time, and even earlier.

"Mr John Couch Adams, when a student at St John's College, Cambridge, in 1841, formed the design of detecting the position of a perturbing planet which should account for the anomalous motions of Uranus. He made a preliminary essay on the problem in 1843, assuming the distance of the suspected body from the sun to be double that of Uranus. I learn from good authority that he obtained a place for the unseen planet not very different from that which he finally adopted. Early in 1844 he obtained from Greenwich the valuable series of places of Uranus, which were afterwards in like manner applied for by M. Leverrier. In September 1845, he communicated to Professor Challis the elements of the new planet's orbit (neglecting the inclination) and an ephemeris of its geocentric place.

* * * *

"Mr Adams, in communicating his results (at a later time) to the Astronomical Society, with characteristic modesty says:—'I mention these dates merely to show that my results were arrived at independently, and previously to the publication of M. Leverrier, and not with the intention of interfering with his just claims to the honours of the discovery, for there is no doubt that his researches were first published to the world, and led to the actual discovery of the planet by Dr Galle.'

"And such is no doubt the fact. The priority of Mr Adams in the mathematical investigation is as certain as that the researches of M. Leverrier alone produced the discovery of Neptune." (Arts. 127-140.)

We may add in the words of another writer—"Had there been hope and confidence Leverrier and Adams must have changed places. . . . . Though the basis was sound there was not sufficient faith."

These extracts will prepare the reader for the information that large portions of the work are of interest to the unscientific: indeed, all will find lessons of the highest value in these biographical sketches. An instructive example is contained in Lagrange's directions for the study of mathematics. "I *never studied*," says he, "*more than one book at a time;* if good, I read it to the end. I did not perplex myself with difficulties, but returned to them twenty times, if necessary. I considered reading large treatises of pure analysis quite useless. We ought to devote our time and labour chiefly to the applications. I *always read with my pen in my hand*, developing the calculations, and exercising myself with the questions." (Art 84, note). We have taken the liberty of transposing some of the italics in this passage, and have endeavoured to attach them to the remarks most worthy of attention. We must be allowed to take exception to one sentence of the above extract. Lagrange says—"We ought to devote our time and labour chiefly to the applications." This is not very consistent with his own practice, for he was eminently successful in the invention and improvement of *methods* in analysis, and appears to have devoted immense labour and much time in perfecting those methods, which he gave to the world in *large treatises.* Nor does it quite square with what the author of the Dissertation makes known to us in the following passage: "he himself (Lagrange) is stated to have preferred, amongst all his papers, one in the Turin Memoirs of 1784 on the Integral Calculus." It should always be borne in mind that every development of human thought has its value. Those discoveries which appear to be most widely separated may have affinities to be afterwards exhibited. Different minds are constituted to derive enjoyment from, and to advance the progress of, different elements of knowledge,—one revelling in the abstraction which traces to its conclusions the assumption, as an axiom, of a known impossibility, or developing the wonderful and real consequences of arguing on the supposed intersections of lines which never can meet; another reconciling with the Newtonian theory some irregularities in the motion of Venus; a third tracking the windings of ice-streams, and determining their laws of motion. The results, perhaps, are in themselves of no higher importance to the human race than the fall of an apple or the hues of the rainbow. As exponents of mere matter and force we could dispense with nine-tenths of our science: as an exponent of mind every tittle is valuable.

The author undoubtedly holds mere ingenuity rather cheap,—and we are disposed to agree with him; though he perhaps strains his position a little when he declares (as we understand the passage), that to make contrivances in which the result depends rather upon laws of geometry than of physics hardly entitles the inventor to be ranked amongst men of genius (Art. 35). The distinction here drawn does not appear to be philosophical, though the standard set up may happen to be correct. The measure of an invention or a discovery ought surely to be sought in the number, diversity, and complexity of the elements of thought required; and this being done, the conclusions arrived at will probably be the same as those which the author's standard will give. Thus the separate condenser of Watt will be placed far above his parallel motion; the reflecting quadrant of Hooke and Hadley above the joint of the former; and further, we presume, the condenser will be placed above the nautical quadrant,—but of this we are not quite sure.

Our limits allow us to refer to only one more topic; and that we are obliged to hurry over. This topic is polarization "Malus had already, in the end of 1808, announced a property of light which, if not absolutely new, was entirely so with reference to the circumstances in which it was produced. The polarization of light was in reality discovered by Huygens previous to 1680. He had observed that the two rays into which common light is divided in passing through Iceland spar have a singular diversity of character, which Newton afterwards described as an opposite polarity. * * A definite notion of such a distinction may be formed by imagining a musical string vibrating at one time in a vertical, at another in a horizontal plane. If we could possibly imagine light to consist of vibrations of this description, the two rays of Iceland spar might be conceived, the one to vibrate in a plane passing through the axis of the crystal, the other in a plane perpendicular to that. Such light might truly be said to have acquired the property of *having sides.* In the language of Newton, it is *polarized.*

The discovery of Malus consisted in showing that light may acquire properties identical with those of either ray yielded by refraction through Iceland spar, by the very simple process of simple reflection at a particular angle from any transparent body. Thus, for a surface of water, he found this angle to be 52° 45′ with the perpendicular, and for glass 54° 35′." (Art. 479.) It was subsequently shown by Sir David Brewster that the tangent of the angle is always equal to the refractive index of the substance. "Sir David Brewster's genius was first called forth by the announcement of Malus's great discovery, in 1808, of the polarization of light by reflection. * * * From this time (1813) Sir David Brewster became a regular contributor to the London Philosophical Transactions, which, as well as those of Edinburgh, contain a series of elaborate experimental investigations due to him, which have hardly been surpassed. * * * To him are due

"I. The laws of polarization by reflection and refraction, and other quantitative laws of phenomena.

"II. The discovery of the polarizing structure induced by heat and pressure.

"III. The discovery of crystals with two axes of double refraction, &c.

"IV. The laws of metallic reflection.

"V. Experiments on the absorption of light." (Arts. 521-524.)

Here we must close our extracts. We have time to mention only the lucid exposition of the beautiful theory of Young and Fresnel, of the discovery of circular polarization by the latter, and of that of depolarization by Malus and Arago.

These investigations have succeeded in rendering light, which, in the days of Newton, was hardly comprehended at all, now the most familiarly understood of the elements of nature. But is there no analogy in these respects between heat and light? That luminous heat should exhibit many of the properties of light it was natural to expect: but does the same apply to non-luminous heat? The brilliant and convincing discoveries of Melloni and Forbes leave no doubt about the matter. We subjoin a few extracts from the Report on Radiant Heat presented by Professor Powell to the British Association in 1840.

"Professor Forbes took up the inquiry in November 1834.

"(1.) He proved distinctly the stoppage of a considerable proportion of heat, when the tourmalines were crossed—with brass heated below luminosity.

"(2.) In the third section of the same memoir (Edin. Trans. vol. xii.) he details his researches on the polarization of heat by refraction and reflection.

"(3.) In the fourth section, the author enters on the modifications which polarized heat undergoes by the intervention of crystallized plates between the polarizing and analyzing plates of the apparatus."

On the 1st of February 1836 Professor Forbes announced to the Royal Society of Edinburgh that he had that day succeeded in establishing the *circular polarziation* of heat—even when unaccompanied by light—by direct experiment. This was shortly followed up by the establishment of elliptic polarization. Thus the analogy between heat and light was shown to be complete.

We shall conclude these remarks in Professor Powell's words:

"The sole and undisputed credit of first unequivocally establishing the grand facts of the *polarization of heat*, even from non-luminous sources, by transmission through mica, through tourmaline, and by reflection, together with the peculiar and invaluable property of mica split by sudden heating (a fact holding a parallel rank with that of the diathermancy of rock salt); *depolarization* of heat; its consequent double refraction and interference; its *circular* and *elliptic polarization;* its length of wave, and the production of that wave by transverse vibrations; the confirmation of the circular polarization by the rock-salt rhomb, and the peculiar effects of metallic reflection; these constitute the unquestionable claims of Professor Forbes."

We hope that, as soon as justice to the subscribers to the Encyclopædia shall permit, the Dissertation will be republished in an octavo form; and we feel sure it will find a lasting place amongst the standard scientific works of the present age.

Elements of Chemistry, Theoretical and Practical. By WILLIAM ALLEN MILLER, M.D., F.R.S., &c., Professor of Chemistry in King's College, London.

PART I. *Chemical Physics*, 1855.
PART II. *Inorganic Chemistry*, 1856.
PART III. *Organic Chemistry*, 1857.

In our early student days, the date of which we shall not stop to define, the text-books in use, though they might in some cases be called *Manuals*, were never Hand-books, but rather Arm-books, which had to be squeezed firmly between elbow and side, when carried to and from lodgings and class-rooms. These unhandy volumes were also costly, at least as measured by the depth of a student's purse, for none of them could be procured for less than a guinea, and many cost more. By-and-by, all at once, publishers seemed to discover that "a great book is a great evil," and fell to producing compact volumes within the grasp of the most boyish hand, and costing only about half the sum which was charged for the ponderous tomes of the earlier era. The change was welcomed by all, except, perhaps, the authors and proprietors of the supplanted big books. Teachers felt free to require the poorest students to provide themselves with text-books. Students no longer hunted the book-stalls for cheap ancient editions of some Megabiblon which, in its last issue, differed as much from its first development as a tiger-moth does from a hairy caterpillar. The lecturer, if he missed in the new Finger-book, such ample expositions of favourite topics as filled pages of the old Arm-books, felt that he would have reason to congratulate himself if his pupils knew thoroughly the contents of the smallest of the smaller volumes. The pupil, if he thought there was room for still further omission and condensation, acknowledged, nevertheless, after counting the pages, that in the course of a session he might master them all. So far, unusual contentment for a season prevailed.

Meanwhile, however, as fast as the text-books were growing smaller, the sciences of which they treated were growing larger. Physiology would not cease expanding because Mr A. must raise the price of his Hand-book if he added another sheet to it; nor would Chemistry stand still because Mr B. had stereotyped his last edition. What was to be done in these circumstances? To bring out text-books on the same science, of different kinds, and, therefore, of different sizes and prices, so as to suit different classes of students. Our publishers have done this to the full. If text-books are wanting on any subject which interests a considerable number of readers, it is through defect of authors, not of publishers. The work before us is a happy compromise between such highly-condensed treatises on Chemistry as that of Professor Fownes, and such would-be exhaustive Thesauri as Gmelin's misnamed many-volumed *Hand*-book. Both of these are excellent in their way; the former amply sufficient for the ordinary wants of the student of medicine, for whom it is chiefly intended; the latter a storehouse of reference for men of all professions who have an interest in Chemistry. But Fownes is too brief, and Gmelin too diffuse, besides being too unwieldy and unmanageable, to suit a great and increasing class of students, who seek to acquire a large, though not an exhaustive, acquaintance with the science of which the works in question treat. To them Professor Miller's three volumes will be most acceptable. He is Professor in a College where, besides students of medicine, students of law, of theology, of agriculture, of engineering, and of the military art, attend lectures together. The first-named may be the most numerous, but are not more zealous chemical students than many of the non-medical pupils, who, moreover, have generally more time to devote to the study of chemistry. The author has thus had experience of a diversified class of students, and has written for each section of them. His work is in reality three works in as many volumes, each so independent of the others that it may be consulted as a separate treatise. The first volume, that on Chemical Physics, is the most remarkable; we have no rival work, indeed, in the language. It discusses chemical affinity, weight, measure, molecular force, elasticity, cohesion, adhesion, crystallization, light, heat, electricity, and magnetism. Those subjects, no doubt, are considered in treatises on Natural Philosophy, and as departments of physics have monographs of great value devoted to each of them; but we know no single work which discusses them as they are discussed here, and it is of great importance to students of chemistry, to have in their hands a discussion of physics from the chemist's point of view.

The second volume is devoted to the range of subjects included under Inorganic Chemistry: the third embraces the immense and difficult subject of Organic Chemistry, and furnishes a truly admirable exposition of its vast and intricate details.

It would not be more foolish to show a brick as the sample of a palace, than to quote sentences from Professor Miller's elaborate work as indices of its excellence. But as microscopic observers have certain *test*-objects by which they try the powers of new microscopes, so there are certain subjects which afford tests of the expository skill of chemists and physicists. Let the reader, for example, try Professor Miller on the Laws of Combination, the Classification of Crystals, the Polarization of Light, Electrolysis, Actinism, the Constitution of Salts, the Metallurgy of Iron, the Assay of Silver, Organic Analysis, the Alcohols and their derivatives, the Organic Bases, Homologous Series, the Nutrition of Animals, and the Notation and Nomenclature of Gerhardt. In addition, let him, after the fashion of the *Sortes Virgilianæ*, take several dips at random between the leaves, and read whatever pages thus open to view. He will come, we believe, to as favourable a conclusion regarding the merits of Professor Miller's work by this process, as we have arrived at by steady travelling from title-page to finis in each volume. Three qualities have specially attracted us, as characterising Professor Miller's expositions:—judicial sagacity and impartiality in stating and comparing conflicting doctrines or arguments; undeviating lucidity in describing phenomena or discussing laws; and a literary grace which makes his book very pleasant reading. The first of those qualities gives his work that eclectic character which should be found in every comprehensive text-book. The second is the merit, without which all other merits are meritless, in a treatise for learners. The third is not indispensable, as much profitable study of unattractive German and English authors has satisfied us, and we suppose all men. But there is no reason why French scientific treatises should be the only graceful ones, as our author practically illustrates. He has wisely judged that the intrinsic difficulties of his text are sufficiently great, without adding to them the adventitious darkness of an involved syntax and an obscure style, and without one line of "fine" writing, has made his book most pleasant, as well as most profitable in perusal.

PROCEEDINGS OF SOCIETIES.

Royal Society of Edinburgh.

Monday, 1st December 1856.—The Right Rev. Bishop Terrot, Vice-President, in the Chair. The following Communications were read:—

1. *Opening Address.* By Bishop Terrot.

2. *On the Minute Structure of the Involuntary Muscular Tissue.* By Joseph Lister, Esq., F.R.C.S. Eng. and Edin. Communicated by Dr Christison.

In this paper the author describes the discovery made in 1847 by Professor Kölliker, that involuntary muscular fibre is capable of being resolved into nucleated elements, supposed to be of the nature of elongated cells, and hence termed "contractile" or "muscular fibre-cells." He then notices a paper by Professor Ellis of University College, London, in which that distinguished anatomist expresses his belief that "the fibres are long, slender, rounded cords of uniform width," and that the nuclei "appear to belong to the sheath of the fibre." The author then proceeds to describe the involuntary muscular tissue as it presents itself in two situations where he has recently examined it, namely, the minute arteries of the frog's foot and the small intestine of the pig. He finds that in these organs the involuntary muscular tissue is composed of slightly flattened, elongated elements, with tapering extremities, each provided at its central and thickest part with a single cylindrical nucleus imbedded in its substance. Professor Kölliker's account of the tissue is thus completely confirmed in these two instances.

It further appears, from what has been seen in the pig's intestine, that the muscular elements are, on the one hand, capable of an extraordinary degree of extension, and, on the other hand, are endowed with a marvellous faculty of contraction, by which they may be reduced from the condition of very long fibres to that of almost globular masses. In the extended state they have a soft, delicate, and usually homogeneous aspect, which becomes altered during contraction by the supervention of highly refracting transverse ribs, which grow thicker and more approximated as the process advances. Meanwhile the "rod-shaped" nucleus appears to be pinched up by the contracting fibre, till it assumes a slightly oval form, with the longer diameter transversely placed.

The author further remarks, that these properties of the constituent elements of involuntary muscular fibre explain in a very beautiful manner the extraordinary range of contractility which characterizes the hollow viscera.

Monday, 15*th December* 1856.—Professor CHRISTISON, V.P., in the Chair. The following Communications were read:—

1. *On the Ovum and Young Fish of the Salmonidæ.* By WILLIAM AYRTON, Esq. Communicated by Professor ALLMAN.

2. *Notice of the Vendace of Derwentwater, Cumberland, in a Letter addressed to Sir William Jardine, Bart.* By JOHN DAVY, M.D. (See Number of this Journal for April 1857, p. 347.)

3. *On the Races of the Western Coasts of Africa.* By Colonel LUKE SMYTH O'CONNOR, C.B., Governor of the Gambia. Communicated by Professor KELLAND.

Monday, 19*th January* 1857.—The Right Rev. Bishop TERROT, V.P., in the Chair. The following Cummunications were read:—

1. *On the Application of the Theory of Probabilities to the question of the Combination of Testimonies.* By Professor BOOLE. Communicated by Bishop TERROT.

2. *On New Species of Marine Diatomaceæ from the Firth of Clyde and Loch Fine.* By Professor GREGORY. Illustrated by numerous drawings, and by enlarged figures, all drawn by Dr GREVILLE.

3. *Short Verbal Notice of a simple and direct method of Computing the Logarithm of a Number.* By EDWARD SANG, Esq.

Monday, 2*d February* 1857.—The Right Rev. Bishop TERROT, V.P., in the Chair. The following Communications were read:—

1. *On the Urinary Secretion of Fishes, with some remarks on this secretion in other classes of animals.* By JOHN DAVY, M.D., F.R.S., London and Edinburgh.

The urinary secretion of fishes, the author believes, has hitherto received so little attention owing to certain difficulties attending its investigation. He brings forward the few and imperfect observations he has made, with the hope of inducing others more favourably situated to prosecute the inquiry.

The fishes he has examined in quest of their urinary secretion have been fifteen; of those with a urinary bladder he found a fluid only in three, the Perch, Ling, and Ray; and in those without this organ, only in two, in their ureters—those of the Pike and Turbot.

His experiments to ascertain the composition of the secretion were attended mostly with negative results. In one instance, that of the Pike, he detected lithic acid; in some others there were indications of the presence of urea in the fluid urine.

The conclusions he ventures to draw are, that the secretion is small in quantity, mostly liquid, and that urea or some other analogous nitrogenous compound is its principal ingredient.

2. *On the Reproductive Economy of Moths and Bees; being an Account of the Results of Von. Siebold's Recent Researches in Parthenogenesis.* By Professor Goodsir.

(See Number of this Journal for April, p. 319.)

3. *On the Principles of the Stereoscope; and on a new mode of exhibiting Stereoscopic Pictures.* By Dr W. Macdonald.

Monday, 16th February 1857.—Dr Christison, V.P., in the Chair.

The following Communications were read:—

1. *On the Crania of the Kaffirs and Hottentots, and the Physical and Moral Characteristics of these Races.* By Dr Black, F.G.S.

2. *On a Roche Moutonnée on the summit of the range of hills separating Loch Fyne and Loch Awe.* In a letter from the Duke of Argyll to Professor Forbes.

What appears to me to be the peculiarity of the "Roche Moutonnée" I am now about to describe, is its position, forcing us to seek for its explanation in causes with which the physical geography of the country can have had comparatively little to do. On going to one of the highest points on the ridge separating Loch Fyne and Loch Awe (probably about 1800 feet above the level of the sea), during last autumn, I was surprised to observe close to the summit so remarkable an example of a well-rounded surface of rock as to attract my attention from a considerable distance. The direction from which the abrading force has acted is about N.N.E. It has passed over a lower shoulder in its way—lower by about 100 feet; but the effect is strongest upon the rocks of the main peak itself, and especially upon one or two prominent faces within twenty or thirty feet of the summit. Above this it may be observed sloping off, as it were, with diminished force, over successive ledges towards the top, until it passes close behind the very highest point, leaving that point itself apparently untouched. I need hardly say, that in this case glacier action is impossible. Even if this hill had itself been the seat of the glacier, it could only have been snow so near the summit. There is one explanation which immediately suggests itself to the mind, and, however difficult it may be to realize the conditions which it involves, it is the only one which it seems to me to be possible to suggest. It is that this peak, when subject to that grinding force, was a rocky islet just appearing above the surface of a glacial sea, and that floating icebergs, drifting from the north-eastward, were constantly grounding upon its sides.

3. *On M. J. Nicklès' claim to be the Discoverer of Fluorine in the Blood.* By George Wilson, M.D., F.R.S.E., Regius Professor of Technology in the University of Edinburgh.

A communication was made to the French Academy, at its meeting on the 3d of November 1856, by M. J. Nicklès, entitled "Presence du Fluor dans le Sang." From the tenor of M. Nicklès' remarks, it would seem that he was not aware that the existence of fluorine in the blood was announced by me in 1846, and specially demonstrated in 1850; nor is he acquainted with the researches which others besides myself have made in this country and in America, into the distribution of fluorine throughout the different kingdoms of nature.

My researches have been chiefly published in the "Transactions" of this Society, and of the British Association, but have been brought in part before the Chemical Society of London. They are known in Germany, Denmark, Sweden, and America, and have been referred to by many authors in this country. It is reasonable, accordingly, to infer that some knowledge of them has reached Paris; and it might have been supposed that they had not altogether escaped the notice of M. Nicklès, whose name appears on the title-page of the *Journal de Pharmacie et de Chimie*, as editing the department of that work entitled "Une revue des Travaux Chimiques publiés à l'Etranger."

I bring no charge, however, against M. Nicklès. In these days of multiplied monographs it would be unjust to blame any man for ignorance of a single series of special researches. Nevertheless, seeing that this author's name appears on the title-page of the *Journal de Pharmacie* side by side with those of our Vice-President Dr Christison, as its Edinburgh Correspondent, and of Dr Redwood, the Secretary of the Cavendish Society, as its London Correspondent, the countrymen of M. Nicklès may think themselves entitled to quote the legal maxim, "de non apparentibus et de non existentibus eadem ratio," and to infer that what of reputed English science is not known to him, does not exist to be known. Whilst, therefore, I wish M. Nicklès all success in extending our knowledge of the organismal distribution of fluorine, I ask from him, now that he is made aware of the fact, acknowledgment of my priority in reference to the discovery which he specially claims, and of the other discoveries which the papers referred to announce.

Monday, 2*d March* 1857.—The Right Rev. Bishop Terrot, V.P., in the Chair. The following Communications were read:—

1. *On the Functions of the Spinal Cord.* By Professor Hughes Bennett.

The object of Dr Bennett's communication was to unite two separate kinds of research, which of late had been directed towards advancing our knowledge of the structure and functions of the spinal cord. From these it would, he thought, appear, that the views considered to be so firmly established by the genius and labours of Charles Bell required great modification. Dr Bennett then gave a sketch of these views, and of the present opinions of physiologists regarding the functions of the spinal cord. He indicated certain facts which had long been recognised as difficult of explanation in accordance with them. He then described the results of several experiments by M. Brown-Séquard on the columns of the cord in living animals, which he himself (Dr B.) had witnessed, and which satisfied him that, on the posterior columns being cut across, increase of sensibility in the inferior extremities was the consequence, instead of paralysis. He also described the discoveries recently made in the structure of the spinal cord, by Budge, Kölliker, Lockhart Clarke, Stilling, Remack, Wagner, Van der Kolk, Schiling, Kupffner, and especially by Owsjannikow. He pointed out how the structural discoveries threw light on the experimental ones, and from the whole inquiry drew the following conclusions:—

1. Although the anterior and posterior roots of the spinal nerves may still be considered motor and sensitive, we can no longer apply these terms to the anterior and posterior columns of the cord.

2. The fibres in these columns do not convey impressions directly and

continuously to the brain as hitherto supposed, but enter the gray matter, and operate through the ganglionic cells of that matter.

3. That all so-called reflex movements are carried on by a definite system of conducting fibres and ganglionic cells, passing through the grey matter; in other words, they are *diastaltic* and not reflex.

4. That the particular fibres and cells which are necessary to spinal diastaltic acts have yet to be discovered; so that a new field of inquiry is opened up to the physiological histologist.

2. *On the Delta of the Irrawaddy.* By T. LOGIN, C.E., Pegu. Communicated by WILLIAM SWAN, Esq.

3. *Notice of a Collection of Maps.* By A. K. JOHNSTON, Esq.

Monday, 16th March 1857.—Dr CHRISTISON, V.P., in the Chair. The following Communications were read:—

1. *Notice respecting Father Secchi's Statical Barometer, and on the Origin of the Cathetometer.* By Professor FORBES.

(See Number of this Journal for April, p. 316.)

2. *History of an Anencephalic Child.* By Dr SIMPSON.

3. *On certain Laws observed in the Mutual Action of Sulphuric Acid and Water.* By BALFOUR STEWART, Esq. Communicated by Dr G. WILSON.

The object of this paper was to show that where sulphuric acid combines with water, distinct reference is made to certain definite compounds or hydrates of sulphuric acid.

The combination of these two liquids is attended with contraction of volume; that is, the volume occupied by the compound is less than the sum of the volumes occupied by its ingredients when uncombined. By means of a simple formula (assuming 1·8485 to be the specific gravity of strong liquid sulphuric acid), we may find what ought to be the specific gravities of the different strengths in Dr Ure's table, were no contraction to take place. By this table we may find the actual specific gravities of such mixtures; and dividing the actual or observed specific gravity by the calculated specific gravity, and deducting unity from the quotient, we have the proportional condensation. The proportional condensation is greatest for strength 73 of Dr Ure's table, which is the strength of a hydrate composed of one atom of liquid acid and two atoms of water.

The author's experiments confirmed a maximum point corresponding to the hydrate $HO, SO_3 + 15\,HO$, and showed a minimum point corresponding to the hydrate $HO, SO_3 + 6\,HO$. In conclusion, the author's results were briefly stated thus:—

1. The points of elevation, depression, or peculiarity in the curve of condensation, denote definite compounds, whatever be the standard strength used.

2. The use of varying the standard is simply to render such points more prominent, or, in other words, to convert a point of peculiarity into one of elevation or depression, as the case may be.

Monday, 6th April 1857.—Dr CHRISTISON, V.P., in the Chair. The following Communications were read:—

1. *On the Structure of Pedicellina.* By Professor ALLMAN.

The author maintained that the genus Pedicellina, notwithstanding the circular arrangement of its tentacula, does not properly belong to the infundibulate Polyzoa at all, but is in reality hippocrepian, of which type, however, it presents a remarkable modification. The intestine at first sight appears to terminate within the margin of an orbicular lophophore, and, consequently, within the circle of tentacula, and thus to present a striking exception to the admitted plan of the Polyzoa. It was shown, however, that the anomaly which thus seems to exist was only apparent, for the lophophore, when carefully examined, is found to be constructed on the hippocrepian type, with the tentacula confined to the outer or convex margin, and the arms of the crescent united at their extremities so as to enclose a space, around which the tentacula will then be arranged in an uninterrupted circle, and within which the intestine opens, its termination being thus quite normal, and properly external to the lophophore.

As in the ordinary hippocrepian Polyzoa, so also here the mouth is furnished with an epistome, which, however, is less complete than in the others, and not provided with special muscles; and it is moreover highly probable that the calyx, which constitutes a universal feature in the ordinary hippocrepian genera, enters here into the composition of the peculiar cup which surrounds the base of the tentacula, and which the author believes has its homology in a permanently inverted portion of the endocyst, united externally to the uninverted endocyst, and internally to the calyx and tentacula.

2. *On a Case of Lateral Refraction in the Island of Teneriffe.* By Professor C. Piazzi Smyth.

In his astronomical visit to Teneriffe last summer, the author was instructed to inquire into the lateral oscillation of stars, as seen by Baron Von Humboldt in his ascent of the mountain. During a month's residence on the place of the alleged observation no approach to anything of the sort was ever noticed, although a powerful equatorial, with a twelve-foot telescope, and high magnifying powers, was employed to detect any irregularity in the motions of the stars. The author, concluded, therefore, that the anomalous movements described by Humboldt could not have been produced by any general or cosmical action of the atmosphere, or of light or heat, which astronomers were bound to consider.

3. *On Insect Vision and Blind Insects.* By Andrew Murray, Esq. (This Paper appears in the present Number of this Journal.)

4. *On the mode in which Light acts on the Ultimate Nervous Structures of the Eye, and on the relations between Simple and Compound Eyes.* By Professor Goodsir.

Since the publication, in 1826, of Joh. Müller's *Vergleichende Physiologie des Gesichtssinnes*, physiologists have admitted three fundamental forms of the organ of vision. 1*st*, The eye-spot, organized for the mere perception of light. 2*d*, The compound eye, in which the picture on the nervous surface is a mosaic. 3*d*, The simple eye, in which the retinal picture is continuous. The difference between the simple and compound eye, as explained by Müller, and since generally admitted, consists in this, that the formation of the picture in the simple eye is the result of the convergence of all the pencils diverging from the visible points of the object on corresponding points of the retina, by means of the lenticular structures of the organ; while, in the compound eye, the picture is formed by the stopping off, by means of the constituent crystalline columns of the eye, all rays except those which pass in or near the axes of the columns. The extent of surface of any object, and the number of separate parts of such surface, represented on the nervous structure of a compound eye, will vary, therefore, in terms of the distance of the object, the curvature of the superficial ocular surface, the corresponding inclination of the crystalline columns to one another, the size of their individual transverse sections, and their lengths. The continuous retinal picture in the simple eye is psychically interpreted as a continuous image. If, therefore, the possessor of a compound eye perceives a continuous image of an object, it must be the result of a more complex psychical operation, in virtue of which, the separate portions of the ocular mosaic picture are psychically combined, and interpreted as a continuous whole.

The successive researches of Treviranus, Gottsche, Hannover, Pacini, H. Müller, and Kölliker, have determined the existence and general structure of close-set rods or columns, which extend between the inner and outer surfaces of the retina, in the midst of the nervous and vascular textures of that membrane. The outer extremities of these rods present a crystalline columnar aspect, and constitute, collectively, the external layer of the retina, usually termed Jacob's membrane. The ultimate filaments of the optic nerve, after being connected in a plexiform arrangement in the ganglionic layer of the retina, terminate each independently in the more perfect portion of the retinal field, by passing into, or becoming continuous with, the inner end or side of a rod. Kölliker considers these rods as nervous structures, that is, as terminal portions of the nerve-filaments themselves, and holds that they constitute the parts of the nervous structure of the eye on which objective light primarily acts.

Having myself carefully examined the structures to which I have now alluded, I have been able to verify the more important anatomical details, as described by their discoverers, and agree with Kölliker in considering the rods as the primary optic apparatus. I cannot, however, coincide with this distinguished observer in holding these rods as modified nerve filaments. I hold them to be special structures appended to the extremities of the ultimate nerve filaments, and referable to the same category as the Pacinian bodies, touch-corpuscles, rods of Corti, &c.; and, moreover, so far am I from coinciding with Kölliker in his speculations as to the part of the rod on which the objective light acts, that I have found myself compelled, not only from the consideration of the structures themselves, but also from the development of the eye itself, and the arrangements of the compound eye, to conceive the rays of light as acting upon the retina, not as they impinge upon it, or pass through it from before, but as they pass backward again out of the eye after reflection from the choroid.

The general aspect of the rods, and more especially of those portions termed Müllerian filaments, where they collectively amalgamate in the limitary membrane of the retina, indicate, as I believe will be generally admitted, that they consist of a modification of connective tissue, enveloping and supporting the extremities of the ultimate nerve filaments in such a manner as to form special structures, which, from their functions, may be termed *photæsthetic bodies*.

That special structures are required for the initiation of action in the filaments of the optic nerve by objective light, appears to be established by the facts, that the nervous filaments of the retina, and the cut extremities of these filaments on the stump of the optic nerve, are not affected by it, although irritation of the same filaments by electrical or other means produces subjective luminous phenomena. Subjective sounds may be produced by various modes of irritation; but actual sonant vibrations can only excite the acoustic filaments through the medium of the rods of Corti, or the corresponding terminal structures in the vestibule. Corresponding terminal structures are in like manner appended to the tactile, olfactory, and gustatory nerves, apparently for a similar purpose, to provide the necessary conditions of the initial excitement of the nervous current by those secondary properties of external bodies to which the organs of touch, taste, and smell, are related.

When the attention of anatomists was directed, a few years ago, to the structure and physiological signification of the columns of the retina by the observations of H. Müller and Kölliker, I became satisfied that those structures are not, as the latter asserted, nervous structures, properly so called, but special structures, of the same nature as the Pacinian bodies and the tactile corpuscles. I stated and explained my opinion of the nature of these bodies in a lecture on the retina delivered and reported in 1854. But I had generalized these relations of nervous filaments to special terminal exciting structures, still further, in the zoological lectures which I delivered in 1853, for my late distinguished colleague and preceptor Professor Jameson. I also expounded it at considerable length in my course of lectures last winter (1855–6). I shall now state the doctrine in general terms, not only because it is necessary for the elucidation of the distinctive characters of the simple and compound forms of eye; but also because I am anxious to put on record, by submitting it to this society, a generalization which appears to me of primary importance in the general physiology of the nervous system. I assume, as established, the doctrine of Du Bois Raymond, that a nerve filament is capable of propagating the nervous current equally well in both directions; and that the physical and physiological characters of this current differ in no respect, are in fact identical in the so-called motor and in the so-called sensory filaments, whether special or common. I also assume as established that the specific manner in which a centripetal nerve current is converted at the central extremity of the filament, that is to say, is physiologically reflected into motor filaments, or, psychically interpreted as sensation, depends upon the physiological or psychical endowments of the different portions of the nervous centre with which the filaments are connected. These two positions being assumed, then, I hold that, although the ultimate nervous filament may have its functional current (that is the common nervous current) excited or initiated by electrical or other physical or chemical agencies, yet this current can only be initiated or excited, for the special functional purposes for which each nervous filament is provided in the economy, by the structure or tissue with which such filament is connected peripherally. If so, then, not only are the individual filaments of the nerves of special sense provided with current-exciting structures at their peripheral extremities, by means of which alone the objects to which they are related can initiate the nerve current; but also centripetal nerve filaments of whatever kind, are provided, in their connection with the textures from which they proceed, with arrangements, by means of which alone their functional currents can be initiated.

From this point of view every particular structure in the organism from which nervous filaments proceed to the nervous centre, may be considered with reference to the nervous system, as a peripheral nervous organ,—that is, an organ capable of exciting or initiating centripetal nerve current; which is physiologically converted, or psychically interpreted at the corresponding central organ, according to the special endowments of that central organ.

After this preliminary statement, I am in a position from which I can explain the mode in which I understand the structure and actions of the rods of the retina in the simple, and the columns in the compound eye.

1. *In the simple eye.*—A ray of light can only impress an ultimate retinal nervous filament under certain conditions. These conditions are, that it should impinge upon the distal extremity of the filament in, or parallel to, the axis of that filament, or within a certain angle to that axis.

All rays impinging on the distal extremity of an ultimate retinal nervous filament under the conditions stated I term *photogenic* rays. Rays impinging upon, or passing through, the filament in any other direction, may be termed *aphotogenic.* The distal portion of the ultimate retinal nervous filament, I distinguish as the *photæsthetic surface.*

In order that the ultimate retinal nervous filament may be subjected to the rays of light under the required conditions of vision, its distal extremity or photæsthetic surface is inclosed in a peculiar structure, consisting of a so-called *rod* or *cone* (which I distinguish as the crystalline column), and its appended Müllerian filament, with its nuclear enlargements. This structure constitutes a specific kind of peripheral nervous organ, which, from its function, I term a *photæsthetic body.*

A photæsthetic body consists of a distal segment, or dioptric portion, elongated, cylindrical, or club-shaped, homogeneous, transparent, and highly refractive, usually termed the rod or cone ; and a proximal segment or peduncle, with its nuclear enlargements, into which the ultimate nervous filament passes, and within which it apparently terminates, probably at its outer end.

The entire aspect and arrangement of these photæsthetic bodies, their predominance over the other parts of the retina at the axial spot of the eye, and the direct continuity of their stems with the nerve filaments at that spot, appear to me to indicate not only the nature of their functions, but also the general features of the mode in which it is effected. It appears to me that the rays which act upon the nervous filaments must be such rays as the arrangement permits to pass from behind, forwards in the axes of the photæsthetic bodies. It has now been ascertained, that the quantity of light reflected, and consequently irregularly dispersed within the eye-ball from the choroid, and bacillary layer, &c., is very considerable ; and it consequently becomes a very important question, to determine in what manner this reflected and irregularly dispersed light is prevented from affecting the retina. The view which I have already given of the structure and probable mode of action of the photæsthetic bodies affords the basis of a hypothesis which meets all the conditions of the question, and is in full accordance with the comparative anatomy and development of the organ of vision. I cannot interpret the functions of the structure of the retina as now determined, except by assuming that the photæsthetic columns are impressed not by the light as it enters the eye, or as it is more or less irregularly reflected and dispersed in its interior, but only by those rays which, in their passage backwards to the pupil pass along, or nearly in, the axes of the crystalline rods or columns of the photæsthetic bodies, so as to reach the photæsthetic spots under the required conditions. No confusion, therefore, can result from the multitude of convergent and divergent rays which pass through the chamber of the eye, and through the retina. By this means, the numerous rays not necessary for vision, are as it were eliminated from the operation, the eye being blind to them, and affected only by such as are reflected backwards to the pupil along the axes of the crystalline columns.

2. *The Crystalline Columns of the Compound Eye.*—As stated in my lecture on the retina, formerly alluded to, I conceive the crystalline columns in the eye of the insect or crab, to act in the same manner as the retinal rods in the spheroidal or simple eye. That they do so may be held as established by the researches of J. Müller on the laws of vision in the compound eye. Müller even refers to the columnar structure of the retina, as presenting a certain similarity to the structure or arrangement of the compound eye. F. Leidig, in an elaborate memoir published in Müller's Archiv. in 1855, on the structure generally of the Arthropoda, ex-

amines minutely the structure of the simple and compound eyes, and arrives at the conclusion that the crystalline columns of their compound eyes, as well as the corresponding structures in their so-called simple eyes or ocelli, are of the same nature as the so-called rods and cones, that is, the photæsthetic bodies which I have already described in the retina of the vertebrate eye. But Leidig entirely loses sight of a fact, which, if unexplained, vitiates his conclusion as to the physiological identity of the bodies in question. In the annulose or molluscous eye, whether in its so-called simple or compound form, the crystalline columns are directed, like the tubes of so many telescopes, towards the object, the corresponding nervous filaments passing to them from behind; whereas the crystalline rods of the vertebrate retina are directed away from the object, that is, towards the back of the eye—are in contact, in fact, with the choroid, while their nervous filaments are connected to them in front, that is, between them and the object.

On the other hand, if I am correct in holding that the vertebrate eye is acted upon by those rays only which are reflected from its choroidal surface, I have not only explained physiologically why its retinal columns are reversed, but I am legitimately entitled, as Leidig is not, to consider them as the homologues of the crystalline columns of the annulose and molluscous eye.

But the teleological explanation of the opposite arrangement of the corresponding structures in the vertebrate and invertebrate eye, is, in the present phase of the science, insufficient. The difference must be explained morphologically. This explanation is afforded by the different modes in which the vertebrate and invertebrate, that is, the simple and compound eyes are developed.

In the compound eye the primordial ocular papilla or convexity, which is only slightly protuberant, has its cutaneous or superficial surface immediately converted into the crystalline columnar structure, the individual columns of which are connected with the filaments of the subjacent optic nerve. The columns are all therefore directed to the object.

The primordial cerebro-cutaneous spheroidal protuberance or papilla of the simple refracting or vertebrate eye, is speedily hollowed out in front by the development in or upon it of the lens and vitreous humour, so that from a spheroidal convex surface, the primordial protuberance assumes the form of a cup, with its mouth directed forwards, and its cavity occupied by the refracting media of the organ. This cup-shaped mass is the retina; the crystalline rods are not developed on its concave surface, but on its outer or convex surface, as they exist on the convexity of the compound eye, that is, in the direction of the radii of the sphere, but directed backwards, on account of the nearly spheroidal surface.

In conclusion, I may state what appears to be the physiological superiority of the simple over the compound eye. As the simple eye is acted on by reflected light only, it cannot be disturbed by rays not required for the definition of the image. It is also arranged so as to admit of a much more delicate or minute mosaic representation of the object, from its microscopic and reversed photæsthetic bodies being in contact with the reflecting choroidal surface on which that image is formed. It moreover combines the advantages of the contiguous image, formed by the lenticular structures, and the mosaic image, which results from its crystalline rods.

Monday, 20th April 1857.—Dr Christison, V.P., in the Chair. The following Communications were read:—

1. *On the recently discovered Glacial Phenomena of Arthur's Seat and Salisbury Crags.* By Robert Chambers, Esq.

2. *On a Dynamical Top, for exhibiting the Phenomena of the Motion of a System of Invariable Form about a Fixed Point; with some Suggestions as to the Earth's Motion.* By Professor CLERK MAXWELL.

The top is an instrument similar to that exhibited by the author at the meeting of the British Association in 1856. It differs from it in being of smaller size and entirely of brass, except the ends of the axle; and in having six horizontal adjusting screws and three vertical ones, instead of four of each kind.

It consists of a hollow cone, with a heavy ring round the base, and an axle, terminating in a steel point, screwing through the vertex. In the ring are the nine adjusting screws, and on the axle is a heavy bob, which may be fixed at any height.

By means of these adjustments the centre of gravity of the whole is made to coincide with the steel point, and the axle of the top is made one of the principal axes of the *central ellipsoid.*

The whole theory of the spinning of such a system about its centre of gravity depends on the form of Poinsot's ellipsoid corresponding to the particular arrangement of the screws. The top is intended to exhibit those cases in which the three axes of this ellipsoid are nearly equal. In these cases the instantaneous axis is never far from the normal to the invariable plane, which we may call the invariable axis. This axis is fixed in space, but not in the body; for it describes, with respect to the body, a cone of the second order, whose axis is either the greatest or the least of the principal axes of inertia.

To observe the path of the invariable axis in the rapidly revolving body, we must have the means of recognising the part of the body through which it passes at any time. For this purpose a disc of card is placed near the upper end of the axle. The four quadrants of this disc are painted red, yellow, green, and blue, and various other marks are added; so that by observing the colour of the spot which appears the centre of motion, and the diameter of the coloured spot, the position of the invariable axis in the body at any instant may be known, and its path traced out.

This path is a conic section, whose centre is in the principal axis. If that axis be the greatest or least, it is an ellipse with its major axis parallel to the mean axis. If the axle of the top be the mean axis, the path is an hyperbola as projected on the disc.

When the axle is the axis of greatest inertia, the direction of motion in the ellipse is the same as the direction of rotation. When it is the axis of least inertia these directions are opposite. All these results may be deduced from Poinsot's theory, and verified by means of the coloured disc.

The theory of precession may be illustrated by this top in the way pointed out by Mr Elliot, by bringing the centre of gravity to a point a little below or above the point of support.

The theory and experiments with the top suggest the question—Does the earth revolve *accurately* about a principal axis? If not, then a change of the position of the axis will take place, not in space, but with respect to the earth, so that the apparent positions of stars with respect to the pole will remain the same, but the latitude of every place will undergo a periodic variation, whose period is about 325 days. To detect this variation, the observations of Polaris with the Greenwich transit circle for four years have been examined. There appeared some doubtful indications of a variation not exceeding half a second. A more extensive investigation would be required to determine accurately the period, and the epoch of maximum latitude at a given observatory, which must depend on the longitude of the station, as the pole of the "invariable" axis travels round the mean axis from west to east.

3. *On the true Signification of certain Reproductive Phenomena in the Polyzoa.* By Dr ALLMAN.

When the reproductive phenomena of Alcyonella, as manifested both in gemmation and true generation, are viewed in their proper sequence, they will be found to present a series of acts which admit of an obvious comparison with the class of phenomena commonly known as the "alternation of generations."

From the fecundated ovum an embryo is produced in the ordinary way after the segmentation of the vitellus. In this embryo, which presents at first the form of a locomotive ciliated sac, sexual organs are never directly developed, but there are produced within it by a process of *gemmation* the following series of zooids. 1. A polypide, which, like the containing sac, is essentially nonsexual, and which is eminently organized for the functions of digestion. 2. A peculiar bud, at first undistinguishable from the polypide-bud, but which never develops digestive organs, and is soon seen to be filled with proper ova, each with its germinal vesicle and germinal spot. This body may, in accordance with common usage, be called the ovary of the zooid from which it is developed, but since it is produced from this zooid in the manner of a bud, exactly as the polypide is, it may itself be fairly viewed as a unisexual zooid, in which the whole organization becomes subservient to the reproductive function, while all the other functions and their special organs become masked and suppressed by the dominant development of the organization destined for generation. 3. Another unisexual bud developed upon the polypide, endowed with a male function and commonly called the testis, but truly a distinct zooid, with its whole organization rendered subservient, as in the ovary bud, to generation. 4. A nonsexual bud of peculiar form (the statoblast) also developed from the polypide.

The essential features in the reproductive phenomena just enumerated present themselves in an indefinitely repeated series, where the first and last terms of each cycyle consist in a fecundated ovum, and the intermediate terms in a succession of gemmæ.

4. *On the Destructive Distillation of Animal Matters.* Part IV. By Dr ANDERSON, Glasgow.

5. *Analysis of Specimens of Ancient British, of Red Indian, and of Roman Pottery.* By MURRAY THOMSON.

Ancient British Pottery.

Silica,	52·49	51·24	51·86
Alumina,	13·29	12·46	12·87
Peroxide of iron, containing phosphates corresponding to 1·01 Phosph. Acid, and also a trace of manganese.	18·19	18·94	18·56
Lime,	4·85	5·13	4·99
Magnesia,	0·60	1·64	1·12
Soda,	3·06	2·97	3·01
Potass,	0·55	0·78	0·66
Organic matter,	2·14	2·33	2·23
Water,	4·70	4·76	4·73
	99·87	100·25	100·23

Ojibbeway Pottery.

Silica,	42·70	43·60	43·15
Alumina,	22·71	22·12	22·41
Peroxide of iron,	10·58	10·03	10·30
Lime,	1·33	1·46	1·39
Magnesia,	2·60	2·88	2·74
Organic matter,	10·28	10·10	10·01
Water,	9·79	9·99	9·89
	100·19	100·18	100·185

Lustrous Red Roman or Samian Ware.

Silica,	54·78
Peroxide of iron, containing phosphates corresponding to 0·42 Phosph. Acid,	21·43
Alumina,	8·74
Lime,	12·67
Magnesia,	1·33
Water,	1·26
	100·21

6. *Theory of Linear Vibrations.* Part VI. *Alligated Vibrations.* By Edward Sang.

This part of the paper contains an inquiry into the action of a vibrating body upon a linear elastic series, as representative of the action of a sound-emitting substance upon the air.

The general conclusions are these :—That the observed phenomena of sound are inconsistent with the supposition of a perfectly elastic vibratory medium, and that either the viscidity, or some as yet unknown quality of the air, has to do essentially with the production of those phenomena, so that any analysis in the present state of our preparatory knowledge must be futile. And that the undulatory theory of light is altogether conjectural, since far from knowing how one supposed wave would influence another, we do not yet know anything of the manner in which such waves can be formed at all.

Royal Physical Society.

Wednesday, 26*th November* 1856.—Robert Chambers, Esq., President, in the Chair.

1. *Opening Address.* By Robert Chambers, Esq.
2. *On* Hydractinia Echinate. By T. Strethill Wright, M.D.

(See Number of this Journal for April, p. 298.)

3. *On the Structure and Habits of the Slow Worm* (Anguis fragilis, Linn.). By Daniel R. Rankin, Esq., Carluke. Communicated by Professor Fleming.

(See Number of this Journal for January, p. 102.)

4. *Description of New Insects from Quito. List of Old Calabar Insects.* By Andrew Murray, Esq., W.S.

(See Number of this Journal for April, p. 220.)

Dr John Alex. Smith exhibited the cranium of a red deer (*Cervus elaphus*), which showed an interesting variety in the development of its antlers; the right antler being without branches, and 13 inches in length; and the left 16¾ long with its first branch, or brow antler (as it is commonly termed, from projecting over the brow), 6½ inches long, but in this case rising from the back part of the horn, at about two inches from its base, and projecting backwards. It was believed to be of great age, and the horns may show an accidental variety depending on that cause. The stag was recently shot at the Doune of Rothiemurchus by Lord Alexander Russell, to whose politeness the Society was indebted for its exhibition. Dr Smith also exhibited a rabbit, taken in a trap near Carnwath, in the beginning of this month, and kindly sent to him by Mr John Dickson, gunmaker, Princes Street, from the singularity of the extreme length of the fur on the upper part of its body. The peculiarity was believed to be dependent on the rabbit being a cross with an escaped individual of the long-haired, so-called Russian rabbits, which are frequently kept by rabbit fanciers.

Wednesday, 24th December 1856.—This meeting was adjourned, owing to the death of Mr Hugh Miller on the morning of that day.

Wednesday, 28th January 1857.—W. H. Lowe, M.D., President, in the Chair.

The President opened the business of the meeting with some remarks on the loss which the Society, and science in general, had sustained in the death of Mr Hugh Miller.

1. *Observations in British Zoophytology* :—1. Clava (*three new species*). 2. Eudendrium (*two new species*). *Illustrated by Specimens and Drawings.* By T. Strethill Wright, M.D.

(This Communication is printed in the present Number of this Journal.)

2. *Notice of Dredgings in Lamlash Bay.* By Robert K. Greville, LL.D.

Dr Greville gave a sketch of the results of the dredgings carried on in Lamlash Bay last summer, by the Rev. Dr Miles and himself, as a Committee of the British Association, and stated that they would be published in their Transactions. He laid on the table tabulated lists of marine animals taken in that locality, referring particularly to some of the more interesting species, and believed that locality to be pretty nearly worked out. He mentioned that this last season seemed, from some unknown cause, to have been generally unfavourable to the inquirers in this department of natural history, from the unusual rarity of marine animals. Dr Greville then gave some interesting details of the habits of various marine creatures, including several species of small fishes, as observed by him in a large vivarium in Arran, adding, that he believed in this way we would ultimately be enabled to acquire a very complete knowledge of the habits of many most interesting species.

3. *On the Prehensile Apparatus of* Spio seticornis. By Thomas Strethill Wright, M.D.

(This Communication is printed in the present Number of this Journal.)

4. *Ornithological Notices.* By John Alex. Smith, M.D. (Specimens were exhibited.)

5. *Notes on the British species of* Patella, *from information communicated by Dr Knapp.* By Andrew Murray, Esq., W.S.

The object of this paper was to point out a very marked variety of the *Patella vulgata*, which had been found by Dr Knapp in Guernsey and Jersey. It was principally characterized by its rich yellow or brown-creamy colour inside, its more depressed form, and more prominent ribs, white at the top. A very fine series of species both of this variety and the other British species of Patella was exhibited. Notwithstanding its marked peculiarities, Mr Murray considered it only a variety of *P. vulgata*, and proposed to call it *P. vulgata*, var. *intermedia*.

Wednesday, 25th February 1857.—Professor Balfour, President, in the Chair. The following Communications were read :—

1. *On the genus* Ateuchus (*the Egyptian* Scarabæus), *and its South American representatives, with descriptions of new species of the latter.* (Specimens were exhibited.) By Andrew Murray, Esq. W.S.

Mr Murray commenced by referring to the interest which attached to this group of beetles, from its having been an object of veneration to the ancient Egyptians, and sculptured so frequently on their ancient monuments. He exhibited a series of specimens of these antiques, and pointed out that it was quite easy to distinguish to which species they ought to be referred. Those specimens exhibited all belonged either to *Ateuchus sacer*, or *Ateuchus laticollis*. He detailed several interesting anecdotes connected with their habits, and their wonderful instinct of making, rolling, and burying balls of excrementitious matter, generally containing their eggs. He also explained their geographical distribution, showing that they were confined to the Old World, but possessed representatives in South America (known under the generic name of *Eucranium*), bearing a very close affinity to a South African species (*Pachysoma Æsculapei*). He concluded by describing some new species of these South American beetles, which he had received through the kindness of Dr Stark of Edinburgh, to whom they had been sent from the deserts of Cordova, by Mr Black, a very zealous naturalist (son of our respected member for the city), who is now in Chile.

2. *On the Contemporaneous Geological Age of the "Mountain" and "Burdiehouse" Limestone Beds of the Linlithgowshire Coal-Field.* By Andrew Taylor, Esq.

The object of Mr Taylor's communication was to describe a geological section in the Bathgate Hills—taken from Dechmont Laws to Balbardie House, in which a limestone containing fresh-water fossils, and equivalent to the one worked at Burdiehouse, gradually merged into another limestone containing marine fossils, which is usually recognised as the lowest bed of the carboniferous series.

3. (1.) *Notice of the occurrence of* Apophyllite *at Ratho.* (Specimens were exhibited.) (2.) *Sections of* Lepidostrobi *were exhibited.* By Alexander Bryson, Esq.

4. *Notice of a Discovery of* Diatomaceæ *in the Marl of Waitnean and Brakegoe, near Wick, Caithness-shire.* By Charles W. Peach, Esq., Wick.

5. (1.) *Notice of the Horn of a Reindeer* (Cervus tarandus, *Linn.*), *found in Dumbartonshire.* By John Alexander Smith, M.D.

At the close of last session, I exhibited to the Society several shells and a deer's horn, which had been recently found during the excavation of a cutting on the Forth and Clyde Junction Railway. My friend, James Macfarlane of Balwill, Esq., knowing the district well, was kind enough to draw up at my request a "memorandum," formerly read to the Society; and I have since been furnished with some additional information. The locality in which the horn, shells, and fragments now on the table were found, immediately adjoining the hamlet of Croftamie, situated in the county of Dumbarton, parish of Kilmaronock, in the basin of the river Endrick (which flows into Loch Lomond), and at a distance of nearly a mile from that river, and about four miles from the nearest part of Loch Lomond. The superincumbent mass consisted first of the vegetable mould, then of a stiff till about twelve feet thick, containing a large quantity of stones, some of a round form, apparently water-worn, others angular, and many of them of a great size. Under the till was a bed of blue clay about seven feet thick, and at the lower part of this bed, and close upon the sandstone rock, the horn was dug out of the clay at the depth of about eighteen feet; and at a few yards' distance the shells were found in a similar position, lying at a depth of about twenty-one feet from the surface, the ground cut through rising a little higher at that part. As nearly as can be calculated from the railway plans and sections, these remains lay from 100 to 103 feet above the level of the sea. The shells consisted of the following species:—*Cyprina islandica*, *Astarte elliptica*, and *A. compressa*, *Fusus antiquus*, *Littorina littorea*, and the shelly base of a species of *Balanus*. They are all marine species, at present inhabiting the neighbouring seas. I previously noticed their relation to beds of marine shells found near the shores of Loch Lomond, pointing to a total change in the character of the district, when Loch Lomond existed as an arm of the sea. But into this subject I do not again enter, my communication now referring to the deer's horn (which I exhibit), the

other object of interest found in the railway cutting. The horn was supposed at first to be simply that of a red deer, which, from being water-rolled, had become smooth. The Society, however, would remember I stated that I was inclined to consider it as belonging to the *reindeer*. It is a fragment of the horn of the right side, and has been broken off obliquely, just below the slightly prominent burr,—it shows the origin of the brow antler close to the burr, and at about two inches' distance that of a second antler, or tine, at which part the horn is much compressed in its character, the origin of the antler being quite flattened; beyond this we have the smooth and rounded beam, becoming again compressed and angular at the upper part, where it is broken across. The horn is small, measuring $11\frac{1}{2}$ inches in length, and one inch in breadth midway between the origins of the antlers. These characters all agree closely with the horn of the reindeer. Since the meeting of the Society, at which it was previously exhibited, I have been anxiously seeking for small-sized horns of the reindeer to compare with it, and at last was fortunate enough to get the horns of a young or female reindeer, of the American variety. I ex-

exhibit these horns, and the Society will at once see the very close resemblance between them. (I am indebted to T. B. Johnston, Esq., for kindly favouring me with the annexed careful drawing, which shows the relation between this broken horn, and the perfect horns of the recent reindeer.) And, to set this matter completely at rest, I then forwarded the horn to our great authority in fossil remains, Professor Richard Owen of London, who favoured me with the following reply :—" It gives me pleasure to inform you that the portion of antler from the basin of the Endrick, which you sent for my inspection, is of a young or female reindeer of the existing species, and if, as is most probable, a female, of the large variety called 'Carabou' by the Hudson's Bay trappers." Professor Owen, in his valuable "History of British Fossil Mammals," refers to two instances of the cranium or horns of the reindeer being found in England. The only instance described, as far as I am aware, of its occurrence in Scotland, is that recorded by Dr Scouler of Glasgow, in the "Edinburgh Philosophical Journal" of 1852, p. 135. This consisted of a portion of the distinctive palmated brow-antler. I have much pleasure, therefore, in recording another instance of the remains of this animal—now so exclusively a native of the more northern parts of Europe and America—being found in Scotland.

(2.) *Notes on the Wood Sandpiper* (Totanus glareola, Temm.) *Shot in Mid-Lothian.* By John Alex. Smith, M.D.

Wednesday, 25th March 1857.—Andrew Murray, Esq., W. S., President, in the Chair. The following Communications were read :—

1. *On the Geology of the Neighbourhood of Elie.* By the Rev. Walter Wood, A.M., Elie.

The paper was confined to a view of the relations between the trap and the sedimentary rocks, as displayed on the shore. The prevailing trap rock has been commonly called trap tuffa, but is known by the local name of "Leck." It is uniformly stratified, and never occurs superimposed upon the Coal Measures. The alternate patches of the two rocks are separated by faults filled up by wacke and fragments of sandstone. Hence it would appear that the "Leck" had at one time uniformly covered the sedimentary rocks; that the mass had been broken up by faults; and then by denudation the whole of the tuffa had been removed, except such portions as had sunk to a lower level.

2. *Analysis of Three Waters from Palestine, viz.: The Water of Marah: the Hot Springs of Tiberias; the Baths of Pharaoh.* By Allen Dalzell, M.D.

The waters in question had been sent to the College Laboratory by Dr Stewart of Leghorn, by whom they were brought from the Holy Land. The first water Dr Dalzell wished to mention was from a spot little visited by travellers, on the western side of the Sinai peninsula, and was believed by Dr Stewart to be the "Marah" of Scripture. As taken from its source it was found by that gentleman to be charged with sulphuretted hydrogen. The Marah water, as he received it, had a specific gravity at 60° of 1008·5, and contained 1400 grains of solid matter in the imperial gallon. The following showed the nature and proportions of the constituent salts :—

Chloride of sodium	40·725
Sulphate of lime	12·520
Sulphate of magnesia	40·716
Chloride of magnesium	6·040
	100·000

The second water was that of the Baths of Tiberias, at its source a sulphureous thermal, and of too high a temperature to permit of the hand being held in it. It had not been previously analysed with care. Dr Dalzell found its specific gravity at 60° to be 1022·5, and the solid residue of a gallon to be 2821 grains, or about twice as much as Marah yields; nearly 80 per cent. of its saline matter was common salt, as the following table showed:—

Chloride of sodium	76·85
Sulphate of lime	11·01
Sulphate of magnesia	12·14
	100·000

The third water was also sulphureous and thermal. Its original heat must have been great, as, from some notes accompanying the bottles, it appeared that a thermometer graduated to 120° Fahrenheit, instantly burst on being immersed in it. At 60° he found its specific gravity to be not far from that of the Marah well, viz., 1007·9, and the solid residue from a gallon 1211 grains. Like the Dead Sea, it contained much magnesia, and, as in that water, so here, the amount of sulphate of lime was smaller than in either of the preceding. Its analysis showed, of

Chloride of sodium	73·215
Sulphate of lime	6·720
Sulphate of magnesia	20·065
	100·000

Dr Dalzell concluded by stating, that in a portion of Dead Sea water taken from the northern end, the specific gravity of which was 1210 at 60°, he found 17,402 grains per gallon of solid matter, 56·12 of which was chloride of magnesium, 29·62 chloride of sodium, 11·25 chloride of calcium, a little more that 2 per cent. chloride potassium, 0·43 sulphate of lime, and 0·28 consisted of the bromides of magnesium and potassium.

3. (1.) *A few Fossils from Vancouver's Island were exhibited.* (2.) *Notice of a Tetraodon (believed to be new) from Old Calabar.* (The specimens were exhibited.) By Andrew Murray, Esq.

Mr Andrew Murray exhibited a few fossils from Vancouver's Island. They belonged to the Lower Chalk, and consisted of a species of ammonites and baculites (*B. ovatus*, Say.), *Diceras* (*Caprotina*, D'Orb.), *Venus*, *Unicardium*, and *Psammobica.*

Mr Murray also exhibited a species of *Tetraodon* received from Old Calabar, through the kindness of Mr Wylie. It did not correspond with any of the species described by Lacepede, and was probably new. Instead of being armed with great spines, it was nearly smooth, except on the belly, where it was covered by a number of small prickles. It was dark brown above, and pale beneath, and had a row of six deep red spots along its sides. Mr Murray named it provisionally *T. pustulatus.*

4. (1.) *Observations in British Zoophytology.* (2.) *Description of two new* Protozoa. By Thomas Strethill Wright, M.D.

1. *Observations in British Zoophytology—Trichydra pudica.*—The author had given this title to a very minute Zoophyte, found by him on shells and stones from the Firth of Forth. He described it as follows:—Corallum membranous creeping; cells, sessile, cylindrical, about one-tenth of the length of the extended polyps. Polyps, about one-eighth of an inch in length; shaped like a fresh-water Hydra; very attenuated and transparent; with from four to twelve long waving tentacles. Buccal cavity small, conical, dense, silvery white by reflected light. Polyps very sensitive; bending down the head and tentacles when exposed to strong

light, like a flower drooping on its stalk. He classed this zoophyte at present amongst the Corynidæ of Johnston, on account of the progressive development of the tentacles, which increased in number with the increasing age of the polyp.

Laomedea acuminata.—A description of this zoophyte had been published in December last by its discoverer, Mr Alder. Dr Wright had possessed specimens since May last. In August, and again during the present month, pedicled and very large capsules had been developed from the foot of the annulated polyp stalks, from each of which capsules a single medusoid (of great size when compared with the polyp) was liberated. This medusoid was mitre-shaped, and distinguished by the bright emerald-green reflected colour of its sub-umbrella. It had four tentacles, two long and two rudimentary, all ringed as to their bulbs with dark blue. The auditory sacs were eight in number, placed one on each side of the tentacles. No eye-specks or reproductive apparatus existed. The length was from 1-10th to 1-8th of an inch. Great numbers of these medusoids had been produced, several of which had been examined by members of the Society present, and others.

2. *On two new* Protozoa.—Both these species were marine, and belonged to the family *Vorticellina.* The author had designated the first, which was attached to deep-water shells, *Lagotia* (the hare-eared animalcule.) It inhabited a dark green tube, resembling in shape a soda-water bottle laid on one side, with the neck bent upwards, and prolonged into a trumpet-shaped mouth. The body of the animalcule was long and cylindrical, and was surmounted by a rotatory organ, which, in one aspect, resembled the head and ears of a hare, in another, that of a narrow or compressed horse-shoe, bordered with a fringe of moving teeth. The whole body was clothed with an undulating fleece of cilia. The colour of the body was hyaline, transparent green, or atro-purpureous.

Vaginicola valvata resembled *V. crystallina* of fresh water, but it was distinguished from the latter animalcule, especially by the presence of an oval horny valve, situated about half-way down its tube, and which closed down in an inclined position over the animal when the latter was contracted. The valve was developed within, and covered by a fleshy plate, which was attached by one edge, and continuous with a pellicle which lined the whole of the inside of the tube. The tube and the horny plate of the valve were not hinged or connected together otherwise than by their fleshy coverings. In dead and empty tubes the valve was absent.

Wednesday, 22d April 1857.—W. H. Lowe, M.D., in the Chair.
The following Communications were read:—

1. *Notes on Scottish Lepidoptera in* 1855-56. (Numerous specimens were exhibited.) By R. F. Logan, Esq.

In this communication Mr Logan added twenty-four species to the list of *Heterocera* occurring near Edinburgh, many of them discovered by the industry and energy of the Messrs Wilson.

2. *On the Chalk Flints of the Forth.* By Professor Fleming.

The author stated, that having visited the Black Rocks, Leith, on the 28th ult., at a low ebb-tide, after strong easterly winds, he was surprised to find a large heap of *Chalk Flints*, from which the covering of sand had been removed by ripple action. Similar flints had been observed by Mr Christie of Hawkhill, in a field to the eastward of the house, and the author had detected a single nodule in the brick-clay of Kinghorn. Having previously observed a bed of flints, with angular masses of *chalk*, in the middle of a deposit of brick-clay, on the Aberdeenshire coast, he refuted the usual notion that the flints occasionally found on the shores of the

Forth were the remains of *ship-ballast*, and gave it as his opinion that they were the wreck of cretaceous strata, which formerly existed in the neighbouring sea, and were a prolongation of the Denmark beds.

3. *Observations in British Zoophytology.* By THOMAS STRETHILL WRIGHT, M.D.

The principal object of this notice was to elucidate some points in the anatomy and physiology of *Tubularia indivisa*, which have escaped detection or presented difficulties to the numerous authors who have written on this zoophyte.

4. *Notice of two Fossils found in a bed of Shale below St Anthony's Chapel, Arthur's Seat.* By JAMES M'BAIN, M.D., R.N.

This bed rests upon Amygdaloidal trap-tuff, and is covered by another bed of columnar basalt, on which the chapel is built. It has been long known to the geological explorers of Arthur's Seat that this shaly bed contained fossil organisms, apparently of a vegetable character, to which the general term "fucoid" has been applied. In June 1854, on visiting this spot, and chipping a portion of the thin laminated clay, I found a small tooth imbedded in it, which apparently belonged to the genus Holoptychius—most probably to the *Hol. Hibbertii.* The other fossil organism evidently belongs to the vegetable kingdom. Several specimens have been found, but they all appear to be mere fragments. The nearest resemblance to these specimens which I have seen figured in plates is that of *Bechera charæformis*, accompanying the Memoir of Mr James Prestwick, "On the Geology of the Coalfield of Coalbrookdale," from the Transactions of the Geological Society of London, vol. v. for 1840.

Botanical Society of Edinburgh.

Thursday, 13th November 1856.—Professor FLEMING, V.P., in the Chair.

The following Communications were read :—

1. *Notice of Diatomaceæ, Desmideæ, &c., collected in Ceylon.* By Dr KELAART.

2. *Notice of the Occurrence of* Crambe maritima *near Edinburgh.* By Mr JOHN W. BROWN.

3. *On the Stellate Hairs of* Aralia papyrifera. By Professor BALFOUR.

4. *Notice of the Results of three days Botanizing in the neighbourhood of Totworth Court, Gloucestershire.* By Professor BALFOUR.

5. *Notice of the Stoppage of a Water Pipe by the Roots of a Tree.* By JOHN DUNCAN, Esq. Communicated by Professor BALFOUR.

In a field at Burnhead there is a large reservoir, and from this water is conveyed in a leaden pipe for some distance to a well, the water of which is drawn up by a pump. In the course of last autumn no water could be drawn from the well, and on examination the bottom of it was found to be dry, and filled with an enormous matting of roots. These roots had also penetrated into the leaden pipe, and filled it up completely, so as to prevent the water from flowing. On cutting through the pipe and pulling out the roots, which were very firmly impacted, the water flowed in abundance. The roots were traced by Mr Duncan to a sycamore tree (*Acer Pseudo-platanus*) growing near the well.

6. *On a Method of Preserving Plants in their Natural Form, and with the Colour of the Flowers.* By Messrs REVEIL and BERJOT. Communicated by Professor BALFOUR.

7. *On* Callitriche hamulata *of Kutzing, found near Jardine Hall.* By F. TOWNSEND, Esq. Communicated by Sir WM. JARDINE.

The plant was gathered in a ditch communicating with the river Annan, close to Jardine Hall. Mr Babington has decided that it is the plant described in his Manual as *C. pedunculata*, var. *sessilis*. The important character in *C. hamulata* is the falciform bracts. These fall off early, and were not noticed by Mr B. in ordinary wild specimens. He has, however, of late observed them in cultivated specimens of his *C. pedunculata*, var. *sessilis*. Mr B. considers *C. hamulata* as the type of the species, and *C. pedunculata* to be a variety.

8. *On Garden Plants found in Waste Ground near Falmouth.* In a Letter from Mr W. P. COCKS to Professor BALFOUR.

Thursday, 11*th December* 1856.—Professor BALFOUR, V.P., in the Chair. The following Communications were read:—

1. *Description of a Method of Preserving Plants of their Natural Form and Colour.* By THOMAS R. MARSHALL, Esq.

The plant to be operated on should be placed in a box, in such a manner as to preserve the natural disposition of its parts. The fine sawdust (perfectly dry) of box, or other hard wood, is then to be carefully sprinkled over it, taking care not to shift the position of the leaves. Every part of the plant must be completely covered with the dust. Several plants may be dried in one box—avoiding contact, however. The plants to be preserved ought to be quite fresh when put into the box; if they be lax, place the stems in water till the vessels again distend and recover their natural firmness. About a fortnight in the dust is sufficient to dry the plants in summer (in a natural heat); succulent plants require longer. To assist in freeing the plants from the sawdust, the box may be made with a wire grating and sliding bottom; slightly shake the plant to free it from the dust; what still adheres may be brushed off with a soft hair pencil.

2. *On the Species of Pine called in Moffat "Dr Walker's Pouch Fir."* By Professor FLEMING.

3. *Notes on some new Species of Marine Diatomaceæ from the Firth of Clyde.* By Professor GREGORY.

4. *Notice of Hepaticæ, found near Aberfeldy.* By JOHN LOWE, Esq.

Thursday, 8*th January* 1857.—Professor BALFOUR, V.P., in the Chair. The following Communications were read:—

1. *On the Production of Ergot on Rye.* By KENNETH CORBET, Esq., Beauly. Communicated by Dr DOUGLAS MACLAGAN.

The author noticed the occurrence of ergot on rye in the neighbourhood of Beauly, and stated that he found that this native ergot was more certain in its medical action than that imported from the Continent. He expressed his opinion that the production of ergot was connected with an abortive condition of the pollen, whose application to the stigma did not result in the development of an embryo. He found that by cutting off the stamens in the early stage the ovary became liable to an attack of ergot.

2. *On a Monstrosity in the Fruit of* Silene inflata, *with some Remarks on Placentation.* By A. DICKSON, Esq.

Mr Dickson exhibited a specimen with partitions in the ovary. He considered that the specimen he produced went to support the view of central placentation in all cases, as suggested by Schleiden.

3. *Notice of Plantain Flour.* By MURRAY THOMSON, Esq., late Assistant in the Laboratory of the Industrial Museum of Scotland. Communicated by Professor GEORGE WILSON.

4. *Analyses of Three Australian Wines.* By MURRAY THOMSON, Esq. Communicated by Professor GEORGE WILSON.

5. *On the Injurious Effects of* Uroceras gigas *on Fir Trees.* By the A. THOMSON, Esq., Banchory.

The author stated that last summer his forester had observed a Scotch fir tree, about thirty-five years old, die very suddenly. The tree was cut down and taken to the saw-mill. During the preparation of the wood a large fly was observed in a burrow in the wood. Subsequently another fly, a grub, and the remains of a cocoon were seen. The insect was examined, and found to be the *Uroceras gigas.* It has been rarely noticed in Scotland. It appears, however, that in Germany it often causes great destruction in the forests. If there be any appearance of the insect spreading in this country, it would be well to draw further attention to it, so that every tree showing symptoms of it might be destroyed. This is the only remedy found of use in Germany, where they say hundreds of acres have been sacrificed on one estate after another, with the view of checking its progress. Specimens of the timber and of the insect were exhibited, along with a piece of foreign timber containing a grub of a similar nature.

6. *On the Occurrence of the Seeds of Bearded Darnel in Inferior Samples of Wheat.* By GEORGE S. LAWSON, Esq.

7. *Notes on* Pinus cephalonica, *and other Coniferæ, at Craigo House, Montrose.* By Mr P. S. ROBERTSON, Golden Acres.

Thursday, 12th February 1857.—Professor BALFOUR, V.P., in the Chair.
The following Communications were read:—

1. *Notes of a Botanical Excursion to Switzerland and other parts of the Continent during last summer.* By Mr R. M. STARK.

2. *List of Plants observed in the Neighbourhood of Blackford, Perthshire.* By Mr ALEX. BUCHAN.

3. *Notice of the Plants of Mount Olympus.* By Dr JOHN KIRK. *With an Account of the Ascent of the Mountain, and Observations on the Country near Broussa.* By Dr DAVID CHRISTISON.

Thursday, 12th March 1857. The following Communications were read:—

1. *Notice of a Botanical Trip to Moffat and the Mountains in its vicinity, in July* 1856. By Professor BALFOUR.

2. *On an Abnormal Development of the Nectary in Ranunculus.* By A. J. MACFARLAN, Esq.

3. *Notice of* Chara syncarpa *new to Scotland.* By W. NICHOL, Esq.

4. *Remarks on Boucherie's Method of Preserving Timber.* By Professor BALFOUR.

5. *Recent Botanical Intelligence.* By Professor BALFOUR.

Thursday, 9th April 1857.—Professor BALFOUR, V.P., in the Chair.

Mr I. Anderson, S.S.C., exhibited a plant of a hybrid Rhododendron between *R. atrovirens* and *R. formosum*, which was stated to be quite hardy, being chiefly remarkable for its large blossoms, which were triple the size of the seed-bearer (*R. atrovirens*).

The following Communications were read:—

1. *On the Effects of a Solution of Bicarbonate of Ammonia, in promoting Vegetation.* By C. J. BURNETT, Esq.

2. *Does Magnetism Influence Vegetation?* By H. F. BAXTER, Esq. Communicated by Professor BALFOUR.

The author states that the results of his inquiry into this subject are negative, that is, no positive evidence has been obtained to show that magnetism either does or does not influence vegetation. After noticing the opinions of Becquerel, Dutrochet, and Wartmann, the author says :—"As it may be considered a law in vegetable physiology that all plants have a tendency, during the germination of their seeds, to develop in two diametrically opposite directions (the root and the stem), the question arose—might not this direction be influenced or counteracted by submitting the seeds whilst germinating to the influence of magnetic force." Accordingly, a series of experiments were undertaken by the author, which are classed under two principal heads: 1*st*, Those in which the line of magnetic force was directed *perpendicularly* to the plants; and 2*d*, In which the line of force was directed *transversely* to the plant. The author gave details of the experiments, which were varied and multiplied. No definite conclusions, however, could be drawn from them relative to the effect of magnetism.

3. *On* Lycium mediterraneum. By Dr THOMAS ANDERSON, H.E.I.C.S. Communicated by Professor BALFOUR.

Dr Anderson states that, after careful and repeated examination of specimens of *L. Edgeworthii*, Dunal, he is convinced that Dunal's so-called species is only a variety of *L. mediterraneum* (*L. europæum*, Linn.). Dr Anderson then gives revised characters for the species, and concludes with observations on the effects of the climate of India in modifying the habits of plants, and giving rise to numerous varieties.

4. *On the Applications of Botany to Ornamental Art.* By Mr GEORGE LAWSON, F.R.P.S.

Mr Lawson exhibited a panel carved by Mr B. Reeve, representing in its side ornaments *Polypodium alpestre* and *Polystichum Lonchitis*. In connection with this study from nature, he called attention to the inexhaustible source of novelty in design which the vegetable kingdom presents, and which he hoped would be made more fully available than hitherto.

5. *Remarks on Dust Showers, with Notice of a Shower of Mud which occurred at Corfu on* 21*st March* 1857. By Mr GEORGE LAWSON, F.R.P.S.

Mr Lawson remarked :—The attention of botanists has at different times been attracted to showers of various kinds, most of which have been more or less dependent upon, or connected with, vegetable phenomena. The red snow of the Arctic Regions, which has been known since the days of Aristotle, owes to botany its proper explanation as not a product of the clouds at all, the appearance being due to a minute algæ that vegetates on the surface of the snow. Showers of pollen are familiar to all travellers who have penetrated far among the coniferous forests of North America. In this case also, although the pollen forms immense clouds of dust, and is often conveyed to considerable distances, becoming in its course intermixed with foreign matter, still it can scarcely be referred to as a "shower" in the meteorological sense of the term, the plants to which it owes its origin being present, and connecting the phenomenon more or less closely with what occurs to a certain extent in all flowering plants. Of a different character are the showers of dust or sand described by Humboldt and by Ehrenberg as occurring near the Cape de Verde Islands, at a distance of several hundred miles from the African coast, where the decks of ships navigating the ocean became covered with it.

In this dust many minute organisms, especially diatomaceæ, have been found. Mr Lawson then noticed a shower of mud that occurred in the Island of Corfu about a fortnight ago, the particulars of which are contained in the following letter from Mr Mackenzie :—

"A singular meteorological phenomenon occurred here on Saturday, 21st March. The day was squally and showery; those light showers brought down a great quantity of mud; the next morning I found the cauliflowers covered over with this fine dust. On examining the surrounding fields I found the trees and every other object covered in the same manner. As some writers have asserted, and others have denied, that the same phenomenon is of frequent occurrence in Malta, I send you a few leaves with the precipitate still upon them, which will, I think, put the question to rest for ever. The second question is more difficult to solve; namely, is this native dust, or has it been imported by aerial currents from Africa? From the state of the weather during the three previous days, I am led to favour the latter opinion, and forward an extract from my meteorological register.

"Dr Calla tells me that he remembers something of the same kind when a boy, about forty years ago.

Date.	Thermometer.		Barometer.			Wind.
	Max.	Min.	8 A.M.	3 P.M.	8 P.M.	
March 18, . .	60	52	30·11	30·09	30·09	W.S.W.*
March 19, . .	59	50	30·10	30·10	30·09	S.E.†
March 20, . .	60	51	30·05	29·99	29·94	S.E.‡
March 21, . .	59	51	29·81	29·80	29·81	S.E.§

* Overcast and calm. † Densely overcast.

‡ Gloomy and threatening—high wind in the night.

§ Squally and showery throughout the day and night, and with yesterday's rain there fell a great quantity of mud of a dirty red colour; the plants throughout the island are covered with this fine precipitate. This phenomenon is said to be of frequent occurrence in Malta.

"Corfu, 25th March 1857."

Observations of the barometer, &c., as registered by Mr Cockburn at the Royal Society's Rooms, were laid before the meeting for comparison.

6. *Registering of the Flowering of certain Spring Plants in the Royal Botanic Garden, Edinburgh, from 12th March to 15th April* 1857, *as compared with the five previous years.* By Mr James M'Nab.

Thursday, 14*th May* 1857.—Professor Balfour, V.P., in the Chair. The following Communications were read :—

1. *Notice of Two Cases of Poisoning with the Seeds of* Thevetia nereifolia. Communicated, with remarks, by Dr Douglas Maclagan.

The history of these cases, which occurred in India, was furnished by Dr John Balfour, H.E.I.C.S. The symptoms were narcotico-irritant, the irritant character predominating, and the somnolence and other cerebral phenomena being, in Dr Maclagan's opinion, probably as much those of exhaustion as of true narcotism. There was vomiting of a peculiar character. The letter narrating the cases contained portions of the plant sufficient to enable Dr Maclagan to identify it as *Thevetia nereifolia*, Juss. (*Cerbera Thevetia*, L.) This plant, now naturalized in India, appears to have been introduced probably from South America. Dr Maclagan had compared the *Thevetia nereifolia* of the Indian collections with the *Cerbera peruviana* of Mathew's catalogue, and had no doubt of the identity of these plants, which are given as synonymous in Decandolle's Prodromus.

2. *Account of the Insect which infests the Seeds of* Picea nobilis. By Andrew Murray, Esq., F.R.S.E.

This beautiful silver fir (the *Picea nobilis*) was first introduced into this country from the north-west of America, by Douglas in 1831. In what state the seed sent by him arrived here I have been unable to ascertain with perfect accuracy. The fact that plants of an age corresponding to that period are exceedingly rare would seem to indicate either that the quantities imported by Douglas were less than we have reason to suppose, or that from some cause or other they had not been productive. On the other hand, Professor Lindley informs me that he never heard that Douglas's importations were in any way attacked by insects, and that the Horticultural Society of London raised what he sent home without anything of the kind being observed; and I am informed by my friend Mr M'Nab, that the cones sent by Douglas, which have been preserved as specimens, show every symptom of having been perfectly sound. No second importation of seed to this country was made in any quantity till Jeffrey sent home some packages in 1852. These proved all bad, and apparently had suffered from the ravages of an insect. Mr Beardsley and my brother next sent home a quantity in 1854, along with the seeds of other pine trees, some of which proved new. In an account of their expedition, and of the novelties discovered by them, which I had then the honour of reading to this Society, I noticed the fact that, in almost every cone of *P. nobilis*, the seeds were being eaten by a small caterpillar. My brother had found these caterpillars in the green as well as in the mature cone, their eggs evidently having been deposited in the kernel while the cone was yet soft, and easily penetrated. One or two subsequent importations of seed (the last a very large one, made last autumn on behalf of the Oregon Botanical Association), proved to be also to a greater or less extent infested by an insect. From these importations I have bred the insect, and find that it belongs to the genus *Megastigmus*, one of the *Chalcidites*, a family of the so-called Ichneumon flies.

3. *On the supposed influence of the Moon on Vegetation in Peru.* By Archibald Smith, M.D.

4. *On some of the leading plants of the lowest zone in Teneriffe.* By Professor C. Piazzi Smyth.

The author described the manner and characteristics of growth of the chief plants as met with advancing from the sea-coast inland, and found both the indigenous and the cultivated plants to exhibit a poverty of growth as compared with many other lands in the same latitude, or 28.° The cause of this, he thought, was owing to the special predominance of the Trade-wind throughout the Archipelago of the Canaries during the whole of the summer season, and to the want of rain, and the low temperature which the said wind produces, both primarily and secondarily. In the details of the native plants, the author treated at length on the *Dracæna Draco*, as being, *par excellence*, the characteristic plant of the lowest zone of Teneriffe, and having in one of its specimens, the Great Dragon Tree of Orotava, acquired more fame than any other individual specimen of the vegetable kingdom; and he concluded with an exhibition of the forms of the Dragon tree at different ages, and other Teneriffe plants, optically projected on a screen 8 feet square, from photographs of which the original negatives had been prepared by himself last summer, and positive copies had been made with much skill and success by M. Orange in the course of the winter.

Professor Balfour read the following analysis of specimens of volcanic sand from the Andes, sent by Professor Jameson, of Quito, and analysed by Mr Bloxam, assistant in the Industrial Museum:—By qualitative analysis it appears to be composed of silicic acid, peroxide of iron, alumina, carbonate of lime, and small quantities of potassa and soda. A stream of carbonic acid passed through water, in which the sand was suspended, dissolved out much carbonate of lime. The sand contains small quantities of the protoxide of iron. Its quantitative composition is as under:—

Silica,	68·00
Peroxide of iron, and alumina,	21·20
Carbonate of lime,	9·10
Magnesia and alkalies,	1·70
	100·00

SCIENTIFIC INTELLIGENCE.

ZOOLOGY.

Distribution of American Turtles.—At a recent meeting of the Boston Society of Natural History, Professor Agassiz stated that he had been engaged in an investigation into the Geographical distribution of the Turtles of this country. For a correct determination of specific differences, it became necessary to collect specimens from all parts of the country as extensively as possible, and he thinks he has obtained specimens of nearly all the species existing in North America, and that he has been able to trace their geographical distribution very completely. The results to which he has arrived show this fact, that several species which have been supposed identical throughout their whole geographical range, are now demonstrated to be really distinct; whilst others which have been described as different species, the young alone in some instances having served for description, have been found to be one and the same. He particularly called attention to the danger of describing species solely on theoretical grounds as different, because they inhabit different parts of the world, or as identical from general resemblances. Dumeril and Bibron in their work on Herpetology, and others, have attempted to identify marine turtles of different waters without sufficient authority. Professor Agassiz had taken particular pains to inquire about the Sphagis or Leather-backed Turtle, which is found from the West Indies, northward, and which has been taken at Cape Cod. This animal has been said to inhabit the Mediterranean, but after a thorough investigation he can find only seven or eight instances recorded of its having been found there. The museum at Salem furnishes an opportunity for distinguishing between the Imbricata of the West Indies and that of the Indian Ocean, which have been considered the same. Holbrook describes the Tryonix of Georgia as existing in the Northern Lakes, and he traces the exact course by which it could ascend along the coast and up the Mississippi river to the lakes. But Professor Agassiz finds that there are four different species in the United States, three of which are to be included in the one species of Holbrook, and that each species has its own limited locality.

The Chelidra, or Snapping Turtles, have the most extensive geographical range of any of the Chelonians. The snapping turtle of Massachusetts is found in South Carolina, Alabama, Louisiana, Missouri, and even at the head waters of the Osage.

Of the family of Emydæ, *E. Blandingii* is the true type. The swimming Emydæ are either southern or western species; there are none in new England except those which have only a limited power of swimming.

Emys oregonensis was described by Nuttall as existing west of the Rocky Mountains. Professor Agassiz doubts its existence west of the

Rocky Mountains, because no turtles have been found in those high regions lying between the Rocky Mountains and the Sierra Nevada. Upon the Alleghanies turtles have been found at a height of eleven hundred feet only, and there are no indications of their existence above this height. He has had two specimens from localities east of the Rocky Mountains, one of which was brought from Minnesota. He thinks Mr Nuttall's specimen must have come from this side of the mountains.

Professor Agassiz concluded that there is no general law regulating the distribution of the chelonians of North America. They are distributed through four grand divisions of the country, a north-eastern, a southern, and a Pacific range. The facts of their geographical distribution are now well established, but the reasons are by no means evident at present. The probability is, that different individuals of the same species of animals are adapted by peculiar organizations to different climacteric influences, and that there is no general law of distribution for which physical agents can account.—(*Wells's Annual of Scientific Discovery for* 1857.)

Resistance of Insects to Influence of Cold.—Dr Wyman, at a recent meeting of the Boston Society of Natural History, stated that he had examined chrysalids of the common mud wasp, a species of Pelopæus, and found that they were not frozen during the coldest weather. On the morning of February 7th, when the thermometer had been $-18°$ Fahr., and had risen to about $-8°$ Fahr., they were still unfrozen, and when removed from their pupa cases, made obvious muscular motions. The pupa preserved its usual transparency and flexibility; when crushed upon the surface upon which they rested, the fluids of the body instantly became opaque and were congealed. The question naturally presents itself, as to the source of the heat which enables them to preserve their temperature when exposed to so low a degree of cold. The non-conductors by which they are surrounded consist of a casting of mud, and within this a tightly woven, but thin, silky cocoon. It would seem that so small a body, exposed to cold so intense, must have an internal source of heat. He had also examined the eggs of the moth of the canker-worm, and found their contents unfrozen.—(*Wells's Annual.*)

BOTANY.

Senegal Gum, according to Soubeiran, is of two kinds; the *Hard Gum from Galam*, and the *Friable Gum or Sadrabeida.*

The *Hard Gum, from Galam*, or from below the river, consists of exudation from the bark of two closely allied species of *Acacia*, the *A. Verek* (Flor. Seneg. Tentam.), and the *A. Neboued* (id.). As their origin is different, so these substances are not exactly alike. The gum of *Acacia Verek* is white, wrinkled, and dull externally, glassy within, "in the shape of tears, often vermicular and twisted, but generally ovoid or spherical, two inches, often less, in diameter, with a slight and agreeable flavour, accompanied by a little acidity, which is scarcely observable but by those who habitually use it." It is perfectly soluble in water, and affords a much clearer and thinner mucilage than that of Gum Arabic: it reddens litmus-paper, though less than gum does. The *Acacia Verek* is a tree of middling stature, 18–24 feet high at most, much ramified, the branches twisted and armed with numerous sharp-pointed thorns: the wood is hard, the bark grey, and from the latter the gummy liquid naturally exudes, which becomes hard in from twenty to thirty days. It is more abundantly diffused, and forms thicker forests on the right bank of the river than the left, growing in Senegal, all round Saint Louis, in Oualo and Ghioloff, and in the country of the Moors, to the confines of the Sahara Desert, as far even as the shifting sands which extend to Cape Verd. In all these localities it is associated with the *Acacia Ne-*

boued (the *Mimosa Neb-neb*, and Red Gum-tree of Adanson), which chiefly differs from *A. Verek* by its redder gum, which is almost always formed in round balls, from half-an-inch to an inch in diameter, transparent, and slightly bitter-tasted. The *Neboued Gum*, which dissolves perfectly in its own weight of water, also forms a much thicker mucilage than the *Verek*, and colours litmus-paper very little.

The *Senegal Gum* is chiefly collected by the nomade Arabs of the Southern Sahara, who call themselves Bedaouins (wanderers), but whom the Colonists name Moors. A few quintals of the substance are very occasionally brought by the Negroes of Oualo and Ghioloff, who inhabit the left bank of the river: the first are a most apathetic race, and the latter, who offer a remarkably fine sort of gum, are much debarred from entering the market by the Moors, who are jealous of their neighbours, and who seek to monopolize the trade in gum.

There are several distinct tribes of Moors, who devote themselves to the collecting of gum, and each claims and explores its own peculiar oasis or forest of gum-trees. The best gum is obtained from the Oasis of Sahel, where hardly any tree grows but *Acacia Verek;* the tribe called Trarzas owns this forest. An inferior article is produced in the Oasis of El-hiebar, which consists more of *Acacia Neboued* than *A. Verek;* it is in the possession of a very numerous family of Marabouts. Again, a still less valuable gum, called *Gonakie*, comes from the Oasis of El-Fatak; while scattered bands of Arabs collect small quantities of gums, of greater or less value, in remote spots, far from the river.

The *Ghioloff Gum*, which comes in very small quantities, is infinitely the finest, the purest, and clearest, with a bright surface, a glassy, almost crystallized fracture, and in large bits. The Moors are so averse to its exportation, that it is only obtainable as a sort of contraband article.

The *Bondou Gum* is very often mixed with the *Galam Gum*, is difficult to be distinguished by sight alone, and baffles the eye of experienced traders, but is recognized by its bitter flavour. It is the produce of an *Acacia*, near *A. albida.*

The *Gonaké* or *Gonaté Gum* (so called from the tree which yields it, and to which the natives give that name) is collected abundantly in the Oasis of El-Fatak. It is redder than the other gums; but the facility with which it is dried and pulverized affords an easy mode of adding it to the better sorts and adulterating them; and the Moors thus habitually increase the volume and weight of the more saleable gums. The taste alone detects its presence, for it is very bitter. It exudes from *Acacia Adansoni* of the *Senegal Flora* (*Mimosa Gonakié*, Adanson).

The *Friable Gum*, or *Sabra-béida* (corrupted into Salabréda), is offered in the form of a coarse salt; its fracture is glassy, the surface always dull and often wrinkled, and it is found either in rounded tears, or in long, vermicular fragments; the flavour is always rather bitter. Its different colours, whitish, red, green, and yellow, depend on the age and strength of the gum tree which affords it; the more or less sandy nature of the soil has also a marked effect. It melts readily in its own weight of water, and forms a thin mucilage, which slightly reddens litmus-paper. January, February, and March are the times when it is collected, in the forests not far from Bakel; and it is sold by stealth, by the Moors, and as fast as they can gather it, for it will not bear to be buried, like the Gum of *Acacia Verek.* It is produced by an *Acacia*, nearly allied to *A. albida:* the tree is very thorny, much smaller than *A. Verek*, and grows in the sands of the Sahara, near Galam, on the right bank of the river. The white bark gives it the name of *Sabrabéida* (the White Tree); its gum is very inferior to the hard gum, and is never vended at St Louis, except when the harvest of hard gum fails. (*Hooker's Journal of Botany*, Feb. 1857).

Anacharis Alsinastrum.—This plant, according to Caspary, is *Serpicula occidentalis* of Pursh, a species which is not found in Europe, nor anywhere in the Old World. It is common in temperate and tropical America, and has been introduced into Britain.—(*Botan. Zeitung*).

Cajuput Oil.—The green colour of the oil of *Melaleuca Cajeputi* according to Reinwardt, is said to be due to the copper vessel from which it is distilled.—(*De Vriese, Pl. Bat. Orient.*)

Parthenogenesis.—Naudin has lately confirmed the views of Bernhardi and others relative to Vegetable Parthenogenesis, or the production of fertile seeds without the contact of pollen. He performed experiments on the pistilliferous plants of Hemp and Bryony, as well as on plants of *Ecbalium Elaterium* and *Ricinus communis.*—(*Comptes Rendus*, 1856.)

Pinea de Terra of Spain.—Dr A. Harvey of Southampton writes, "I send you a small parcel of the seeds of a species of Pine which grows in Spain, and is just now attracting the notice of our railway companies,—its timber being singularly hard and heavy, and, as far as appears, remarkably durable.

"The comparatively short time that ordinary *sleepers* last, and the necessity there is for constantly renewing them, makes the annual charge, on the side of working expenses, in the item of sleepers alone, a very heavy one to our railway companies. And, if it be true, as I am told it is, that, over the kingdom generally, as many as six or seven millions of sleepers are required annually for the purpose of mere replacement, it is plain that, should sleepers made of this Spanish Pine last anything like twice as long as ordinary sleepers do, the saving to the railway interest would be enormous.

"But however this may be, these Spanish sleepers are at this moment commanding a high price in the market, and so eagerly are they sought after, that it is difficult at present to supply them largely enough to meet the demand.

"There are, I understand, vast forests of this kind of Pine growing in Spain, particularly in the neighbourhood of Bordeaux. It is called in the country *Pinea de Terra*, but is, I suppose, the maritime variety of the *Pinus Pinaster.* It is so hard that it cannot be creosoted ; and it is said that, by burying the cut timber in the moist sand on the sea-shore (which they are in the way of doing in Spain, at low water), its density is so increased after some weeks' or months' immersion there, as to render it almost imperishable, and make it incapable of being sawn or planed."

Berkeley's Introduction to Cryptogamic Botany is a most elaborate work, containing a full account of the structure and arrangement of Cryptogamic plants. It supplies a want which has been much felt of late in Britain. The work is well worthy of the distinguished author. It is intended, however, only for those who have already acquired some general knowledge of botany. There is the want of a table of contents which would certainly have been a most valuable addition. After giving some introductory remarks on the relation which cryptogams bear to other plants, the author proceeds to give a minute account of the structure and physiology of the Order. He considers the plants under the two divisions of thallogens and acrogens. The former are defined as mostly herbaceous, or provided with foliaceous appendages ; foliaceous appendages, if present, destitute of stomata. Spores rarely producing a prothallus ; and if so, giving rise to a second order of spores germinating at definite points. Spermatozoids not spiral. The latter are defined as mostly herbaceous, and provided with distinct, often stomatiferous foliaceous appendages. Spores for the most part producing a prothallus, or if not, complicated fruit, by means of the impregnation of an embryonic cell; spermatozoids spiral. There is at the end a list of some of the most useful works, and memoirs relating more or less to cryptogamic botany in general, and its several branches. The work is one which ought to be in the hand of every botanist who wishes to know the state of cryptogamic botany at the present day.

Schleiden's Handbuch der Botanischen Pharmacognosie has been published at Leipzig. It is a useful work for those who are studying the botanical character of vegetable products used in pharmacy. There are eighty-two woodcuts, showing forms and structure of roots, stems, leaves, fruits, starch, &c.

Dr Asa Gray's First Lessons in Botany and Vegetable Physiology.—This excellent popular work is intended for schools. It is illustrated by upwards of 366 wood engravings, from original drawings by Isaac Sprague, and there is a copious glossary or dictionary of botanical terms.

Dr Asa Gray's Manual of the Botany of the Northern United States, 2d edit.—This work contain descriptions of the United States plants, and ought to be in the hands of every one who wishes to study the northern flora of the States. It is drawn up by an eminent botanist, thoroughly competent for the task. The mosses and liverworts are described by Wm. S. Sullivant, a well-known cryptogamist.

Mr Sullivant's contribution has been also published in a separate form.

Phycologia Australica. By Dr Harvey.—This work has been announced as preparing for publication. It is to contain figures and descriptions of Australian seaweeds.

An illustrated work on the marine botany of Australia, on the plan of the "Phycologia Britannica," will, it is thought, be acceptable to algologists generally, and especially to those who possess a share of the duplicate specimens of Australian algæ distributed by Professor Harvey. Materials amply sufficient for a much more extensive work than that now contemplated have been collected in Dr Harvey's recent tour; but it is thought that a sufficient illustration of the subject may be given by publishing a selection of three hundred of the more characteristic and remarkable species. This number will allow for the full illustration of all the genera, and of the principal sub-types comprised within each genus.

Filices Exoticæ.—Messrs Reeve announce the intended publication of this work by Sir W. J. Hooker. It will contain figures and descriptions of exotic ferns, particularly of such as are most deserving of cultivation.

The drawings and lithographic plates will be executed by Mr Fitch, who is acknowledged to stand unrivalled as a botanical artist; and Sir William Hooker has undertaken to edit the work, and to furnish the descriptive matter. The Royal Gardens of Kew would in themselves afford ample materials for such a work, as the late catalogue of genera and species prepared last year by the able curator, Mr Smith, abundantly testifies, although the *Lycopodiaceæ*, or Club Mosses,—plants of exquisite beauty long supposed to be of difficult cultivation, but now amounting to numerous species in our collections,—are there excluded; and it is well known that no section of the fern-kind requires more accurate illustration, and that none is more difficult to determine.

CHEMISTRY.

Artificial Formation of Sapphires. By M. Gaudin.—Twenty years since M. Gaudin obtained artificial rubies by fusing ammoniacal alum before the oxyhydrogen blowpipe, with the addition of a small quantity of chromate of potash. He has now succeeded in preparing perfectly isolated and colourless crystals of alumina in the form of the sapphire. For this purpose he introduces into a crucible, lined with charcoal, equal weights of alum and sulphate of potash, both previously calcined and reduced to a fine powder, and exposes the crucible for a quarter of an hour to the full heat of a forge. When the crucible is broken, the crevices of the lining are found to contain a mass consisting of sulphuret of potassium, through which are disseminated the crystals of alumina. The mass is treated with dilute *aqua regia*, and the crystals left in the form of a fine sand, which is well washed with water. The crystals vary in size, according to the mass of the materials employed and the duration of the heat; those obtained by M. Gaudin, operating on a small scale, were about a millimetre in length. They are colourless, because in this process any metallic oxides which may be added for the purpose of imitating the natural colours of the sapphire are reduced by the charcoal. They are extremely limpid, and surpass natural rubies in hardness. The formation of those crystals depends on the solvent action of the sulphuret of potassium, and by means of this substance, as well as by the chlorides, fluorides, and cyanides, M. Gaudin thinks it will be possible to obtain many other insoluble substances in crystals.—(*Comptes Rendus*, vol. xliv., p. 716.)

Occurrence of Fluorine in the Mineral Waters of Plombieres, Vichy, and Contrexéville. By M. Nickles.—According to M. Nickles, these waters all contain fluorine, the first two in very small, the latter in larger quantity. Its presence was determined by treating the solid residue with pure sulphuric acid, and allowing the vapours of hydro-fluoric acid to act on plates of rock-crystal. He states that, in making such experiments, plates of glass must be rejected, as they are corroded by sulphuric acid, and that even when rock-crystal is employed, it is necessary to purify the sulphuric acid with silica, in order to expel traces of hydro-fluoric acid, which he says are usually found even in the distilled acid.—(*Comptes Rendus*, vol. xliv., pp. 679 and 783.)

A New Oxide and Chloride of Silicon. By M. Wöhler.—When silicon is exposed to a current of dry hydrochloric acid gas at a low red heat, hydrogen gas is evolved along with a new chloride of silicon. It is a liquid forming in the air, and more volatile than the ordinary terchloride. Water decomposes it, yielding hydrochloric acid, and new oxide in the form of a white powder, scarcely soluble in water, but very soluble in the alkalies,—even in ammonia, hydrogen gas being disengaged, and silicic acid produced. Heated in the air, it catches fire and burns with a white flame.—(*Comptes Rendus*, vol. xliv., p. 824.)

On the Existence of Circular Polarization in Cinnabar and Sulphate of Strychnine. By M. Descloizeaux.—It is well known that rock-crystal is the only mineral in which circular polarization, and the remarkable connection between this property and the position of the plagihedral faces, has been observed. As far as hitherto known also, circular polarization is confined to singly refracting crystals, or crystals with only one axis of double refraction. M. Descloizeaux has now detected this property in cinnabar, which very closely resembles rock-crystal in this respect, for he has found both right and left handed crystals, as well as compound crystals, producing the phenomena observed in amethyst and the Brazilian rock-crystal. Its rotatory power is much more considerable than that of rock-crystal, for he found that a plate 0·2 millimetres in thickness produced a rotation of 54° to 60°, while

Biot ascertained that a millimetre of rock-crystal rotates only 18°. The rotatory power of cinnabar is therefore about fifteen times as great. It is worthy of notice, that in the very complete crystallographic examination of cinnabar made by Schabus in 1851, no mention is made of plagihedral faces ; but as these might easily have been overlooked, M. Descloizeaux resolved to make a more minute examination of its crystallographic forms. The anhydrous sulphate of strychnine also possesses circular polarization, but only left-handed crystals have as yet been observed ; its rotating power is 1·5, that of rock crystal being 1.—(*Comptes Rendus*, vol. xliv., pp. 876, 909.)

GEOLOGY.

Tertiary Fauna of Greece—The Pikermi Fossils.—In September last a collection of fossils was brought to Paris from Greece by Messrs Larte, and Gaudry, and described in a memoir submitted to the Academy of Sciences. They were found at Pikermi, a village twelve miles E.N.E. from Athens (supposed by Major Leake to occupy the site of the ancient Attic Demus Epacria). It stands at the south-east foot of Pentelicus, in a ravine cut by streams descending from that mountain, and about four miles from the Ægean Sea. The collection is remarkable for the singular variety of species it includes, of which a few were mentioned, viz :—Semnopithecus, a monkey ; a hedgehog, or perhaps castor ; two giraffes, one taller than the living species ; a huge edent quadruped, resembling the sloth in form, named by them *Macrotherium Pentelicum*, as large as an elephant ; with various bones of gallinaceous birds ; but no fishes or reptiles. They consider the deposit as intermediate between the Molasse and the Subappenine marls—miocene or lower pliocene.

The fame of these fossils had also spread to Germany, and Dr Roth, a Bavarian, after spending many months in exploring the deposit, has brought home a rich collection of the bones, which are described by himself and M. Wagner in a report to the Royal Academy of Munich. They make a large addition to those above named, including remains referable to no less than nineteen distinct species of quadrupeds. The monkey, in Dr Roth's opinion, is not the Semnopithecus, but an animal intermediate between that and the gibbon. He found five species of carnivora—1. A viverrine, which he has named *Ictitherium ;* 2. A glutton, *Gulo Primigenius ;* 3. A hyæna (*H. eximia*) ; 4. A wolf, smaller than the living European one ; 5. A leonine animal, *Machœrodus*, larger than the living lion or tiger ; 6. A rodent, *Lamprodon* (beaver) believed to be a hedgehog by Lartet ; 7. An edent, the *Macrotherium* previously mentioned ; 8. The *Hippotherium gracile*, or ancient horse, whose bones were so abundant as to enable Dr Roth to construct a complete skeleton ; 9. Three jaw-bones of an animal termed *Hipparion*, a doubtful species, supposed to have been a three-toed horse ; 10. *Sus Erymanthus*, a hog larger than the wild boar ; 11. The femur of a *Mastodon ;* 12. Part of a cranium with five teeth of a rhinoceros. Of ruminant animals there are the remains of five species of antelopes, a goat, and an ox (*Bos Marathonius*) larger than the bison. Of the nineteen species of extinct animals exhumed from this rich deposit, thirteen are considered new. Dr Roth met with no bats or insectivora, and Lartet and Gaudry, as already stated, found no fishes or reptiles. The bones were much broken, and no complete skeleton was found with all the parts united.

Now, this singular assemblage of bones was found at the foot of Pentelicus, on the south side, at a point where several streams unite, just in the position where we would expect to find them if the animals had lived and died on the mountain, and left their spoils to be swept down by rains and torrents and buried in the mud and sand they brought with them. Is this, then, a picture of the fauna of Attica towards the end of the tertiary period—thousands of years before man existed? Were races so dissimilar denizens of the mountain at the same time? Did the giraffe, the monkey, the horse, the ox, the goat, the antelope, the hog, dwell in company with the mastodon, the rhinoceros, the lion, the wolf, the hyæna?—and upon a single mountain of very limited extent? In Major Leake's map of Attica, Pentelicus is only nine or ten miles long, its breadth cannot exceed three miles, and its height, if our memory may be trusted, does not exceed 3000 feet. In the living world are there spots where a fauna so diversified and heterogeneous exists within so narrow a space—narrow even if the animals belonged to all Greece? Does it not look rather like a group collected from different countries and different climates? This is, in reality, the conclusion to which Messrs Lartet and Gaudry arrived. Founding on the apparent improbability of so many and such gigantic animals living on a peninsula so narrow as Greece, and so intersected by elevated chains, they have been led to suppose that the Greece of our days and its isles are only the *debris* of a great continent (which they term Greco-Asiatic) now buried under the waves of the Archipelago and the Mediterranean. It was in this state when the hippurite limestone (a member of the chalk formation) was deposited, and afterwards the nummulitic or lower tertiary. The whole was then raised up, forming one continuous range of land with Asia Minor. Upon this land the extinct quadrupeds of Pikermi lived, and here the animals of Armenia, Syria, and Arabia might meet and mingle with those of Illyria and Thessaly. Subsequently, two great lines of fracture, nearly at right angles to each other, shattered this Greco-Asiatic continent, sinking the part of it which forms the Ægean Sea, separating part into islands, and leaving Greece something like the present. A yet later movement, "de bascule," or see-saw, like the two ends of a scale-beam, depressed the southern part of the country under the sea, about the Subappenine period, and forced the land animals to seek refuge in the mountains; those in or near the plain of Athens escaped to Pentelicus, where, cooped up within a narrow space, they perished from insufficiency of food, and their bones, exposed to the elements, were washed down by rains and torrents to the ravine of Pikermi. The bones, with the exception of a monkey, are those of quadrupeds only, because we presume the slow-paced reptiles had not time to save themselves; and no fish are found, probably because the Subappenine sea had not remained long enough at the foot of the mountain to allow the finny tribes to settle and breed.

Few men are so well qualified as M. Lartet by their previous labours to throw light on the problem of the Pikermi bones. We owe to him nearly all our knowledge of the still richer and more varied collection of fossils discovered in the lacustrine deposit at Sansan, close to the north foot of the Pyrenees, which is as great a riddle as that of Pikermi, and not yet solved. From that spot and the adjacent localities of Simorre, Lombez, and Tournan (department of Gers), M. Lartet disinterred no less than ninety-eight genera, subgenera, or species of mammalia and reptiles, a gigantic bird (*Pelagornis*), and some fresh-water fishes. Among the quadrupeds are nearly all those found fossil over the rest of France, and representatives of nearly all the mammalian family—the plantigrade Carnivora, except the bears properly so called, the digitigrade Carnivora, the Edentata, Rodentia, Pachydermata, and Ruminantia, and also a bat and a monkey. Among the genera belonging to these families we have the rhinoceros, elephant, mastodon, deer, antelope, tapir, hog, dog, wolf, civet, marten, hyæna, ox, paleotherium, anoplotherium, and dinotherium. They exceed the Pikermi fossils in variety as much as the Pyrenees exceed Pentelicus in length and breadth. The late M. Prévost, an able geologist, attempted to explain how so many land animals were swept into one small fresh water lake (*Bulletin de la Société Géologique*, 1847-6, p. 338), but D'Archiac, a very high authority, pronounces his explanations a failure.—C.M.

Kidderminster Deposits—Cambrian Rocks—Malverns—Hollybush Sandstone.—We have been informed by the President of the Malvern Natural History Field Club (Rev. W. S. Symonds), that a large annelid, *Trachyderma antiquissima*, Salter, has been detected by Dr Grimshod in these deposits. This gentleman has probably made a still more important discovery in the lower Ludlow shales, but which awaits further investigation.

Kidderminster Passage Beds of the Upper Tilestones into Old Red Cornstones.—The organic remains of these deposits have been determined by Sir P. de Grey Egerton and Mr J. W. Salter.

Fishes— Cephalaspis Lyellii, C. Lloydii,	Old Red fossils.
Crustacea— Pterygotus problematicus, P. Anglicus, Pteraspis Banksii, P. ornatus,	Upper Silurian fossils.
Plants—Very abundant, with Parka decipiens.	

Generalities of the Geology of Northern California and Oregon.—At the Albany meeting of the American Association, Dr Newberry gave a general view of the geology of Oregon and that part of California lying north of San Francisco, and of the age and structure of the three ranges of mountains which, he said, gave character to the topography of the Far West, and of the valleys which lie between them. These "valleys," he said, were rather plains or plateaus than valleys. The Sacramento Valley was a plain lying between the Coast Range and Sierra Nevada—for the most part destitute of trees—through which the river ran with tortuous course, like a brook in a meadow. In the lower part of the Sacramento Valley, there were no rocks older than tertiary; but at the head of the valley he had found the carboniferous limestone—clearly marked by its characteristic basalts, on which were lying the cretaceous and tertiary strata, precisely as on the Upper Missouri.

Crossing the volcanic spur of the Sierra Nevada connecting Mount Shasta with that great chain of mountains, he had descended into the Klamath Basin, which he said formed an appendage to the great basin of the Salt Lake, and was a plain somewhat cut by subordinate ranges of mountains, lying at a considerable elevation, and containing a large number of lakes, of which the Klamath were the most important. This basin was drained through the cañons of Pit river, the largest tributary of the Sacramento, which, like the Klamath river, had forced its way through the mountain ranges which lay between the basin and the sea; Pit river flowing through an impassable cañon nearly an hundred miles in length. The Klamath basin was once to a much greater extent covered by water than now; and before it was so perfectly drained as now, its waters deposited a variety of strata, some of which were as white and fine as chalk, though having a very different composition.

He said further, that the basin or plateau of the Des Chutes was not separated by any barrier from that of the Klamath lakes, and exhibited all its peculiar features still more strongly marked. The Des Chutes basin was a plateau lying between the Cascades and the Blue Mountains, and, with the Klamath basin, belonged, from its topography, geology, fauna, flora, and climate, to the great central basin. Like the Klamath basin it was once covered with water—was a lake drained by the Columbia, as now, but not so perfectly drained. The Columbia had been gradually deepening its bed. The Des Chutes Lake, as it then was, had deposited sediments to the depth of 2000 feet or more, for the streams which now traverse it have cut cañons in this plateau to that depth. These sediments were covered by a floor of trap which had been poured evenly over the whole surface—which had not been subsequently disturbed, and when broken open, exhibited a columnar structure—the columns being quite perpendicular, and sometimes one hundred feet in height. Below the trap was a series of strata exhibiting all possible varieties of volcanic tufa, some very fine and chalky, others coarser; and the different layers, which were from two to ten feet in thickness, and perfectly parallel, were coloured with all the hues of the rainbow—red, green, yellow, blue, orange, pink, white, &c., and as highly coloured as a geological chart for a lecture room. It had often happened to him, travelling over this plateau, to come suddenly and without any warning to the brink of one of these cañons two thousand feet deep, at the bottom of which a stream was flowing.

The Cascade Mountains, he said, were not a simple chain, but a broad belt of mountain peaks, sometimes fifty miles or more in width, many of the summits being covered with perpetual snow, the passes being generally about 7000 feet in height. He had found extensive proofs of the existence, at a former period, of glaciers capping the Cascade range, and extending far below the present limit of perpetual snow. The Cascade range was eminently volcanic, abounding in craters, lava fields, and congealed lava streams, all as fresh and ragged as though just poured out from some volcano; indeed, Mount Hood and Mount St Helens may still be considered as active volcanoes, giving off gases and steam continually, and within a few years have emitted showers of ashes.

Professor N.'s theory of the excavation and filling of the valleys of California and Oregon was, that at one time, probably at a period corresponding with that of the drift in the Eastern States, all that portion of the continent was raised to such an altitude as to produce a degree of cold which covered the mountains and filled the valleys with ice. By this ice the surfaces of rock were worn down, and the marks of glacial action which now abound produced. The valleys were excavated in part by this process. As the continent was depressed, the valleys were occupied by water, in which the ashes from ranges of active volcanoes were discharged and arranged in strata of sediment. As the drainage of these basins progressed by the cutting down of the outlet, they were gradually converted to the dry plains which they now are.

Among other points of interest in the geology of the West which were touched upon, was the geological age of the coal deposits of Oregon and Washington territories, all of which Prof. N. said were tertiary, and were associated by unmistakeable tertiary fossil plants.—(*Wells's Annual.*)

New Fossil Shell from the Connecticut River Sandstone.—Mr E. Hitchcock, Jr., in a communication to "Silliman's Journal," states that he has recently found in the coarse sandstone of Mount Tom (Easthampton, Massachusetts), a shell of a mollusc, the first, he believed, that has been discovered in the sandstone of the Connecticut Valley. It is preserved, and not petrified, and a considerable part of it has disappeared. Enough remains, however, to enable us to refer it to a family, if not to a genus of shells. The upper part is gone, leaving an oval opening about an inch and three quarters in one diameter, and an inch and one quarter in the other. It extends downwards, tapering somewhat rapidly nearly an inch and a-half, and is left without a bottom, the lower opening being about an inch wide. The walls are very thick, in some places nearly half an inch, and made up of several concentric layers. From the resemblance of this shell to a model of the lower valve of the *Sphærulites calceoloides* in the Cabinet of Amherst College, it seems probable that it may be referred to that family of Brachiopods denominated Rudistæ by Lamarck. Its lower parts, as well as the lower valve, are missing, but what remains approaches nearer to the genus Sphærulites than to any other of the Rudistæ of which he has seen specimens or figures. This fossil seems to lend additional strength to the inference derived from the discovery of the Clathropteris, that the upper part of the sandstone of the Connecticut Valley is as high at least as the Liassic or Jurassic series. It might seem even to carry us higher in the series, but it would be premature to draw such an inference from a single imperfect specimen, even though its true analogies be ascertained. The specimen now belongs to Amherst College Cabinet.—(*Wells's Annual.*)

PHYSICAL SCIENCE.

New Planets Discovered in 1856.—The number of planetary bodies belonging to the solar system has been increased during the past year by the discovery of five new asteroids. The whole number of the asteroids at present date is forty-two.

The thirty-eighth asteroid, appearing as a star of the 10th magnitude, was discovered by M. Chacornac at Paris on the 12th of January. It has received the name of *Leda.*

In announcing this discovery to the French Academy, M. Leverrier remarked, that he was now convinced that a large number of small planets exist between Mars and Jupiter, and that before 1860 probably as many as a hundred will have been detected.

On the 8th of February, M. Chacornac also discovered the thirty-ninth asteroid, which appears as a star of the 9th magnitude, and has been called *Lœtitia.*

On the 31st of March, M. Goldschmidt at Paris discovered the fortieth asteroid, *Harmonia.* It appears as a star of the 9-10th magnitude.

On the 22d of May, M. Goldschmidt discovered the forty-first asteroid, *Daphne*, appearing as a star of the 11-12th magnitude.

On the 23d of May, the forty-second asteroid, *Isis*, was discovered by Mr Poyson, of the Radcliffe Observatory, Oxford, England. It was then rather brighter than a star of the 10th magnitude.—(*Wells Annual.*)

On the Original Asteroid Planet.—In a paper read to the American Association, Albany, Professor Alexander succinctly re-stated the principal features of his hypothesis advanced last year, viz., that there was originally but one planet between Mars and Jupiter, and that this, instead of the ordinary form, approximating closely to a sphere, had the shape much very like that of a very thin wafer, the equatorial diameter being enormous in comparison with the polar. In one determination of the equatorial diameter, he made use of the mass of the planet derived from a new relation of masses and distances, which itself seemed to be a consequence of the nebular hypothesis. Four other determinations were, however, given in that connection; but that which included the most extensive relations was also the most consistent with other and independent results.

The other method of obtaining the equatorial diameter consisted, as before, in determining and applying the difference of the velocity of those asteroids which approach most nearly to one, and live in their aphelia and perihelia respectively.

The two independent results were as follows :—

Equatorial diameter, ... $\left\{ \begin{matrix} 75,094 \\ 63,846 \end{matrix} \right\}$ miles.

The polar diameter must have been very small, as it was independent of the density. With a density equal to that of the earth, it would be only from about 8½ to 11½ miles. No less than eleven facts were stated, which this hypothesis would reconcile. The recently discovered asteroids had the position of their orbits represented, and the inclination of the orbit of the original planet was deduced anew, and found to be about 4 deg. 20 min.—(*Well's Annual.*)

Parallax of the Fixed Stars.—M. Struvé, the astronomical director of the Pulkowa Observatory, Russia, in his recent annual report, says:—In my astronomical pursuits the parallaxes of fixed stars have taken a prominent part during the last year, and I think I have made a considerable progress in these researches. Now that the methods of observation are entirely fixed, I am quite sure that if there is a difference of parallax of 0″·1 between any couple of stars situated at a distance less than 5′ from another, four observations made at the epochs of maxima and minima will be entirely sufficient to prove its existence, and to define its amount within very narrow limits.

A short review of my observations shows that μ Cassiopeiæ has a parallax of more than 0″·3, η Cassiopeiæ of more than 0″·2, and Capella of between 0″·1 and 0″·2. For all these cases, the results obtained by the angles of position agree remarkably with those furnished by the distances.

The observations of other stars, namely of α Tauri, α Aquilæ, α Andromedæ, and α Cassiopeiæ, are about to be closed; but to guard me against any pre-occupation, not even the first step has been made for the reduction of these observations.—(*Wells's Annual.*)

Observations on Saturn.—At a late meeting of the American Academy, Mr W. E. Bond exhibited some diagrams of the planet Saturn, and mentioned various facts concerning it; namely, that the inner edge of the rings is constantly approaching the planet itself; that the ball is seen through the rings, which are consequently transparent; that the colour is different in different parts of the rings, the equatorial regions being white, the temperate region reddish, and the polar bluish. He also mentioned that the shadow of the ball upon the ring can be seen on both sides of it, being on one side rather faint, but on the other quite decided. This anomalous appearance he first noticed in October 1852, and as yet he could give no satisfactory explanation of it, nor of the singular shape of the shadow, the convexity of which was towards the ball instead of from it, as it might be expected to be. His observations were made with the great Cambridge refractor in the years 1852, 1854, and 1855.

Professor Pierce, at the American Association, in a discussion on the constitution of Saturn's ring, observed that the analogy between the ring of Saturn and the belt of the asteroids, was worthy of notice. It was to be remembered that in order to have Saturn's ring remain continuous and flattened into so thin a sheet, the radial or vertical tide in the ring produced by the satellites must be neither too large nor too small. But if the solar system were formed according to the nebular hypothesis, the tides in the remaining mass, after the formation of Jupiter, must have been, from his great size, extraordinarily great, and have produced a different sort of ring at the distance of the asteroids from those produced for the other planets.

Mr Vaughan observed that the orbits of interior planets would render those of exterior ones circular, as grinding a stopper in the neck of a jar rendered it circular.—(*Wells's Annual.*)

Solar Spots.—The following is an abstract of a paper communicated to the American Association on the above subject by Dr Peters of Denmark:—

His conclusions, he said, were drawn from observations made in Naples in the year 1845-6. He and his collaborateurs had computed eight hundred and thirteen heliographic places of two hundred and eighty-six spots. They had ascertained that the spots were not invariably attached to the sun's surface, but that they had motions of their own. These motions were a general tendency to move towards the equator, and where a new spot broke out in the neighbourhood of another, the old one moved away from it as if it were pushed away. New spots generally broke out to the east of old ones, and had a motion towards the west, and the motions in longitude were far more considerable than those in latitude. These motions were in some instances at the rate of three or four hundred miles in an hour. Two zones of the sun's surface were particularly fruitful in spots; the maximums occurring at the parallels of 21 degrees of north latitude, and 17 degrees of south. Instances had been noticed in which spots reappeared after an interval of two or three hundred days, although there was one difficulty in determining this accurately, arising from the uncertainty of the time of rotation. Since spots arose from invisible points at the exact moment of their origin, they could not be studied.

The first indication which the telescope revealed was a sort of bubbling agitation in the luminous layer. To this succeeded a small spot, which rapidly attained its full size—almost always in the course of a day. They remained in this, the vigorous epoch of their life, with a well-defined penumbra of regular and rather simple shape, for ten, twenty, and sometimes even for fifty days. But at last their time came. Their margin had always been slightly notched, and soon the notches grew ominously large and deep, penetrating far into the mystic realm of darkness, while hostile columns of light arose, as if by magic, occupying the centre. Deeper and deeper grew the invading notches, until at last electric flashes passed between two of the more prominent, across the disc. The victory was gained, the centre pierced, and the spot divided into two, after which it was very easy to cut it up in detail. Dr Peters explained these facts by the assumption of volcanoes sending up gaseous matter which parts the luminous covering. All the world knows that the sun is supposed to have at least two atmospheres,—the one next its surface dark but supporting another which is luminous, and which sends forth light and heat.—(*Wells's Annual.*)

Photographic Astronomy.—Those interested in the progress of astronomy may recollect, that about six years ago an account was published in the "Boston Traveller" of daguerreotype impressions of the stars Vega and Castor having been obtained at the Observatory of Harvard College, by the aid of the great equatorial telescope. This was the first successful attempt to procure photographic images of any of the fixed stars that has come to our knowledge; but at that time it was found impossible to extend the process to stars of lesser magnitude. This was attributed to the want of sufficient susceptibility in the daguerreotype plates, and the deficiency of power and regularity in the machinery designed for giving the telescope a uniform siderial motion.

These deficiencies have been recently supplied; first, by the construction of a driving clock on the principle of the spring governor, in which the rotary motion of the fly-wheel is regulated by an oscillating pendulum, which has been found, from several years' practical application, to be the most perfect regulator of rotary motion yet devised. A machine of this description has been adapted to the great telescope by those excellent mechanicians, Messrs George and Alvan Clark of East Cambridge, assisted by their father, Mr Alvan Clark senior. This point having been satisfactorily accomplished, we obtained the assistance of Messrs Whipple and Black, whose skill as daguerreotypists is unsurpassed. We knew them to be deeply interested in the success of these experiments, and it is to those gentlemen that we are principally indebted for whatever of success has crowned our efforts in the perfect delineation of stars of the lesser magnitudes, and of the group of stars composed of Mizar and its companion, and Alcor, and also of other stars ranging from the first to the fifth magnitude, evidencing that all stars usually visible to the unassisted eye may be mapped by the aid of photography with a degree of accuracy unsurpassed by the most refined measurements. Of this accuracy we have abundant testimony by measuring the distances of the photographic images taken on different nights.

The last report of the Council of the Royal Astronomical Society of London contains the following paragraph :—

"We may remind our readers that no one has at present produced on our table a photographic image of a fixed star. A good or even a moderate photographic image of a group such as the Pleiades would be something we have not yet had the pleasure of seeing; and a fair approach to getting an instantaneous image of a group of faint points might lead the way to results of great importance."

The connection of photography with astronomy has thus become most intimate, and combined with the electro-magnetic method of recording astronomical observations, seems destined to effect a complete revolution in the methods formerly pursued in observing the positions and physical conditions of the heavenly bodies.—W. C. Bond.—May 7, 1857.—(*Boston (U.S.) Daily Advertiser.*)

Notice of a Powerful Electric Induction Coil constructed by E. S. Ritchie of Boston, U.S.—(Communicated by Prof. William B. Rogers.)—An induction apparatus has lately been constructed by Mr E. S. Ritchie of Boston, which greatly exceeds in power the French Ruhmkorff apparatus, and surpasses even the most energetic of the improved coils described by Mr Hearder of Plymouth. Of the first of Mr Ritchie's instruments a short notice was published in the May number of "Silliman's Journal." In this the secondary wire, about seven thousand feet in length, is wound in the usual way, by continuous layers reaching from end to end of the spool. The condenser is made of sheets of tin-foil, separated by double sheets of varnished paper. The primary current is derived from four Bunsen cells, arranged for intensity. When in action this instrument affords a spark in the air between the terminals of the induction coil of from 2 to 2½ inches long.

In the more powerful apparatus since constructed by Mr Ritchie, he has adopted an ingenious mode of winding the secondary wire, which has the effect of dividing the coil into a multitude of flat rings. The advantage of such an arrangement had already been suggested by Poggendorf, but without any attempt to carry it into effect, or any intimation as to how it might best be done. In order to obtain the result, Mr Ritchie begins the winding at one end of the spool by laying down the wire in successively widening circuits *on a conical surface*, having a steep slope towards the cylinder of the spool. After covering the conical surface with a layer one wire in thickness, the wire is carried down to the spool to commence a second similar layer, and thus on to the end of the spool; the successive layers being separated by rings of gum elastic, and the wire imbedded, as the winding proceeds, in non-conducting current. When wound in this way, it is evident that the contiguous parts of two adjoining layers cannot be separated by a length of wire, counting along the coil, greater than the length of wire in the conical layer. Hence but little difference of tension can exist in the current of adjacent layers, and therefore but little tendency to a discharge across the interposed non-conducting material.

In this apparatus the secondary coil consists of about thirty thousand feet of very fine wire, wound in the manner above described, and the primary of only a few hundred feet of a very thick wire, the two being separated by the walls of a thick and rather narrow bell-glass, so as effectually to insulate the one coil from the other. The condenser is constructed as in the first instrument, but with a larger surface.

Using the current from four Bunsen cells, which has been found to give as great effect as a larger number, we obtain between the terminals of the secondary coil, in free air, *a spark ranging from five and a-half to six and a-half inches*; while, as might be expected, the other phenomena exhibited by the apparatus are of extraordinary energy and splendour.

MISCELLANEOUS.

Obituary of Persons Eminent in Science: 1856.—Admiral Beechey, R.N., a distinguished Arctic navigator and geographer. Henry Bellville, an English meteorologist. A. Binet, an eminent French mathematician, formerly President of the French Academy. Professor Bojer, a well-known French botanist. W. M. Buchanan, editor "Glasgow Practical Mechanics' and Engineers' Journal." Dr Buckland, the well-known English geologist. Alex. Campbell, a distinguished American engineer. Adrien Chenot, a celebrated French metallurgist. M. Coutourier, a young French explorer of Central Africa; died on the Sahara. Joseph Drayton, the well-known artist of the U.S. exploring expedition, and a naturalist of eminence. M. Duval, a French botanist. David Dyson, an English naturalist. Professor von Fuch, the well-known German physicist and chemist. M. Gerhardt, the eminent chemist of Strasburg, France. M. Goujon, a French astronomer. Dr W. T. Harris, the eminent American entomologist. Professor Hentz. Dr John Lock of Cincinnati. M. Loewell, a German chemist of repute. Colonel Madden, President Edinburgh Botanical Society. C. B. Mansfield, of England, well known for his researches in connection with benzole. François Michaux, editor North American "Sylva." Hugh Miller, the eminent Scottish geologist and author. Francisco Orioli, Professor of Physical Science, University of Bologna. M. Partsch, of Vienna, naturalist. Dr W. H. Paris, an eminent English chemist, and friend of Sir Humphrey Davy. Dr Paris was the author of the well-known work, "Philosophy in Sport," &c. J. G. Percival, geologist, &c. M. Constant Prevost, the distinguished French geologist and physicist. John Reeves, an English horticultural writer. Admiral Sir John Ross, the Arctic explorer. M. Schwilgue, the inventor of the marvellous astronomical clock of Strasburg. Daniel Sharp, President Royal Geological Society, England. George Steers, the distinguished naval architect. Robert L. Stevens, a distinguished American mechanic. Paul Stillman, a distinguished American engineer. M. Sturm, French mathematician. William Swainson, the well-known English naturalist. Zadock Thompson of Vermont, naturalist. Dr John C. Warren, Boston, Massachusetts. James Wilson, a Scotch naturalist. William Yarrell, naturalist.—(*Wells's Annual.*)

Death of Dr Robert Ball.—Since our last publication, we regret to have to announce the death of Dr Robert Ball, an esteemed naturalist, whose name was recently brought under notice in connection with the arrangements for the next meeting of the British Association. Dr Ball was born in 1802. He succeeded the late Dr Whitly Stokes as director of the museum in Trinity College. On the establishment of the Queen's University in Ireland in 1851, he entered on the additional duties of Secretary of the Joint Committee of Lectures in connection with the department of Science and Art, and in 1855 he was nominated Assistant Examiner for Ireland to the Civil Service Committee. While holding these several appointments, he was an active member of most, if not of all, the scientific societies of Dublin. He is best known as Secretary of the Royal Zoological Society of Ireland, and as Treasurer of the Royal Irish Academy, an office next in corporate rank to that of President. In 1850 the University of Dublin conferred on him the honorary degree of LL.D. His published papers are scattered through the pages of different periodicals. Three have appeared in the Transactions or Proceedings of the Royal Irish Academy, viz., "On the Species of Seals (Phocidæ) inhabiting the Irish Seas," "On the Remains of Oxen found in the Bogs of Ireland," and "On the Cephalopoda of the Irish Seas." That he was at all times ready to impart his information freely to others, most of the zoological works published in these kingdoms during the last few years afford ample testimony.—(*Athenæum.*)

Collections Zoologiques (Oiseaux et Mammifères) rapportées par S. A. T. le Prince Napoleon Bonaparte.

Les journaux de 1856 ont entretenu le public du voyage d'exploration entrepris dans le cours de l'eté passé par le Prince Napoléon vers les régions extrémes du Nord de l'Europe.

Vous ont également parlé de l'exposition des objets rapportés par son Altesse, mais ils l'ont fait généralement à un point de vue trop superficiel, pour qu'il n'y ait pas encore à revoir après eux le même sujet.

Laissant d'ailleurs de côté tout ce qui n'est point du domaine de la zoologie, nous passerons encore devant la partie ethnologique de l'expédition, que nous n'avons pû suffisamment étudier pour nous occuper uniquement des collections d'ornithologie et de mammalogie.

Les mammifères, en petit nombre (ce qu'il faut attribuer tant à la nature accidenteé et difficultueuse du pays, qu'au caractère du voyage, destiné seulement à l'exploration des côtes se composaient de quelques peaux de *Felis borealis et cervaria*, de *Phoca groënlandica*, de *Canis lagopus* d'un fœtus *de Balæna* et d'un superbe *Castor fiber*, tué en Norwège, une des rares régions Européennes qui recèlent encore ce curieux animal. Il y' avait pénurie de tous les petits rongeurs du Nord.

La collection ornithologique était de beaucoup, plus importante et plus complète. La partie oologique s'y trouvait notamment représenteé d'une manière brillante.

Voici la liste complète des espèces recueillies par l'expédition, nous la restreignons seulement au catalogue des peaux d'oiseaux.

Aquila albicilla, Gr.
Falco peregrinus, Gr,
candicans, Gr.
islandicus, Isl.
Strix nyctea, Gr.
Corvus corax, Isl.
Emberiza calcarata, Gr.
nivalis, Gr.
Linaria groënlandica, Gr.
canescens, Gr.
Tyrannula pusilla, Gr.
Lagopus Reinhardtii, Gr.
Charadrius auratus americanus, Gr.
pluvialis, Isl.
hiaticula, Gr.
Strepsilas interpres, Isl.
Phalaropus hyperboreus, Gr.
Tringa maritima, Gr.
Numenius melanorynchus, Gr. Isl.
Gallinula chloropus, Isl.
Sula Bassana, Gr.
Phalacrocorax carbo, Gr.
Procellaria glacialis, Gr.
Lestris parasiticus, Gr.
Larus leucopterus, Gr.
marinus, Gr.
eburneus, Gr.
tridactylus, Isl.
Sterna arctica, Isl.
Anser bernicla, Gr.
Cycnus musicus, Isl.
Anas acuta americana, Gr.

Querquedula carolinensis? Gr.
Somateria mollissima, Gr. Isl.
spectabilis, Gr.
Clangula Barrowii, Gr.
Fuligula histrionica, Gr. Isl.
glacialis, Gr.
marila americana, Isl.
Mergus serrator, Gr.
Colymbus glacialis, Gr. Isl.
Uria troile, Gr.
grylle, Gr.
Mergulus alle, Gr.
Podiceps arcticus, Isl.
Mormon fratercula, Gr.

Les abréviations Gr. Isl. employées à la suite des ci dessus, signifient Gr. Groënland ; Isl. Islande, suivant les localités ou les oiseaux out été capturés.

Comme on ne manquera pas de le remarquer la plupart des espèces notées ci dessus sont pélasgiennes, cela tient comme nous l'avons expliqué plus haut, au caractère essentiellement maritime de l'expédition du Prince Napoléon, et aux trés courtes relâches à terre des naturalistes attachés à cette intéressante entreprise. Il ne faut pas oublier non plus que ce voyage qui n'a duré que quatre mois s'est opèré pour ainsi dire à vol d'oiseau.

Presque tous les types de la collection de peaux se retrouvent dans la collection d'œufs ; on y remarque en plus un grand nombre *d'Anas*, tous les *Sterna* et *Lestris* de l'Europe septentrionale, des *Tringa*, *Procellaria*, etc. etc., mais de même que dans la collection de peaux ; l'oologie est pauvre aussi en *Passereaux*.

Quoiqu'il en soit de la pauvreté relative de certaines familles, il faut savoir gré au Prince Napoléon d'avoir attaché son nom à l'entreprise scientifique qui a donné ces résultats, ce premier voyage fait espérer beaucoup dans un prochain avenir.

EDM. FAIRMAIRE.

PARIS, *Mars* 1857.

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THE

EDINBURGH NEW

PHILOSOPHICAL JOURNAL.

Mountain Climates considered in a Medical Point of View —(continued). By Dr H. C. Lombard.*

If we proceed, from the diseases of frequent occurrence in high localities, to the consideration of such as are more rarely observed there than in the plain, we should mention, in the first place, pulmonary phthisis and other tubercular affections, which are almost unknown to the ancient inhabitants of the soil, the Indians; if insulated cases of them are met with, it is the Creoles who are attacked.

Rheumatism, which the atmospheric circumstances might be supposed likely to develop, is extremely rare in Puna and the southern Sierra.

To these particulars, which we owe to the observations of Dr Tschudi, I shall add some facts derived from other sources. According to Dr Weddel, inflammatory diseases of the organs of respiration are very frequent at Paz, the capital of Bolivia, which is situate, as has been stated, at 12,238 feet above the level of the sea. He attributes this fact to the dryness of the air, and the low temperature which prevails during the night.†

Humboldt has made the same remark in regard to Mexico,

* From the Bibliothèque Universelle de Genève.

† Weddel. Voyage dans le nord de la Bolivie, 8vo, Paris, 1853.

(7470*), where catarrhal affections and inflammations of the lungs are very frequent.

The last fact I wish to state regarding Alpestrine pathology, refers to the Hospice of the Great St Bernard (8129). The Prior of that establishment has kindly replied in the following terms to the questions put to him, at my request, by Professor Plantamour :—" The diseases to which the monks are liable are inflammations of the chest. The greater number of them become asthmatic after a certain number of years, and are obliged to go down again to the plain. Those who have been born among the mountains can reside for a long time with impunity at the convent."

Dr D'Espine, who acquired his knowledge of this subject by a residence at the Hospice upwards of twenty years ago, has confirmed to me the accuracy of these observations. They may therefore be considered as expressing faithfully the influence of Alpestrine climates on those subjected to them for a certain number of years.

In conclusion, we may add that epidemic or contagious diseases are not arrested in their development by the atmosphere of the lofty regions of our globe. Smallpox, scarlatina, and other eruptive diseases, are unhappily developed with as much severity as in the neighbouring plains. In Mexico they still preserve the recollection of an epidemic scarlet-fever, which carried off, some years ago, a great many victims. Lastly, with regard to typhoid fever ; though it appears, according to Dr Tschudi, to be rare among the Cordilleras, it is unfortunately not so among our own Alps, where it prevails at all elevations. As a proof of this we may mention the epidemic of 1839, which attacked a third part of the St Bernard monks, and caused many deaths in the surrounding valleys.

I might now conclude the series of facts illustrative of the influence of the climate of high mountains on the development of diseases, but as a close analogy exists between the pathology of the elevated regions of the globe, and of those situate at a moderate height, we shall proceed to consider the second part

* The figures placed within brackets after a name indicate the height in English feet.

of our subject, before drawing from it any definite conclusions.

§ 2. *The Physiological and Pathological influence of Alpine and Subalpine Climates (below* 6560 *feet).*

The preceding facts do not present so immediate a practical application as those on which I am now called upon to speak. In fact, with the exception of the Hospice of St Bernard, no permanent place of abode above 6560 feet exists in Europe, a circumstance which constitutes a striking difference between it and the various plateaux of Peru and Bolivia, which have made us acquainted with the influence of heights on the development of diseases.

We have to consider the same question, then, no longer in extreme positions, as has just been done, but in circumstances of ordinary occurrence, both in regard to permanent residence, and localities sought for by invalids.

Although the number of villages, hospices, or posting-stations met with in Europe, in places approaching to 6560 feet in height, is very inconsiderable, still there are a few, such as the Hospices of the Grimsel (7231), St Gothard (6808), the Simplon (6791) ; the station of Mount Cenis (6253), the Villages of Breuil (6585) at the foot of Mont Cervin ; St Verin (6693) in the high Alps ; and Maurin (6241) in the low Alps. But none of these localities are of any interest in a medical point of view ; the case is different, however, with two establishments much resorted to by invalids, and which approach the foregoing in height, I mean the Righi (5906), and St Maurice (5860), in the Grisons, a village well known for its ferruginous springs.

The greater part of the high inhabited localities in the Alps and Pyrenees, many of which are made summer residences for a medical purpose, range between 3937 and 4921 feet in height. Lastly, between 1640 and 3280 feet, we find a great number of villages and establishments which may likewise be considered, though in a less degree, as presenting all the characters of mountain climates.

In tracing the modifications produced on the human body by the heights in question, it is particularly to localities about the height of 3280 feet that I wish my observations to apply, without neglecting, however, the information furnished by villages situate at a higher or lower level.

As we have already seen, the effects produced by a sojourn among mountains are either modifications produced in our different functions, and which ought, therefore, to be considered as purely physiological, or else they contribute to the development of diseases, and thus fall within the province of pathology. If we followed the order adopted in the preceding chapter, we should commence with the physiological influences; but as this is connected very intimately with the treatment of these diseases, it appears to me more natural to begin with the pathological influence; the more so, as the view of the most prevalent diseases among the inhabitants of alpine and subalpine climes, will very naturally complete the observations which have been made in the higher regions of our globe.

1. *Pathological Influence of Alpine and Subalpine Climates.*—In 1833, Dr Isensee expressed himself to the following effect :—" Morbi peculiares montium incolas, quantum tenemus, non afficiunt. Nec ullum de hac re libellum evolvere nobis quidem contigit."* This last remark is still as true as it was twenty-three years ago, for to my knowledge no particular work exists on alpestrine pathology, so that I could gain some precise notion of it only by referring to various isolated works on the diseases of certain mountainous regions, and availing myself of the kindness of such of my colleagues as were in circumstances to furnish me with valuable information on this subject.† If we can say with Dr Isensee, that there is no malady peculiar to the inhabitants of mountains, it is not less certain that various morbid affections are more frequently met with in such situations, while others more habitually fall to the lot of the inhabitants of the plain.

* Elementa Novæ Geographiæ et Statistices Medicinalis, 8vo, Berolini, p. 53.

† Dr Archibald Smith from Peru has written on the subject of the Diseases of the Andes in the "Edinburgh Medical and Surgical Journal," 1840–42.

Inflammatory fever, without any precise localization, such as we have described it, after Dr Tschudi, is not altogether unknown in other mountainous countries. We find it, in fact, pretty frequently in certain parts of our Alps, as, for example, at Briançon (4265), the most elevated town in Europe. Dr Albert writes to me regarding it as follows :—" Inflammatory fever, without localization, and terminating in sweatings, loaded urine, and a slight eruption on the lips, is exceedingly common ; there is scarcely any one who has not had it oftener than once in his life." The frequency of inflammatory diseases is very great at Chamounix (3450), according to Dr Michon, who estimates them at more than the half of all those to which the inhabitants of this valley are subject.

A second point in alpestrine pathology, not less important, is the frequency of *hæmorrhages*, which show themselves, as might be anticipated, with less intensity and frequency than in the high valleys of Peru and Bolivia, but nevertheless much oftener in the alpine and subalpine regions than in the adjoining plains.

Among the hæmorrhages most frequently met with in the inhabitants of mountains, are hæmoptyses. They have been mentioned by Drs Cullen and Mansford as occurring in Scotland and England, as well as by Dr Flechner in reference to Styria.

In the valleys of Neufchâtel, which are about 3280 feet in height, the Genevese workmen are frequently seized with this disease, and it is also equally observed among the other classes of inhabitants. We find, indeed, by a note published by Dr de Pury, on the exemptions from military service in the Canton of Neufchâtel for 1849, that five or six times more persons were exempted, on account of hæmoptysis, in the mountainous parts of the valleys, than in the districts of Boudry and Neufchâtel, which are situate on the shores of the lake.

With regard to other kinds of hæmorrhages, some of them appear to be rarer among the mountains than in the plains ; such is the case with uterine bleedings, whether considered after childbirth or in any other circumstances. Dr Michon has met with only five cases of uterine hæmorrhage during the fourteen years of his practice at Chamounix. Of this number, three were owing to the insertion of the placenta in the neck of the uterus, and two were in consequence of the critical age. Is not this an evident confirmation of what has been said before?

But it does not appear to me that there is any contradiction between the frequency of hæmorrhages in general, especially such as may be called active, and the rarity of uterine bleedings in mountainous countries, since the greater part of the latter may be considered as caused or promoted by a state of weakness; on the contrary, if this remark be generalized, we may conclude, from what has previously been said, that active hæmorrhages are favoured by the tonic action of mountain air, while the same influence will act in an inverse manner in the case of passive hæmorrhages.

Diseases of the nervous centres are rather rare in mountainous countries. This conclusion results from the observations of Dr Albert in the neighbourhood of Briançon, and of Professor Lebert in the valley of the Rhone. Both of them have specified to me epilepsy, apoplexy, and simple or tuberculous meningitis, as being rarely met with in the mountainous countries just named. This establishes a considerable difference between the facts described by Dr Tschudi and those of which we are now speaking. Indeed, I have been unable to find in Europe any observation of cases at all approaching to those terrible cerebral inflammations which carry off such numbers in the high valleys of Peru and Bolivia.

With regard to *diseases of the respiratory organs*, we have mentioned the frequency of bronchitis, pleurisies, and pneumonias, as well as the rarity of phthisis pulmonalis in the countries just named. Let us now consider the effect of alpine and subalpine climates in this point of view.

And, on entering upon the subject, we may mention the opinion which has prevailed from ancient times, and which we find again brought forward in all works on hygiène and pathology, as to the frequency of inflammatory diseases of the lungs *in dry and elevated situations.* But we prefer direct observation to an opinion which may be merely traditionary, and have no foundation in fact. The following is the result of my investigations on this subject.

The first observation I shall make on the frequency of pulmonary inflammations is, that it increases with the elevation. This remark had been made in Germany by Dr Fuchs; and I am able to confirm it by the facts observed in the Alps of Dauphiny and Savoy.

On comparing the deaths caused by pulmonary inflammations in three different localities in Thuringia, Dr Fuchs has found the following proportions;—in the most elevated, at 2772 feet, a mortality of *sixty-seven* per cent; in a medium height, of 1919 feet, *sixty-two* per cent; and lastly, in the lowest locality, at 1598 feet, the mortality from pulmonary inflammation did not exceed *fifty-two* per cent.*

Similar observations have been made by the same author among the Harz mountains, and in some of the cantons of Switzerland, such as those of Uri and the Grisons. The three most elevated localities respecting which I possess documents, are Mont Cenis (6253), the Grande-Chartreuse (4613), the town of Briançon (4285), and Chamounix (3451).

The French soldiers who sojourned on Mont Cenis in 1796, from the 15th December to the 15th of May, were affected in great numbers with pneumonia, which formed the *fourth part* of the diseases observed at that period. †

According to the manuscript observations communicated by Professor Bertrand of Grenoble, it appears that the monks of the Grande-Chartreuse (4613), in the department of the Isère, are frequently attacked with pulmonary inflammations, particularly such of them as are called upon to engage in active duties. The new arrivals are affected with catarrh and momentary loss of voice.

Dr Albert, who has practised medicine for seventeen years at Briançon (4285), and in the villages on the neighbouring

* Mediziniche Geographie. Berlin, 1853.

† Griselle, Traité de la Pneumonie, 8vo. Paris, 1846, p. 135.

heights, writes to me that the diseases which he is usually called upon to treat are inflammations, and that the most frequent diseases of that nature are those of the air-passages, particularly bronchitis and pneumonia; it is to the latter that the greater number of the deaths of adult men are owing. Dr Michon, who has resided fourteen years in the valley of Chamounix (3451), informs me that cases of pneumonia form the *fifth part* of the diseases of the inhabitants of these regions.

At less considerable heights we still find a great number of inflammatory diseases of the lungs. This has been observed by Dr Grifoulière in reference to the mountains of Auvergne; he has pointed out the much greater frequency of affections of this nature in the elevated localities of Auvergne when compared with adjacent plains.* Similar observations have been made by Dr Koch in Wurtemberg,† and by Dr Flechner in Styria.‡

Professor Savoyen of Moutiers writes me, that peripneumonias occupy the first rank among the diseases which attack the inhabitants of the Tarentaise Mountains.

Observations of a like nature have been communicated to me by many medical men who practise in the mountainous districts of the Jura, Savoy, and the valleys of Neufchâtel, where our countrymen, as well as other classes of inhabitants, are frequently seized with bronchitis or catarrhal affections.

Pulmonary inflammations sometimes develop themselves in an epidemic manner in the elevated parts of Switzerland, and commit great ravages among the inhabitants of the smaller cantons. This disease, which is known by the name of *Alpenstich*, was first described by Conrad Gesner in 1564, when it carried off a great number of the inhabitants. Since that time it has often ravaged Switzerland, and has been observed in recent times (1833) by Professor Schönlein, in the valley of Urseren, and in 1829, in the valley of Entremont, by Professor Lebert. According to these observers, the *Alpen-*

* Gazette Medicale de Paris, 1833. p. 473.

† Monatschrift für Medizin, Von Ammon. Leipzig, 1836.

‡ Allgemeines Repertorium der Medizinischen Jahrbücher; November, 1841, p. 162.

stich is sometimes a pleurisy, at other times a pleuro-pneumonia, accompanied with typhoid symptoms, running its course very rapidly, and attended with great danger. It may be compared to the pluro-pneumonia of Peru, of which we have given an account from Dr Tschudi.

Pulmonary catarrh appears likewise to be more frequent in high grounds than in the plains; such, at least, is the opinion of most of the authors and practitioners I have had it in my power to consult on the subject. But this is not the case with influenza or epidemic pulmonary catarrh, which, according to the observations of Professor Lebert, appeared not to visit the mountainous regions of Bex and St Maurice when he practised in that neighbourhood. If this exemption from influenza should be verified, we may find the cause of it in the coolness and dryness of the air, qualities unfavourable to the development of epidemic pulmonary catarrh. I remember, indeed, that when this disorder appeared at Geneva with unusual severity, in the winter of 1834, there was not a single family without one or more invalids, and their number increased every day as long as the south wind continued, and the torrents of rain which accompanied it. But when the north wind began to blow, and a dry cold succeeded the humidity, the number of the sick diminished so rapidly, that in a few days the epidemic was almost completely arrested by this atmospheric change.

Among the documents which I have collected on the subject before us, there are two which I wish to mention, as being in some respects contradictory of those I have quoted. The first contains the facts observed in 1837 and 1839, in the canton of Zurich, by Dr Locher-Balber, from which it appears that pneumonias and pulmonary catarrhs were twice more frequent in the plain than in mountainous districts. Have similar observations been made at other periods? This we are unable to say, for we have nothing either to confirm or refute the statement of the Zurich doctor.*

The second document I wish to refer to, was communicated

* Schweizerische Zeitschrift für Natur und Heilkunde, 1841.

to me by Professor Lebert, who has observed, during a residence in the neighbourhood of Bex (Vaud) and St Maurice (Valais), that pulmonary catarrhs were much less frequent in the mountain villages than in the plain; with regard to pleurisies, the case was rather the reverse; and lastly, he found no difference between these different localities in reference to pneumonia.

I have no wish to disguise the importance of these two series of observations; but if we remark, on the one hand, that Professor Lebert found no predominance of pneumonia in the plains over the mountains, and, on the other hand, that pleurisy has occurred to him most frequently on heights, we will perceive that the affirmations of the Zurich professor are not very precise; and if we add to this the remark that, with the exception of the two authors named, all others are unanimous as to the much greater frequency of pulmonary inflammations bronchitis, pneumonias, and pleurisies, in mountainous countries; we shall be led to consider the last opinion as best founded, since it rests on facts observed in very different localities, such as the Alps of Piedmont, Savoy, Dauphiny, and Switzerland, as well as the heights of the Jura, Auvergne, Wurtemberg, the Harz, Thuringia, and Styria.

Is *phthisis pulmonalis* rare or frequent among the inhabitants of mountains? Such is the question we are now called on to answer, and to which I wish for a short time to draw the attention of my readers.

Dr Fuchs has published, in his Medical Geography, a series of statistical tables, by which he is led to affirm, that "phthisis pulmonalis becomes rarer as the country becomes more elevated."* Let us inquire whether the documents I have collected on this subject confirm the assertion of the doctor of Botterode.

It has been stated above, that, in the elevated regions of Peru and Bolivia, phthisis was almost entirely unknown, and that the few who fell victims to it were Creoles, the descendants of Europeans, who may have carried along with them the

* Op. Cit., p. 35.

germs of a disease which never attacks the Indians, the ancient inhabitants of the country.

With regard to Europe, I have found no mention of phthisis pulmonalis among the diseases which afflict the inhabitants of the most elevated of our Alps, such as St Bernard or the Grande-Chartreuse. In reference to Briançon, Dr Albert writes me, that circumstances of wretchedness or excess, altogether exceptional, are necessary to develop any one of the tubercular disorders which are so common in the lower valleys of the Alps.

Observations to the same effect have been made at Chamounix by Dr Michon; among the Tarantaise Mountains, by Dr Savoyen; among those of Styria, by Dr Flechner; and of the valley of the Rhone, by Professor Lebert. These practitioners agree in declaring that phthisis pulmonalis is more frequent in low and flat countries than on the surrounding high grounds. One of them, Dr Flechner, refers on this occasion to the popular opinion as to the antagonism supposed to exist between goitre and tubercle; so that where the one is frequent the other rarely occurs. Not being at present in a condition to decide on this theory of exclusion, I content myself with stating the fact, that in a great number of lofty localities phthisis pulmonalis is either unknown or excessively rare, which confirms the opinion of Dr Fuchs as to the freedom of heights from the malady in question. But if the preceding facts favour this conclusion, there are others, which must not be passed over in silence, which are altogether opposed to it.

In 1818, Dr Mansford published a work with the intention of showing that in England cases of phthisis were more numerous in proportion as the residence of the inhabitants was elevated above the level of the sea;* a proposition diametrically opposed to that of Dr Fuchs, and yet supported by statistical authorities which appear to me not a little conclusive.

On the other hand, we find in the Memoir of Dr Locher-Balber, already mentioned, a positive confirmation of Dr

* An Inquiry into the Influence of Situation on Pulmonary Consumption. 8vo. London, 1818.

Mansford's observations, in the fact that tubercular diseases were found, in 1837 and 1839, doubly frequent in the mountainous districts of the canton of Zurich, compared with what they were on the banks of the lake.

On adding a few unpublished documents to the preceding, we find in them the confirmation of the opinion which has just been expressed. In fact, nothing equals the frequency of phthisis pulmonalis in the greater part of the Alpestrine valleys of our neighbourhood. Whether we traverse the Jura, ascend the course of the Arve, or repair to the mountains of Bornes and the environs of the lake of Annecy, we encounter, in all of these localities, a very considerable number of phthisical cases. The majority of the patients who came to consult me, or whom I have visited in the regions in question, were tuberculous. Astonished at the prevalence of this species of malady, I have questioned both medical men and the inhabitants, and I have invariably come to the same conclusion. Sometimes it was a patient dying of consumption, and of whom it was told me that, although still young, he was the only survivor of his family or contemporaries; sometimes it was a young man, robust to appearance, and in whom, notwithstanding, the malady had commenced to which seven or eight brothers had already fallen victims. Such facts came under my notice on numerous occasions, during the course of a practice which now extends over more than a quarter of a century.

Thus, then, we cannot hesitate to admit that phthisis pulmonalis is met with very frequently in certain mountainous regions. But how can this conclusion agree with those of Dr Fuchs? It does not, however, appear to me impossible. In truth, the majority of the facts which prove the rarity of diseases of the lungs on high situations have been observed in the very elevated regions of Peru, Bolivia, and the high Alps, while almost all the other observations refer, it is true, to mountainous localities, but situated at very inconsiderable heights—such as the English towns mentioned by Dr Mansford, the hills and mountains surrounding the lake of Zurich, and lastly, most of the valleys of the Jura, Samoëns, Sixt, and the Bornes.

We are now, therefore, in a condition to conclude, with a considerable degree of certainty, that if the low valleys or medium regions of our Alps present a great number of phthisical cases, this disease becomes rarer and rarer as we ascend, in so much that, at a height above 3280 feet we meet only with a few isolated cases, and at 4920 feet pulmonary phthisis entirely disappears. This phthisical zone, above and below which this disorder disappears, may be approximately fixed at between 1640 and 3280 feet.

We shall afterwards see that tubercular diseases are not the only ones which develop themselves within certain limits of height; scrofula, goitre, and cretinism, are likewise very general in the lower valleys and the mountainous regions of our Alps, but beyond a certain height these three diseases entirely disappear. In consequence of this we are constrained to admit that certain anti-hygienic conditions, to which we shall have occasion again to revert, perform a more important part than the atmosphere of mountains in the development of tubercular diseases, as well as of the other morbid affections we have enumerated.

While phthisis disappears at a certain height, we find on the contrary, that *asthma* increases, both in frequency and severity, as we ascend above the level of the sea; a circumstance which has procured for this disorder the name of *asthma montanum.* We have already seen how much the respiration is injured in the high regions of the globe, and how a permanent residence at St Bernard infallibly induces a diseased condition of it. Similar remarks have been made in reference to less considerable heights, such as Chamounix, the Grande-Chartreuse, and the mountains of Styria, by Dr Flechner;* those of the Harz, by Dr Brokman;† of Thuringia, by Dr Fuchs,‡ and the environs of Zurich, by Dr Locher-Balber.§ Lastly, by examining the statistical tables published by order of the Sardinian Government, we ascertain that the number of asthmatic patients exempted from military service, is much more considerable in the mountainous regions

* Op. Cit.

† Die Metallurgischen Krankheiten des Ober-Harzes, 8vo. Osterode, 1852.

‡ Op. Cit.

§ Op. Cit.

than in the plains of Piedmont.* The same predominance of asthma has been noticed in the mountains of Neufchâtel, compared with the districts on a level with the lake, as regards exemption from military service.† We are thus fully authorized to consider pulmonary emphysema, along with its ordinary consequences of asthma, chronic bronchitis, and liability to be affected by atmospheric changes, as a natural consequence of residence on heights, and as manifesting themselves with greater intensity as the level is elevated above the sea.

Cases of *chronic bronchitis* are more frequent in mountainous countries than in the adjacent plains, as we are entitled to affirm from the observations of Professor Lebert in the Valley of the Rhone, of Professor Bertrand among the Alps of Dauphiny, and of Dr Brockman in the chain of the Harz.

Organic diseases of the heart are likewise met with more frequently in the same circumstances, as has been observed by Dr Flechner in Styria, and Dr Brockman among the inhabitants of the Harz. The same result may be deduced from observations collected in the canton of Neufchâtel, where nearly twice the number of exemptions from military service are occasioned by hypertrophy of the heart in the mountainous regions than in the districts bordering on the lake.

The preceding facts, therefore, cause us to regard mountain climates as favourable to the development of diseases of the heart, not only on account of the acceleration of the circulation, under the influence of continual walking up steep ascents, but also in consequence of the rarefied atmosphere, which must tend to disturb the central organ of circulation more or less seriously.

The influence of diminished atmospheric pressure might lead us to suppose that *varices* would be more frequent among mountains than in the plain. But observation does not confirm this supposition. It follows, in fact, from the investigations of Dr de la Harpe, of Lausanne,‡ that varices are much

* Rendiconts. † Manuscript already quoted.

‡ Quelques mots sur les causes probables des varices chez l'homme. Zurich, 1855.

rarer in the mountainous districts than in the lower regions of the Canton de Vaud. It even appears, that, for a period of fourteen years, there has not been a single exemption from military service on account of varices among the inhabitants of the Lake of Joux, which is situate between 3280 and 4265 feet above the sea level.

Diseases of the digestive organs are rather rare among the inhabitants of mountains. The only kinds met with, in any degree of frequency, are diarrhœas and dysenteries in the autumn; still they are not so severe as in the plains. It is particularly in the torrid zone that we observe this favourable influence of mountain air in preventing or curing dysentery and other disorders of the digestive canal, which are the cause of so many deaths in plains and on the sea coasts. Mountainous regions are not, however, entirely exempt from disorders of this nature; for dysentery has been observed at a height of 6560 feet under the tropics, and at 2296 feet among the mountains of Switzerland. About half a century ago, it appeared in an epidemic form in Thuringia, at a height of 1312 or 1640 feet; but it has not since revisited these regions.

In short, it may be said that morbid affections of the digestion are infinitely rarer, and much less severe, on high grounds than in the plains. The same remark applies to organic diseases of the liver and stomach.

The *functions of the uterus* are frequently modified under the influence of mountain climates. Chlorosis is frequently met with, as well as leucorrhœa and various irregularities of menstruation. But, as has been already stated, uterine hæmorrhages are rare, either after childbirth, or in any other circumstances.

Although *intermittent fever* is rather a disease of low, damp, and marshy countries, still high situations are not entirely a protection against it. According to Dr Fuchs, it is observed in Mexico up to a height of 6560 feet.* And among our own Alps it is not a rare thing to observe it at an almost equal elevation. Professor Lebert has had the charge of cases at 6223 feet at the Chalets of Anzeindaz (Vaud), and at 4052 feet in the Hamlet of Posses (Vaud), although there

* Op. cit., p. 64.

were no marshes in the neighbourhood to account for its appearance.

Setting aside extreme cases, and keeping in mind the observations made in different latitudes, it may be affirmed that "The frequency and severity of intermittent fever decrease with the height." It thus appears that the practice almost universal in marshy countries, of leaving the plain and repairing to the mountains, in order to escape from, or to cure, intermittent fever, is founded on a correct observation of facts.

It may be added, however, that, in some cases, marsh miasm may be conveyed by the fogs which rise from marshy plains to the neighbouring heights, so that we may partly ascribe the fevers observed among mountains to the marshes situated at their foot. If this last supposition be correct, we may be justified by it in considering mountainous countries as almost completely exempt from intermittent fevers, save in the few exceptional cases which have just been mentioned.

We have seen that, notwithstanding the existence of atmospheric conditions, which seem calculated to favour the development of *rheumatic diseases*, this class of maladies is almost wholly unknown in the high mountains of Peru and Bolivia. This is, unfortunately, not the case in Europe; in fact, to whatever height we ascend, we encounter the various forms of this complaint. Whether we select as our field of observation the vicinity of Briançon, above 6265 feet, or the heights adjoining Diablerets and the Dent du Midi, or traverse the mountains of Styria or the Harz, we shall everywhere find muscular, neuralgic, or articular rheumatisms. And with regard to the greater or less frequency of these various forms of the disease, different observers are unanimous in declaring that lumbago, torticollis, and sciatica, are much more general among mountaineers than among the inhabitants of plains, while the opposite is the case with articular rheumatism, whether acute or chronic. In confirmation of this last opinion, I may select a single example from many of the same kind. The exemptions from military service on account of rheumatism, have been six times more numerous in the districts adjoining the Lake of Neufchâtel than in the mountainous quarters of the same canton.

Eruptive complaints are as frequent on high grounds as on plains, as we have already remarked, when speaking of Alpestrine climates. Scarlatina, measles, and smallpox, appear in greater intensity wherever they find circumstances tending to promote contagion; perhaps, even in spite of the purity of the air, these diseases are so much the more severe and widely spread, as the dwellings in the high Alps are confined and unhealthy. This latter remark may explain, in a certain degree, the frequency of *typhoid fever* in the majority of elevated localities, where we observe this disease propagated and reproduced every year with the greatest facility. This has been shown to be the case by Professor Lebert in Switzerland, Professor Bertrand on the heights around Grenoble, and practitioners in the Vaudese valleys of Piedmont.

There are still three diseases on which I wish to make some remarks; scrofula, goitre, and cretinism.

Scrofulous diseases are not rare in mountainous countries. But are they more frequent than in the plain? This is a question which I do not hesitate to answer in the affirmative. It appears, indeed, to be unquestionable, from the investigations of Professor Lebert respecting the scrofulous patients of the different districts of the Canton de Vaud, that mountainous regions are more frequently attacked with diseases of this kind. My own personal experience entirely agrees with that of my honourable colleague. In fact, the greater number of the scrofulous patients placed under my care came originally from the declivities of the Jura, or the Alpine regions of Savoy.

Must we suppose, from these facts, that mountain climates are favourable to the development of scrofulous complaints? Before coming to such a conclusion, we must take into account the less easy circumstances, the inferior food, the frequent intermarriages between members of the same family, and the general neglect of the laws of health in building dwelling-houses, and compare all these circumstances with such as surround the inhabitants of towns, where incomes are larger, food more plentiful, ease and comfort more generally diffused. It is necessary, also, to consider the stagnation of the air and humidity of the atmosphere in the deep valleys of the Alps, into which the sun can penetrate only a few hours a day. All these considerations combined are more than sufficient to explain the predominance of scrofula in mountain residents, apart from questions concerning climate. Is the case the same in villages with a good exposure, and whose inhabitants are in somewhat easy circumstances? I think not. On the contrary, it appears to me extremely probable, that where hygienic circumstances are favourable, scrofulous diseases are rarer in the mountains than in the plains. We shall find a confirmation of this view in what remains to be said on goitre and cretinism, diseases which have a close analogy to scrofula.

In most of the valleys of the high Alps we meet with *goitrous* persons and *cretins*. In producing these diseases, what is the influence of climate and of the anti-sanitary circumstances which we have enumerated in regard to scrofula? This we shall not be in a condition to determine for some time to come; but, in the meantime, thanks to the investigations of the Sardinian government, and the numerous works of Swiss and German physicians, we can no longer doubt the fact, that if the woods be cleared away around the villages, the dwellings improved, and, at the same time, the inhabitants placed in easier circumstances, and causes of disease thus removed by a more judicious application of the laws of health, we do not fail to find goitre and cretinism diminish, and even disappear. And if we add to this consideration the fact about to be mentioned, namely, that neither goitres nor cretins are met with beyond a certain limit of height, we shall become more and more convinced of the correctness of this conclusion. In the mountains of Thuringia and of the Black Forest, cretins disappear above 2296 feet. Among the Alps, the absence of cretinism manifests itself at about 2952 feet in northern exposures, and at 5577 feet in southern exposures. Cretins are not met with in the Cordilleras above 14,100 feet.

The inhabitants of countries liable to this infirmity have long been aware of this privileged condition of high grounds, and of the beneficial properties of the invigorating air breathed there, for preventing or ameliorating the physical and intellectual state of children predisposed to cretinism. It is with this view that they send women to be delivered, and their children to reside for a time on heights. It is also on this popular opinion that the experiment has been founded, carried on for twenty years by Dr Guggenbuhl, at Abendberg (3624). Convinced that the high strata of the atmosphere exert a preventive influence on the development of cretinism, this philanthropist was the first to conceive the happy idea of employing this means of counteracting the malady and arresting its development. It is not for me to give a decided opinion, in this place, as to the extent of the results obtained by his method; but, from the facts which have come under my own personal knowledge, it appears that a certain number of cretins and idiots leave this establishment in a physical and intellectual state so considerably improved, that we must admit, with Dr Guggenbuhl, that much of the change may be ascribed to the atmosphere of the high mountains, which not only prevents the appearance of cretinism, but arrests its progress when it has already appeared under the influence of those anti-hygienic causes enumerated above.

Let us now give a short recapitulation of the preceding facts, and thus trace the main features of what I call *Alpestrine pathology*.

We have seen, in the first place, that there are three principal diseases which increase, both in frequency and severity, with the height,—inflammation, asthma, and hæmorrhages.

In the second place, we have ascertained that there are other morbid affections which develop themselves between the limits of a certain range of elevation in such a way that they are rare or unknown above and below these limits. We have fixed, approximately, the phthisical zone between 1640 and 3280 feet; that of goitre and cretinism at heights varying according to the exposure and latitude; and finally, the zone of scrofulas, which has many relations with that of phthisis.

In the third place, we have indicated the comparative frequency of diseases of the heart, chronic bronchitis, muscular or neuralgic rheumatisms, and chlorosis, in mountainous countries; while intermittent fevers, disorders of the digestive canal, articular rheumatisms acute and chronic, as well as uterine hæmorrhages, are met with there more rarely than in the plain.

Lastly, we have ascertained that there are certain morbid affections which appear to be in no respect modified by height. Typhoid and eruptive fevers are of this class.

Such are the results which arise from the investigations I have undertaken on this subject, hitherto so little studied, and which I hope will be of future advantage. In the meantime this view, although very incomplete, of the pathological influence of heights, may furnish some valuable indications to medical men to guide them in the advice they are called upon to give as to the diseases which may be successfully combated by a mountain residence. But before entering upon the practical department of our subject, we require to ascertain, from direct observation, what physiological modifications are preduced on our organs by alpine and sub-alpine climates.

§ 2. *Physiological influence of Alpine and Sub-alpine Climates (below* 6560 *feet).*

We have seen what diseases develop themselves in the native inhabitants of mountains; let us now consider the changes which take place in our organs under the influence of a temporary abode in the same regions.

When the locality chosen for a residence does not surpass 3230 or 4921 feet, none of those serious disturbances usually take place in the respiration and circulation which are observed at greater heights. It seems, on the contrary, that notwithstanding the decrease of atmospheric pressure, these functions are performed with greater ease and regularity.

The respiration becomes fuller and more complete, as if a considerable weight had been removed from the walls of the thorax. This sensation of wellbeing is expressed by the word *lightness*, applied to the air of mountains compared with that of the surrounding plains, which is designated by the opposite terms *heavy* or *stifling*.

The circulation likewise yields in a perceptible manner to the influence of moderate elevations; the pulse becomes calmer and more regular; a just equilibrium is established between the venous and arterial circulation, so that persons predisposed to congestions soon feel themselves greatly relieved after sojourning some time in a lofty locality. It is true that under the influence of a more complete respiration, as well as in consequence of a more active assimilation, a state of plethora frequently supervenes, and this, concurring with a weak atmospheric pressure, may bring on hæmorrhages; a circumstance which deserves serious consideration when it is contemplated to send to an elevated situation a patient predisposed to this kind of morbid affection.

Another effect, not less characteristic of climates of this description, is the activity they infuse into the muscular system. Nothing is more striking than the rapidity with which patients in a state of the utmost debility recover on high grounds the strength which they had believed to have been lost beyond recal. While, in the plains, a walk of a few minutes was sufficient to bring on intolerable fatigue, transported to the invigorating atmosphere of the Alps, they can spend with impunity many hours in roaming about them. The sensations, so novel in their character, which they then experience, find utterance in figurative expressions. Sometimes it is a cuirass which supports and encloses them on all sides, imparting a strength which seems inexhaustible; sometimes it is a facility of motion so great that they feel as if borne up above the earth. Accordingly, we often see frail and delicate beings, who in their ordinary mode of life calculate every movement, in order to avoid a fatigue disproportionate to their strength, yet who, when once they have reached the heights, are able to climb the steepest hills and undertake lengthened walks, drawn on by the wish to contemplate some beautiful view, or to gather some alpine flower to adorn their album.

Lastly, to conclude this view of the influence of heights on the muscular system, we may mention the rapidity with which the strength is recovered when it seems exhausted by long walking. This was often experienced by Saussure; and he describes it in the following manner: "The strength is repaired as speedily (and to all appearance as completely) as it has been exhausted. Merely a cessation of movement for the short space of three or four minutes, even without seating one's self, seems to restore the strength so perfectly, that on resuming progress, one feels as if able to climb at a single stretch to the very peak of the mountain. But in the plain, fatigue like this could not be overcome with so much ease."

The digestive functions are also considerably modified; the appetite becomes more active and regular; its cravings are more frequently felt, and it becomes necessary either to lessen the interval between meals, or to indulge in them more liberally. The kind of food may likewise be varied; for as the stomach bears a greater quantity, it also digests more easily substances which, in the plain, would occasion pain and indigestion.

But it is not merely the muscular strength, the respiration, and digestion, which are modified by the mountain atmosphere, it is more especially the nervous system on which it acts with greatest power. How many persons, enfeebled by too intellectual a life, have recovered, by this means, the power of thinking, and devoting themselves anew to the labours of the study? How many others, worn out with cares and anxieties, have recovered the tranquillity and equipoise of mind necessary to enter with success into active life? Others have found that excessive sensibility and cerebral excitement which renders the will powerless in moderating the tumult of the thoughts, gradually give way to its influence.

These are not the only respects in which the good effects of mountain air are observable; what contributes particularly to the restoration of health is the change it produces in regard to sleep. Persons accustomed to sleep heavily, dreaming much, and awakening almost as fatigued as when they went to bed, feel a great improvement in this respect; the sleep becomes tranquil and refreshing, and the entire constitution, as well as the nervous system, receive from it a salutary impression.

This effect of heights in rendering sleep lighter may sometimes produce sleeplessness in very impressible individuals, but it is seldom that this symptom continues beyond a certain time. When it happens to be otherwise, it is necessary to leave a residence found to be too exciting.

It is probably also in consequence of some modification of the nervous system that the atmosphere of mountains causes a very different state of feeling from that of the plain. At the same temperature, cold is much less felt on the heights, and occasions no disagreeable impression, thus permitting a longer stay in the open air, without any apprehension of bad consequences, even in the most delicate persons.

We may therefore conclude, by way of recapitulating the preceding facts, that if the respiration be freer, the circulation more regular, and the digestion more active, it is evident that it is by modifying the functions of assimilation and sanguification (hematosis), that the air of heights gives a new life to debilitated constitutions; and, on the other hand, that if the muscular vigour be increased, the sleep more tranquil, and the intellectual functions calmer, it is because the air of mountains exercises a twofold action on the nervous system—sedative as regards the brain, and stimulating in respect to the functions depending on the nervous centres, the spinal marrow, and the ganglions. It thus definitely appears that, when we wish to render nutrition more complete, and re-establish the equilibrium between the animal and mental functions, we should recommend a sojourn in some elevated locality; while we should carefully avoid the use of exciting therapeutic agents, whenever we have to do with plethoric persons, disposed to inflammations or hæmorrhages, and who are excessively nervous, or labouring under some organic disease accompanied with fever or great vascular irritability.

Let us now apply the results of our investigations to medical practice, and take a review of the different diseases on which the air of mountains may exercise a favourable or unfavourable influence.

III. *What are the Diseases which may be mitigated or made worse by a sojourn among Mountains?*

The atmosphere of heights exercises, as we have seen, a special stimulating action on the digestive functions; it is not surprising, therefore, that stomachs weakened by a too sedentary life, or injured by bad treatment, should derive benefit from a mountain residence. We frequently see invalids seized with gastralgia or dyspepsia in various degrees;

hypochondriacs with a sluggish and slow digestion; all *who feel their stomachs,* to use the expressive remark of a lady of my acquaintance, who indicated her state of perfect health by saying that she did *not feel any part of her body;* all patients who experience during digestion, heaviness, acidity, flatulence, or pains; to all such nothing can equal the invigorating action of high places, which not only restore the appetite, but render digestion easy and rapid.

I have myself had experience of this, by a residence of this kind after a bilious fever which had in some measure paralyzed my digestive powers. I had scarcely spent a few days at Mornex,* when my appetite and the power of digestion were re-established.

But there are two difficulties against which it is necessary to be on our guard; the first is the disproportion which often exists between the digestive power and the desire for food, the last being often so urgent that one would be tempted to indulge it, if great prudence be not used with regard to the quantity of food. The second evil against which it is necessary to guard, is the constipation which often comes on in high grounds, both in consequence of a more complete assimilation, and as the result of a peculiar influence on the peristaltic motions. This tendency must be speedily counteracted, as it cannot fail, combined with a more substantial nourishment, to bring on some gastric or intestinal derangement.

It naturally results from what has been said, that diarrhœas dependent on a state of weakness, or not induced by any organic cause, will be mitigated by an abode of this nature, provided always the precautions just spoken of be attended to. When the intestinal flux is produced or kept up by ulcerations or some disease of the liver, not much is to be expected from a mountain residence, except, perhaps, its giving some strength to a broken constitution, and thus resisting the ordinary consequences of an incurable malady.

We have seen that the atmosphere of high grounds exercises a powerful influence on hematosis, that the respiration is fuller, and the circulation more regular; it will therefore be under-

* Highest part of the village, 1857 feet; Bellevue Hotel, 1801 feet; Chapuis Hotel, 1630 feet.

stood that all classes of patients or convalescents in whom the blood is impoverished, either from primary or secondary causes, ought to derive from it a speedy improvement.

Experience in this case is in perfect harmony with theoretical inductions. In fact, convalescents who have been subjected to a lengthened regimen, long confinement, or an energetic antiphlogistic treatment, almost always find themselves improved on leaving the plain.

The case is the same with those suffering from chlorosis and anæmia, who speedily regain strength and colour under the same influence. We cannot insist too much on the benefit which this class of patients may obtain, such of them especially as have not been benefited by the use of iron and skilful treatment. This is likewise the case with chlorosis accompanied with cough and fever, which has so great a resemblance to acute phthisis, that the most careful practitioners are often deceived by it; nothing can equal the effect of heights in removing the cough as well as the fever, in restoring the appetite, and re-establishing the health.*

The same remark applies with still greater force to persons enfeebled by a long residence in warm countries. If they are merely debilitated by tropical climates, or seized with anæmia, in consequence of chronic hepatitis or frequent attacks of dysentery, I am unacquainted with any therapeutic resource for counteracting these morbid states comparable to the invigorating air of the Alps; and more than one patient can tell of the happy change it has wrought in them. What we can affirm in this respect of the mountains of Switzerland, the inhabitants of India and Africa can say of the Neilgherries and the Himalaya, and the heights which overlook the western coast of Africa, which would be the tomb of a much greater number of Europeans, without the valuable resource of mountain air, which preserves from pestilential effluvia, and imparts some vigour to constitutions exhausted by the heats of these inhospitable countries.

Finally, there is another form of chloro-anæmia which is likewise very notably mitigated by high grounds, I mean that

* See Dr Rilliet's Memoir on this subject. (*Archives de Medecine*, February 1855).

which results from frequent attacks of intermittent fever. Such a situation presents the double advantage of changing an air charged with deleterious effluvia for one essentially tonic, which exerts the most favourable influence on marsh anæmia, whether it be accompanied or not with anasarca and obstructions of the spleen.

In cases of dropsy, caused by some internal disease, not much advantage can be expected from such a change of air, but rather the contrary; for the activity imparted to the circulation and assimilation, as well as the almost absolute impossibilit of walking without going up hill, are at variance with the action of the therapeutic remedies required for this disease.

It is the same with confirmed phthisical cases, as the disorder advances with greater rapidity on high grounds than in the plain. The apprehension of hæmoptysis is another reason for preventing us sending to the mountains such as are threatened with phthisis. But when there is no hectic fever, and the tubercles are not far advanced, it is not rare to find the malady checked by sojourning in an elevated locality, provided it be exposed to the east or south. The experience of the medical men of Geneva is unanimous in admitting that the air of Mornex (1630 to 1856) unites in the highest degree the qualities indicated above; and that it exercises an eminently beneficial influence on diseases of the chest not far advanced, by allowing a certain amount of exercise and abode in the open air. Some villages situated on the hills which overlook Mornex appear to enjoy the same advantage.

The various forms of asthma and pulmonary emphysema, present very different results on heights; some of them are very considerably mitigated, so that the patients almost escape the oppressive paroxysms, and can take exercise and food without injury. There are even some of them who cannot breathe freely except on the mountains, and experience a sense of suffocation when they descend to the plain. But the contrary is observed in the greatest number; they suffer the more the higher the level above the sea. In all asthmatic patients, fine weather relieves the respiration, while humidity renders it difficult, and this remark particularly applies to alpestrine localities, where this class of patients ought never to remain after the weather becomes cold and damp.

Among the other disorders of the respiratory apparatus which are benefited by heights we may enumerate chronic pulmonary catarrhs, more especially when they do not depend on any organic disease of the heart. Those recovering from influenza or acute pulmonary catarrh are in the same condition, as well as patients suffering under hooping-cough. With regard to the latter, when the first month is over, nothing can effect a greater improvement than this remedy, provided, however, the place chosen as a temporary station have a good exposure, and combine the qualities we have ascribed to the climate of Mornex, which is justly regarded as highly favourable to this class of diseases. But it must not be forgotten with regard to this, as well as all thoracic complaints, that the air of mountains predisposes to inflammations, and that we ought to take into consideration this pathogenetic cause in a disease which so frequently becomes complicated with broncho-pneumonia.

We have seen that the muscular strength is greatly increased under the influence of which we are speaking; it will therefore be understood that all cases of paralysis, not connected with a state of cerebro-spinal congestion, ought to be benefited by this means. This is likewise observed in the weakness which so frequently complicates hysteria, as well as those which follow rheumatism in the joints, gout, and diseases of the spinal marrow. It is not rare, in the latter cases, to witness persons long confined to bed recover strength in a few days, and able to take pretty long walks without much fatigue.

But just as we have seen the appetite exceed the digestive powers, and require to be kept in check, so the same thing often happens with the muscular strength, which, under the excitement of a mountain atmosphere, sometimes appears to be more speedily and completely restored than it really is; hence often follows an excess of fatigue felt for a long ime afterwards, if the strength be pushed to the extreme limit of which it is thought capable. Accordingly, it is necessary to recommend great prudence, both with regard to the exercise taken on foot, and with respect to the amount of diet.

Diseases of the nervous system are also greatly relieved by an elevated residence. This is the case with hysteria and hypochondriasis in their different forms; with simple, (not rheumatic) neuralgia; megrims (hemicrania), which sometimes disappears suddenly on removing from the plain to the mountain; sleeplessness, which in the majority of cases soon yields to the same influence; finally, all the different forms of nervous fatigue, intellectual or cerebral, which, for the most part are favourably modified by the same means. With regard to chorea and epilepsy, they do not undergo from it any perceptible change.

The various irregularities of menstruation which have been mentioned above are among of disorders which appear to be in a manner quite peculiar, under the influence of the quality of the air. On heights, leucorrhœa is diminished; menstruation is more copious; while uterine discharges, which are increased by weakness, are very promptly and very remarkably mitigated.

With respect to other hæmorrhages, we have seen that the air of mountains aggravates them, when they depend on an excess of vitality or too active a circulation; but that, on the contrary, if they arise from a defect in the plasticity of the blood, there is no curative means equal to the vivifying influence of an elevated locality to restore the strength by putting an end to loss of blood in this way.

Hæmorrhoidal congestions become less frequent on heights, which assist the restoration of the equilibrium in the venous circulation. It is true that, under this influence, transitory congestions sometimes occur; but this crisis is rather favourable, and most frequently contributes to restore health and comfort to persons labouring under infirmities of this kind.

Finally, and to conclude this enumeration of cases which may be benefited by change of air, it may be affirmed, that of all who have been subjected to this influence none have undergone so rapid and complete an improvement as the diseases of children. Whether they be enfeebled by any acute or chronic morbid affection, or suffering from a state of diathesis, such as tubercles or scrofula, they seldom fail to recover strength and appetite; their colour becomes healthy, and that even in the space of a few days, which is for the most part sufficient to work such a change in these little patients as to make them scarcely recognisable.

And now that we have reviewed the various morbid affections which are modified by the atmosphere of heights, I have nothing more to do, in order to conclude this long investigation, than to make known the different localities which may be chosen, and point out the hygienic precautions requisite for obtaining all the benefit that may be expected from a therapeutic agent so valuable as that under consideration.

IV. *What are the Localities best adapted to different Diseases, and the Hygienic precautions necessary for a sojourn among the Mountains?*

Let us begin with making a few preliminary remarks on the circumstances calculated to favour success, and then take a review of the resources afforded by Switzerland and the neighbouring districts of Savoy, in order to accomplish the object indicated for this chapter.

The first remark, to which it appears to me of importance to attend, is, that it is necessary to proportion the height to the degree of sensibility of impression in the patients. Some of them are so truly sensitive in regard to change of air, that removal from the town to the country is sometimes sufficient to produce a considerable alteration in their state of health; it is not necessary, therefore, to go far, or to ascend high, in search of what may be found at the door.

Other persons are influenced by changes of height, apparently by no means considerable, but still sufficient to bring on a real transformation. For this class of patients, we may choose localities in the immediate neigbourhood of towns, and adapt them, in regard to height and exposure, to the susceptibility of impression and nature of the disorder we wish to remedy. We may apply these principles to some villages in the neighbourhood of Geneva, which, notwithstanding slight differences of level, possess very different atmospheric qualities. Similar observations have no doubt been made regarding other towns; but it is evident that I cannot enter into details of this nature without lengthening this memoir much beyond the limits assigned to me.

Let us now speak of the hygienic precautions necessary to derive the greatest benefit from an abode of this nature. The first and most indispensable is easy access, with a carriage road, and sufficient means of transport for conveyance thither, as well as for the exercise of convalescents or patients incapable of the fatigue of even a moderate walk. The second condition relates to lodgings, which ought to be comfortable, dry, well-aired, and admitting of being warmed, the latter being more necessary, as the changes of temperature are greater and more sudden. The third relates to diet, which ought to be substantial, varied, and suited to convalescents. One may carry with them supplies of tea, wine, or other secondary substances, if they wish to have them of superior quality. With respect to bread and flesh, the essential bases of all restorative alimentation, their good quality is of the highest importance if we wish to obtain full benefit.

The last two circumstances I wish to mention, are, the length of time to be spent among the mountains, and the season most suitable for the purpose; and I unite the two, as they are so intimately connected with the height of the locality selected as a residence. In fact, the higher the level, the more decidedly tonic and exciting are the qualities of the air: above 3937 or 4921 feet, therefore, the stay should not exceed six weeks or two months; while below 3280 feet, it may last without inconvenience for two or three months. It often happens that changes of place are necessary for success; because the body sometimes becomes very speedily habituated to the tonic air of heights, and the benefit gained at first will not fail to diminish unless we seek in a higher locality what we once found in a lower one. Sometimes, also, the excitement produced by this means exceeds proper limits, bringing on want of sleep, palpitations, frequency of pulse, or nervous agitation, when it becomes necessary to descend again to a milder climate.

With respect to the most favourable season, that depends, first on the height, secondly on the exposure. When the latter is to the south or east, and the height not great, as, for example, from 1968 to 2624 feet, one may leave the plain in the month of April or May; to places about 3280 feet, whatever may be the exposure, it is not possible to send patients before the end of June ; in regions so elevated as between 3280 and 4921 feet, July, August, and the first half of September are the only months in which one can reside, for any length of time. But, as may be readily supposed, a more or less southern exposure will cause exceptions to this general rule.

Having indicated the most favourable and the most necessary conditions for rendering a mountain residence of real benefit, it only remains for us to give some details, as abridged as possible, as to the resources which Switzerland and some of the adjoining parts of Savoy offer in this point of view.

No valley can be compared with that of the Leman for the variety of its sites. We there find, in fact, almost southern climates, where the oleander and pomegranate tree grow in the open air; while other localities present all the characters of northern climates, where the snow lies for six or eight months, and the vegetation is almost polar.

As an example of the localities where the air is mild and the temperature high during winter, we may mention Montreux and the surrounding villages from Villeneuve to Vevey; and, on the other hand, as sites truly alpestrine, we may name the Ormonds, St Cerques, Lallias, Glion, and many others, whose height varies from 3280 to 3937 feet. We shall commence by enumerating them in their geographical order, and afterwards classify them according to their meteorological properties.

If we take Geneva as a centre whence to set out in search of a place of abode for invalids, we shall find, as has been mentioned, many villages which, by their exposure and difference of level, present some of the characters of a mountain climate, when compared with the town. Such is the case with Lancy (1312), on the eastern declivity of a small hill exposed to all winds, and particularly to the north wind, which renders the air of this locality remarkably bracing; Jussy (1551), which is in a similar situation, and offers the same characters; Cologny (1495), and Bessinges (1636), where Colonel Tronchin has erected an establishment for convalescents which appears to exercise a very favourable influence on all who require to be strengthened; Burdigny (1531), Peissy (1640), and Choully (1656), which are brought very near Geneva by the railway, and offer most valuable resources to patients.

To the villages just named, may be added others whose situation singularly adapts them to such as require an air at once mild and stimulating, such as Champel (1364), Grand-Sacconex (1476), Petit-Sacconex (1453), Pregny (1485), Chambesy (1285), Chouny (1535), and Vaudoeuvres (1525). If we compare these different sites with the town of Geneva (1230), we shall not, perhaps, find the difference of level so considerable as to justify us in expecting much change, and yet medical experience testifies to the contrary; for I can refer to patients who experience very marked effects by a change of height not exceeding 65 or 98 feet; as, for example, from the lower part of the town to the highest streets, or to the plateau of Tranchées or Champel.

If we proceed from the immediate vicinity of Geneva to localities a little more remote, the first we meet with, as enjoying a well-deserved reputation, is Mornex (1630 to 1856), situate on the eastern and southern declivity of the Petit-Salève. This village, which is of great length, offers different sites, more or less sheltered from the north-wind, and has most of the properties we desiderate,—easy access, means of conveyance, comfortable lodgings, and a hydro-therapeutic establishment. Mornex thus enjoys a reputation to which it is well entitled.

Not far from Mornex is a village which forms a complete contrast to it. Situate in the gorge which separates the two Salèves, Monnetier (2335), possesses all the properties of a true mountain climate; the air is keen, constantly renewed, and the temperature lower than at Mornex, so that this locality may be regarded as essentially tonic, and consequently very suitable for patients and convalescents weakened by long confinement, or frequent relapses. Persons affected with anæmia, chlorosis, or hysteria, as well as those suffering from disorders of the nervous system, or liable to passive hæmorrhages, generally find themselves greatly benefited by a residence in this place during the summer months. It will be obvious that one ought to come to it later, and leave it earlier, than Mornex. We must not forget to mention two advantages possessed by Monnetier, and which render it more and more adapted to patients, namely, an excellent carriage-road, which enables the most delicate persons to reach it without quitting their coach, and the rebuilding of the old chateau, which has just been converted into a comfortable dwelling-house, where patients will find all that they can desire, in one of the most picturesque situations that can be found, a steep rock, from which there is a very extensive view of the plain, the lake, and the mountains of our valley.

If, from Monnetier, we ascend the heights of the Grand Salève we find, at 3842 feet, various chalets and dwellings, of a more or less comfortable description, which afford great conveniences to those who seek a truly alpestrine atmosphere. The Treize-Arbres, Grange-Gaby, and some others, situate either on the culminating point of the Salève, or on its eastern declivity, enjoy all the meteorological qualities favourable to health; and it is much to be desired that the intended buildings and carriage-road were speedily completed, that patients may be able to avail themselves of such a valuable place of resort in a neighbourhood so near Geneva.

If we leave the shores of the lake and ascend the course of the Arve to its source in the valley of Chamounix, we shall find various localities more or less suitable. On the sides of the Môle we come to the very picturesque chalets of La Tour (2956), where those who are satisfied with what is strictly necessary, without seeking for luxury or indulgence, will find a very agreeable abode among meadows and fir-woods, which rise to the summit of the Môle (6128). The same thing may be said of the chalets situate on the plateau of the Voirons, below the summits of the Calvaire (4777), and the Pralaire (4613), where the invigorating air will make ample amends for any defect of comfort.

The valleys of Samöens (2329), and of Sixt (2444), may likewise be chosen for the same purpose. Their easy access, and the boarding-houses and hotels lately established in these places, hold out inducements to patients to make them their residence.

Such, likewise, is the case with the village of St Gervais (2674), which is situate above the baths, on a very steep hill, and presenting the most varied prospects. The invigorating air of this place, the excellent hotel of Mont-Joly, and the delightful excursions which may be made to the places around, have long caused the village of St Gervais to be a residence highly appreciated by the sick and convalescents. All who have there recovered their strength and health retain the most agreeable recollection of it, and are ready to recommend their friends to follow their example.

Not far from St Gervais, lie the valley of Chamounix and the village of Prieuré (3451), which is well known as an object of picturesque excursions, and which in every respect deserves its European reputation, but which may also be sought for on account of its height and truly alpestrine climate. The great advantages in lodgings, diet, and means of conveyance possessed by the village of Chamounix, may in my opinion be turned to the best account by all whose health requires an atmosphere essentially tonic. The result has confirmed my anticipations; and it is from actual experience that I can recommend a sojourn of some weeks in this elevated valley. The most suitable season is that of the great heats, which are very endurable at Chamounix, owing to the currents of cold air which descend from the high peaks and refresh the atmosphere.

If we come back to Geneva, and turn towards the side of the Jura, we shall find, between the lake and the mountains, numerous villages, many of which are very well situated, and present favourable conditions; such as Divonne, which unites two advantages, an invigorating air and a well conducted hydro-therapic establishment; Crassier (1562), Gilly (1584), where there is a house for convalescents established by M. Eynard, and which daily renders great services; Gingins (1788) which has good boarding-houses; Aubonne and Lavigny (1712); Orbe (1466), and a few others.

As we approach the Jura, many localities occur, which present in various degrees the characters of mountain climates.

Such is the case with Vallorbe (2569), and the valley of the lake of Joux (3362), and particularly St Cergues (3432), a village placed at the entry of the passage of the Rousses on the eastern declivity of the Jura, in a very favourable exposure. The air breathed in this place possesses all desirable qualities, so that St Cergues during the summer season is either the abode of invalids, or a starting-point for excursions to the neighbouring summits, especially to the Dôle (5449), at the foot of which it is situated.

In the environs of Morges, Lausanne and Vevey, are to be found many stations which may be chosen for the purpose of which we are now speaking; such are the numerous plains situate on the high ground which overlooks Lausanne, between the Croisettes (2624), and the Chalet-à-Gobet (2838). Further to the east, the tower of Gurze (3044), and on the hills which rise above Vevey, between the lake and the Dent de Jaman, the sulphurous baths of Lallias (3448), where there is a well-managed establishment, wholly surrounded with woods and green sward; Charney (5334), which by its southern exposure unites the characters of a mountain climate with those of a mild and almost southern atmosphere; the Pleiades, situated at the foot of the mountain of that name (4488), to the north-west of Vevey; Avants (3212), where there is a good inn; and, lastly, Glion, one of the best localities, situated on an isolated round hill, immediately above Montreux, which it overlooks like an eagle's nest. On this picturesque site an excellent hotel has recently been built, at the foot of the Dent de Jaman, and in front of it one of the most beautiful views found in our valley, a position which has deservedly procured for it the name of the *Vaudese Righi.*

When we ascend the course of the Rhone, and leave the valley from Aigle on the way to the mountain, we find at the foot of the Diablerets a very picturesque valley, that of the Ormonds, which is divided into two parts. The Sépey, or Ormond-dessous, is 3704 feet in height; while the Plans, or Ormond-dessus, is 3815 feet. At some distance, in the valley of the Mousses, we find a good hotel, much frequented, especially by the English, at Comballaz (4426). These different localities, and particularly the latter, are situated, as has been seen, at a great height above the level of the sea; they accordingly enjoy an essentially alpestrine climate; the air is invigorating, the temperature moderate, even when the heat of the plains is intense. It is not surprising, therefore, that the Ormonds should be much frequented in the summer season. Sépey is reached by a good road, and the lodgings and diet are such as to leave nothing to be desired. Many invalids of my acquaintance have there obtained fresh vigour, bodily and intellectual; others, more easily impressed, have experienced vertigo and palpitations, occasioned by the keenness and rarity of the air; while the majority of them have derived substantial benefit from an abode in this delightful valley. But it must not be forgotten, that its considerable height does not admit of a visit before the month of July, nor a stay beyond the end or even middle of September, especially in the most elevated station, that of Comballaz.

Leaving the latter place, and crossing the Col du Pillon, we reach the valley of the Simmenthal and that of the Vaudese Gruyère, whose numerous villages have become, like the Ormonds, objects of excursions and places of abode. Chateaux d'Oex (3260) and Rossinière contain many boarding-houses, where everything may be found that can be desired.

The neighbourhood of Bex (1424) may likewise be selected for the purpose in view; the Plans (3674), Grion (4051), and Chesières (4002), do not supply all the conditions of easy access and comfort which may be desired, but the vivacity and purity of the air, as well as the vicinity of such a town as Bex, partly make up for these inconveniences.

On the other side of the Rhone, ascending the Val-d'Ilier as far as Champéris (3385), we come to the village of that name, in the bottom of a beautiful valley, situated on the eastern slope of the Tours-Sallières, at the point where the passage of the Cols de Coux and de Champ unite, and in a highly picturesque situation. The lodgings and victuals have been improved of late years, so that we may venture to recommend Champéris as a medical station, as well as a starting-point for excursions into the neighbouring valleys of Mont Blanc.

The Valais is rich in alpestrine localities, among which are to be specified Zermatt (5331) at the foot of Monte Rosa, and

Loëche (4458), both of which are very well known to tourists and invalids. They are placed at a great height, almost in the immediate vicinity of the glaciers, and consequently possess an essentially tonic atmosphere. Although Loëche is frequented chiefly for its thermal waters, there can be no doubt that its elevated position greatly contributes to the benefit of the numerous invalids who take up their abode there every year.

Immediately above Neufchâtel is the mountain of Chaumont (3845), where patients may reside with advantage. If we leave the capital of the canton and repair to the north-west, we arrive at the Vallées, which are so well known as the seat of manufactures, but which may likewise be resorted to as a mountain country by engravers and clockmakers who wish to re-establish their health without interrupting their work. They may choose, according to the nature of their occupation, either Locle (3021), Chaux-de-Fonds (3392), or Chaux-du-Milieu (3533).

In the immediate vicinity of Soleure rises the Weissenstein, where we find, at the height of 4206 feet, an excellent inn, well known to the inhabitants of the neighbourhood, who resort to it to be cured by drinking whey.

The Bernese Oberland, which is justly so much resorted to as one of the most beautiful countries of the world, may likewise become a place of rendezvous for all who wish to sojourn for a time among the mountains. They will find there very diversified stations, from the margin of the lakes of Thun and Brienz to the baths of Rosenlaüi. Let us notice some of these localities in succession, and endeavour to indicate the characters peculiar to each of them.

We may name, in the first place, the baths of Gurnigel (3789), where one breathes a perfumed air, in the midst of magnificent fir-woods, and having a most extensive view in front; all make use of the sulphurous waters. The baths of Blumenstein (2205) are much less elevated than these, but may in some respects serve similar purposes. The same may be said of Thun (1844), Interlacken (1837), Brienz (1916), Meyringen (1988), and still more decidedly of Lauterbrunnen (2595), Grindelwald (3432), or the baths of Rosenlaüi (4432), which, owing to their great elevation, cannot be visited except in the warmest months of the year. The immediate vicinity of the glaciers, and the numerous excursions which may be made in the neighbourhood, make Rosenlaüi a very agreeable station when the weather is fine, and the snows of the Scheideck have disappeared from the paths.

If we leave the canton of Berne and visit the lake of the Four Cantons, we find, in the first place, the Righi (5938), the most elevated abode in Europe, to which numerous invalids resort every year in search of some alleviation of their maladies, as well as the re-establishment of their strength, exhausted with fatigue or suffering. The establishment of Kaltbad admits of the combined use of cold water and the restorative air of the high Alps. Persons suffering from chlorosis or hysteria, and particularly hypochondriacs, obtain great relief by this combination of two means of cure contributing to the same object.

In front of the Righi, and on a promontory elevated 968 feet above the lake of Lucerne, stands Seelisberg (2405), a village admirably situated in a country which abounds in picturesque sites. It is accordingly a place of resort during a few of the warm weeks of summer, and a good number of convalescents and invalids can speak of the benefits they have derived from it.

Ascending the course of the Aa, we arrive at Engelberg (3389), in the centre of a delightful valley, rich in points of view and alpestrine walks, which have long made it in request by tourists and valetudinarians.

Returning to the most picturesque lake of Switzerland, and perhaps of the whole world, that of Lucerne, we find many villages on its banks which may be chosen for a temporary abode. The greater number of them have inns or comfortable places of residence; others are less fortunate, but of these the number is decreasing every day. A very comfortable inn has just been built on the Stossberg, at the height of 6978 feet, in a locality which commands an enchanting view.

In the adjoining districts, the canton of Appenzell has also its contingent of villages recommended by medical men. This is the case with Gais (3031), where visitors come to inhale the mountain air, and benefit by drinking goat's whey. Heinrichsbad (2516) and Weissbad (2690) are also much frequented.

In the neighbourhood of the lake of Zurich, there is an establishment on Mount Albis, where a trial can be made of the cold water treatment, as on the Righi. Dr Brunner's success is no doubt owing to his long experience in hydro-therapics, but the air respired at Albisbrunnen must also be a valuable auxiliary in the cure.

Lastly (for I must hasten to conclude this dry enumeration, which, notwithstanding its length, is no doubt very incomplete), I ought to say a few words on the most highly situated baths of Europe, those of St Moritz, in the canton of the Grisons, 5859 feet above the level of the sea. These ferruginous waters are very rich in mineral matters, and their efficacy is no doubt greatly increased by the position of the place where they are used.

And now that we have taken a review, following the geographical order, of the various villages or establishments which may be recommended to our invalids, it only remains for us to classify them according to their meteorological qualities, which depend especially on the absolute height, and also, though in a smaller degree, on the exposure and configuration of the ground. Keeping in view the whole of these circumstances, we may establish three classes, in which the different localities we have spoken of may be arranged.

I. *Climates at once tonic and soothing* (*below* 3280 *feet*).

Such is the case with Mornex, the villages of St Gervais, Sixt, Samoëns, Chernex, Seelisberg, and a few other stations in the neighbourhood of the lakes of Thun, Brienz, or Lucerne. The greater part of them are situated at a height which does not exceed 3280 feet, and their exposure is almost always eastern or southern.

The patients who ought to avail themselves of this climate, are the dyspeptic, the phthisical in the first stage, the neuralgic, the rheumatic, as well as those recovering from typhoid fever or hooping-cough.

The height and exposure render these different stations habit-able in the spring, and residence at them may be prolonged till autumn.

II. *Tonic and invigorating climates* (*about* 3280 *feet*).

We place in this category the village of Monnetier, the Chalets of Treize-Arbres on the Salève, those of Voirons, Chamounix, the baths of Lalliaz, Glion, Plans near Bex, Château-d'Œx, and Rossinière, the Ormonds, upper and lower, Champeris, and Louesche-les-Bains, Grindelwald, Engelberg, and Gais.

These different establishments are placed at an elevation of about 3280 feet, and if situated lower, they owe their meteorological qualities to a northern exposure, and local circumstances which admit of the atmosphere being frequently renewed.

The patients who can be sent to them with advantage are those affected with chloro-anæmia, hypochondriacs, some neuralgic patients, and such as are subject to passive hæmorrhages, and lastly, puny and scrofulous children.

The heights of these places being considerable, they should not be visited till about the end of spring, and they ought to be left after the autumnal rains have lowered the temperature.

III. *Climates essentially tonic and exciting* (*above* 3280 *feet*).

Such are Comballaz, Grion near Bex, the baths of Gurnigel and Rosenlaüi, the Weissenstein, Stossberg, and the Righi, and lastly, St Moritz in the Grisons.

The air breathed on these heights, which range between 3936 and 5904 feet, will be found too exciting for a great number of patients; but by using the precautions already referred to, some of them derive great benefit. Such is the case with a certain number of hysterical and hypochondriac subjects, as well as persons whose nervous system has been exhausted by too intense study or severe suffering. But it must be recollected that a sojourn of this kind cannot be extended beyond a few weeks, both on account of the exciting qualities of the rarefied atmosphere, and the coldness of the temperature after the summer months have elapsed.

CONCLUSIONS.

Having gone over the whole series of questions which mountain climates, considered in a medical point of view, present to our notice, it only remains for us, before concluding, to sum up in a few words the practical consequences which flow from them.

We have seen that the atmosphere of heights exercises a vivifying influence on the whole economy, which facilitates sanguification, renders digestion more complete, re-establishes the strength, and restores tranquillity to the cerebro-spinal nervous system.

In the second place, we have determined that this kind of climate predisposes to inflammations, hæmorrhages, and asthma.

On reviewing the series of localities most favourable to invalids, we have been able to classify them according to their meteorological qualities ; observing in some an air at once tonic and sedative ; in others, a climate tonic and invigorating ; in others, finally, an atmosphere essentially tonic and very exciting, which consequently is adapted to a very small number of invalids, and during a period comparatively of short duration.

Having then applied the results of experience to each of the localities enumerated, we have determined the curative indications applicable to each of them ; so that we have had it in our power, notwithstanding the difficulty of the subject, and the small number of documents relative to it which science possesses, to give some directions for making the most judicious choice both with respect to the different localities, and the different morbid affections which it is expedient to send thither.

May these researches, imperfect as they are, contribute to the cure or alleviation of any who are suffering, and we shall add with the poet,—

"Hoc erat in votis."

N.B.—We must refer the reader to a correction of some inaccuracies in Dr Lombard's paper, as given in a letter from Dr A. Smith, who was long a distinguished medical practitioner in Peru, and who was one of the first writers on the influence of elevation on diseases in the Andes of Peru. This letter appears in the "Extracts from Correspondence" in the present number of this Journal.—[*Edit. Phil. Jour.*]

The Chemistry of the Iron Manufacture of Cleveland District—(continued). By William Crowder, F.C.S., Newcastle-on-Tyne.

First Series.

Experiment No. 1, *at No.* 1 *Furnace, May* 20, 1856.

Table showing the load of Hutton stone, hæmatite, and limestone, actually at work at the time the specimens were taken.

N.B. In all these experiments the quantity of coke (30 cwt.) is used as a standard. Any variations in the burden being made in the stone and flux, but the quantity of coke is always the same.

	Cwt.	qrs.	lb.
Standard.			
Coke, . . .	30	0	0
Charge.			
Hutton stone calcined, .	37	0	0
Hæmatite, . .	2	2	0
Limestone, . .	12	2	0

These weights, calculated on the ton of iron produced, gave—

	Cwt.	qrs.	lbs.
Coke, . . .	38	1	2
Hutton stone calcined, .	47	0	23
Hæmatite, . .	3	0	21
Limestone, . .	15	3	2

Quality of the iron produced, No. 1.

Characters of the iron.—Colour dark grey, fracture open, exhibiting confused facets of graphite over the entire section of the pig; soft under the chisel. The pig exhibited a convexity at the edges; suitable for mixing with scrap or broken castings for foundry purposes.

Analysis of the Iron made at No. 1 *Furnace, May* 20, 1856.

Quality, No. 1.

Residue insoluble in dilute hydrochloric acid = 6·48 per cent.

Analysis of the Insoluble Matter.		*The same after calculating off the Oxygen.*	
Silica,	3·56	Silicon,	1·71
Alumina and trace of iron,	0·60	Aluminium,	0·31
Lime,	0·09	Calcium,	0·06
Magnesia,	0·11	Magnesium,	0·07
		Graphite,	1·86
		Combined carbon,	0·37
Soluble in Hydrochloric Acid.			
Silica,	0·20	Silicon,	0·09
Lime,	0·56	Calcium,	0·40
Magnesia,	trace.	Magnesium,	trace.
Protox. manganese,	0·18	Manganese,	0·14
Phosphoric acid,	1·27	Phosphorus,	0·56
Sulphur,	0·08	Sulphur,	0·08
		Iron,	94·35
			100·00
		Total carbon by chromate of lead,	2·23

The following is the composition of the iron when the soluble and insoluble constituents are added together:—

Silicon,	1·80
Aluminium,	0·31
Calcium,	0·46
Magnesium,	0·07
Manganese,	0·14
Phosphorus,	0·56
Sulphur,	0·08
Graphite,	1·86
Combined carbon,	0·37
Iron,	94·35
	100·00
Total carbon by chromate of lead,	2·23

The characters of the slags were:—

A, 9 A.M.—Compact; glassy on under surface; fracture dull; slightly honeycombed on the upper surface, which was covered with an exceedingly thin but distinct layer of well-defined crystals.

B, 12 N.—Crystalline texture.

C, 5 P.M.—Roughin. A mass of confused crystals, scattered through which may here and there be detected a few clusters of cubical or short prismatic crystals.

In this set the silica, alumina, and several constituents were repeated.

Analysis of Slags from No. 1 *Iron, May* 20, 1836.

	A, 9 A.M.		B, 12 NOON.		C, 3 P.M. Roughin.	
	I.	II.	I.	II.	I.	II.
Silica,	29·00	29·55	30·70	30·65	...	32·00
Protoxide of iron,	0·58	...	0·64	...	0·65	
Protoxide of manganese,					0·13	
Alumina,	23·73	22·95	20·35	20·75	21·22	22·30
Lime,	36·18	37·96	34·78	37·95*	33·62	33·93
Magnesia,	4·80	4·25	6·75	6·75	3·45	3·00
Potash,	...	...	...	...	0·48	...
Soda,	...	...	...	...	0·29	...
Sulphuret of calcium,	2·02	2·02	2·47	...	2·58	2·58
Phosphuret of calcium (Ca P),	1·57	1·42	1·57	...	2·34	2·31
	97·88	98·15	97·26	...	...	...
Sulphur,	0·90	0·90	1·10	...	1·15	1·15
Phosphoric acid,	2·20	1·98	2·20	...	3·26	3·20
Or Phosphorus,	0·96	0·87	0·96	...	1·43	1·41

FIRST SERIES.

Experiment No. 2, *at No.* 1 *Furnace.*

The second set of specimens from the same furnace was collected two days after, when on No. 3 iron, with a very similar burden of stone :—

	Cwt.	qrs.	lb.
STANDARD,			
Coke,	30	0	0
CHARGE.			
Hutton stone calcined,	37	0	0
Hæmatite,	2	2	0
Limestone,	12	2	0

These weights, calculated on the ton of iron *produced*, give :—

	Cwt.	qrs.	lb.
Coke,	38	0	2
Hutton stone calcined,	46	2	19
Hæmatite,	3	1	2
Limestone,	15	3	10

* The figures 37·95 for lime indicate the total quantity, as well as that which exists as sulphuret and phosphuret.

Quality of the iron produced = No. 3.

Characters of the Iron.—Upper part of the pig dark grey, from presence of graphite, gradually merging towards the lower part of the pig into a paler aspect, in consequence of absence of graphite; convex at the edges of the pigs; suitable by itself for foundry purposes. Transverse strength of a bar 3 feet between the bearings, 1 inch × 1 inch sectional area, upwards of 730 lbs.

Analysis of the Iron made at No. 1 *Furnace, May* 22, 1856.

Quality, No. 3.

Residue insoluble in dilute hydrochloric acid = 5·28 per cent.

Analysis of the Insoluble Matter.		*The same after calculating off Oxygen.*	
Silica, . . .	3·08	Silicon, . .	1·48
Alumina and trace of iron	0·52	Aluminium, . .	0·27
Lime, . . .	0·20	Calcium, . .	0·14
Magnesia, . .	0·16	Magnesium, . .	0·10
		Graphite, . .	1·10
		Combined carbon, .	1·15
Soluble in Hydrochloric Acid.			
Silica, . . .	0·24	Silicon, . .	0·12
Lime, . . .	0·58	Calcium, . .	0·41
Magnesia, . .	0·28	Magnesium, . .	0·17
Protoxide of manganese,	0·11	Manganese, . .	0·09
Phosphoric acid, .	1·77	Phosphorus, . .	0·78
Sulphur, . .	0·09	Sulphur, . .	0·09
		Iron, . . .	94·10
			100·00
		Total carbon by chromate of lead,	2·25

Subjoined is the composition of the iron when the soluble and insoluble constituents are added together:—

Silicon, . . .	1·60
Aluminium, . .	0·27
Calcium, . . .	0·55
Magnesium, . .	0·27
Manganese, . .	0·09
Phosphorus, . .	0·78
Sulphur, . . .	0·09
Graphite, . . .	1·10
Combined carbon, . .	1·15
Iron, . . .	94·10
	100·00
Total carbon by chromate of lead,	2·25

The following were the characters of the slags :—

A, 9 A.M.—Grey compact slag, with few traces of crystallization, except on the upper surface, where it is slightly developed.

B, 12 N.—The same as (A), but rather lighter in colour.

C, 5 P.M.—(Roughin) crystalline texture.

Analysis of Slags from No. 3 Iron, May 22, 1856.

	A, 9 A.M.	B, 12 NOON.	C, 5 P.M.
Silica, . .	30·00	31·00	31·50
Protoxide of iron, .	0·38	0·57	0·64
Protoxide of manganese,	0·24	...	0·14
Alumina, . .	24·78	25·87	23·61
Lime, . .	38·11	35·62	34·47
Magnesia, .	2·20	2·50	3·95
Potash, . .	...	...	1·31
Soda, . .	...	...	0·54
Sulphuret of calcium,	1·46	2·13	1·68
Phosphuret of calcium (CaP),	0·92	0·42	1·17
	98·09	98·11	99·01
Sulphur, .	0·65	0·95	0·75
Phosphoric acid, .	1·28	0·60	1·65
Or, Phosphorus, .	0·56	0·26	0·72

First Series.

Experiment No. 3, at No. 2 Furnace.

The burden of the furnace was as follows :—

Standard.	Cwt.	qrs.	lb.
Coke, . .	30	0	0
Charge.			
Hutton stone calcined,	47	0	0
Hæmatite, . .	3	2	0
Limestone, . .	14	0	0

These weights, calculated on the ton of iron *produced*, gave—

	Cwt.	qrs.	lb.
Coke, . .	32	1	17
Hutton stone calcined,	50	2	8
Hæmatite, . .	3	0	7
Limestone, . .	15	0	19

Quality of the iron produced = No. 5.

Characters of the Iron.—The bright graphite was observed to be entirely absent, and replaced by dull grey points on a pale ground, very aptly described by the term "mottled iron." Used for the manufacture of wrought iron.

Analysis of the Iron made at No. 2 *Furnace, May* 27, 1856.

Quality, No. 5.

Residue insoluble in dilute hydrochloric acid = 3·04.

Analysis of the Insoluble Matter.		*The same after calculating off Oxygen.*	
Silica,	1·48	Silicon,	0·71
Alumina and trace of iron,	0·44	Aluminium,	0·23
Lime,	0·20	Calcium,	0·14
Magnesia,	0·07	Magnesium,	0·04
		Graphite,	0·74
		Combined carbon,	1·83
Soluble in Hydrochloric Acid.			
Silica,	0·20	Silicon,	0·10
Lime,	0·34	Calcium,	0·24
Magnesia,	trace.	Magnesium,	trace.
Protoxide of manganese,	0·70	Manganese,	0·60
Phosphoric acid,	3·30	Phosphorus,	1.44
Sulphur,	0·16	Sulphur,	0·16
		Iron,	93·79
			100 00
		Total carbon by chromate of lead,	2·57

The following is the composition of the iron when the soluble and insoluble constituents are added together:—

Silicon,	0·81
Aluminium,	0·23
Calcium,	0·38
Magnesium,	0·04
Manganese,	0·60
Phosphorus,	1·44
Sulphur,	0·16
Graphite,	0·74
Combined carbon,	1·83
Iron,	93·77
	100·00
Total carbon by chromate of lead,	2·57

The following were the characters of the slags which in this case were taken respectively at 9 A.M., 12 N., 3 P.M., and 5 P.M., besides which a sample of the Roughin was also collected :—

A, 9 A.M.—Slightly crystalline, glassy on the under surface.

B, 12 N.—Blue colour, more crystalline than (A).

C, 3 P.M.—Slightly crystalline, glassy under surface, like (A).

D, 5 P.M.—Compact, stony fracture, glassy under surface, slightly crystalline on the upper side.

E, Roughin.—Dark grey, almost back, a mass of confused crystallization.

Analysis of Slags from No. 5 Iron, at No. 2 Furnace, May 27, 1856.

	A, 9 A.M.	B, 12 N.	C, 3 P.M.	D, 5 P.M.	E, Roughin
Silica,	30·90	32·75	31·90	32·00	33·55
Protoxide of iron,	0·64	1·15	0·80	0·38	0·45
Protoxide of manganese,	...	...	...	trace	...
Alumina,	24·26	22·51	24·42	22·35	20·46
Lime,	32·84	34·98	34·47	32·76	32·52
Magnesia,	2·95	2·49	4·30	5·46	6·52
Potash,	...	...	...	0·95	...
Soda,	...	...	...	0·43	...
Sulphuret of calcium,	2·88	2·47	2·70	3·01	2·88
Phosphuret of calcium (Ca P),	2·32	2·42	0·77	1·37	1·47
	96·79	98·77	99·36	98·71	97·85
Sulphur,	1·28	1·10	1·20	1·34	1·28
Phosphoric acid,	3·23	3·36	1·08	1·92	2·04
Or, Phosphorus,	1·42	1·48	0·47	0·84	0·90

First Series.

Experiment No. 4, at No. 2 Furnace.

This set of specimens, from the same furnace as before, was collected two days after, when the furnace was on strongly mottled iron, with a very similar burden to the preceding.

Standard.	Cwt.	qrs.	lb.
Coke,	30	0	0
Charge.			
Hutton stone calcined,	47	0	0
Hæmatite,	3	0	0
Limestone,	14	0	0

These weights, calculated on the ton of iron produced, gave—

	Cwts.	qrs.	lbs.
Coke,	32	0	16
Hutton stone,	50	1	12
Hæmatite,	3	0	24
Limestone,	15	0	0

Quality of iron produced = strongly mottled.

Characters of the Iron.—The characters previously described for mottled iron are more strongly developed, in the greater distinction between the dark points and the white background, showing an approach to their total absence, as in white or silvery iron; used in the manufacture of wrought iron.

Analysis of the Iron made at No. 2 *Furnace, May* 29, 1856.

Quality strongly mottled.

Residue insoluble in dilute hydrochloric acid = 3·72.

Analysis of the Insoluble Residue.		*The same after calculating off Oxygen.*	
Silica,	1·84	Silicon,	0·88
Alumina and trace of iron,	0·44	Aluminium,	0·23
Lime,	0·31	Calcium,	0·22
Magnesia,	0·14	Magnesium,	0·08
		Graphite,	0·86
		Combined carbon,	1·83
Soluble in Hydrochloric Acid.			
Silica,	0·12	Silicon,	0·06
Lime,	0·43	Calcium,	0·31
Magnesia,	trace.	Magnesium,	trace.
Protoxide of manganese,	1·51	Manganese,	1·18
Phosphoric acid,	3·61	Phosphorus,	1·58
Sulphur,	0·19	Sulphur,	0·19
		Iron,	92·58
			100·00
		Total carbon by chromate of lead,	2·79

The following is the composition of the iron when the soluble and insoluble constituents are added together :—

Silicon, . . .	0.94
Aluminium, . . .	0·23
Calcium, . . .	0·53
Magnesium, . . .	0·08
Manganese, . . .	1·18
Phosphorus, . . .	1·58
Sulphur, . . .	0·19
Graphite, . . .	0·86
Combined carbon, . .	1·83
Iron, ...	92·58
	100·00
Total carbon by chromate of lead,	2·79

The slags in this case were taken at 9 A.M., 11 A.M., 2 P.M., 3 P.M., and 5 P.M.; and the roughin not being all alike in colour, two specimens were selected for examination.

A, 9 A.M.—Very slightly crystalline; light grey colour; glassy under surface; slightly crystalline on top.

B, 11 A.M.—More crystalline than A; filled with large cavities containing crystals; glassy under surface.

C, 2 P.M.—Very crystalline; exceedingly glassy on the under surface, and also in streaks throughout the mass.

D, 3 P.M.—Same as C.

E, 5 P.M—Same as C and D, but less glassy.

F, Roughin.—Quite white, only slightly crystalline as compared with the preceding.

G, Roughin.—Black slag, almost devoid of crystalline texture. Honeycombed on the upper surface.

Analysis of Slags from Strongly Mottled Iron, at No. 2 *Furnace, May* 29, 1856.

	A, 9 A.M.	B, 11 A.M.	C, 2 P.M.	D, 3 P.M.	E, 5 P.M.	F, Roughin	G, Roughin.
Silica, . . .	33·40	33·45	34·05	33·20	32·75	35·35	36·85
Protoxide of iron, .	0·70	1·07	0·96	1·21	1·00	1·60	1·08
Protoxideof manganese	...	...	...	0·62	...	...	...
Alumina, . . .	24·21	26·80	25·85	20·80	26·48	27·86	24·42
Lime, . . .	33·91	34·01	35·40	32·41	33·11	27·97	31·29
Magnesia, . . .	4·54	1·50	1·85	7·34	3·50	5·33	3·28
Potash, . . .	1·23	...	...	...	...	...	...
Soda, . . .	0·56	...	...	...	...	...	...
Sulphuret of calcium,	3·10	2·88	2·43	2·79	2·63	3·42	2·70
Phosphuret of calcium, (Ca P.) . .	0·17	0·14	0·58	0·21	0·14	0·20	0·40
	101·82	99·85	101·12	98·58	99·61	101·73	100·02
Sulphur, . . .	1·38	1·28	1·08	1·24	1·17	1·52	1·20
Phosphoric acid, .	0·26	0·22	0·83	0·29	0·22	0·28	0·57
Or Phosphorus, .	0·11	0·09	0·36	0·13	0·09	0·12	0·25

Annexed are the preceding results tabulated for comparison.

FIRST SERIES.

	No. I.	No. 3.	No. 5, or Mottled.	Strongly Mottled.
Silicon,	1·80	1·60	0·81	0·94
Aluminium,	0·31	0·27	0·23	0·23
Calcium,	0·46	0·55	0·38	0·53
Magnesium,	0·07	0·27	0·04	0·08
Manganese,	0·14	0·09	0·60	1·18
Phosphorus,	0·56	0·78	1·44	1·58
Sulphur,	0·08	0·09	0·16	0·19
Graphite,	1·86	1·10	0·74	0·86
Combined carbon,	0·37	1·15	1·83	1·83
Iron,	94·35	94·10	93·77	92·58
	100·00	100·00	100·00	100·00
Total carbon,	2·23	2·25	2·57	2·79

SECOND SERIES.

Experiment No. 1, at No. 1 Furnace.

STANDARD.	Cwt.	qrs.	lb.
Coke,	30	0	0
CHARGE.			
Hutton stone,	35	0	0
Hæmatite,	2	2	0
Limestone,	12	1	0

These weights, calculated on the ton of iron produced, gave—

	Cwt.	qrs.	lbs.
Coke,	42	3	8
Hutton stone,	48	1	6
Hæmatite,	3	2	8
Limestone,	16	3	2

Quality of iron produced, No. 2.

The characters of this iron may be stated to be intermediate between the already described No. 1 and No. 3 qualities.

Analysis of the Iron made at No. 1 Furnace, August 1856.

Quality, No. 2.

Residue insoluble in dilute hydrochloric acid = 3·60.

Analysis of the Insoluble Residue.		*The same after calculating off Oxygen.*	
Silica,	1·00	Silicon,	0·51
Alumina and trace of iron,	2·00	Aluminium,	1·06
Lime,	0·22	Calcium,	0·15
Magnesia,	0·12	Magnesium,	0·07
		Graphite,	2·61
		Combined carbon	none.
Soluble in Hydrochloric Acid.			
Silica,	4·52	Silicon,	2·17
Lime,	0·27	Calcium,	0·19
Magnesia,	0·19	Magnesium,	0·11
Protoxide of manganese,	1.93	Manganese,	1·50
Phosphoric acid,	3·49	Phosphorus,	1·53
Sulphur,	trace.	Sulphur,	trace.
		Iron,	90·10
			100·00
		Total carbon by chromate of lead,	2·61

When the soluble and insoluble constituents are added together the composition of this iron is—

Silicon,	2·68
Aluminium,	1·06
Calcium,	0·34
Magnesium,	0·18
Manganese,	1·50
Phosphorus,	1·53
Sulphur,	trace.
Graphite,	2·61
Combined carbon	none.
Iron,	90·10
	100·00
Total carbon by chromate of lead,	2·61

The following are the characters of the slags which were taken at 9, 12, 3, and 5 o'clock :—

9 A.M.—White, compact, and very slightly crystalline, *without* glassy appearance.

12 N.—Do., honeycombed on the surface.

3 P.M.—Do., do., do.

5 P.M —Do., without honeycomb.

Analysis of the Slags from No. 2 Iron, at No. 1 Furnace, August 28, 1856.

	A, 9 A.M.	B, 12 N.	C, 3 P.M.	D, 5 P.M.
Silica, . . .	29·80	30·10	30·55	31·40
Protoxide of iron, .	0·38	0·26	0·32	0·38
Protoxide of manganese,	...	...	...	0·35
Alumina, . .	27·86	27·02	27·01	26·09
Lime, . . .	36·90	35·97	35·87	33·40
Magnesia, . .	0·88	3·00	2·37	By loss. 3·17
Potash, . . .	...	1·20	...	...
Soda, . . .	...	0·80	...	...
Sulphuret of calcium,	3·71	3·71	3·48	3·93
Phosphuret of calcium,	0·36	0·21	0·34	1·28
	99·89	102·27	99·94	100·00
Sulphur, . .	1·65	1·65	1·55	1·75
Phosphoric acid, .	0·51	0·29	0·32	0·50
Or Phosphorus, .	0·22	0·13	0·21	0·72

In the above analyses the sulphuric acid was determined for the sake of ascertaining whether the omission of this ingredient was likely to influence the analysis by omitting it in general. The following were the results :—

	9 A.M.	12 N.	3 P.M.	5 P.M.
Sulphuric acid, =	0·35	0·20	0·30	0·15

These quantities being so small, it was considered that the determination might safely be omitted, because, when the proneness of sulphuret of calcium to pass by oxidation into sulphate of lime is taken into account, there is little doubt that the sulphuric acid must have been formed after the slag had run from the furnace.

Second Series.

Experiment No. 2, at No. 2 Furnace.

Standard.	Cwt.	qrs.	lbs.
Coke . .	30	0	0
Charge.			
Hutton stone, .	50	0	0
Hæmatite, . .	2	0	0
Limestone, . .	15	2	0

These weights, calculated on the ton of iron produced, gave—

	Cwt.	qrs.	lbs.
Coke, . .	31	2	12
Hutton stone, .	51	2	9
Hæmatite, . .	2	0	12
Limestone, . .	16	0	7

The iron produced was strongly mottled, and similar to that of the first series.

In another experiment, which was carried on *day and night*, between the 31st of August and 8th of September, the yield of iron, as seen in the subjoined return, was almost the same as the above.

Return of the total quantity of material introduced into No. 2 *Furnace.*

	Tons.	cwt.	qrs.
Hutton stone, .	637	9	0
Limestone, . .	197	8	1
Hæmatite, . .	25	4	0
Coke, . .	378	0	0
	1238	1	1
PRODUCE,			
Slag, . .	427	5	0
Iron (quality strongly mottled)	246	0	0

Analysis of the Iron made at No. 2 *Furnace, August* 28, 1856.

Quality strongly mottled.

Residue insoluble in dilute hydrochloric acid, 4·24.

Analysis of the Insoluble Residue.		*The same after calculating off Oxygen.*	
Silica, . . .	0·44	Silicon, . . .	0·22
Alumina and trace of iron,	0·48	Aluminium, . .	0·25
Lime, . . .	0·20	Calcium, . .	0·14
Magnesia, . .	0·07	Magnesium, . .	0·04
		Graphite, . .	1·51
Soluble in Hydrochloric Acid.		Combined carbon, .	1·41
Silica, . . .	0·52	Silicon, . . .	0·25
Lime, . . .	0·52	Calcium, . .	0·36
Magnesia, . .	0·38	Magnesium, . .	0·23
Protoxide of manganese,	2·22	Manganese, . .	1.72
Phosphoric acid, .	3·94	Phosphorus, . .	1·74
Sulphur, . . .	0·23	Sulphur, . .	0·23
		Iron, . . .	91·90
			100·00
		Total carbon, by chromate of lead .	2·92

The following is the composition of the iron when the soluble and insoluble matters are added together :—

Silicon, . . .	0·47
Aluminium, . .	0·25
Calcium, . .	0·50
Magnesium, . .	0·27
Manganese, . .	1·72
Phosphorus, . .	1·74
Sulphur, . .	0·23
Graphite, . .	1·51
Combined carbon, .	1·41
Iron, . . .	91·90
	100·00
Total carbon, by chromate of lead,	2·92

The characters of the slags which were taken at 9, 12, 3, and 5 o'clock, were :—

9 A.M.—Light grey, very slightly crystalline, slightly honeycombed.

12 N.—Strongly honeycombed.

3 P.M.—Slightly crystalline, very slightly honeycombed.

5 P.M.—Dark grey colour, very slightly crystalline, honeycombed.

Analysis of Slags from Strongly Mottled Iron, at No. 2 *Furnace, August* 28, 1856.

	A, 9 A.M.	B, 12 N.	C, 3 P.M.	D, 5 P.M.
Silica, . . .	31·25	31·15	31·50	33·00
Protoxide of iron, .	0·45	0·64	0·64	23·00
Protoxide of manganese,	0·97	0·17	1·11	
Alumina, . .	24·58	24·35	20·89	
Lime, . . .	36·45	36·08	34·93	33·40
Magnesia, . .	3·19	5·22	6·60	7·10
Potash, . . .	0·71	...	...	...
Soda, . . .	0·22	...	...	...
Sulphuret of calcium,	3·02	3·03	3·17	3·06
Phosphuret of calcium,	0·20	0·29	0·28	0·36
	101·04	100·93	99·12	99·92
Sulphur, . . .	1·34	1·35	1·41	1·36
Phosphoric acid, .	0·23	0·40	0·38	0·51
Or Phosphorus, .	0·13	0·18	0·17	0·22

The above 31·25 per cent. silica in (A) 9 A.M., after weighing, was fused with carbonate of soda and potash, in order to ascertain whether the slags are completely decomposed by digestion in acid, and the quantity of silica obtained was 31·15, being a difference of 0·10, which is clearly no more than the loss which may be expected in repeating the analysis.

Second Series.

Experiment No. 3, at No. 3 Furnace.

	Cwt.	qrs.	lbs.
STANDARD.			
Coke,	30	0	0
CHARGE.			
Hutton stone,	35	0	0
Hæmatite,	3	0	0
Limestone,	12	0	0

These weights, calculated on the ton of iron produced, gave—

	Cwt.	qrs.	lbs.
Coke,	41	3	19
Hutton stone,	47	2	0
Hæmatite,	4	0	21
Limestone,	16	1	19

Quality of the iron produced = No. 1.

Characters of the Iron.—Similar to the No. 1 in first series. In this, as in the preceding experiment, a quantitative determination of the weight of slag and iron was also made, but with this difference, that in the present case the weights were only taken 12 hours a day, between 5 A.M. and 5 P.M., from August 21 to August 30; this includes stoppages.

Return of the quantity of material introduced into No. 3 Furnace and produce of Slag and Iron.

N.B. The experiment was only carried on 12 hours per day.

	Tons.	cwt.	qrs.
Hutton stone,	228	8	0
Hæmatite,	20	2	0
Limestone,	78	17	0
Coke,	201	0	0
Total material introduced,	528	7	0
PRODUCE.			
Slag,	169	3	0
Metallic iron,	96	14	0

Analysis of the Iron made at No. 3 *Furnace, August* 28, 1856.

Quality, No. 1.

Residue insoluble in dilute hydrochloric acid = 3·12.

Analysis of the Insoluble Residue.		*The same after calculating off Oxygen.*	
Silica,	0·64	Silicon,	0·29
Alumina and trace of iron,	0·72	Aluminium,	0·38
Lime,	0·17	Calcium,	0·12
Magnesia,	0·12	Magnesium,	0·07
		Graphite,	1·41
		Combined carbon,	1·09
Soluble in Hydrochloric Acid.			
Silica,	0·64	Silicon,	0·31
Lime,	0·34	Calcium,	0·24
Magnesia,	0·19	Magnesium,	0·11
Protoxide of manganese,	1·12	Manganese,	0·87
Phosphoric acid,	3·57	Phosphorus,	1·56
Sulphur,	0·04	Sulphur,	0·04
		Iron,	93·51
			100·00
		Total carbon by chromate of lead,	2·50

The following is the composition of the iron when the soluble and insoluble constituents are added together:—

Silicon,	0·60
Aluminium,	0·38
Calcium,	0·36
Magnesium,	0·18
Manganese,	0·87
Phosphorus,	1·56
Sulphur,	0·04
Graphite,	1·41
Combined carbon,	1·09
Iron,	93·51
	100·00

Total carbon by chromate of lead, 2·50.

The following are the characters of the slags which were taken at 9, 12, 3, and 5 o'clock :—

9 A.M.—White slag, dull fracture, slightly honeycombed.

12 N.—Very white, slight crystalline fracture, slight honeycombed.

3 P.M.—Do. do. do.

5 P.M.—Do. do. do.

Analysis of the Slags from No. 1 *Iron, at No.* 3 *Furnace, August* 28, 1856.

	A, 9 A.M.	B, 12 N.	C, 3 P.M.	D, 5 P.M.
Silica,	29·35	32·95	30·95	32·75
Protoxide of iron,	0·18	0·31	0·18	0·20
Protoxide of manganese,	0·30	0·40	0·25	0·20
Alumina,	21·46	21·07	23·90	21·26
Lime,	37·21	33·85	35·32	33·92
Magnesia,	6·20	6·79	3·21	5·96
Potash,	0·75	...	0·58	...
Soda,	0·48	...	0·41	...
Sulphuret of calcium,	3·93	3·60	3·84	3·76
Phosphuret of calcium (Ca P),	0·68	0·72	0·68	0·92
	100·54	99·69	99·32	98·97
Sulphur,	1·75	1·60	1·71	1·67
Phosphoric acid,	0·95	1·00	0·96	1·28
Or Phosphorus,	0·42	0·44	0·42	0·56

Annexed are the preceding results tabulated for comparison :—

SECOND SERIES.

	No. 1 Iron.	No. 2 Iron.	Mottled Iron.
Silicon,	0·60	2·68	0·47
Aluminium,	0·38	1·06	0·25
Calcium,	0·36	0·34	0·50
Magnesium,	0·18	0·18	0·27
Manganese,	0·87	1·50	1·72
Phosphorus,	1·56	1·53	1·74
Sulphur,	0·04	trace	0·23
Graphite	1·41	2·61	1·51
Combined carbon,	1·09	...	1·41
Iron,	93·51	90·10	91·90
	100·00	100·00	100·00
Total carbon,	2·50	2·61	2·92

An apparent anomaly is here observed in the production of No. 1 iron at No. 3 furnace, with a less consumption of coke than in the production of No. 2 iron at No. 1 furnace. This is one of those daily fluctuations to which furnaces are liable, from variations in quality of material and other circumstances.

THIRD SERIES.

The following series of slags and iron were from Messrs Bell Brothers, Clarence Iron Works, Middlesboro' :—

The burden of the furnace, &c. is not furnished in this instance, the object being rather to compare the results with those obtained at Messrs Cochrane and Company's, and also to assist in establishing a law which appears to occur in all cases in the gradual change of composition in the slags from 9 A.M. to 5 P.M. I shall have occasion to refer to this more particularly presently.

The slags in this instance were all fused, previously to treatment with acid, as some difficulty was experienced in making the silica filter rapidly when the decomposition was effected by hydrochloric acid. Otherwise the fusion with carbonate of soda was quite unnecessary, the effect being produced equally well with acid.

With this exception, their analysis was conducted as in the two preceding series of Messrs Cochrane and Company.

The slags were collected by my friend Mr Pattinson, the chemist to Messrs Bell Brothers, as well as the specimens of the iron which accompanied them.

Instead of collecting them at intervals of two or three hours, the slags were in this case collected every hour from 9 A.M. to 5 P.M., consequently there are in all nine specimens. It was not deemed necessary to make complete analyses of every one of these; I contented myself with an examination of three, and the silica alone was determined in the remainder.

The following were the external characters :—All white; the earlier ones having a dull fracture, increasing slightly in crystalline texture up till five o'clock; four and five o'clock, were slightly honeycombed.

Analysis of Messrs Bell Brothers' Slags from Foundry Iron.

	No. 1. 9 A.M.	No. 2. 1 P.M.	No. 3. 5 P.M.
Silica,	27·65	28·20	29·00
Protoxide of iron,	0·72	0·94	0·85
Protoxide of manganese,	0·35	0·15	trace.
Alumina,	24·69	23·45	23·40
Lime,	37·39	36·40	36·38
Magnesia,	3·55	3·55	2·80
Potash,	0·46	...	...
Soda,	0·99	...	...
Sulphuret of calcium,	4·39	4·84	4·61
Phosphuret of calcium,	0·43	0·93	1·18
	100·62	98·46	98·22
Sulphur,	1·95	2·15	2·05
Phosphoric acid,	0·60	1·30	1·65
Or Phosphorus,	0·26	0·57	0·72

The following are the determinations of silica in the intermediate hours; the above are also inserted for the connection:—

	9 A.M.	10 A.M.	11 A.M.	12 N.	1 P.M.	2 P.M.	3 P.M.	4 P.M.	5 P.M.
Silica,	27·65	27·75	28·50	29·00	28·20	27·00	27·50	27·00	29·00

Subjoined are the analyses of the specimens of iron taken on the same day from the same furnace:—

Analysis of Messrs Bell Brothers' Iron.

Quality, No. 1.

Residue insoluble in dilute hydrochloric acid = 4·40.

Analysis of the Insoluble Residue.		*The same after calculating off Oxygen.*	
Silica,	1·88	Silicon,	0·90
Alumina,	0·52	Aluminium,	0·28
Lime,	0·31	Calcium,	0·22
Magnesia,	0·16	Magnesium,	0·10
		Graphite,	1·40
Soluble in Hydrochloric Acid.		Combined carbon,	0·56
Silica,	0·72	Silicon,	0·34
Lime,	1·30	Calcium,	0·93
Magnesia,	0·27	Magnesium,	0·16
Protoxide of manganese,	0·59	Manganese,	0·46
Phosphoric acid,	3·68	Phosphorus,	1·62
Sulphur,	traces.	Sulphur,	trace.
		Iron,	93·03
			100·00
		Total carbon by chromate of lead,	1·96

The following is the composition of the iron when the soluble and insoluble constituents are added together :—

Silicon, . . .	1·24
Aluminium, . .	0·28
Calcium, . . .	1·15
Magnesium, . .	0·26
Manganese, . .	0·46
Phosphorus, . .	1·62
Sulphur, . . .	trace.
Graphite, . . .	1·40
Combined carbon, . .	0·56
Iron, . . .	93·03
	100·00
Total carbon by chromate of lead,	1·96

Analysis of Messrs Bell Brothers' Iron.

Quality, No. 3.

Residue insoluble in hydrochloric acid = 5·20.

Analysis of the Insoluble Residue.		*The same after calculating off Oxygen.*	
Silica, . . .	3·44	Silicon, . . .	1·65
Alumina, . . .	0·68	Aluminium, . .	0·36
Lime, . . .	0·27	Calcium, . .	0·19
Magnesia, . .	0·13	Magnesium, . .	0·08
		Graphite, . .	0·68
Soluble in Hydrochloric Acid.		Combined carbon, .	1·24
Silica, . . .	0·32	Silicon, . . .	0·15
Lime, . . .	1·04	Calcium, . . .	0·74
Magnesia, . .	0·27	Magnesium, . .	0·16
Protoxide of manganese,	1·04	Manganese, . .	0·81
Phosphoric acid, .	3·52	Phosphorus, . .	1·55
Sulphur, . . .	0·04	Sulphur, . . .	0·04
		Iron, . . .	92·35
			100·00
		Total carbon by chromate of lead, .	1·92

The composition of the iron when the soluble and insoluble constituents are added together, was—

Silicon,	1·80
Aluminium,	0·36
Calcium,	0·93
Magnesium,	0·24
Manganese,	0·81
Phosphorus,	1·55
Sulphur,	0·04
Graphite,	0·68
Combined carbon,	1·24
Iron,	92·35
	100·00
Total carbon by chromate of lead,	1·92

Analysis of Messrs Bell Brothers' Iron.

Quality No. 4.

Residue insoluble in dilute hydrochloric acid = 2·72.

Analysis of the Insoluble Residue.		*The same after calculating off Oxygen.*	
Silica,	0·60	Silicon,	0·29
Alumina,	0·52	Aluminium,	0·27
Lime,	0·20	Calcium,	0·14
Magnesia,	0·13	Magnesium,	0·07
Protoxide of iron,	0·16	Graphite,	1·06
		Combined carbon,	1.26
Soluble in Hydrochloric Acid.			
Silica,	3·24	Silicon,	1.55
Lime,	0·40	Calcium,	0·30
Magnesia,	0·13	Magnesium,	0·08
Protoxide of manganese,	1·38	Manganese,	1·06
Phosphoric acid,	...	Phosphorus	1·57
Sulphur	...	Sulphur,	0·03
		Iron,	92·32
			100·00
		Total carbon by chromate of lead,	2·32

The following is the composition of the iron when the soluble and insoluble constituents are added together :—

Silicon,	1·84
Aluminium,	0·27
Calcium,	0·44
Magnesium,	0·15
Manganese,	1·06
Phosphorus,	1·57
Sulphur,	0·03
Graphite,	1·06
Combined carbon,	1·26
Iron,	92·32
	100·00
Total carbon by chromate of lead,	2·32

Annexed are the preceding results tabulated for comparison.

	No. 1.	No. 3.	No. 4.
Silicon,	1·24	1·80	1·84
Aluminium,	0·28	0·36	0·27
Calcium,	1·15	0·93	0·44
Magnesium,	0·26	0·24	0·15
Manganese,	0·46	0·81	1·06
Phosphorus,	1·62	1·55	1·57
Sulphur,	trace	0·04	0·03
Graphite,	1·40	0·68	1·06
Combined carbon,	0·56	1·24	1·26
Iron,	93·03	92·35	92·32
	100·00	100·00	100·00
Total carbon,	1·96	1·92	2·32

General Conclusions.

The preceding analyses of slags and irons are exceedingly instructive. Without attempting to extort conclusions which are not perfectly obvious, attention may be directed to a number of facts, developed by the preceding investigation, which seem to indicate a progressive change both in the composition of the slags during their collection from morning till night, and in the composition of the pig-irons from No. 1 to No. 5.

In reference to the slags, it will be seen, that in the eight *sets* examined, the silica increases from 9 A.M. to 5 P.M., and the lime and alumina diminish. The magnesia does not appear to follow any rule; at least, it is not so obvious as that of the other constituents.

With regard to the sulphur and phosphorus, the small quantity of these ingredients, more especially of the latter, renders it very difficult to lay down a rule without exceptions.

Out of the eight sets, the general tendency of the sulphur was to increase from 9 A.M. to 5 P.M. in seven cases; whilst in one case it decreased, but only very slightly. The phosphorus also appears to follow the same law.

The texture is, as a general rule, progressively more crystalline from 9 till 5 o'clock. In the two experiments made on the large scale, the proportion of crude iron to slag was *in each case* exactly as 4 to 7.

The Crude Iron.

In the analysis of the crude iron, a great similarity is observable in the proportion of some of the ingredients, as, for example, in the aluminium, calcium, and magnesium.

The *manganese* appears to increase invariably from No. 1 to No. 5 quality.

Phosphorus also increases decidedly in two series; in the third series it is doubtful.

Sulphur increases slightly.

Graphite decreases from No. 1 to No. 5, whilst combined carbon increases; but this merely confirms an already ascertained fact.

The total quantity of carbon always increases from No. 1 to No. 5.

On a New Species of Eurypterus from the Old Red Sandstone, Herefordshire. By the Rev. W. S. Symonds, F.G.S., President of the Malvern Natural History Field Club.*

The best evidences of the succession of the Old Red Sandstone strata in England and Wales are to be seen along the range of the Black Mountains of Herefordshire, the Fans of Brecon and Caermarthen, the Gadir, near Talgarth, and the Scyrrid and Sugar Loaf, near Abergavenny. The succession and transition from the Upper Ludlow (Silurian) rocks into the Old Red rocks above, may be well studied near Ludlow, in Shropshire, Kington, Herefordshire, and Malvern, Worcestershire ; while the mass of Old Red rocks intercalated between the Silurians and the Carboniferous limestone shale, is estimated by Sir Roderick Murchison at "a thickness of not less than 8000 to 10,000 feet." (*Siluria*, p. 242.)

Commencing with the transition beds near Ludlow, we have there the fossil fishes *Plectrodus*, sp. *Onchus Murchisoni*, Ag. ; *Cephalaspis* (Pteraspis) *ornatus*, Egerton ; *Auchenaspis Salteri*, Egerton ; *Cephalaspis Murchisoni*, Egerton ; together with the crustaceans *Pterygotus anglicus*, Ag. ; *Eurypterus pygmæus*, Salter ; and the little mollusc, *Lingula cornea*, so characteristic of the Tilestones. In the Kington district, Mr R. W. Banks discovered many of the heads of those singular fish, *Pteraspis* (Kner.), so closely allied to *Cephalaspis*, associated with the remains of the crustaceans, *Pterygotus anglicus*, *Himantopterus*, and *Eurypterus pygmæus*.

Near Kidderminster, we have gray Tilestones passing upwards into true Cornstones, both the tilestones and cornstones being charged with the remains of *Cephalaspis Lyellii*, *Cephalaspis Lloydii*, *Pteraspis ornatus*, *Pterygotus anglicus*, and *Eurypterus*, the seed panicles called *Parkia decipiens*, and many other vegetable remains. These beds are no doubt Upper Tilestones passing into the Lower Cornstones, which are surmounted by the great overlying masses of Old Red Sandstone and Cornstones, which constitute the mass of so

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many of the rounded and wooded hills of Herefordshire, Shropshire, and Monmouthshire. Take away the elevated Silurian ranges, and the hills of Herefordshire are Cornstone groups, saved by their hard, impure limestones, from denudation; and though now separated by valleys often many miles across, were once as continuous as the rind of an orange. The *Cephalaspis Lyellii* is an abundant organism of these deposits, and occurs high up in quarries above Foxley and Moccas, near Hereford, on the flanks of Kentchurch Park, Monmouth Cap, and Grosmont Hills, and on the flanks of the Scyrrid and the Blorenge. It will be remembered that the *Cephalaspis Lyellii* is found in the Upper Tilestones, associated with the *Eurypterus*. Above the true Cornstones, near the summit of Kentchurch Park, on the top of Rowlestone Hill, near Eyas Harold, and on the flanks of the Black Mountains, near the Hay, we find a gray building stone of considerable thickness overlying the great mass of Cornstones already alluded to; these gray beds pass upward into dark and chocolate-coloured sandstones, which are succeeded by the quartzose conglomerate of the Upper Old Red. These gray building stones have lately furnished the remains of a well-preserved Eurypterus, a crustacean which is associated with Silurian fishes and shells at Kington, and Old Red Sandstone fish and plants near Kidderminster. For a drawing of this fine fossil I am indebted to Mrs Walter Burrow of Malvern; it was discovered by an intelligent labouring man in a quarry near the church at Rowlestone, between Hereford and Abergavenny, where I carefully examined the correlation of the beds, to which I was conducted by the Rev. W. Wenman, who had obtained possession of the Eurypterus. Mr J. W. Salter, of the Museum of Practical Geology, informs me that he has done me the honour to call the species *Eurypterus Symondsii*, and that he will describe it in the Decades of the Society. Mr Salter also tells me that the chief character of the species of Eurypterus "is the very wide front deeply margined, and the occurrence of those lateral rugæ so peculiar to this species."

Theory of Linear Vibration. By Edward Sang, Esq., F.R.S.E.

I.—*Notice of the Present State of the Theory.*

In the following pages there is given a strict analysis of the vibrations of a linear elastic system, from which all approximative operations are excluded, and which leads from the assumption that *the redressing tendency is proportional to the disturbance* to the enunciation of an absolutely general law.

This law does not harmonize with the usually received ideas concerning the propagation of sound, and seems, indeed, to be altogether irreconcileable to the undulatory theory of light, so that the train of reasoning which has led to it must necessarily challenge a close scrutiny.

The general problem, "To compute the motions of a system of bodies which attract each other according to a given law," has, as yet, been resolved in a very limited number of cases.

When the system contains only two bodies, the solution has been attained to for a considerable variety of supposed laws of attraction, the most important among which is, when the attraction varies inversely as the square of the distance. These solutions are accomplished by observing that each of the two bodies must move as if it were attracted to the centre of gravity, and by thus reducing the problem to the case of a single body attracted to a fixed point.

Beyond this the labours of the most eminent mathematicians have failed to carry us, except in one or two very restricted examples.

When the attractions are supposed to be directly proportional to the distances and also to the masses of the bodies, it is easy to show that the resultant of all the attractions exerted on any one body of the system must be directed towards the centre of gravity of the system, and must be proportional to the distance from that centre: so that, in this particular case, the law of the motion of the system can be completely investigated; and, so far as I know, this is the only variety of the problem of three bodies that has been solved.

Let A, B, C, D, &c., be the masses of a number of bodies which attract each other as the masses and distances jointly; then, ϱ being a coefficient common to all the system,

$$\varrho \,.\, \mathrm{A} \,.\, \mathrm{B} \,.\, \sqrt{\{(x_{\mathrm{A}}-x_{\mathrm{B}})^2+(y_{\mathrm{A}}-y_{\mathrm{B}})^2+(z_{\mathrm{A}}-z_{\mathrm{B}})^2\}} \qquad (1.)$$

is the value of the attraction subsisting between the two bodies A and B.

In order to compute the effect of this attraction upon the motion of the point A, we decompose it into three tendencies parallel to the directions x, y, z. Now, the cosine of the angle which the line AB makes with the direction x is

$$\frac{x_{\mathrm{B}}-x_{\mathrm{A}}}{\sqrt{\{(x_{\mathrm{A}}-x_{\mathrm{B}})^2+(y_{\mathrm{A}}-y_{\mathrm{B}})^2+(z_{\mathrm{A}}-z_{\mathrm{B}})^2\}}} \quad . \quad (2.)$$

wherefore the effect of the attraction (1), estimated in the direction x, is

$$\varrho \,.\, \mathrm{A} \,.\, \mathrm{B}(x_{\mathrm{B}}-x_{\mathrm{A}}) \quad . \quad . \quad (3.)$$

which is independent of the ordinates y and z.

The total tendency of all the attractions of the other bodies of the system to cause A to move in the direction x must therefore be

$$\varrho \,.\, \mathrm{A}\{\mathrm{B}(x_{\mathrm{B}}-x_{\mathrm{A}})+\mathrm{C}(x_{\mathrm{C}}-x_{\mathrm{A}})+\mathrm{D}(x_{\mathrm{D}}-x_{\mathrm{A}})+\&c.\}\,;$$

wherefore the second derivative of the variable x_{A} is

$$_{2t}x_{\mathrm{A}}=\varrho\,\{\mathrm{B}(x_{\mathrm{B}}-x_{\mathrm{A}})+\mathrm{C}(x_{\mathrm{C}}-x_{\mathrm{A}})+\mathrm{D}(x_{\mathrm{D}}-x_{\mathrm{A}})+\&c.\} \qquad (4.)$$

which, on adding zero in the form $\varrho\mathrm{A}(x_{\mathrm{A}}-x_{\mathrm{A}})$, and placing the origin of co-ordinates at the centre of gravity of the system, becomes

$$_{2t}x_{\mathrm{A}}=-\varrho \,.\, \Sigma\mathrm{M} \,.\, x_{\mathrm{A}} \quad . \quad . \quad (5.)$$

in which $\Sigma\mathrm{M}$ is used to denote the entire mass of the system.

It results from this value of the second derivative of x_{A}, that x_{A} is a circular function of t, viz.,

$$x_{\mathrm{A}}=\mathrm{U}_{\mathrm{A}} \,.\, \sin\,\{t\sqrt{(\varrho\Sigma\mathrm{M})}+u_{\mathrm{A}}\} \quad . \quad (6.)$$

in which U_{A} and u_{A} are two constants to be determined by the condition of the system at a given epoch.

Similarly for the other ordinates of the body A, we have

$$\left.\begin{aligned} y_{\mathrm{A}}&=\mathrm{V}_{\mathrm{A}} \,.\, \sin\,\{t\sqrt{(\varrho\Sigma\mathrm{M})}+v_{\mathrm{A}}\} \\ z_{\mathrm{A}}&=\mathrm{W}_{\mathrm{A}} \,.\, \sin\,\{t\sqrt{(\varrho\Sigma\mathrm{M})}+w_{\mathrm{A}}\} \end{aligned}\right\} \quad . \quad (6.)$$

Whence there results this remarkable law, that if a system of planets were to attract each other with intensities proportional to their distances and masses jointly, each of them would describe an ellipse about the centre of gravity as its centre; that all the periodic times would be identical, and that the positions of the orbits would be unchanging. Hence at every revolution the old phases and conjunctions would recur.

Now this supposition has considerable analogy with the condition of a congeries of elastic particles; while, at the same time, there is an essential distinction between the two. In an elastic system one body acts only on certain of the others—the coefficients of elasticity are not proportional to the masses, neither are the attractions proportional to the distances, but to the derangements of these distances from their mean state. The elastic system, therefore, wants the very conditions which rendered the previous problem resolvable. The supposition that the attractions are proportional to the distances of the attracting bodies enabled us to separate the variations of the three rectangular co-ordinates, and left us at liberty to treat the motions in the direction x as if those in the directions y and z had no existence; and the supposition that each body of the system attracts every other body, brought into play the property of the centre of gravity; therefore, as both of these suppositions are foreign to the character of an elastic system, this method of analysis fails to apply to it.

The theory of vibration which I am about to give, results from the complete resolution of the problem—"To determine the motions of a system of bodies, the attractions of which are proportional to their distances though not to their masses;" a solution which at once leads to that of the kindred problem—"To discover the law of the motions of a series of particles placed in a straight line and acting on each other by redressing tendencies proportional to the derangements of their distances."

Before proceeding to explain the peculiar artifice by which the variables are separated in the general equation of motion, it may be proper to pass under review the Newtonian theory of sound, since it was while seeking to remedy the glaring deficiency of that theory that I discovered the general principle from which the solution flows.

In order to discover the law according to which sound travels, Newton supposed a line of aërial particles, each acting on the two adjoining ones; and having imagined a peculiar species of vibration among these particles, he sought for the conditions under which such a vibration can exist. Having thus obtained a peculiar phase of the general law, he supposed the particles to become infinitely numerous, and arrived at an expression which he believed to indicate the velocity of sound.

The velocity supposed to be obtained in this way differs greatly from that found by actual observation, and various attempts have been made to remove the discrepancy. The most notable of these attempts is that of Laplace, who has taken into consideration the heat developed by the compression of air, and has argued that this development of heat must augment the coefficient of elasticity. Ivory has followed in the same line; and it has been tacitly admitted that this correction has reconciled the theory of Newton with observation.

For my own part, I never was able to see that Newton has demonstrated anything at all concerning the velocity of sound; or rather I have always felt perfectly satisfied that not one of the conditions of the problem enters into Newton's imaginary solution of it. While studying under the able and almost parental guidance of John Leslie I had ventured to urge this objection against Newton's logic. Careful and repeated revisions only served to confirm my belief in the soundness of the objection; yet I hesitated to lay it before the mathematical world. When such giant minds as Newton, Laplace, and Ivory, have concurred in assent, the gauntlet of an unknown and adventurous knight-errant might only have served to excite derision; but this objection has been strengthened by the long-sought-for and long-despaired-of discovery of a strict and unassailable analysis.

The experimental determination of the velocity of sound is accomplished by creating a sudden concussion, and by observing what time elapses ere the sound of it be heard at a given distance; and the problem is to discover, theoretically, what this time should be. The problem, in relation to discrete bodies may be stated thus:—

A linear series of bodies, A, B, C, ... K, L, M, is united by springs or other elastic connections. The whole being in a state of quiescence, an impulse is suddenly communicated to the one end, A: Query—In what time will that impulse be felt at the other end, M?

Let us see how Newton attempts to answer this question.

He imagines to himself a peculiar kind of vibration among these bodies. Each one is oscillating backwards and forwards about its mean position; the extents, and the periodic times of the oscillations, are all alike; but the bodies A, B, C, &c., are successively a little in retard of their antecedents in respect of the epoch of the oscillation. He then proceeds to inquire under what circumstances such an oscillation is possible; and this inquiry he conducts with great skill and clearness.

He takes two alternate bodies, as A and C, and supposes them to be, by any conceivable means, made to oscillate in the way described, and inquires what must be the relation between the elasticity of the connection and the data of the oscillations, in order that the intermediate body B may also oscillate in the same way.

Let U be the half extent of the oscillation of each body; x_A, x_B, x_C, the distances of each from its point of quiescence, e an unknown coefficient, and u the interval of time between the epochs of the successive oscillations. Then we may put

$$\left.\begin{aligned} x_A &= \mathrm{U} \,.\, \sin e\,(t \quad\ ) \\ x_B &= \mathrm{U} \,.\, \sin e\,(t+u) \\ x_C &= \mathrm{U} \,.\, \sin e\,(t+2\,u) \end{aligned}\right\} \quad . \quad . \quad (7.)$$

The first and the last of these motions, namely, x_A and x_C, are supposed to be derived from some extraneous source; and the question is, to ascertain whether an elastic connection between A and B, and another between B and C, can keep the intermediate body B vibrating in this way. Let ϱ be the coefficient of elasticity for these connections, then we must have

$${}_{2t}x_B = \frac{\varrho}{\mathrm{B}}\left\{ x_A - 2x_B + x_C \right\} \quad . \quad . \quad (8.)$$

from the action of the springs on the one hand, and

$${}_{2t}x_B = -e^2\,\mathrm{U} \sin e\,(t+u) \quad . \quad . \quad (9.)$$

from the supposed law of motion on the other hand; and our business is to see whether these two equations, (8) and (9), be compatible.

From the known properties of equidifferent arcs we find that equation (8) takes the form

$$_{2t}x_B = -\frac{U\varrho}{B}\left(2\sin\frac{eu}{2}\right)^2 \sin e\,(t-u), \qquad (10.)$$

and on comparing this with the preceding value of the second derivative of x_B, we have the same variable factor $\sin e(t-u)$ in both; wherefore, we conclude, that such an oscillation is possible, if the elasticity ϱ, and the interval of time u, be arranged so as to satisfy the equation—

$$e = 2\sin\frac{eu}{2}\sqrt{\left(\frac{\varrho}{B}\right)} \quad . \quad . \quad . \quad . \qquad (11.)$$

and if the intermediate body B be at first impressed with the proper velocity.

This is what Newton's demonstration shows; but it is all that it does show.

The corollary which Newton drew from this demonstration is remarkable for its beautiful simplicity.

If a fourth body D be placed beyond C, and be made to vibrate according to the law—

$$x_D = U \,.\, \sin e\,(t-3u) \quad . \quad . \quad . \qquad (11.)$$

then an elastic connection between C and D may be substituted for that extraneous influence which sustained the oscillation of C; and, extending this reasoning to any number of vibrating bodies, he reached this beautiful law, that,

If a series of bodies, A, B, C . . . . . K, L, M, *of equal weights be connected by springs, having their coefficient of elasticity* ϱ, *and if these be once made to oscillate according to the law—*

$$\begin{aligned} x_A &= U\sin e\,(t) \\ x_B &= U\sin e\,(t-u) \\ x_C &= U\sin e\,(t-2u) \\ x_D &= U\sin e\,(t-3u) \\ &\&c. \qquad \&c., \end{aligned}$$

then it is sufficient that the oscillations of the two extremes A *and* M *be maintained, in order to preserve those of all the others, provided the equation*

$$e = \text{chord } eu\sqrt{\left\{\frac{\varrho}{B}\right\}}$$

be satisfied.

In this paraphrase of the exceedingly concise and clear language of Newton I have retained all the essential parts of his reasoning, and have omitted only those considerations by means of which he passed from a discrete series to a concrete line.

The inference which Newton draws from this affords a notable example of *non sequitur*. The region of maximum density of such a pulsation must pass along the series with a velocity determined by the distance between the particles and by the time u; therefore, he concludes, sound must travel with this velocity. To take a homely, but not too forcible, illustration, this is to mistake the seeming longitudinal motion of the threads of a revolving screw for a longitudinal motion of the screw itself.

If I can show that some modes of vibration exist in which the regions of maximum density are stationary, shall I be able thence to argue that the velocity of sound is zero? or if I can prove that, in other modes of vibration, the epochs are coincident throughout the whole length, would that demonstrate the instantaneous transmission of sound? It is not enough to show that such and such a mode of vibration is possible; we must show that it results from the conditions of the problem. Now, the essential character of the Newtonian pulsation absolutely excludes the idea of transmission. The motion of the particle B depends not on that of A alone, but also on that of C: both A and C must be made to vibrate accurately in order that the elasticities of the connections may keep B vibrating in accord with them; and it is to be observed that these elasticities are not capable of communicating that oscillation to B,—they are only able to maintain it after it has been begun. So also with the series of bodies A, B, C, ... K, L, M: the oscillations of the first and last must be maintained, and those of all the intermediates must be begun simultaneously and accurately, otherwise their motions cannot be predicted by the formula. So far, then, is Newton's investigation from indicating the time in which sound is transmitted from A to M, that it actually presupposes the whole column A . . M to be sounding, in order to bring the motions within the scope of analysis. Nay, more: if the extreme bodies A and M be so far separated that $e \,.\, mu$ is half a revolution; that is, to say if A be at its extreme right when M is at its extreme left position, the very oscillations of A and M, which are consistent with the progression of epochs t, $t-u$, $t-2u$, &c., would also be consistent with the progression t, $t+u$, $t+2u$, &c. In other words, the same motions of A and M may support, indifferently, an oscillation which gives a progression from A to M, or one which gives a progression from M to A, according as the initial velocities of B, C . . . K, L are arranged. Hence, then, in order to test the result of Newton's reasoning by experiment, we must identify one of his pulses, and follow it along the vibrating column. It will be time enough to reconcile theory with observation when such an observation shall have been made.

As I have already said, the true conditions of the problem are represented by supposing a string of bodies A, B, C, . . K, L, M, connected by elastic ties and in a state of repose, to receive a sudden impulse at one end.

Perfectly satisfied that the only mode of determining theoretically the velocity of sound is to trace the effect of an impulse given to an elastic series in repose, I had often unsuccessfully attempted the solution of the problem as now stated.

When the railway was constructed from Manchester to Liverpool the problem again appeared, but with a new aspect; it became this,

To discover the effects of a collision upon a train of wagons fitted with elastic buffers.

Stimulated now by the practical importance of the subject I again and again renewed my attempts, but without success.

The moment that the body A begins to move, the spring which connects it with B is compressed, and B also begins to move: the spring between B and C is compressed, and induces motion in C, reacting also to retard the advance of B, and so on all along the series; wherefore even the initial motion of B cannot be ascertained without taking all the other bodies into account. The very first step, then, to the solution of the problem must be the complete integration of all the equations of motion.

In the month of November last (1855), while explaining to a young friend the source of the difficulties of the question, I was fortunate, by following out a particular train of thought, to discover a general method by which these integrations can be effected, and which readily extended to the investigation of the motions of a system of bodies which attract each other with intensities proportional to their mutual distances, though not to their masses.

(*To be continued.*)

On the Electric Fishes as the Earliest Electric Machines employed by Mankind. By GEORGE WILSON, M.D., F.R.S.E., Regius Professor of Technology, University of Edinburgh.*

Were the question put to a circle of scientific men, "With what form of electrical apparatus were mankind first acquainted?" we should be certain to hear much ingenious discussion concerning the date of Von Kleist's earliest Leyden jar (1745), Hauksbee's glass friction-machine (1709), and Otto Von Guericke's famous sulphur ball (1670). Few, however, would go further back than this primitive instrument, unless the magnet were included among electrical apparatus, which in the form of the compass-needle it cannot be; and even if we dignified with the name of instruments the pieces of amber and precious stones which the predecessors of Guericke rendered attractive and luminous by friction, we should gain nothing by going beyond 1600, when Gilbert, the introducer of the word *electricity*, published his truly scientific treatise "De Magnete." The discussion would thus range at utmost over only two centuries and a half; and as the Magdeburgh sphere of sulphur is the earliest artificial arrangement which can be fairly called a machine, our oldest electrical instrument is apparently less than 200 years old.

Such, accordingly, has been the conclusion of our historians of Electricity; nor did it occur to me, whilst prosecuting researches into the early history of electrical instruments, to doubt its accuracy. Last summer, however, I was directed towards a new channel of inquiry, by a paper read to the Archæological Institute at its meeting in Edinburgh by my colleague Professor Simpson, in which he drew attention to the application of the living torpedo as a remedial agent by the ancient Greek and Roman physicians, in demonstration of the antiquity of the practice of employing electricity therapeutically. I had not looked at the subject in this light before,

* Read to the Natural History Section of the British Association, at Dublin, August 27, 1857.

but inquiry soon satisfied me that a living electric fish was the earliest, and is still the most familiar, electric instrument employed by mankind. Before entering into the proof of this it is worth while noticing, that although the historians of Electricity have not overlooked the fact that the ancients were aware of the electrical powers of the torpedo, they have passed unnoticed the early therapeutic employment of the fish as a truth which, however interesting to the naturalist or the physician, had no significance for them. Priestley for example, in his "History and Present State of Electricity," 1775, refers to the gymnotus as "possessed of a kind of natural electricity, but different from the common electricity, in that persons who touch it in water are shocked and stunned by it, so as to be in danger of drowning" (vol. i. p. 497), and quotes Muschenbroeck's query, "whether the sensation communicated by the torpedo does not depend upon a similar electricity?" (P. 498.) But both references occur under "Miscellaneous Experiments," illustrating the then "present" state of electrical science, and no historical importance is attached to them. This is the more remarkable, that when Priestley wrote, the only electrical power known to characterize the fishes which he names was that of giving the "shock;" and so marvellous did this phenomenon appear to him, that he goes the extreme length of declaring, that "the electric shock itself, if it be considered attentively, will appear almost as surprising as any discovery that Sir Isaac Newton made; and the man who could have made that discovery by any reasoning *a priori* would have been reckoned a most extraordinary genius."*

It seems strange, after these statements, that Priestley should have given no place in his history either to the ancient recognition of the shock-giving power of the torpedo, or to its application as a remedial agent; but the explanation of his silence probably lies in the fact, that he was not fully satisfied that the shock of the torpedo or gymnotus was electrical. "It is to be regretted," he says, "that none of the persons who have made experiments on these fishes should have endeavoured to ascertain whether they were capable of exhibiting the phenomena of attraction and repulsion, or the appearance of electric light,

* Preface to first edition of History of Electricity (1767), p. xv.

as experiments of this kind are of principal consequence, and must have been easy to make."* Later historians of Electricity, especially those writing after the experiments thus referred to, had (in spite of their difficulty, which Priestley quite undervalued) been successfully made, have not failed to quote the classical references to the torpedo, but have attached no importance to its medical use ; and no Natural Philosopher, so far as I am aware, has even hinted the claim of the electric fishes to rank first in order of time among electrical instruments.

The subject is one of greater interest to physicists than to naturalists, but I bring it before the Natural History Section of this Association rather than before the sections devoted to Physics and Chemistry, in the hope of inducing naturalists placed in favourable localities to inquire how far uncivilized nations familiar with electric fishes employ their powers remedially.

The subject admits of a twofold division,—into, 1*st*, The antiquity of the practice of using the electrical fishes as remedial agents ; 2*d*, The extent or generality of that practice.

So far as I have yet ascertained, the fishes which have been or are thus employed, are limited to different species of the torpedo, the gymnotus, and the silurus or malapterurus ; the first a widely distributed marine genus, the second abounding in many of the rivers of South America, and the third in certain of those of Africa. Of none of these fishes but the gymnotus can it with certainty be affirmed, that those who made use of them were aware that they were electrical instruments ; and in the case of the gymnotus this remark applies only to its therapeutic use in very recent times. There is reason, indeed, to believe that it had been employed for centuries by the South American savages as a mysterious heroic remedy ; but in speaking of the zoo-electric machine as the earliest electric instrument, I must throughout be understood as looking at the living apparatus from a modern electrician's point of view.

The antiquity of the practice first concerns us, and must be rested chiefly on the case of the torpedo, as employed by the civilized dwellers on the shores of the Mediterranean. From their writings we can trace the practice back for nearly two thousand years ; certainly to before the Christian era.

* Op. Cit., vol. i. p. 498.

On this point I shall mainly be content to quote the statements of the Rev. C. David Badham, M.D., whose recent death lovers of science and literature equally deplore.* In his learned and most amusing volume, "Prose Halieutics, or Ancient and Modern Fish Tattle," he thus writes of the torpedo, under its Greek name Νάρκη ;—"Besides those Sicarian Skate, ... there is one of much smaller dimensions, but of far more marvellous powers, which, long before Leyden phials were invented, or the principles of electricity understood, had pressed this redoubtable agent into its service, and was wont to give practical lessons in the science to all who did not object to the 'charge.' The peculiar powers of this fish are cursorily alluded to, or commemorated at length, by a whole host of ancient writers,—

> 'Quis non edomitam miræ torpedinis artem
> Audit et emeritas signatas nomine vires?'

asks Claudian; Plato compares Socrates to a Narké, from that sage's well-known capabilities of electrifying his auditory; and its achievements have been amply detailed by Aristotle, Cicero, Plutarch, Pliny, Oppian, Ælian, Athenæus, and Galen." (P. 455). So far as medical use is concerned, Dr Badham observes, that "the electric properties of this enchantress of the sea suggested to ancient practitioners to try its efficacy in the cure of headache and painful nervous affections, by applying it epidermically; and Dr Galen, who seems to have been a strong homœopathist, advises the numb-fish (which he erroneously supposed to retain some electrical virtue after death and stewing) as a dish to paralytic patients, with a view to cure their numbness; no doubt on the *similia similibus* principle." (P. 459.)

Whether Galen held the theory which Dr Badham, half in jest, half in earnest, attributes to him, it is interesting to notice that the term torpedo (happily translated numb-fish), implies that the Roman physicians were more struck by the ultimate paralyzing effect of the torpedo's discharge than by the earlier convulsing one. Galen, indeed, referred the powers of the fish to its exertion of "a torporific action peculiar to itself" (Op. Cit. p. 456), so that we can scarcely say that he

* A brief sketch of this gifted man will be found in *Frazer's Magazine* for August 1857.

looked upon an electric fish as a shock-machine. We must not, however, attach too much importance to the mere name of the one electric fish known to the classical naturalists and physicians. The sensations excited by what a modern electrician would call the discharge of electricity, great in quantity, and moderately high in intensity, through the body, are in reality indescribable; but the ancient observers have depicted those sensations, to the extent that they had experienced them, as faithfully as any modern has done. We acknowledge, and escape the difficulty of precise description, by calling the sensations in question, as a whole, "an electric shock." And as the ancients were familiar with the "shock," though they had no single term for it, I count it no anachronism to say that the torpedo was for them as for us, a living, electric shock-machine. The title, it will be observed, is a distinctive one, applicable only to a few creatures. The observations of Galvani, interpreted and greatly extended by Matteucci, Müller, Dubois Reymond, and others, have shown us that the higher animals, and probably all animals, are in a true sense electric machines, but not that they are shock-machines. They constantly develop electricity; but to the slight extent that it acts externally to their bodies, its quantity is too small, and its intensity too low, to confer upon it the slightest shock-giving power; moreover, the animal cannot, by an act of volition, influence the electrical currents which it unconsciously develops. On the other hand, a few creatures, all scaleless inhabitants of the waters, develop electricity, great in quantity, high in intensity, and admitting, as the creature wills, of being retained latent, or set free with killing force. These fishes thus correspond to our artificial therapeutic electric instruments, such as the coil-machine, in the quantity and quality of the electricity they furnish, but differ from them in this important particular, that we cannot compel them to give a shock any more than we can compel a leech to bite or to suck blood. So much are we at the mercy of their will in this matter, that in the case of the torpedo, Badham, speaking of himself, says, "We were not able, during a long sojourn at Naples, to obtain one shock in our own person; while many lazzarone friends, who did not seek it, had frequently their arms 'astonished' (the word is Réaumur's) for a whole day after lugging a narké on board,"* How far the ancients realized this fact. of which to some extent they must have been cognisant, and what devices they followed to induce the torpedo to give its shock, does not appear very clearly from the Greek and Roman writings which have come down to us. Galen's ascription of similar properties to the dead as to the living torpedo, is not reconcilable with the belief that he was fully aware of the purely voluntary nature of the electric discharge. The same remark in all likelihood may be applied to the majority of the ancient practitioners who employed the torpedo in medicine. Nevertheless, it will be seen from their prescriptions, copied in the sequel, that they were generally strict in requiring that the fish should be alive, and whatever antiparalytic virtues Galen may have attributed to its cooked body, "he denies that it has any narcotic effect as a medicine, unless when applied alive" (*De Simpl.* vii.)† A similar conviction probably led to the cruel practice of boiling the living torpedo in oil, with a view to produce an anodyne liniment. On this point, as on others connected with the subject before us, we may look for more precise information than at present we possess when the great work on the Greek and Latin physicians, in course of publication at Paris, has made further progress.‡ Meanwhile, the following references to the torpedo, for the majority of which I am indebted to Dr Simpson, will sufficiently illustrate the electro-practice of the ancient physicians. I quote them in chronological order, so

* "Prose Halieutics," p. 456. It is notorious, also, that electric fishes of various genera have been kept for weeks, or even months, along with other fish, without exerting their fatal electric powers upon them. In the case of the torpedo, indeed, and perhaps also of the silurus or malapterurus, these powers are probably serviceable chiefly as means of defence. It is otherwise with the gymnotus, which systematically kills its prey by electric discharges. Its immense batteries, however, are much more powerful than is requisite for the slaughter of the small fish on which it lives, and are largely employed by it as offensive and defensive weapons. It appears, indeed, to be a pugnacious creature.

† See Dr Francis Adams' Commentary on Paulus Ægineta, vol. iii. p. 266.

‡ "Collection des Médecins Grecs et Latins publiée sous les auspices du Ministère de l'Instruction Publique, par le Dr Ch. Daremberg." Scholars in all parts of Europe are contributors to this important work, which, though chiefly concerned with Ancient Medicine, discusses incidentally nearly all the Sciences, Arts, and Usages of the Civilized Greek and Roman world.

far at least as centuries are concerned. Asclepiades, who flourished in the first century B.C., employed the torpedo in inflammation; but only fragments of his works have reached us. The following reference to these and other pre-Christian writings has been kindly furnished to me by my friend Dr Charles Wilson:—

"Of the application of the torpedo as a stupefacient, we find, besides, mention in several writers anterior to Scribonius: Nicander alludes to it; and Asclepiades, who practised medicine in Rome a century before Scribonius, employed it in inflammation; and Anterus, a freedman of Tiberius, was successfully treated for gout through the application of a live torpedo, by advice of Charicles."*

Pliny (first century) has many references to the torpedo. The following is one of the more general and speculative:—

"And then, besides, even if we had not this illustration by the agency of the echeneïs, would it not have been quite sufficient only to cite the instance of the torpedo, another inhabitant also of the sea, as a manifestation of the mighty powers of nature? From a considerable distance even, and if only touched with the end of a spear or staff, this fish has the property of benumbing even the most vigorous arm, and of rivetting the feet of the runner, however swift he may be in the race. If, upon considering this fresh illustration, we find ourselves compelled to admit that there is in existence a certain power which, by the very exhalations, and, as it were, emanations therefrom, is enabled to affect the members of the human body, what are we not to hope for from the remedial influences which nature has centred in all animated beings?" †

The succeeding quotations illustrate more precisely the mode of applying the torpedo:—

Scribonius Largus (first century) thus writes:—"Capitis dolorem quemvis veterem et intolerabilem protinus tollit, et in perpetuum remediat torpedo viva nigra, imposita eo loco qui in dolore est, donec desinat dolor, et obstupescat ea pars; quod quum primum senserit, removeatur remedium, ne sensus auferatur ejus partis. Plures autem parandæ sunt ejus generis

* "De Renzi, Storia della Medicina in Italia," t. i. p. 275.

† Natural History, Book xxxii., Chap. ii., Bohn's Translation, vol. vi. p. 4.

torpedines, quia nonnunquam vix ad duas tresve respondet curatio, id est torpor: quod signum est remediationis."*

Galen (second century) refers in similar terms to the treatment of headache: "Sed et torpedinem totam, dico autem animal marinum, capitis dolores sanare capiti admotam sedemque eversam coërcere à quibusdam est proditum. Verum ego quum utrumque essem expertus, neutrum verum comperi. Eam igitur cum cogitassem vivam esse applicandam, cui caput doleret, posse enim fieri ut hoc medicamentum anodynon esset, ac dolore liberaret similiter ut alia quæ sensum obstupefaciunt, ita habere comperi. Putoque eum, qui primus est usus tali quapiam motum ratione experiri aggressum."†

Aëtius, who wrote in the end of the fifth century, does little more than abbreviate the prescription of his predecessors:—"Torpedo viva apposita diuturnum capitis dolore depellit, et prolabentem sedem intrò pellit mortua verò, aut omnino non, aut modice hæc facit."‡

Paulus Ægineta (end of the sixth or the beginning of the seventh century), who, as his learned commentator, Dr Francis Adams, tells us, "continued to be looked up to as one of the highest authorities in medicine and surgery during a long succession of ages," thus condenses the opinions of his predecessors:—"Torpedo; when applied to the head, *while still alive*, in cases of headache, it procures relief to the pain, probably by its peculiar property of producing torpor; and the oil in which the *living* animal has been boiled, when rubbed in, allays the most violent pains of the joints." § The accomplished scholar, whose translation I have quoted, refers, in the relative commentary and elsewhere (*op. cit.*, vol. i. p. 359), to the general employment of the torpedo by the Greek, Roman, and Arabian physicians, adding the significant query

* De Comp. Medicament. cap. 1, from "Medicæ Artis Principes," vol. iii. p. 196.

† Galen's Works, edited by Kühn, vol. xii. p. 365. Reference is also made by Galen to the power of the torpedo in producing numbness or torpor, in vol. iv. p. 497, vol. vii. p. 109, and in vol. viii. p. 72, and p. 421, in the same edition of Galen.

‡ Tetrabiblon I. Sermo ii. cap. clxxxv., from "Medicæ Artis Principes," vol. ii. p. 96.

§ The Seven Books of Paulus Ægineta, translated, &c., by Francis Adams, published by Sydenham Society, vol. iii. p 266. See also vol. i. p. 359.

—"Is not this an application of the principle of galvanism in medicine?"

Marcellus (whom I quote out of order) prescribes standing on a live black torpedo, on a moist shore which has been washed by the sea, till torpor is felt through the feet up to the knee, as a cure for gout.*

From these accounts, and especially from that of Scribonius Largus, it appears that in the treatment of severe and obstinate headache, *e.g.*, the torpedo was laid on the aching head, or aching part of the head, and left there till it had thoroughly benumbed it. The fish was probably wetted occasionally with sea-water (as Marcellus plainly intends), or immersed in it, otherwise it must soon have ceased to be "*torpedo viva*;" but whether dead or alive, its good effects must have frequently been owing as much to its acting as a cold poultice or wet bandage, as to its efficiency as an electric machine. It was faith, however, in its electrical powers that led to its therapeutic use; and this is all that concerns the present inquiry.

How early the torpedo was employed in medicine cannot be precisely determined. The labours of Daremberg and his colleagues will doubtless throw light on this point; but as Scribonius Largus, Pliny, and other writers of the first century, all describe the medical use of the torpedo, and Asclepiades and Nicander refer to it a century earlier, it at least dates from before the Christian era. It is probable, also, that the ancient physicians borrowed their torpedinal remedy from the Mediterranean fishermen long after they had acquired faith in it; and altogether we may safely say, in round numbers, that the electrical machine, as embodied in the torpedo, is at least 2000 years old. It is probably very much older, for barbaric nations love what the French call "heroic" remedies; and the shock of the provoked torpedo is likely to have been held medicinal by the earliest fishermen of the Mediterranean sea. It would be interesting to ascertain whether the Italian sailors of the present day have any traditional respect for the torpedo

* "Aldrovandus de Piscibus, lib. iii. cap. 45. De Torpedine, § Usus in Medicina." To this elaborate work, which contains the whole literature of the ancient remedial use of the torpedo, I would refer those who wish to prosecute further the medical aspect of a question discussed here only in its relation to physics proper.

as a mediciner. It is sold in the Neapolitan markets as an article of food; but I do not know if Galen's successors agree with him in imputing to it medicinal virtues after it is cooked. Apparently not, but the naturalists and electricians of Italy, a country prodigal of both, will enlighten us on this not unimportant matter.

Another electric fish besides the torpedo was known to the civilized nations of antiquity, and to nations whose civilization is of much earlier date than that of the Greeks and Romans. The Nile breeds one, if not more electrical fishes; and when we remember what an inquisitive, intelligent people the ancient Egyptians were, and that both their medical skill and their practice of animal worship were likely to interest them in the singular endowments of the electric fish, we may well expect to find its powers chronicled, if not employed, by their priests and physicians. As yet, however, nothing has been extracted from either the hieroglyphics or the paintings on the tombs to fulfil this expectation. A very competent authority, indeed, adduces the *absence* of pictorial representations of the Nile fish from the Egyptian monuments as a proof of the special esteem with which it was regarded. "It might reasonably be expected," says Sir J. Gardner Wilkinson, "that the *raad*, or electric fish of the Nile, would be one of the most sacred, and forbidden for food; and it seems not to be represented among those caught in the ancient fishing scenes." He adds regarding it—"It is a small fish, and the one I saw measured little more than a foot long by four inches in depth, but it had the power of giving a very strong shock. It is the *Melapterurus* (*Malapterurus ?*) *electricus*, and may have been the ancient *Latus*."* Thus far Egyptian antiquity is silent as to the very existence of an electric fish; but the name by which the malapterurus is known to the modern Egyptians, has been referred to as proving that their predecessors had more or less precisely ascertained that the same force which is present in the thunder-cloud is present in the shock-giving fish. If this view is well founded, it is difficult to say how remote the period is to which we must carry back the commencement of

* Popular Account of Ancient Egyptians, vol. ii. p. 192.

electrical science, if not also of electrical art. Mr Murray embodies the questionable view of this subject in the statement, " the silurus of which we have to speak is the *silurus* of the Nile (*Malapterurus electricus*), called raasch [query raad ?], or thunder-fish, by the Arabs."*

Wilkinson, referring to the same subject, says, " The name *raad* (' thunder') is very remarkable, since the modern Egyptians are quite ignorant of its peculiar powers; and if it was borrowed by them from their predecessors, the question naturally arises, Were they acquainted with electricity ? "† The author probably intends here by " predecessors," the more ancient Egyptians, on whose customs and character he has thrown so much light. As the word *raad*, however, is Arabic, its origin, though ancient, may be much later than the latest of the Pharaohs. Assuming, as should seem, this view, Alexander Von Humboldt asks, " Did an ingenious and lively people, the Arabians, guess from remote antiquity that the same force which inflames the vault of heaven in storms is the living and invisible weapon of inhabitants of the waters ? It is said that the electric fish of the Nile bears a name in Egypt that signifies thunder." ‡ It might be pleaded in behalf of this view that the sagacious Arabian physician Averrhoes explicitly affirmed of the torpedo, as Dr Badham notices, that " the power which this fish possesses of affecting the skin, seems to be of a kind analogous to that by which the magnet acts upon steel,"§ and would have extended this explanation to the silurus. To what extent, however, this ambiguous utterance is to be understood as implying the discovery by Averrhoes of the bond which modern science has shown to unite electricity and magnetism, and the expression by himself or his countrymen of this truth in the name given to the silurus, it is needless to inquire, till we have disposed of the philological question, Does the word *raad* really signify thunder-fish ? The reply must be in the negative. Humboldt himself became satisfied of this, and states in a note to

* Edin. Phil. Jour., July 1856, p. 47.

† Popular Account of Ancient Egyptians, vol. ii. p. 192.

‡ Personal Narrative; Bohn's Edition, vol. ii. p. 131.

§ Prose Halieutics, p. 457.

the passage already quoted, "It appears, however, that a distinction is to be made between *rahd*, thunder, and *rahadh*, the electrical fish; and that this latter word means simply 'that which causes trembling.'"*

The question is one which only Arabic scholars can answer, and I have accordingly referred it to Mr Edward Stanley Poole, a learned Orientalist, whose decisive reply I give in full:—"I fear the electric fish of the Nile will not sustain the credit of my ancient Egyptian friends for scientific knowledge. The Arabic appellation of the fish in question, namely *raa'ád*, is certainly given to it on account of its *causing trembling*. This is sufficiently plain, from a comparison of words from the same root; and is expressly asserted in an excellent Arabic work 'Abdollatiphi Historiæ Ægypti Compendium,' p. 82. The Arabic appellation of thunder is somewhat different (*raad*), and has evidently originated from the supposition that thunder is a trembling, or a state of agitation of the clouds; or from its being a cause of trembling. For the former of these two derivations we have the authority of El-Beydáwee ('Commentary on the Kur-án,' ch. ii. v. 18). 'Raa'ád' is a generic noun, and 'Raa'ádeh' is a noun of unity, meaning a single fish of the kind called 'Raa'ád.'

"My reading of these words admits of no doubt, and is well known to Arabic scholars."

The modern Arabic name of the Nile electric fish thus does not justify the conclusion, that the Egyptians of past or present times believed that the shock of the fish was the same in nature as a lightning-shock. A name exactly equivalent in meaning is given, as Humboldt incidentally informs us, to the gymnotus as well as the torpedo, by the South American Spaniards "who confound all electric fishes under the name of *tembladores*, literally "tremblers," or "producers of trembling."†

At the present day the silurus of the Nile is sold in the markets of Cairo, and used as food.

The second point to be considered is the extent or generality of the practice of using electrical fishes as shock-machines. In

* Personal Narrative, vol. ii. p. 131.

† Ibid., vol. ii. p. 113.

this, however, as in other matters, it will be found that extension in space to a great degree corresponds to duration in time.

In ancient epochs the torpedo was probably employed medically on all the shores of the Roman empire, including our own, which it visited, and traces of its therapeutic use probably survive in some of them to the present day. I am unable, however, to indicate any such traces more precise than the recognition of the shock-giving powers implied in its vernacular titles, such as the Maltese "name of *Haddayla*, a term which has reference to its benumbing powers;"* the French one, *La Tremble;* and the English, specially expressive names, *cramp*-fish and *numb*-fish.

One modern people, however, makes use of the torpedo exactly as the ancients did, though whether as a tradition from the Mediterranean electro-physicians, or as an independent discovery, I have not the means of ascertaining. The Abyssinians, Dr Badham tells us, employ the torpedo (I presume from the Red Sea) in the treatment of fever. "The patient is first strapped to a table, and the numb-fish then applied successively over every organ of the body: the operation is reported to be both very painful and very successful."†

It is likely, from what I have to mention of other nations and other electric fishes, that the torpedo is still employed on many shores.

Next to the torpedo, the gymnotus is the most famous among electrical fishes, and it is by far the most powerful. The shock, indeed, of a large gymnotus is so severe, that no lover of heroic remedies, having one at command, need long for a magneto-electric coil machine. Several species or varieties of the fish occur, as Humboldt tells us, in the large rivers of South America, the Orinoco, the Amazon, and the Meta, besides frequenting their tributaries, and the smaller streams of an extensive bordering region. They have accordingly been familiar for centuries to the Indians, who are constantly reminded of their presence, even in rivers too deep to let them be caught or frequently seen, by the shocks which they feel

* Noad's Electricity, 3d edit., vol. i. p. 241.

† Prose Halieutics, p. 459. Badham does not give his authority.

when bathing or swimming in the river.* The shallower streams, also, and basins of stagnant water, near the sources of the Orinoco and elsewhere are, in this writer's words, "filled with electrical eels," so that their shock-giving powers are forced upon the attention of all visiting those districts; and we cannot but feel curious to know whether any therapeutic use has ever been made of living machines so powerful. At first sight it might appear that their very power had prevented their use. Humboldt mentions that "the dread of the shocks caused by the gymnoti is so great, and so exaggerated among the common people, that during three days we could not obtain one, though they are easily caught, and we had promised the Indians two piastres for every strong, vigorous fish."† And that this fear, however exaggerated, is in the main well founded, is rendered certain by the unexceptionable testimony of Humboldt himself, not only in his famous account of the battle between the wild horses of the savannahs and the gymnoti, whose favourite pools they reluctantly invaded, but also in his description of the effect of a gymnotus-shock received in full force by himself.

"It would be temerity," says he, "to expose ourselves to the first shocks of a very large and strongly-irritated gymnotus. If by chance a stroke be received before the fish is wounded or wearied by long pursuit, the pain and numbness are so violent that it is impossible to describe the nature of the feeling they excite. I do not remember having ever received from the discharge of a large Leyden jar a more dreadful shock than that which I experienced by imprudently placing both my feet on a gymnotus just taken out of the water. I was affected during the rest of the day with a violent pain in the knees and in almost every joint. To be aware of the difference that exists between the sensation produced by the voltaic battery and an electric fish, the latter should be touched when they are in a state of extreme weakness. The gymnoti and the torpedos then cause a twitching of the muscles, which is propagated from the part that rests on the electric organs, as far as the elbow. We seem to feel at every stroke an internal vibration, which lasts two or three seconds, and is

* Personal Narrative; Bohn's edition, vol. ii. p. 113.

† Op. et loc. cit.

followed by a painful numbness. Accordingly, the Tamanac Indians call the gymnotus, in their expressive language, *arimna*, which means 'something that deprives of motion.'"* We cannot wonder, then, that the Indians who had had experiences, such as Humboldt underwent, and who, unlike the philosopher, were unacquainted with the limits within which the shock-giving power of the gymnotus is restricted, should be unwilling to provoke its anger. This, however, has not kept them from employing it in medicine. All my information on this point is derived from Humboldt, and he does not enter into details, but the following statement is sufficiently explicit:—

"In Dutch Guiana, at Demerara for instance, electric eels were formerly employed to cure paralytic affections. At a time when the physicians of Europe had great confidence in the effects of electricity, a surgeon of Essequibo, named Van der Lott, published in Holland a treatise on the Medical Properties of the Gymnotus. These electric remedies are practised among the savages of America, as they were among the Greeks."†

I have not been able to obtain sight of Van der Lott's work, but Humboldt plainly records the Indian use of the gymnotus in medicine as a device of the Americans, not an imitation of European practice.‡

From a further statement it appears that the Spaniards had not taught this practice to the Indians, or borrowed it from them. "I did not," observes Humboldt, "hear of this mode of treatment in the *Spanish* colonies which I visited; and I can assert that, after having made experiments during

* Op. cit., vol. ii. p. 119. † Op. et loc. cit.

‡ We are indebted to the Dutch for our earliest knowledge of the gymnotus. Muschenbroeck (1762) quotes several of his countrymen as having written regarding it, and refers generally to the "Acta Haarlemensia," as containing further information on the subject. He does not, however, make any allusion to its medical use, although dwelling in exaggerated terms on its electrical powers (Introd. ad Philosoph. Natur., § 902–905). It is probable, nevertheless, that in the archives of the societies of Holland, references to the therapeutic employment of the gymnotus by the Indians will be found. Priestley, who quotes Muschenbroeck, but does not appear certain whether the gymnotus is not a sea as well as a river fish, adds a fact on the authority of Fermin (Nat. Hist. of Surinam, p. 59), which is of some interest, as the sequel will show. One of the Surinam electric fishes (probably a species or variety of gymnotus) is called "*Anguille tremblante*, the trembling eel." (History of Electricity, vol. i. p. 498.)

four hours successively with gymnoti, M. Bonpland and myself felt till the next day a debility in the muscles, a pain in the joints, and a general uneasiness, the effect of a strong irritation of the nervous system."*

On this point it remains to state, that even in Europe the gymnotus has been used as an electric machine in the end of last century. One sent from Surinam to Stockholm lived more than four months in a state of perfect health. "Persons afflicted with rheumatism came to touch it in hopes of being cured. They took it at once by the neck and tail: the shocks were in this case stronger than when touched with one hand only. It almost entirely lost its electrical power a short time before its death."† In this case, the gymnotus was known to yield electricity by those who employed it; but the practice was probably borrowed from the aborigines of its native country. At all events, it is quite certain that, alike without knowledge of artificial electrical machines, or acquaintance with the therapeutic uses to which the Greeks and Romans put the torpedo, the wild Indian doctors had made trial of the healing electric virtues of the living gymnotus.

Within the last three years a new electric fish has become known to us, belonging to the same genus as the *silurus* or *malapterurus* of the Nile. It is found in the muddy brackish water of the River Old Calabar, near Creek Town, which lies about sixty miles up that river. This stream empties itself into the Bight of Benin, within a short distance from the delta of the Niger, in lat. $5\frac{1}{2}°$ north, and long. 8° east. The fish, accordingly, has been named the *Malapterurus Beninensis* by Mr Andrew Murray, who has described and figured it in the *Edinburgh Philosophical Journal* for July 1855, p. 49. ‡

We are indebted to the zealous and intelligent missionaries of the United Presbyterian Church of Scotland, resident at dif-

* Op. et loc. cit. † Quoted by Humboldt, Personal Narrative, vol. ii. p. 121.

‡ Mr Murray's description of the *Malapterurus Beninensis* is preceded by an interesting *résumé* of the natural history of electric fishes. An important supplement to this paper is given in the *Edinburgh Philosophical Journal* for October 1855, which also contains a very valuable "Review of the present state of Organic Electricity," by Professor Goodsir of Edinburgh. The electrical powers of the living malapterurus are at present under investigation, and the authors named above will in due time make the results known. I confine myself solely to the special point of which this paper treats.

ferent stations on the River Old Calabar, for our knowledge of the new species of electric fish. Quite recently they have sent home living specimens, some of which are now in Edinburgh; and through the kindness of Professor Goodsir and Mr Murray, I, along with others interested in the electric energies of the animal, have had the opportunity of observing their shock-giving powers. The shock is a sharp one, felt from the fingers to the wrist, the elbow, or the shoulder, according to the activity of the animal, and the position in regard to it of the hands of the experimenter. The fish varies in length from two to twelve inches, is sluggish in its general movements, but retentive of vitality and electrical energy even in unfavourable circumstances.

As soon as my attention was turned to the remedial employment of electric fishes, I proceeded to inquire whether the Africans along the Old Calabar river made any therapeutic use of its malapterurus. But before my inquiries were completed, I learned that the natives did make this use of the fish. In truth, the fact had been published by Mr Murray two years ago, but I had overlooked the circumstance. The statement which is quoted below, is the more interesting, that it was not furnished in reply to queries, but was volunteered by Mr W. C. Thomson, who was stationed for several years at the Creek Town Mission station on the River Old Calabar. Mr Murray says:—"Mr Thomson tells me that the electric properties of the fish are made use of by the natives as a cure for their sick children. The fish is put into a dish containing water, and the child made to play with it: or the child is put in a tub or other vessel with water, and one or more of the fish put in beside it. It is interesting to find that a remedy which has only of recent years come into favour among ourselves should have been already anticipated by the unlettered savage, who probably has had the remedy handed down to him by tradition from remote generations."*

Unaware of this very precise announcement and inference, I applied to the Rev. W. Anderson, who brought from Old Calabar the living fishes at present in Edinburgh, and received the following answer:—

"In reply to your query, I have to state that I am not

* *Edin. Phil. Jour.*, October 1855, p. 379.

aware of any statement having been published in reference to the remedial properties of a shock from the fishes, neither have I ever seen them used in any way in sport;* but Mrs Anderson, to whom belongs all the credit of bringing the fishes home, testifies that the native mothers generally keep one of the fishes in a native-made bason, and that on washing their infants in the morning the practice is to dip either the hands or the feet of the infant, so as to cause it to receive a shock. This is done, they say, for the purpose of *strengthening* the child. The strong and the healthy have to undergo the operation as well as the weak and sickly." And that the fish is not an inactive agent in this singular process may be safely inferred from what follows—" So far as Mrs Anderson's observation goes, there is no liking for the affair on the child's part; plenty of struggling and squalling. The natives use the fish as food."

A third and independent account of the native usages in reference to the malapterurus has been kindly furnished to me by the Rev. Dr Somerville, who obtained it from Mr John R. Wylie, recently a teacher at Creek Town, Old Calabar, but at present in Edinburgh on sick leave. Mr Wylie says: "The Calabar women use this fish in the following manner: They put one or two, according to size, in a tub of water, and then wash their children (infants) in the tub with the fish and all. They must have a strong sense of the benefit derived from this, as in general they dislike doing anything which makes their infants cry; and this process makes them do so most lustily. They also make the children drink a great quantity of the water in which these fish have been. I have been in yards, and seen, on several occasions, the process described."

The ascription of remedial virtues to the water in which the malapterurus has been kept, is a fact of interest when taken in connection with the similar opinion entertained by the Greeks, according to Ælian, in reference to the water in which a torpedo had lain.

* This letter is dated August 6, 1857. Mr Anderson has very recently returned to this country, and whilst at Old Calabar, to which he almost immediately goes back, was shut out from English scientific periodicals, and too intently occupied with his religious duties to make investigations in natural history. The statement, accordingly, contained in his letter has all the value of an independent testimony.

After learning these facts, I was anxious to ascertain the native name of the malapterurus. Mr Wylie gives it as, "Ryak eke odumade owo," "*Fish which bites man*, or *Electric Fish.*" The Rev. Mr Anderson enters into greater detail. "The native name of the electric fish is Edidem or Edidim. Edidem is the word for *King*, or rather *Emperor*. Old Duke Ephraim, and King Eyamba, too, were called Edidem, *i.e.*, absolute monarchs, for they did what they pleased. King Eyo is not Edidem ; he is simply Aboug, *a chief, lord, ruler, limited monarch.*

But the word *dum* (pronounced like the Scottish *tume*, empty) means *to bite ;* and if the fish be called edidum or edidim (as some suppose the word to be pronounced), then the meaning is *the biter*, or *the biting*.

I cannot *here* express any opinion as to the correctness of either view. The word may mean *emperor*, *the biting*, or it may have another meaning still, "Edi idim," cont. edidum, "*it is in the spring*, or comes to the spring." * The meaning of the name is thus uncertain.

After the triple testimony adduced, it will not be doubted that the employment of the malapterurus as a remedial electric machine is an established practice among the natives of Old Calabar ; and few will question the justness of Mr Murray's inference, that the practice is one of great antiquity among them.

It thus appears, that the nations bordering the Mediterranean, the Abyssinians, the Indians of South America, and the dwellers on the western rivers of Africa, have independently used the torpedo, the gymnotus, and the malapterurus as living shock-machines. The practice certainly dates from before the Christian era, so far as the first-named fish is concerned, and in all probability is of much earlier date for all the electric fishes.

Two conclusions, accordingly, seem unavoidable ; namely, 1st, That the oldest electrical machine employed by mankind was

* After the reading of this paper was concluded, Sir John Richardson "read extracts from a letter to Dr Baikie, now engaged in exploring the Niger, in which that gentleman stated that he had met with an electric fish in Fernando Po, and which Sir J. Richardson believed was identical with the malapterurus, which had been described by Dr Wilson, from the coast of Old Calabar. The natives called this fish the "Tremble-fish" (*Athenæum*, 5th September 1857). Sir John Richardson informed me afterwards, that he understood this word, or rather its African equivalent, to be of native origin, and not a translation from any European language. This, however, is not quite certain.

the living electric fish; 2d, That the electrical machine most familiar to mankind is also the electric fish. The latter conclusion is of much less interest to myself than the former; and daily as galvanic batteries, and other electrical apparatus, are more widely known, it will become less significant. But as the present usages of uncivilized nations represent their past usages back even to a remote antiquity, the light in which a barbaric people still regards creatures so remarkable as the electric fishes is certain in most cases to illustrate the history of electrical science and electrical art. Writing as a physicist, I would remind naturalists, that it was the careful study of the powers of the torpedo that first enabled electricians to understand some of the most important laws of action of their artificial machines and batteries. I have elsewhere pointed out, that in Cavendish's "Account of some Attempts to Imitate the Effects of the Torpedo by Electricity" (*Phil. Trans.* 1776), will be found the first enunciation of "that distinction between *intensity* and *quantity* as affecting electrical phenomena, which has since proved so important a guide to the explication of electrical problems."* Faraday dwells largely on this point;† nor does it admit of the slightest doubt, that inorganic electricity, both as a science and an art, is very largely indebted to organic electricity, alike for the explanation of the laws which it obeys, and for the contrivances by which it works.

Every addition, accordingly, to our knowledge of the electric fishes has a value even for the pure physicist; and, so far as the present inquiry is concerned, it is important to remember, that we are as yet ignorant how many such fishes there are, and not less ignorant of the light in which many of those known to exist are regarded by the nations familiar with them. Apart from the marine genera not yet fully investigated, there is every reason to believe, from the statements of Humboldt and others, that undescribed species or varieties of the gymnotus occur in the South American rivers. Dr Barth, in his recent volumes,‡ also mentions that he saw at Yo, on the north shore of Lake Tsad, "*a specimen of the electric fish,*

* "Life of Cavendish," printed for the Cavendish Society, 1851, p. 466, where the whole question is treated at length.

† "Electrical Researches," third and fifteenth series, January 1833 and November 1838.

‡ "Travels and Discoveries in Central Africa," vol. iii. p. 36.

about ten inches long, and very fat, which was able to numb the arm of a man for several minutes."

Wherever they occur, it would be of interest to learn from the natives familiar with them,—1*st*, What therapeutic or other virtues, good or bad, they attribute to them. 2*d*, To what cause or source they impute their electrical powers. 3*d*, By what name they distinguish them. The name alone, fully interpreted, would often supply some answer to the first two queries. The appellations of Electric Fishes, already in use, are very significant, and divide themselves into two groups. Those in the first refer to the benumbing or deadening *sensation*, produced by the zoo-electric shock: those in the second to the involuntary *muscular contractions*, convulsions, or cramps, which follow all but the slightest electric shock. To the first group belong the Greek term Νάρκη, the Latin *Torpedo*, the Maltese *Haddayla*, and the English *Numb-fish*, which are exactly equivalent in meaning, and recognise mainly that painful, but complex nervous sensation, including both deadness and 'livingness,' which those ignorant of electrical shocks are familiar with as the sensation of one's foot or hand asleep. The Indian (*Tamanac*) name for the gymnotus, *arimna*, translated by Humboldt, "that deprives of motion," belongs to the same category, but perhaps signifies simply "deadening."

To the second group belong the Arabic *Raa'ád*, the French *Tremble* and *Anguille tremblante*, the Spanish *Temblador* and *Tembladera;* besides the Dutch *Sidderaal;* German *Zitteraal;* Swedish *Darrål;* and Danish *Krampeaal;* names for the Gymnotus signifying *Shudder-eel* or *Cramp-eel;* the African word translated by Dr Baikie *Tremble-fish*, and the English *Cramp-fish*, all of which, but especially the last, recognise the powers of the creature as a convulser or shock-giver.

Some of those words are doubtless but translations of older words of similar import. Others are as certainly independent applications of essentially the same name by nations, each of whom invented the term. In no language are the titles of the electric fish more expressive than in our own. A combination of the English names for the torpedo, so as to yield the term *Cramp-Numb-Fish*, would most happily designate any one of the electric fishes.

EXTRACTS FROM CORRESPONDENCE.

On the subject of Mountain Climates. By Dr ARCHIBALD SMITH, *in a Letter to the Editors of the Edinburgh New Philosophical Journal.*

GENTLEMEN,—Having resided as a medical practitioner for about twenty years in Peru, traversed its mountains and valleys, and attended much to the different Andine climates and diseases, as modified by elevation above the sea, it is not without satisfaction I now see those subjects taken up, and communicated far and near, in the pages of your accredited Journal.

But as I believe accuracy in the observation and statement of facts, to be *a sine qua non* in the progress of all scientific investigation, I beg leave to invite your attention to some inaccuracies which appear to have crept into the valuable article on "Mountain Climates considered in a Medical point of view," published in your recent number for July 1857, by Dr Lombard, from the Bibliothèque Universelle de Genève.

Without strict regard to the order of arrangement pursued by the writer of the article referred to, I shall at once take upon me to offer some restrictions on the statement about dogs and cats (p. 13).

"Cats cannot live at an elevation above 13,000 feet; carried to this height, they invariably sink, after being seized with very singular shocks of tetanus."

"Dogs bear up longer than cats, especially if they have been whelped in the country. Conveyed to these regions, they may continue to live there for one or more years, although seized with convulsive movements very like those in young dogs when attacked with the dog malady."

On the perusal of the supposed facts here asserted, I was so surprised, that to make assurance in my own mind doubly certain, I immediately wrote to a friend just returned from Peru, for more precise information about travellers' tales so novel as this extraordinary story about dogs in particular. The friend to whom I allude is Mr William Donavon, who passed *thirty years* in that country, where he is universally known and respected, and remarkable for his truthfulness and sincerity of character, as well as the extent and accuracy of his information concerning the Puna districts of the Andes, where he long and successfully employed himself at the mines. The following is his reply to my inquiries in a letter dated London, 4th July 1857:—

"As to cats in the Punas, we have them at Casacancha, Palcamayo, Huallay, in Cerro-Pasco, and in the haciendas around the Cerro. But I have always seen them look very stupid and inactive, always stowed away near the estufa or buchara (the fireplaces), as they could not bear the cold. Moreover, you know there are no mice nor rats in the Punas to call their attention. They do not live long there." Now to say that cats "do not live long" in the above-mentioned localities (not one of which is under 13,000 feet, while Cerro-Pasco is considerably above 14,000 feet), is not the same as to affirm that they "cannot live" at these heights. It appears that they do live, though they be not long-lived in those inhospitable climates, foreign alike to their constitutions and natural pursuits :—they inhabit those regions.

As to dogs, again, Mr Donavon writes,—"In the year 1843, I took to the Cerro a young bull-terrier bitch. She used to go out with me every day, and hunt the llamas on the Pampas. I brought her down to Lima with me once or twice. She never had a fit; but her puppies always died; for with the cold she could not rear one. Old Hodge* had a pointer and spaniel there for several years, and my bitch lived to the year 1852, being then about nine years old. In all the mineral 'haciendas' (grinding and amalgamating establishments), you have numbers of dogs from the coast and Quebradas, and they breed there. As to the shepherd's dogs, on the very coldest Punas you will find thousands of them."

Though from memory I cannot speak with precision concerning the cats, as my friend Donavon is able to do, I can certainly confirm, and that very emphatically, what he says above of the dog species. A dog of my own, cross-bred between an English pointer mother and a Newfoundland father, lived many years at the mines of Cerro-Pasco; and hundreds and thousands of other dogs besides, of which some were water dogs, others for the chase, but most of all sheep and watch dogs; nor can I charge my recollection in any way, that dogs from the warmer valleys that have got over the dog-sickness there, are unusually liable to convulsions on their arrival at the mines. I remember one instance of a bull-terrier belonging to a Cornish miner falling down dead, I believe of apoplexy, while jumping up and fondled by his master,—a solitary case, which might happen anywhere.

All over the pastoral slopes of the Cordillera and Puna ranges, up to the line of permanent snow (at 15,000 feet on northern aspects), dogs swarm round every shepherd's hut; and troublesome customers I often found them in approaching their quarters, which they are all open-mouthed to defend against strangers. And woe to the shepherd without his dogs, for then his flocks would be scattered, and his substance eaten up by the fox! Wherever there are sheep there must be a hardy race of dogs to guard them on the

* Captain Richard Hodge of Cornwall, who long resided in Cerro-Pasco.

lofty Punas, for these faithful animals always keep out of doors by night to watch the sheep gathered near the station, where the shepherd sleeps warmly in his hut.

The division into alpestrine regions, or those situated above 6560 feet, and the subalpine below this limit, which is said to "contain the greater part of the villages or establishments to which patients are sent" (p. 9), very well agrees with the old distinction of Sierra and Costa in Peru.

Thus, the coast climates, which consist of many gradations, extend from the shores of the Pacific to the deep gorges, or narrow ravines that lead to the "Sierra," which begins at the elevation of about 7000 feet, the usual limit of the rain-line on the western slope of the Andes. The coast lands, over a zone of 5000 feet, immediately underneath the rain-line, are rainless and arid in perpetuity; and throughout the other subjacent 2000 feet between this and the sea, the collines, or "lomas," as they are called, are periodically refreshed by sea-vapours and drizzle, and then they become covered with a beautifully luxuriant flowery verdure up to their very tops. This coast vegetation is most abundant about Lima in the months of July, August, and September.

But though the "Costa" division of Peru corresponds very nearly in altitude with the subalpine, as above defined, it differs materially in the other characteristic assigned; for it *does not* contain the villages or establishments to which patients are usually sent, either for the purposes of cure or convalescence. Indeed, if we except Chorrillos as a sanitarium for Lima in the winter months, irrespective of sea-bathing, the climate of the coast all under the elevation of the rain-line, where, as I have said, the Sierra begins, is abandoned by those in search of restoration to a firm state of health for the more invigorating Sierra or Alpestrine regions. And when the sick of the mountains descend to the coast for recovery, they come rather in search of a physician than of a mere change of climate; for the climate of the coast is that of ague, dysentery, and phthisis—diseases little known in the more temperate districts and villages of the upland country.

The term "Puna" appears to be used in Dr Lombard's paper very vaguely; and I know of no such place as "the Valley of Puna," so particularly mentioned at p. 10. The word Puna is not applicable on the Andine chains to any one spot in particular, but to all or any of the cold tracts of natural pasture-land above the elevation of 12,000 feet, where corn cannot attain maturity, nor lucern admit of cultivation. Small patches of green barley may be seen in the little inclosures about the houses in Cerro-Pasco; but even at Quinoa, three leagues lower down, barley rarely attains to perfect ear on account of the blighting frosts; but it produces plenty of "alcaser," or barley straw cut green, to feed mules and horses with in the Cerro. And this leads me to say, by the way, that the climate of Quinoa is very much milder than that at the mines, and resorted to with certain relief by those who suffer from the "veta," "seroche," or Puna sickness (all these names are given to the same ailment), in the Cerro. This disease is seldom, however, so durable or severe as to need any active medical treatment. I have only known one instance of its proving fatal, and that was by hæmoptysis on the Puna, at Casacancha or Palcomayo.* The victim was a youth just arrived from Spain, of a full habit of body, and florid complexion. The pulse, though much accelerated in the seroche illness, soon subsides even at the height of 14,000 feet. When residing at the Cerro-Pasco mines, during the whole of the year 1826, I transmitted regular medical reports of the Company to the late Sir Alexander Crichton, as one of the directors of the Peruvian Mining Company in London, and by referring back to my medical journal of that date, I find that when I dismissed my patients to convalesce, from the effects of acute disease, at our sanitarium in a milder region, the pulse is repeatedly stated by me at 80° in the Cerro.

In enumerating the different effects of a residence in alpestrine valleys, we are told (p. 11), "that the appetite is sometimes increased, but for the most part it is destroyed altogether." On this subject I can say of myself, and the fifty or sixty English under my inspection at Cerro-Pasco in 1826, that our appetite was anything but destroyed. After the symptoms of the seroche passed over, which happened in a few days, the appetite became keen and vigorous, even at that great height; but at our sanitarium Huarriaca, at the elevation of about 10,000 feet, our convalescents seemed never to weary of eating "*choclos*," or the tender maize, a very favourite kind of food in those parts. At Tarma and Obrajillo, too, about the same altitude, patients from the coast, weak, languid, and dyspeptic, in the subalpine climates, find the appetite almost at once restored as they ascend to these bracing hill-land climates.

We are further told, that in man the least exertion is attended with great fatigue in the alpestrine climates, and that beasts of burden lose their strength even more speedily than man, &c.

The fact is here too generally expressed, if it be meant to include the New World in this statement; for as regards Peru, it is only true of exotics, whether these be men or animals, *and that only*

* Had this youth been conveyed in a litter to a temperate climate at only 10,000 feet elevation, the hæmoptysis would have instantly and spontaneously ceased. It is properly a disease of the coast, from relaxation; and of the high regions of the central Cordillera, from congestion: both extremes are evaded at the elevation of from 8000 to 10,000 feet.

in lofty regions. At the height of from 8000 to 10,000 feet the power of muscular exertion is found to be greatly increased by the native of the coast who ascends to these Sierra climates. The native llama carries heavy burdens on the high Sierra table-lands with far more ease to itself than on the coast. And the native mountain Indian, with his naturally wide and well-expanded chest, is capable of his greatest activity of exertion, with the utmost freedom of respiration, on the cold Punas. It was proved to the satisfaction of all concerned at the Cerro mines, that the Indian born and bred in the adjoining districts and villages could work out his daily stem with a weight of hammer in hand which our powerful-looking Cornish men could not manage. Besides, the Indian, after his subterranean task was finished, used to ascend to open day through steep and slippery shafts, with a burden of ore on his back that would have sunk our less acclimated European to the bottom of the pit. This difference of muscular power between the Indian native and exotic European, was neither to be remedied nor accounted for by the habitual use of coca by the native. The source of the difference lies deeper,—in the organic adaptation of each to the peculiar element in which he was born and permitted to grow to manhood. Were the Cerro-Pasco Indian transported to Cornwall, with the help of all the coca in Peru at his command, he would have no chance with the Tribilcocks and Trewithicks of Truro! With respect to loss of strength on the Andine passes of steep ascent, just like continuous steps of stairs, it is wonderful how seldom the muleteer has occasion to stop his train of mules for the sake of a faint or weary one. True, dead carcases and skeletons "may be seen lying in the elevated passes," and so may they on the arid sands of the coast; and so would they in our streets if every carcase were allowed to remain, as in Peru, where the animal fell. There is no remedy; the old, or lean and diseased sore-backed mule must die in harness. But look to the shaggy Sierra-bred little mule, and see how easily it carries the allotted burden of ten arrobas ten pounds, over the snow-covered passes of the steep western Cordillera, and how lightly, in case of need, it can trot under the same weight over the plains of the Puna. Very fat horses, when pressed in ascending the Cordilleras, are sometimes known, not merely to stop to recover breath, but to fall down dead,—from pulmonary apoplexy I think.

We are further informed (pp. 12, 13), that at La Paz in Bolivia (formerly called Upper Peru), at the elevation of 12,234 feet bulls lose their "combative energies."

I have been long aware, that even the English bull-dog, after a year or two years' residence in Lima, and other relaxing climates on the coast of Peru, really lost his combative energies to a remarkable degree, becoming gradually tame and listless; and I have heard it said that bulls brought from a distance to fight in the ring there, also fell off very much in their combative energies when kept for some time in that climate before they were provoked to the combat; but now, for the first time I learn, that at the elevation of La Paz, these animals are subject to the same deterioration of courage. Cerro-Pasco is at least 2000 feet higher than the height ascribed to La Paz; but yet at Cerro our miners used to enjoy themselves at the bull-fights exhibited there during the Indian festivals; and some of the best fighting bulls are reared on the Puna pasture lands of Huamalies, and other upland provinces.

It so happens, that now-a-days there are never good bull-fights in the Sierra; simply because the Indians of the interior never understood the practice of this art like the dark Zambo of the coast, and much less could they imitate the scientific skill of the Spaniard in this national game of gladiatorship. At the Indian feasts we see the bull led on tied to a lasso, and with the points of his horns cut off, or covered with a knob of wood. And though thus disarmed and lassoed, yet the Indian does not venture to goad the animal to the fight until his own courage be artificially raised by rum or the maize beer called chicha. I suspect something of this sort must also have taken place at La Paz, when the curious traveller jotted down that at the elevation of 12,234 feet bulls were bereft of "combative energies." I, at least, would not like to encounter the untamed bull of the lofty Conchucos, or even the "*toro bravo*" of Junin, at the elevation of 13,000 feet.

I shall not detain you by following Dr Lombard through his enumeration and description of diseases as observed by Dr Tschudi in his travels over the elevated inland districts of Peru. But it may be a mere act of justice to the medical reader to say, that this clever writer and naturalist was never, that I heard of, a regular practitioner in Peru, nor admitted as such by the proper medical tribunal in Lima. His medical experience, therefore, must be considered as of a desultory character; and fairly to be received as the accidental incident of travel, in regions generally without the benefit of a resident physician.

His medical observation and practice on the Andine heights seem to have been different from mine. As an instance of this, I may invite attention to the Urticaria, which is described to be a common sequence of the seroche, or Puna sickness. I can only say that no urticaria-like eruption appeared as a sequel to the Puna sickness in the Pasco Peruvian Mining Company, and yet all of them had suffered more or less severely. I never witnessed any connection between this sort of eruption and the Puna sickness; but were the sequence either common or usual, it could not have escaped my observation under the circumstances of my professional duties to a public company.

The *Meningitis* of Dr Tschudi can be no other disease, I think, than the native Tabardillo, a fatal malady, which much resembles typhus fever, and might, with quite as great propriety, have been called Enteritis as Meningitis; for at one time the gastro-enteric, and at another the cephalic symptoms assume early prominence in the Tabardillo. In pleuro-pneumonia,* the "costado" of the Spaniard and native, it appears that Dr Tschudi pronounces bleeding unsafe; whereas with our people in the Peruvian Mining Company I found bleeding indispensable. *Were the Doctor's patients Indians?*

The Verruga is described as a "pustule or boil;" but it is neither the one nor the other, but just, as its name implies, a wart-like disease of the skin, in which the vascular papillæ, only covered by a thin pellicle at top, bleed profusely from time to time. Among the crop of verrugas some excrescences here and there attain to a considerably larger size than the general stock, and are distinguished by the epithet "verrugas madres" or mother-warts, which occasionally bleed much. This disease is chiefly seen on the western slope of the Andes, and within the rain-line, or in the dry and arid subalpine quebradas.

The reader who may desire to learn more of the climates of Peru in a medical point of view than I can here introduce from my own experience, I beg leave to refer to my *Practical Observations on the Diseases of Peru, described as they occur on the Coast and in the Sierra.* These observations I published in the years 1840 and 1842, in a series of papers in the *Edinburgh and Medical Surgical Journal*, and in 1856 I published an article, to which I may also refer, in *The British and Foreign Medico-Chirurgical Review* for October of that year. [But in referring to this article, which is titled *Influence of the Climates of Peru on Pulmonary Consumption*, I must correct the repeated mis-spelling of the name Tarma, which in the paper is incorrectly printed Zarma.]

Here I meant to have ended; but before doing so, let me say that, in the remarks I have offered at the suggestion of Dr Lombard's valuable contribution, I have been encouraged by that gentleman's own frank acknowledgment that he is still in search of more data and original observations to illustrate a subject of which he has only commenced the investigation. If any of my observations can facilitate his progress in the collection of authentic materials or facts, I will be pleased in thinking that I have not altogether neglected the opportunity of throwing my handful of gleanings into the gathering-in of his general harvest.

One more remark, and I shall have concluded. Turning again

* *Pleurodynia* and *acute rheumatism* were troublesome affections among the Cornish miners; and I have seen natives disabled by chronic rheumatism in the neighbourhood of Pasco.

to Dr Lombard's article referred to in the *Edinburgh New Philosophical Journal*, I read, under the head of "What are the Meteorological Characters of Mountain Climates?" p. 6, the following general proposition, which, if applied to the Andine climates, needs some limitation:—"The atmospheric pressure diminishes with the height, and the rapidity of evaporation increases with the diminution of atmospheric pressure. The higher, therefore, a locality is above the sea the drier will be the air, and the more speedily will it extract moisture from the bodies exposed to it." Now, I would crave leave to indicate that this rule cannot hold true universally, or in an absolute sense; for much of the effect here ascribed to elevation will depend on solar influence. In illustration of what now occurs to me on this subject, let me say, that during the dry season in the Sierra or alpestrine regions of Peru, I observed that in Cerro-Pasco the sun by day was very scorching, while by night the air was of the freezing temperature. About the height of this season, say July and August, the fauces in many cases, more especially in the white or European race, became so desiccated over night, that one so affected would awake in the morning, having the throat and nostrils incrusted with a dried-up mucous secretion. But in the same locality, during the wet season, that is from November to May, when Fahrenheit's thermometer rarely rises above 42°, or falls so low as 36°, nothing of this painful incrustation is observed in the fauces and air passages: Here, then, at the same elevation, the drying process is greatly influenced by sun and season.

In the subjacent valley of Huanuco again, at the elevation of from 6000 to 7000 feet, the air is more uniformly *dry* and serene than at Cerro-Pasco at 14,000 feet, throughout the whole year; and for months no dew is observable, nor is there moisture sufficient in the air to support natural pastures on the adjacent mountains generally, though by irrigation the plains and lower hill-slopes are in the enjoyment of a perpetual spring, and never-ending supplies of fruit, flowers, and crops. But what is true of the relative dry state of the atmosphere on the western slope of the Andes is not so at the same corresponding elevations on the eastern slope: the ascent on the western or Pacific Ocean aspect, is estimated at 232 feet to the mile, while on the eastern or Atlantic side the slope is but 152 feet to the mile. We have seen that the whole sub-alpine range of climate on the western side is nearly rainless, and a zone of about 5000 feet of it absolutely rainless. Whereas on the eastern side, the whole corresponding subalpine region, as far as altitude is concerned, is one continuous forest, with an atmosphere far more damp and humid than that of the lofty Cordillera, for at least eight months in the year. Lieutenant Herndon assures us that the indications of the barometer at the eastern foot of the Andes is not to be depended on. He says, that "the trade-winds are dammed up by the Andes; and that the atmosphere in those parts is, from this cause, compressed, and consequently heavier than it is farther from the mountains, though over a less elevated portion of the earth. See pp. 261-2 of a most interesting work, titled "*Exploration of the Valley of the Amazon, made under direction of the Navy Department, United States.* Part I. By Lieutenant Herndon. Washington, 1853." I am, &c.

ARCHIBALD SMITH.

2 Manor Place, Edinburgh,
21st August 1857.

PROCEEDINGS OF SOCIETIES.

*British Association for the Advancement of Science. Dublin, August 26—September 2, 1857.**

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

A Report on Theoretical Dynamics, prepared by Mr A. CALEY, was read.

A Report on Meteoric Phenomena, prepared by the Rev. Professor POWELL, was presented.

Professor LOOMIS *of the United States*, read a paper *on Certain Electric Phenomena.*

Professor LOOMIS, also read a paper *on the Relative Accuracy of the Different Modes of Determining the Geographical Longitude.*

The Rev. CHARLES EVANS read a paper *on the Interpretation of Certain Symbolic Formulæ, and Extensions of Taylor's Theorem.*

Dr SCHLAGINTWEIT read a communication *on Some Physical and Geological Observations*, made by him in India.

Professor HENNESSY next read a paper *on Simultaneous Isothermal Lines.* Having referred to the part already taken by the Association in connection with the distribution of mean temperature over the surface of the earth, he dwelt on the importance of studying simultaneous distributions of the temperature. The movements of the winds, and in general almost all the daily perturbations of the atmosphere, depending much more on simultaneous conditions of the temperature in different places than on the mean amount over long periods, it would be desirable to attempt to trace the former class of lines, when it was attempted to obtain a complete connection between the different classes of the atmospheric phenomena. The nature of isothermal lines was then adverted to, and the differences between them and those of mean temperature, which might be fairly anticipated. The differences between such lines on the land and sea were characterized, and reference was made to the phenomena of land and sea breezes, which would probably be found to have some connection with the distribution of these isothermals. Professor Hennessy, in conclusion, pointed out that these lines might assist either in further confirming or disproving the supposed connection between terrestrial temperature and terrestrial magnetism.

General Sabine observed that he had not heard for many years views

* This abstract has been prepared from reports which appeared in "Saunders's News-Letter" and "The Freeman's Journal" of Dublin.

developed on the question of temperature more hopeful than those just brought forward by Mr Hennessy, and he hoped that gentleman would continue his researches on the subject.

Professor Curtis read a paper *On a System of Geodetics*, and the conjugate system traced on the two sheets of a surface of centres, with special application to the case in which the two sheets are an ellipsoid and a confocial hyperbaloid.

Mr M. Donovan read a paper explaining the construction of *A Moveable Horizontal Sun-Dial*, which shows correct solar time within a fraction of a minute, and communicated some observations on a new acoustic phenomenon.

Professor Hennessy then read a paper *On the Resistance of Fluids to Solidification by Pressure.* With the aid of the principles developed by Professor W. Thomson and Professor Clausius, it was shown that the efficiency of compression to contract a volume of fluid, as long as it continued in that condition, was much less than its efficiency in producing change of state when the fluid should happen to be so circumstanced as to be incapable of losing the heat acquired by the work performed upon it by pressure.

Papers were read by—

Mr James Thompson *on the Plasticity of Ice;*

Captain Blakely, *a Mathematical Investigation of the Proportion between the Length required for an Electric Telegraph Cable and its Specific Gravity;*

Mr Gustaf Plarr read a paper *on Certain Transformations of a Series of Exponentials*, and

Mr James Nasmyth *on some Phenomena in connection with Molten Materials.* He stated, on introducing the subject to the notice of the Section, that his object for so doing was to direct the attention of scientific men to a class of facts, which, although in their main features they might be familiar to practical men, yet appeared to have escaped the attention of those more accustomed to scientific research. The great fact to which he desired to call attention is comprised in the following general proposition, namely: That all substances in a molten condition are specifically heavier than the same substances in their unmolten state. Hitherto water was supposed to be a singular and special exception to the ordinary law, namely, that as substances were elevated in temperature they became specifically lighter; that is to say, water at temperature 32°, on being heated does, on its progress towards 40°, instead of becoming lighter, actually increase in density until it arrives at temperature 40°, beyond which, if we continue to elevate the temperature, its density progressively decreases. From the facts which Mr Nasmyth brought forward, it appears that water is not a special and singular exception in this respect, but that, on the contrary, the phenomena in relation to change of density when near the point of solidification is shared with every substance with which we are at all familiar, in a molten condition; so entirely so that Mr Nasmyth felt himself warranted in propounding as a general law the one previously stated by him, namely, that in every instance which he is acquainted with, a molten substance is more dense or specifically heavier than the same substance in its unmolten state. It is for this reason that if we throw a piece of solid lead into a pot of melted lead, the solid metal will float in the fluid metal. Mr Nasmyth stated that he found that this fact of the floating of the unmolten substance in the molten holds with every substance on which he has tested the fact: upon such, for instance, as iron, silver, copper, tin, lead, zinc, antimony, bismuth, glass, pitch, wax, tallow, &c. He further stated that the law holds with equal integrity in respect to alloys or combinations of various meltable substances. Also, that the normal condition, as to density, is resumed in most substances a little on the molten side of solidification, and in a few cases the resumption of the normal condition occurs during the act of solidification. Mr Nasmyth stated that he considered this subject as well worthy of the attention of geologists, who might find in it a key to the explanation of many phenomena of eruption or upheaval of the earth's crust: namely, that on the approach to the point of solidification, molten mineral substances below the crust of the earth must, in accordance with the before-stated law, expand, and tend to elevate or burst up the solid crust, and also express upwards through the cracked surface streams more or less fluid, of those substances which we know to have originally been in that condition. Mr Nasmyth stated that the aspect of the lunar surface, as revealed to us by powerful telescopes, appeared to yield a striking confirmation of the above remark. He concluded by expressing a hope that the facts which he had brought forward might receive that careful attention which their importance appeared to him to entitle them to.

Sir W. R. HAMILTON read an abstruse paper *on some Applications of Quaternions to Iones of the Third Degree.*

Signor BOLZANI read a communication by the Cavaliere O. F. Mossotti, *on the Distribution of the Orbits of Comets in Space*, in which he showed, from examinations of the newest data of the positions of comets, and by drawings and diagrams, that the culminating points of most comets was in the direction of the Galaxy, or Milky Way, and that those proceeding from other regions are in less number the farther they recede from the zone in which that congeries of stars is seen.

Professor HENNESSY read a paper *on the Direction of Gravity at the Earth's Surface.* For all practical purposes, he said, the direction of gravity was considered perpendicular to the earth's surface; and a similar assumption was often made in writings claiming a high degree of scientific accuracy. This arose from defining the earth's surface as the surface of equilibrium of the waters. If the earth were stripped of its fluid covering, the irregular surface so laid bare might be intersected by a surface so placed that the volume of all the eminences rising above it would be equal to the volume of all the depressions. With the data at present possessed it would be nearly possible to have the mean surface. They were not in a position to say how far it approached or differed from a surface of equilibrium, or in other words, they could not assume that gravity was rigorously perpendicular to such a surface. Actual observation showed that in many places it was not so, and this non-perpendicularity was generally referred to irregularities of surface. If, as everything led them to believe, the earth was originally in a state of fusion from heat, all the strata of equal density of the fluid mass would be surfaces of equilibrium. Following out the theory, the paper went on to show that if it could be ascertained what was the form of the outer surface of the earth's solidified crust, and the distribution of the water over it, they might be able to determine whether changes of internal structure took place within the earth subsequent to the formation of that crust. Observations showed that such internal changes had taken place, and consequently that the direction of gravity might have changed.

Professor JELLET read a paper *on some General Propositions Connected with the Theory of Attraction.*

M. LEON FOUCAULT addressed the Section in French upon a *Telescope Speculum of Silvered Glass.* After a brief but lucid description of the telescope, he pointed out the difficulties which were found in its construction in the two different kinds of instrument—those which formed the image by refraction, and those in which the reflection was thrown upon a metal surface. He pointed out the difficulties of working out the achromatic telescope and their causes, and the still greater difficulty which was found in giving the precise form to the metal surface before it was capable of producing accurate images. The great and almost insuperable difficulty of repolishing the metal speculum was explained, as but a very minute fault rendered the instrument valueless. He remarked upon this branch, that as the metal surface was of course easily tarnished, and therefore requiring to be repolished frequently, there was the more danger of destroying the mirror altogether. It occurred to him, he said, that it might be possible to form a reflecting surface, which should be easily figured, easily restored, and which should possess far more illuminating power than either the achromatic or the ordinary reflector, of which the specula are composed of alloy of copper and tin. The process at which he arrived was this:—To form a speculum of glass, no matter how imperfect the material, or how untransparent, provided it was free from air-bubbles. Then he deposited on this a film of silver by a process invented some years ago, and which had latterly been much improved. He found that it could be deposited in uniform thicknesses, exceedingly thin, and that when looked through it was then found to be transparent, and to transmit a blue light, familiar to those experienced in optics. He explained, that when it became necessary, owing to depositions made by the atmosphere, by which the silver became infinitesimally oxidized, it was possible, by light friction of soft leather, charged, if necessary, with peroxide of iron, to remove that obstruction. Thus the speculum was light, unalterable, and extremely strong, and the reflecting surface was extremely brilliant. Inequalities in thickness were at once detected by the transparent quality of the speculum. He also stated the process which he used for depositing the silver, and showed that the coefficient was not less than 0·91. He exhibited one of the specula, and a reflecting telescope, upon the new principle, was placed in one of the windows.

Dr Greer said that he had the pleasure of frequently looking through different mirrors constructed upon the novel principle of M. Leon Foucault. He had put them to a severe test, and he had compared one of seven inches with an excellent achromatic of five inches, and unquestionably that of M. Foucault was the superior.

Professor Thompson read a paper by M. Louis Soret *on the Correlation between Dynamical Electricity and other Physical Forces*, and followed it up by some observations, in which he showed that there was nothing novel in the views or experiments recorded in the paper, but that they were valuable as confirming the experiments of Joule.

Mr Thomas Martin *on Certain Properties of the Radii of Curvature of Curves and Surfaces, and their Application to the Method of Polar Reciprocation.*

Major-General Sabine *on the Amount and Frequency of the Magnetic Disturbance and Aurora at Point Barrow, on the shores of the Polar Sea.* The lecturer stated that his results were derived from observations made by Captain Maguire and the officers of the Plover, between July 1852 and July 1854. Point Barrow is situated on the most northern coast of America. Tables made on a large scale were used, exhibiting the variations with and without the disturbances at different hours of the day at Point Barrow and at Toronto. The horizontal force of the earth at Toronto was about double what it was at Point Barrow. It was found that when the disturbances were greatest in amount, the greatest displays, which he considered a magnetic phenomenon, took place. The last letter he had received from Sir John Franklin expressed that navigator's determination to put up instruments for the observation of those phenomena at the several stations at which he might winter. It could not be doubted that such observations were made and recorded with the instruments they took for that purpose. It could not be doubted that when they were detained at some point the following year they carefully made the observations, and it was possible they might have even extended them to another winter. These observations were numerous, and were of such a kind as would have been left in the ships when the explorers proceeded overland. When he (General Sabine) was with Captain Parry in 1818, they made observations as to the figure of the earth, and various other matters, on their way to Behring's Straits. They were exposed to considerable risk of the ships being lost, and when about to take to the boats and proceed overland, they merely carried with them an abstract of the observations, leaving the full records deposited in cases in the cabins of the ships. He had no doubt that in the ships of Sir John Franklin his observations were to be found; and this was the reason why men of science were so anxious to recover the ships; for, first of all, the journals would contain valuable information, and next, it was a sacred duty to those who had lost their lives in gaining such important results to do them the justice and honour of bringing them to light.

Captain Maguire said that the most interesting part of the phenomena they observed was the aurora. At seven o'clock in the morning the magnet used to be most disturbed, and then there was seldom any appearance of aurora. All nature was then perfectly still, and the clouds and snow could not be distinguished from each other. The rays of the aurora used to shoot to a point over their heads, and were so beautiful, that although the temperature was 40° below zero, they used never to be tired looking at them. He had observed at some periods the temperature of the water to be 28° above zero (Fahrenheit), and that of the air to be 40° below zero, so that the water had the appearance of a boiling sea. The observations were made under his directions by Mr Hall and Dr Simpson.

The Rev. Professor Haughton read a paper by Dr Simpson, R.N., of the Plover, *On the Temperature of the Air, registered at the Plover's winter quarters at Point Barrow, in the years* 1852-3-4. Having read the paper, Professor Haughton observed that the results communicated on this occasion were an answer to the unfounded popular cry that no good results had accrued to science from the Arctic expedition. Many more observations made in ships engaged in eastern and western expeditions existed, and these also ought to be made available to science. Through the kindness of Captains Maguire and Collins some of them had been placed at his disposal; but he believed there were in the Admiralty many more observations, mathematical, tidal, and meteorological, which ought to be made available.

Rear-Admiral Fitzroy drew the attention of the section to *the meteorological papers* lying on the table, which had been recently published by the Board of Trade. The report to which he referred would show what progress had been made, and therefore he would not occupy valuable time by entering into details. He would only observe, generally, that a great number of valuable observations had already been made on board some hundred ships with excellent instruments, approved by the Kew Committee of the British Association, and that those observations were regularly tabulated in such a manner as to admit of their being combined in groups, or used individually. The worthy co-operation of officers at sea had already accumulated more observations than could be reduced and tabulated with duly corresponding quickness. Therefore more reduction of observations, rather than more observers, with a larger number of instruments, seems necessary, and this can only be accomplished by employing a larger staff. Government has shown the utmost willingness to attend to the recommendations of competent authorities with respect to the establishment and support of the meteorological office at the Board of Trade, and only desired to apply the vote sanctioned by Parliament for meteorological observations at sea to the best possible advantage. The United States, Great Britain, and Holland, had already co-operated largely in this work, and France had just lately established a similar department for collecting and discussing such observations.

Professor W. Thompson exhibited and explained *Mr Whitehouse's Relay and Induction Coils in action on short circuits.* The peculiarities of Mr Whitehouse's induction coils, which fit them remarkably for the purpose for which they are adapted, as distinguished from the induction coils by which such brilliant effects of high intensity were described. The chief part of the receiving apparatus, the relay, was fully described, and was shown in action after some introductory remarks, explaining the general nature of a relay, an electrical hair trigger. The relation of Mr Whitehouse's relay to the Henley receiving-instruments was pointed out. The author expressed his conviction that, by using Mr Whitehouse's system, to take advantage of each motion for a single signal instead of the to and fro motion, as in all systems hitherto practised, the Henley single needle instrument might be easily used so as to give as great a speed on one line of wire alone as is at present attained by two with the double-needle instrument. The beautiful method of reading by bells would be most ready and convenient for giving the indications to be interpreted as the messages ; but the author believes that either by the eye or ear the messages may be read off with the rapidity and care which will render the use of one telegraphic wire in all respects as useful as that of two.

Professor Thompson made a communication *on the Effects of Induction in Long Submarine Lines of Telegraph.* A general explanation of the theory was given, and the law of squares was demonstrated to be rigorously true. It was pointed out, that when the resistance of the instruments employed to generate and to receive the electric current are considerable in comparison with the resistance of the line, the phenomena do not fulfil the law of squares, because the conditions on which that law is founded are deviated from. The application of the theory to the alternate positive and negative electrical actions used by Mr Whitehouse for telegraphing was explained, and the circumstances which limited the speed of working were pointed out. Curves illustrating the enfeeblement of the current towards the remote end, and the consequent necessity of the high-pressure system introduced by Mr Whitehouse, were shown. The embarrassment occasioned by the great electrical effect through the wire which follows the commencement of a series of uniform signals with a full strength of electric force, was illustrated in one diagram, which showed a succession of eight impulses, following one another at equal intervals of time, and giving only one turn of the electrical tide at the remote end, or two motions of the relay, including the initial effect. The remedy was illustrated by another diagram, in which a succession of seven equal alternate applications of positive and negative force, following a first impulse of half strength, was shown, proving seven turns of the tide at the remote end, following one another at not very unequal intervals of time, and consequently giving eight turns of the relay, or eight distinct signals.

M. Raillard made a communication entitled an *Examination of some Problems in Meteorology ; New and Complete Explanation of the Rainbow.*

Professor Hennessy read two papers, one *on Vertical Movements in the Atmosphere,* and the other *On the Distribution of Heat over the British Isles.*

The Rev. GEORGE SALMON, F.T.C.D., *on the Surface of Centres of an Ellipsoid.*

Mr DANIEL VAUGHAN *on Secular Variation in Lunar and Terrestrial Motion from the Influence of Tidal Action.*

Dr LEE *on the Discovery of the Asteroid No.* 46, *on the 17th August* 1857, *by N. Pogson, at Oxford.* The official duties of the discoverer at the Observatory at Oxford prevented him from being present at the present meeting. The asteroid was named Hestia, and was discovered by Mr Pogson at his private residence. In 1856 he discovered the planet Isis on the 28th of May in the Radcliffe Observatory; he also discovered Ariadne on the 15th of April; and he was the second discoverer of Amphitrite on the 2d of March 1854.

Dr LEE presented certain results of some measures obtained by Rear-Admiral Smyth *on the Double Star of Virginis* for the epoch 1857. It had been assiduously watched by astronomers, and offered phenomena sufficient to induce the conviction that the Newtonian law of gravitation obtained in the remote stellar regions.

Professor CALLAN read a paper on *The Electrodynamic Induction Apparatus.*

Sir W. A. HAMILTON explained *Tables by Mr C. Thompson to Simplify and Render more General the method of finding the Time of Observing Circumpolar Stars in the same Vertical.*

M. LEON FOUCAULT delivered a discourse *on a Modification of Nichol's Prism, or a New Polarizer without Canada Balsam.*

Professor STOKES made a communication *on the effects of Wind on the Intensity of Sound*, in which he propounded the theory, that if a sound be created near the surface of the earth, during the prevalence of a wind in any direction, the retardation of the current of air at the surface, due to friction, causes the wave of sound to lose its spherical form, and to assume that of an ellipsoid, and that this change in the form of the wave causes its intensity of propagation in the direction of the wind near the surface of the earth to be greater than in the opposite direction.

Mr J. P. HENNESSY read a paper *on the Origin and Elimination of Euclid's "Reductio ad Absurdum."* The results to which he called attention were, first, that Euclid's indirect demonstrations may be eliminated; and secondly, the origin of indirect proof. He traced the "Reductio ad Absurdum" to its fundamental principles, and pointed out its logical characteristics.

M. C. FULBROOK read a paper *on the Variation in the Quantity of Rain due to the Moon's Position, in reference to the Plane of the Earth's Orbit.* He produced results showing that, during the period immediately preceding and after the ascent of the moon through the plane of the earth's orbit from S. to N., a greater quantity of rain fell than had fallen during the corresponding period of the moon's descent through the plane of the same orbit. He supposed that what happened in southern latitudes was exactly the reverse.

Mr J. J. MURPHY read a paper containing *A Proposal for the Establishment of a Uniform Reckoning of Time over the World, in connection with the Electric Telegraph.* The period in all probability was not remote when the telegraph would effect an almost instantaneous communication between parts of the world which were separated by an extensive arc of longitude, and differed in their solar time by several hours. The system which was introduced all over Great Britain, of keeping Greenwich time, could not be applied over extensive arcs of longitude. A difference of half an hour between solar time and clock time at any place was no inconvenience, but a difference of six hours would be much too great. It would be necessary for distant places to continue to keep their local solar time; but in order to time the receipt and dispatch of telegraph messages, it would be necessary either to reduce the time of one place to that of any other with which it communicated, or to adopt a uniform reckoning of time for all. Mr Murphy proposed a simple self-acting method for meeting the requirements of the case. Let every electric telegraph station that communicates with distant stations be furnished with a clock, similar in other respects to a common clock, provided with a double circle of figures on the dial, the inner circle being fixed as in the common clock, but the outer one being capable of being moved round. Let some one meridian, say that of Greenwich, be chosen as that to which all others shall be referred. Let every such clock throughout the world indicate Greenwich time on the inner or stationary circle of figures; but when a clock is set up at any station, let the outer circle be moved round and set, so that while the hour hand shows Greenwich time on the inner circle, it may show local solar time on the outer circle. The perfect convenience of this plan is obvious. It reconciles the necessity of keeping local time with the advantage of uniform time, and gets rid of any trouble in reducing the one to the other. The system might be rendered more workable still by abolishing the distinction of east and west longitude, reckoning either all east or all west from 0 to 360, and by abolishing the distinctions of A.M. and P.M., reckoning time from midnight up to 24 o'clock.

M. L'Abbe Moigno observed that a practice of this kind was already in use in France.

Dr Stevelly brought under the notice of the section a paper by Mr James Drummond, entitled *Outline of a Theory of the Structure and Magnetic Phenomena of the Globe*. It started from the generally received hypotheses that the earth had cooled from a molten to a solid state, and assumed the existence, within an external crust constituting the earth's surface, of a fluid nucleus agitated by a system of internal tides similar to those of the ocean, and also of mountainous inequalities upon the inner surface of the crust. The internal agitations of the fluid nucleus accounted for earthquakes, volcanic and magnetic phenomena on the exterior of the earth.

All the papers having been read,

The President said, we now adjourn the section, with the hope that, when it meets next year, we shall be enabled, at the close of its deliberations, to report as satisfactory a performance of its duties as has taken place on this occasion.

Section B.—CHEMICAL SCIENCE.

Professor W. K. Sullivan read a paper *upon the Occurrence of the following Acids of the Series* Cn H*n* O4 *among the Products of the Distillation of Peat, Formic Acid, Acetic Acid, Propionic Acid, and Butyric Acid.* He stated that he first observed the presence of butyric acid in the acetic acid prepared from peat about five or six years ago, but had not an opportunity of examining the subject further until recently, when he became possessed of a large quantity of raw products of peat, which he hoped gradually to investigate. The process of separating the acids, and the result of the analysis of some of the compounds of each, were fully described. The salt of baryta, which was obtained with butyric acid, contains four equivalents of water, and therefore corresponded with one of Chancel's salts. The tendency of butyrite of baryta to crystallize in the anhydrous form was remarked to the great difficulty of obtaining the hydrated ones, which accounts for Lerches having always obtained that salt as an anhydrous one.

Professor W. A. Miller remarked on this point, that butyrite of baryta appeared to be capable of forming several salts, and that he had obtained it in plates or tubes not unlike the prussiate of potash. This salt was anhydrous. The salt of potash examined by Professor Sullivan crystallized in pearly scales; it was not therefore the salt of the acid first observed by Mollner in the fermentation of conida, tartrate of lime. Professor Andrews mentioned the interesting facts, that the acids found by Professor Sullivan as a product of distillation had likewise been found by Dr Hodges of Belfast to be formed in process of the preparation of flax.

Professor Andrews read a communication *on the Action of Heat upon Ozone*, with some observations on the occurrence of that body in the atmosphere.

Dr Voelcker read a paper *on the Proportion of Organic Phosphorus in Legumin.*

Dr Gladstone read a paper *on the Novel Use of the Prism in Detecting Impurities.* The author described the methods of examining substances by means of a prism, especially the instructive results obtained with liquids when the ray of light traverses them in a wedge-shaped vessel. He suggested this as a means of detecting coloured impurities when they do exist, and of proving their absence when they are wrongfully suspected. He showed the value of the means in respect to coloured confectionery, tea, and mustard, and remarked on its use in examining wines, liquors, pigments used in the fine arts, gems, pharmaceutical preparations, &c. He stated that the prism and hollow wedge were already used as a commercial means of ascertaining the purity of certain substances.

Mr Michael Donovan read a paper *on Hygrometers and Hygrometry.*

Dr Stevenson Macadam read a paper by Mr John Kyle *on the Chemical Composition of an Ancient Iron Slag from Ayrshire.*

Professor W. A. Miller made a communication in the nature of a report *on Electro-Chemistry.* He did not propose to enter into the whole subject, but would confine himself to a very few points, as it was impossible to compress the whole communication into a small space within the time.

When Professor Miller had concluded his remarks, a long discussion ensued, in which Professor Andrews, Mr W. Sykes Ward, Dr Gladstone, Dr Odling, and the President, took part, and the latter regretted that Professor Miller's communication on a subject of very considerable theoretical interest had been so short.

Dr Daubeny gave an account of *a New Method of Refining Sugar*, conducted at Plymouth by Mr Oxland, and known by his name. It consists in the adoption of the superphosphate of alumina in conjunction with animal charcoal, as a substitute for the albumen usually employed for that purpose. In both cases the object is to separate and carry down the various impurities which colour and adulterate the pure saccharine principle present in the syrup expressed from the cane or other vegetable which supplies it. As, however, bullock's blood is the material usually procured for the purpose of supplying the albumen, a portion of uncoagulated animal matter, together with certain salts, is left in the juice in the ordinary process of refining, which impairs its purity and promotes its fermentation—thus occasioning a certain loss of saccharine matter to result. Nothing of the kind happens when the superphosphate is substituted, and so much more perfect a purification of the feculent matters, under such circumstances, takes place, that several varieties of native sugar, which, from being very highly charged with feculent matters, are rejected in the ordinary process of refining, are readily purified by this method. The employment of superphosphate of alumina also gets rid of so much larger a portion of the impurities present in the sugar, that much less animal charcoal is subsequently required for effecting its complete clarification than when bullock's blood has been resorted to. The quantity of superphosphate necessary for effecting the object is, for ordinary sugars, not less than twelve ounces to the ton; whereas, for the same quantity, as much as from one to four gallons of bullock's blood is found to be required. Dr Daubeny suggested that this re-agent might be advantageously resorted to not only in the purification of sugar, but also in other processes of the laboratory, when the removal of foreign matters, intimately mixed with the solution of a definite component, becomes a necessary preliminary in its further examination.

Mr A. H. Hamilton, son of Sir W. R. Hamilton, read a paper *on Electrical Currents in the Earth's Surface.*

A paper *on various Compounds of Cyanogen*, was read by the President.

The following papers were also read by—

Dr Miall—*On the Melting Points of Bodies.*

Professor Mallet—*On the Atomic Weight of Aluminium.*

Dr Gladstone read some notes:—First, *on Explosive Potassium.* Second, *on Froth.* Third, *on the Decomposition by Heat of certain Ammoniacal Salts.* His remarks, particularly on the second subject, gave rise to a long discussion as to the importance of discovering some method of remedying the inconvenience caused by the froth in certain fluids used for the purpose of photography. It was stated that froth did not depend upon the state of the fluid, for it was found even when it was very viscid. In using collodion there was little inconvenience caused by the presence of froth, whereas it was very great in any substance in which albumen was used.

Dr Odling communicated a paper by Mr E. Riley *on Fused Cast-Iron.*

Professor G. Wilson read a paper *on the various Processes for the Detection of Fluorine in any Substance.*

Professor Hodges read a supplementary report *on the Process Employed in the Preparation of the Flax Plant for Textile Purposes.*

Professor Voelcker *on the Methods of Analyzing the Superphosphates*, which elicited some discussion upon the value of having careful and accurate analyses made of artificial manures.

Dr Gladstone read a paper *on the Decomposition by Heat of certain Ammoniacal Salts in Solution.*

Mr Alphonse Gages, curator of the Museum of Irish Industry, read a paper *on some Arseniates of Ammonia.* After mentioning the arseniates of ammonia already described by Berzelius and Mitscherlich, and noticing the doubtful character of the description given in books about the processes for preparing the salts of ammonia and arsenic acid, and the doubtful character of their constitution, he then described his own experiments, in which he verified the constitution of the salts mentioned by Berzelius and Mitscherlich, showing, however, that the salt containing three equivalents of ammonia described by the former contains seven equivalents of hydrated water. He described three new double salts, formed by arseniate of ammonia, in which soda, potash, &c., act as the second bases. He also exhibited some beautifully-crystallized compounds of arsenic acid, with morphia and quinine, which may probably be of interest as therapeutical agents.

Dr Woods, *on the Time required by Compounds for Decomposition.* This contains many points with reference to the conditions which influence the intensities of electric currents arising from different chemical actions, and subjected to the same amount of resistance. The heat absorbed in the decomposing part of the cell was shown in all the instances to be the same in equal times, so that the decomposition, and consequently the intensity of the current, is inversely proportional to the quantity of heat required for the decomposition of an equivalent of the substance used in each case. Other important results, and some predictions which Dr Woods had already had an opportunity of verifying, were also brought forward in this paper.

Dr Lee communicated a paper by the Rev. J. B. Read, *on a New Method of Forming Ammonia Iodides of Metals.*

Dr Odling and Dr Dupré *on the Presence of Copper in the Tissues of Plants and Animals.* The authors had made more than 100 examinations by a great variety of processes, and had recognised the presence of copper in nearly every instance. In several specimens of wheat grain and of human viscera the amount of copper had been estimated. From 100 grains of wheat-ash the authors had obtained 251 thousandths of a grain, and from a sheep's liver rather more than one-half a grain of oxide of copper. The process was to precipitate the copper electrolytically on a platinum wire, to dissolve in nitric acid, and to ignite the residue of the evaporated solution.

Professor W. B. Rogers communicated a paper by Dr A. A. Hayes *on some Modified Results attending the Decomposition of Bituminized Coal.*

Professor Sullivan *on the Solubility of Salts at High Temperature, and on the Action of Saline Solutions on Silicates under the Influence of Heat and Pressure.*

Dr Odling read a paper *on the Effects of Alum in Panification.*

M. L'Abbe Moigno read a paper *upon Three New Electrotype Processes,* and exhibited specimens of considerable interest. The first of these improved processes consists in the employment of platina wires instead of copper, and of making a skeleton figure resembling roughly the outline of the cast sought to be obtained, by means of which, according to M. Lenoir s process, busts, statues, and groups can be produced in full relief by a single operation. The second of these consists in M. Oudrey's process for galvanizing or coppering iron and cast-iron to any thickness required without the cyanide bath. He added remarks upon its employment in commerce and in the navy. The process was not fully communicated, as it is commercially desirable to keep it a secret, but sufficient was communicated to show that the cyanide bath, which is not only expensive but dangerous, can be dispensed with, and that the present system, according to which there is a great waste of material, is avoided, although the substance that is placed upon the iron to induce the deposit of the copper is not stated. The last branch of the paper treated of Messrs Christofe and Bouillet's process for strengthening electrotypes, the principle of which is to leave an opening in the back of the thin electrotype obtained by precipitating, and to put into it various little pieces of brass, which, on being melted with an oxyhydrogen blast, become diffused all over the interior surface of the copper without injuring it in any way, and thereby impart to it the strength of cast-iron.

M. l'Abbe Moigno also presented, in the name of M. Bertsch, microscopic photographs; in the name of M. Bingham, improved photographic copies of oil paintings; and in the name of M. Niepsce de St Victor, a perfectly new method of exhibiting, by means of photography, the phosphorescence and fluorescence of bodies.

Dr Gladstone regarded the photographic experiment to which he had just referred as of the greatest importance to art; for it might be regarded as in some degree tending to throw light upon the hitherto unsolved question of what became of light which had struck an object, and become either absorbed or changed.

Dr Daubeny exhibited some *Specimens of Paper which had been converted into Parchment.* The discovery, he believed, had originated in the experiments made in connection with the manufacture of gun-cotton, as it was accidentally discovered, when dipping paper into nitric acid, that the same effect was not exercised upon it as upon the cotton, but it was rendered tough. The alteration visible in the conversion of common paper into parchment after being dipped into weak sulphuric acid, is believed to be attributable to the substitution of an atom of water for an atom of hydrogen.

Mr Sykes read a paper *on the Preservation of Albumenized Collodion Plates.*

Dr Barnes and Dr Odling read a paper *upon the Condition of the Thames Water, as affected by London Sewage,* and said it was now established that the pouring in of the contents of the drains did not affect the water as seriously as was thought. The organic matter of the Thames was chiefly in a state of vitality, and therefore there was not so much putrefaction as was generally supposed; at high water there was the greatest, and at the ebb tide the least amount of organic matter.

Professor W. K. Sullivan, Ph. D., read a paper *on the Method of Determining the Nitrates of Plants.* He pointed out the great importance of finding a process for the purpose, because, in determining the amount of nitrogen in plants by the usual processes, a part of the nitrogen of the nitric acid is included in the result, and consequently the true amount of assimilative azotic principles cannot be deduced from ultimate analysis, if nitrates be present. The chief feature of the process is the use of sulpho-vinate of silver to precipitate the vegetable acids, the silver salts of which are insoluble in absolute alcohol, while the nitrate of silver is soluble. He also pointed out a method of separating lactic and acetic acids from one another when present.

Mr G. C. Foster read a paper containing *Suggestions towards a more Systematic Nomenclature for Organic Bodies.*

Sir J. Murray read a paper *on the Choice of Annual compared with Perennial Fertilizers.* He had to submit to the Chemical Section the comparative value of fertilizers, which were found too soluble on their flooded lands, or in wet seasons, as compared with a chemical manure, now first manufactured purposely as such, which remained almost insoluble until the required display of its constituent ammoniates and phosphates were liberated, at such times and in such quantities as the nourishment of green crops and the ripening of grain demanded. Although he was the first to apply dissolved bones and bone-earth, and he produced luxuriant crops by vitriolized bones forty years ago, notwithstanding his being the originator of that agricultural improvement, yet he felt that the soluble phosphates were too soluble; that they melt very fast in a rainy climate, and run into subsoil below the mould, or were carried off in floods and rivers. The same objection in some degree applied to salt of ammonia. After many years' experience in the north, and on his experimental fields near Dublin, as also by a long series of experiments carried out for him by Mr Brabazon, the gardener of the Richmond Lunatic Asylum, and by Mr Wrigly, the governor, from 1835 to 1842, he felt more and more the conviction that the above principal qualities of manures should be consolidated and locked up, like a magazine of manuring elements, to be liberated little by little, and month by month, as the crops, seasons, and times of germination, and the formation of heavy ears of grain, demanded suitable supplies of ammoniacal and phosphatic imbibition. Aware that double phosphate of ammonia and magnesia were found in calculi and secretions, and in the deposits of pigeons and other animals, and that this salt retained its constituent principles until acted upon by degrees by some common acids, he recommended parties to set about an artificial factory of a salt, so sparingly furnished by nature, and which hitherto was only shown as a specimen in the collections of chemical professors. He now laid before them some of the precipitate or double phosphate of ammonia and magnesia. The result of its composition and use were—first, a triple salt or precipitate composed of equal parts of phosphate of ammonia and phosphate of magnesia. This compound of the chief elements of real guano is fortunately so insoluble that it will remain long in the tanks or lands. Yet, when young turnips or early germination of other crops require fast feeding, the farmer can dissolve any reasonable proportion of his triple phosphate by sprinkling over the lands or middens a little muriatic acid, mixed in any light dust, or in water or sewerage. This acidulous solvent will render plenty of triple phosphates absorbable in plants, and will enable the young crops to imbibe all they can take, and to reserve the residue for a succeeding growth. Wheat and other grains need little or no phosphates till they begin to perfect their seed when ripening. Turnips want phosphate constantly for five months; but evanescent superphosphates of lime, which were like sugar in the first rains, will not wait nine months to enrich the ears of corn, nor will it stay five months to give a daily meal to turnips or potatoes. It was a better plan to lay on the land more lasting food. Ammoniacal and phosphatic salts are evanescent, if not preserved in more durable combination with a more permanent fixant than any hitherto applied by art. Having alluded to means which all farmers can use to save the waste of animal and other emanations about their tenements, he would place before them a sample of the dried-up generator of triple phosphates wherever this dried-up, acidulated, and bicarbonated alkaline powder can meet with ammoniates and phosphates. It arrests them, and locks them up in a magazine, from which none of them can escape until a little sprinkling of cheap muriatic acid renders them obtainable by degrees.

Mr R. L. Johnson then read a paper *on Illuminating Peat Gas.* He stated that it is now nearly half a century since a Parliamentary Committee appointed by Government to report on Irish peat named the town of Sligo and the Hill of Howth as the extreme points of a straight line, and Galway and Wicklow Head as the extreme points of another straight line, between which two straight lines lay the six-sevenths of all the peat in Ireland, the remaining one-seventh being distributed throughout localities on either side of these lines. Having named the different localities where peat is distributed, the total number of which in acres appears to be three millions, Mr Johnson entered into a detailed description of the mode by which he obtained illuminating gas from common peat or turf, which he produced by the double decomposition of the constituents of the peat. He stated that works for the production of the gas have been recently erected, and are in actual operation in two places in Ireland. The gas produced was good, and its cost, as stated to him by a gentleman who was using it, less than two shillings the thousand cubic feet. He stated that from one single pound weight of common peat an hour's light may be produced, and that its cost being so very small, it should ultimately be extensively used throughout Ireland, and in its production there was one-third of charcoal.

Professor Sullivan corroborated Mr Johnson's statement, and said that he saw the gas produced when the experiments were going on, and that it appeared good; and from what he had seen and heard from men who gave the study of peat considerable attention, Mr Johnson had succeeded in producing a cheap and good light from a heretofore valueless though abundant source.

Dr Rawdon M'Namara read a paper *on Coloured Confectionary*, in which he drew the attention of the Section to the large quantity of highly poisonous colouring matters employed in the manufacture of confectionary. He referred to cases of deaths resulting from this practice. He then alluded to the manner in which these substances are coloured by vegetable colouring materials of a harmless nature, and suggested that a list of such colours should be compiled by parties competent to the task, from which alone confectioners should be permitted to select their colours. He gave a sketch of such a list, and exhibited some beautifully-coloured confectionary, in which such colouring matter had been detected. These confections he had for some time in his possession, and their colours did not appear to have faded. In conclusion, he cautioned the public against buying any confectionary in which green or blue colours exist, as such colours are probably produced by poisonous agencies.

Mr Alphonse Gages read a paper *on the Specific Gravity of that extremely dangerous compound, Chloride of Nitrogen.* He gave the determinations, which were extremely close to those given many years ago by Sir Humphry Davy. He also mentioned the fact that chloride of nitrogen dissolves in absolute alcohol without decomposition, but if the solution be allowed to stand for a few hours, it decomposes; and others may probably afford a means of determining accurately the composition of this interesting body. He described an apparatus for introducing the chloride of nitrogen into the alcohol, and mentioned the character of the reaction which took place.

Mr Jasper Rogers read a paper *on the Properties of Carbonized Peat Moss, in its uses Chemically and Medicinally.* Its value medically he elaborately pointed out, especially in all the cases of indigestion, dyspepsia, &c. But he specially drew attention to the value of the preparation as a means for preventing infection from the dead and the evils of decomposition after burial. He pointed out the means by which it might be used.

Professor Cameron read a paper *on Urea as a direct source of Nitrogen in Vegetation.* He showed that nitrogen was also available as food for plants, when a constituent of urea, as in its ammoniacal combination; or, in other words, that urea, without being converted into ammonia, may be taken up into the organisms of plants, and there supply the necessary quantity of nitrogen. He described the experiments which led him to this conclusion, which were very elaborate, and were made on barley plants in confined spaces supplied with air freed from ammonia. The following conclusions were deducible from the results of his experiments, viz:—1. That the perfect development of barley can take place, under certain conditions, in soil and air destitute of ammonia and its compounds. 2. That urea in solution is capable of being taken unchanged into the organisms of plants. 3. That urea need not be converted into ammonia before its nitrogen becomes available for the purposes of vegetation. 4. That the fertilizing effects of urea are little if at all inferior to the salts of ammonia. 5. That there exists no necessity for allowing drainings or other fertilizing substances containing urea to ferment, but that, on the contrary, greater benefits must be derived from their application in the recent or unfermented condition.

Mr J. W. Rogers read a paper *on the Chemical Properties of the Potato, and its Uses as a General Article of Commerce if properly manipulated.* The object of the paper was to show that the matter of the potato was in reality equal in nutritive value to the dry matter of wheat, whilst the quantum of food produced from a given quantity of land was nearly four times that produced from wheat. He exhibited some very interesting specimens of the production of the potato in meal, flour, &c., and gave the following results of analysis:—

	Starch.	Gluten.	Oil.
Components of the potato per cwt.,	84,077 lb.	14,818 lb.	1,104 lb.
Do. of wheat, . . .	78,199	17,536	4,265

And gave the following important fact as to the quantum of food from an acre of land:—

	Starch.	Gluten.	Oil.
Dry matter of potato, . . .	3427 lb.	604 lb.	45 lb.
Dry matter of wheat, . . .	825	185	45

Mr Patrick then read a paper *on the Composition of the Iron Ore of the Leitrim Coal Field, with some remarks on the advantages of that district for the Manufacture of Iron.*

A paper by Dr Lloyd *on the Purification of Large Towns by means of Dry Cloacæ* having been read,

The concluding communication was made by Dr Gilbert, being *a Preliminary Notice of Researches on the Assimilation of Nitrogen by Plants, by Messrs Lawes, Gilbert, & Pugh.* The great importance of settling the question, Whether or not plants can assimilate the free nitrogen, of which the atmosphere to such a great extent consists? was first insisted upon. In a purely scientific point of view the question was of high interest, and if answered in the affirmative this would add a very striking fact to the history both of nitrogen itself and of the vegetative functions. A true theory of many agricultural facts and practices also required a definitive solution of this debated point. Earlier writers supposed that the free nitrogen of air could be taken up by plants. De Saussure and others came to an opposite conclusion; and this latter view had been pretty generally adopted by scientific observers. Boussingault in particular had brought experimental evidence to show that plants did not assimilate the nitrogen of the air. But during the last few years a most elaborate and extensive series of investigations had been made by M. G. Ville of Paris, the results of which led him to conclude that plants assimilated a considerable amount of free nitrogen. M. Boussingault had followed up the inquiry in various ways, and still maintained the opposite opinion. It was hence of the highest importance that a third party should undertake the subject, and it was to this end, and the results so far obtained, that the authors brought their plan for discussion before the Section. They described the several methods adopted by MM. Boussingault and Ville, and then illustrated by drawings their own methods and results. In all cases the plants were growing in soil and atmosphere destitute of all combined nitrogen in the first instance. To some, however, as their growth seemed to indicate the need, small and known quantities of ammonia were added. Drawings of the progress of the plants showed an enormous increase of growth where the ammoniacal supply was given. In these cases the plants promised to yield seed, and their height and general development was pretty natural. In the other instances, owing to the combined nitrogen of the seed sown and the free nitrogen of the air, the plants were exceedingly small, and withered before coming to perfection. The final result could not, however, be known until the growing plants, the soil, and the pots in which they grew, were analysed, when the debtor and creditor account, so to speak, of the nitrogen could be made up. Other researches were also in progress to determine the relation of the gases evolved during the growth of plants, to the constituents actually assimilated.

In the discussion which followed, the President and Professor Daubeny took part; the latter gentleman expressing his satisfaction that the question was now taken up by some third person, and it was being conducted on such a considerable scale, and at Mr Lance's Observatory; for he had read with some surprise the apparent sanction given by the Institute of France to the opinions of M. Ville, which so many scientific considerations would lead us to hesitate in adopting.

After further remarks from Dr Gilbert, Dr Pugh, one of those associated with him in the inquiry, entered into further explanations illustrating the methods adopted and the difficulties and sources of error to be overcome or avoided.

Section C.—GEOLOGY.

Mr Jukes described so much of *the One-Inch Geological Map of Ireland* as is published, or is on the point of publication, mentioning the maps of the counties of Wicklow, Wexford, and Waterford, and parts of the adjacent counties from Dublin Bay to Cork Harbour, and entering into some details as to the geological structure of the country.

Mr E. Wood, F.G.S., read a joint paper by Professor De Konnick and himself, *on a New Genus of Crinoids from the Carboniferous Rocks near Richmond in Yorkshire*, all of which have been discovered by Mr Wood. They are very remarkable, inasmuch as the stems of all the species are much thinner at the base than at the summit, probably proving them to be unattached, and floating free on the water. The paper was illustrated by some large drawings and a splendid series of specimens.

Mr Fox read a report *on the Temperature of some Deep Mines in Cornwall*, and gave a tabular statement of the result of his observations. He said, that in the case of Tresarcan mine the depth had been increased 540 feet between 1837 and 1853, and the temperature had increased 8°5 in the deepest level, or in the ratio of 1° in 63·5 feet. Mr Fox drew attention to these numbers as among the most interesting facts which had come under his observation.

Sir R. I. Murchison *on the Quartz Rocks, Crystalline Limestone, Micaceous Schists of the North Western Highlands of Scotland proved to be of Lower Silurian Age, through a recent Discovery of Fossils by Mr C. Peach, by Sir R. I. Murchison, F.R.A., and with a Note on the*

Fossils by J. W. Salter, Esq. F.G.S. The opinion stated by Sir I. Murchison to the meeting in Glasgow, as to the age of the above rocks, had been confirmed by Mr Peach's discovery of fossils in them similar to those found in the "calciferous sand rock" of America, which immediately overlies the Potsdam sandstone. This is in harmony with the fact of American types appearing in the lower silurians of Scotland and Ireland, which are not known in England and Wales. The author was confirmed in his belief of the probable lower silurian age of the mica schists, quartz rocks, and altered limestones of Connemara.

The Rev. Mr Symonds remarked that Hugh Miller searched for fossil fishes in the nodules from a rock, coloured as old red sandstone, in the island of Skye, but he was evidently inclined to rank them as lower beds. Sir R. I. Murchison's idea of these rocks is, that they are lower silurian, or perhaps Cambrian, and in this Sir Roderick differs from Professor Nichol. As far as the fossils go, the rocks belong to the lower silurian age, but the fossils are rather obscure. Hugh Miller probably would have now agreed with Sir Roderick on the point to which this paper refers, viz., the physical position of the quartzites of West Scotland.

Mr Forbes confirmed Sir R. I. Murchison's ideas, as he finds traces of favosites in the rocks on the west coast of Norway which are as completely mica schists as those found in the north-western Highlands of Scotland.

Mr Jukes corroborated Sir Roderick's views, as the rocks on the northwest of Ireland are in the same strike as those of the north-west of Scotland. In Galway there were in the mica schists limestones containing nodules in which would probably be found similar fossils. One fact connected with the junction of these beds is, that the upper rocks contain angular fragments of the lower already converted into mica schists.

Colonel Portlock made some observations on the great importance of studying local geology thoroughly as the only means to enable the geologist to generalize on a larger scale.

Professor Haughton exhibited some specimens of *fossil stems from the yellow sandstone of Hook Point, County Wexford*. One of the specimens exhibited a singular structure, the central column being placed near the outer edge, and twining round the stem in a spiral manner. All the other stems shown contained the central vascular bundle in its usual position. He considered these plants to be closely allied to stigmaria found in similar deposits in Donegal and Mayo.

Professor Phillips wished to express his obligations to Mr Haughton for the interesting facts he had laid before the Section. He conceived it highly probable that Mr Haughton's specimens, the spiral structure, may be due to a climbing plant surrounding another, and that in fact there are the remains of two plants in the fossil. There were climbing plants found in the coal measures. Professor Phillips thought it possible that further examinations of other specimens would enable Professor Haughton to add further discoveries in regard to the curious structure in question.

Professor Harkness read a paper *on the Records of a Triassic Shore.* The area occupied by the trias strata referred to occurs in the north-west of England and the south of Scotland. The deposits which form this series consist of argillaceous strata and sandstones, and these beds have their surfaces marked by ripples, which have resulted from the action of the wind on shallow water. Ripples of another character also occur, and these have been produced by the influence of small rills traversing a muddy shore. Tracks which have originated from the wanderings of crustaceans likewise make their appearance on the surface of the sandstone, and with these are found associated the sinuous tracks of annelids, as well as the pitted hollows which form the entrances into the burrows of these animals. Pseudomorphic crystals of salt are also exhibited in the state of small pyramidal elevations on the under sides of the sandstones, affording evidence of natural salt-pans on this triassic shore. Small pittings mark in many instances the faces of the sandstones, and the surfaces reposing upon these pitted faces manifest little dome-like elevations. These have arisen from the effect of rain-drops, in most instances of a small size, resulting from fine rain; in some instances, however, oblong impressions make their appearance, and they are the results of heavy drifting rain. All the physical conditions on these ancient shores are such as we find under favourable circumstances on the sandy and muddy coast of our present seas.

The Rev. W. S. Symonds read a paper *on a New Species of Eurypteras from the Old Red Sandstone of Herefordshire.* This fossil was discovered by the parish clerk of Rowlstone, Herefordshire, and presented to the Rev. W. Wenman. Mr Symonds examined the correlation of the rocks in which the fossil was found, and stated that they were gray sandstones of the upper cornstones, and pass upwards into red and chocolate coloured sandstones and the old red conglomerate.

Professor Phillips noticed the interesting nature of the problem connected with the discovery of this new fossil in a rock immediately succeeding the upper silurian rock containing peroxide of iron. The author had proved the continuance of organic life in a series of rocks probably two thousand feet higher than had hitherto been found in the particular geological period to which his paper referred.

Mr Du Noyer read a paper *on the Junction of the Slates and Granite of Killiney Hill, County Dublin.* He called attention to the way mica schist and granite were intermingled with each other near their line of junction, giving them the appearance occasionally of interstratification, but showing that this appearance was fallacious, and was the result of masses of the mica schist being caught up in shallow hollows of the granite, and dipping down into them, as if passing under some of the projecting tongues of granite. He also called attention to some curious arrangement of the mica in portions of the granite adjoining the slates, and brought forward some interesting facts relating to the veins of granite and eurite traversing both the granite and the slates.

Signor Pisani of Lucca, read Professor Meneghini's paper *on the Recent Advance of Palæontological Research in the Tuscan Territory.*

Colonel Portlock made a few observations upon it. The eruption of igneous rocks at successive epochs has introduced much local variation in the deposits, and so remarkable have these eruptions been, that Professor Meneghini and other Italian geologists have shown that it is possible to arrange them in a chronological order in reference to the stratification. Notwithstanding the difficulty consequent on these eruptions, the true sequence of the whole series of sedimentary rocks, from the bottom of the secondary to the recent alluvium, has been now established. The interest of these determinations increases as we approach the more recent epochs; and two important facts should not be overlooked, viz., the remarkable physical coincidence of the cretaceous and tertiary limestones, combined with the distinctive character of their fossils; and, secondly, the recurrence of the same fossil forms and of the same physical conditions.

Dr Griffith—*Notes on the Rocks below the base of the Carboniferous*

Rocks of Ireland. He said these rocks occur in three districts in the north, viz., at Pomeroy, at Curlew Mountains in Sligo, and at the Croaghmoyle Mountains in Mayo, and in one large district in the south, viz., in Cork and Kerry. He concluded by stating that he considered he was justified in calling these rocks silurian, and therefore introducing different letters and columns on his map.

Professor JUKES read a paper, the joint composition of himself and Mr Du Noyer, *on the Geological Structure of Dingle Promontory.* The object of this paper was twofold :—1st, To describe the very curious structure of the Dingle Promontory, comprised of upper silurian (Wenlock and Ludlow) rock on the extreme west of the promontory, overlaid by rocks 10,000 or 12,000 feet thick, called Glengariff grits and Dingle beds, chiefly green and purple grits and conglomerates, with red slates and some calcareous bands (cornstones). 2d, To point out the bearing of these facts on the nomenclature of these rocks.

Mr SLATER, *on the Fossils of the Dingle district.* The author stated that the Wenlock and Ludlow formations were both present at Dingle, each well developed, and bearing a great resemblance to the similar beds in Great Britain, with, however, some difference in the distribution of the fossils. The author also drew attention to the fact that this is the only upper silurian district in Ireland,—that of Uggool, County Mayo, being rather the uppermost beds of the great Llandovery or Mayhill sandstone series, so fully developed in Connemara.

Professor Phillips said, that about fourteen years ago he had spent three days in the Dingle district, and could say from his researches then, and by what he had since read and heard, that the subject presented many and great impediments to the acquirement of a sound and satisfactory conclusion. In his opinion, the beds discovered by Mr Jukes should be called the "Dingle or Glengariff" beds, and not "Devonian."

Professor J. R. MALLET exhibited the *Section and Geological Map of the State of Alabama*, recently prepared by the late Professor Tuomey, to accompany his Report on the State Survey. The principal geological features of the country were noticed, and the resulting peculiarities of soil and economic advantages briefly alluded to.

Professor PHILLIPS then read his paper *on the Ironstone Bands in the Oolites of Yorkshire.*

Mr JAMES YEATS exhibited a *Fossil Cone*, probably from the *Green Sand Formation*, and explained the appearances, which proved that it belonged to the proper coniferæ, illustrating his statement by producing specimens of cones belonging to the cycadeæ.

Mr A. B. WYNNE next read a paper on a section taken in a north and south direction across the Galtee Mountains, in the south of Ireland.

Mr O'KELLY called attention to and exhibited *a Section across Slievenamuck*, south of Tipperary, where there is an east and west vault, with a throw of at least 5000 feet, which brings the coal measures abutting against the silurian.

Mr G. H. KINAHAN read a paper *on the Igneous Rocks of Valentia*, which are found in the old red sandstone formation and ocean, of several distinct characters, the most largely developed being a greenstone, which occurs in more than one locality, as well on the island of Valentia as on the mainland.

Professor W. B. ROGERS read a paper *on the Discovery of Paradoxides in New England.* This fossil was discovered in a quarry near Boston, which had been open for thirty years without its being suspected by men of science that the rock was fossiliferous. A specimen which Professor Rogers had succeeded in tracing to that quarry had been lying in a museum for many years. It had been named *P. Harlanni*, and was supposed to be a foreign specimen. These rocks lie between great ridges of igneous rocks running along the eastern margin of the state of Massachusetts, and although greatly metamorphosed, they exhibit very good specimens of Trilobites. The parodoxides is a fossil found at several localities in Europe, and always in the lowest fossiliferous beds. Some specimens from Boston appear to be very similar to *P. Spinosus* of Barrande, which species is abundantly found in all the lower beds of Bohemia. It is therefore important as determining the age of these New England rocks. Up to the present time the oldest fossiliferous beds in the district in which these fossils had been found were beds containing coal plants. These, however, are separated from the beds near Boston by a large mass of igneous and metamorphic rocks. Professor Rogers remarked that the discovery of these fossils confirmed the idea, that during the earlier geological epochs there was a more general uniformity in the distribution of organic life than is at present the case. A series of exquisitely executed photographs of the specimens referred to were exhibited.

Mr Robert Mallet produced his *Fourth Report upon Earthquake Phenomena*, in abstract, under three heads, the first head gives—*First*, the discussion of the British Association Catalogue of 6000 earthquakes, by curves representing the distribution in time,—(*alpha*) for all historic duration, (*beta*) for seasons, (*gamma*) for months. *Secondly*, the distribution in space over the earth's surface. The important conclusions are—*First*, that the intensity of seismic forces is, in long periods, uniform or invariable; *secondly*, that it is paroxysmal; *thirdly*, that there is a real preponderance during the winter season in each hemisphere respectively. As to distribution in space: The spot on the earth's surface which suffers most seismic disturbance is the island of Luzon in the Indian Archipelago. The *second head* of the Report referred to is the construction of seismometers, in which the author described the various sorts of instruments that had been proposed at various periods and by different persons, and mentioned their defects. The first instrument consisted merely of a bowl of treacle, the motion of which, and the line which was marked upon the side of the vessel, indicated the direction and force of the shock. An Italian invented another contrivance almost equally rude. It was a bowl containing quicksilver, and having eight spouts projecting from the edge. The shock was shown by the particular spouts out of which the mercury was cast. Mr Mallet having alluded to the inherent difficulties of the subject, described the principles of the new seismometer, which he proposed as best meeting the conditions in the present state of our knowledge. It consists essentially of four heavy balls propelled along slightly inclined planes in paths whose directions are those of the four cardinal points, with means of determining in time the paths that they described as due to a given disturbance of the whole system. Under the *last head* Mr Mallet described the work already done and the state of the experiments upon the rate of wave transit in the rocks of Holyhead, taking advantage of the great blasting operations in progress there, in which as much as eight tons of gunpowder is sometimes fired at once. The shock was so great as to be felt at a distance of two miles, and even to throw crockery off a shelf at a distance of eight miles. The length of base over which the transit is measured is nearly a mile (4486 feet), and has been trigonometrically measured with scrupulous care.

Mr Austin observed that an illustration of the elasticity of the earth's surface was afforded some years ago upon the occasion of an explosion of gunpowder at Hounslow. He was himself distant thirty miles from the place at the time, and yet felt the shock of it. At a distance of forty miles from the spot a gentleman happened to be seated in his gig conversing with another. The latter had one foot on the step and the other on the ground, and remarked to his companion that he felt some movement of the earth beneath his foot. This he felt five times, and, taking out his watch, he noted accurately the time when he felt the shocks. On the very same day, at three o'clock in the afternoon, a paper which was published at Lewes stopped going to press, and next day had a notice to this effect :—" Just as we were going to press yesterday five slight shocks of earthquake were felt at this place," naming the time at which the explosion occurred. He himself at a distance of thirty miles felt the earth wave, and also heard the air wave; but the gentleman who felt the shock at the gig told him that he heard no sound whatever, but merely the passage of something beneath his feet. He believed that Lewes was distant from Hounslow about ninety miles, a remarkable distance for a wave to be propagated from so simple an occurrence as the explosion of a mass of gunpowder.

In answer to an observation from a gentleman in the body of the room, Mr Mallet alluded to the earthquake of Rio Gambia, where the shock came up perpendicularly, and shot people into the air to the height of 100 feet.

Professor Haughton suggested a means by which Mr Mallet's observations upon granite rocks might be made instrumental to the ascertaining of the horizontal velocity of the earthquake wave, and the point from which the shock proceeded.

Mr Sorby, *on some facts relating to Slaty Cleavage.* Mr Sorby states some conclusions which had presented themselves to his mind regarding the ultimate structure of slate rocks, showing that two orders of structure are detected by the microscope—one referable to pressure on a plastic, the other to pressure on a partly rigid body. He mentioned the systematic presence of mica, varied by quartz, in certain slates, and stated his view of the origin of these two minerals by metamorphism from felspar clay. Experiments on the effects of pressure on plastic and rigid materials were given, and a tabular view of two varieties of structure due to pressure and metamorphism on rocks originally, not essentially, dissimilar.

Professor King, *on Mineral and Rock Cleavage.* The principal conclusions he has come to are, that mineral cleavage is a superinduced structure, the same as rock cleavage; and that rock cleavage is due to the same law, modified, that produced mineral cleavage. As regards what has often been termed slaty cleavage, he considers that there are two kinds—a true and a false one; and he has come to the following conclusions. That true slaty cleavage is ordinary rock cleavage affected by compression applied perpendicularly, or nearly so, to the planes of the latter; and that false cleavage is simply due to pressure applied laterally to the horizontal direction of its planes.

Professor Haughton exhibited a model illustrative of his views on slaty cleavage, and adduced arguments in support of the mechanical theory.

Professor H. D. Rogers disagreed, and pointed out great difficulties which the advocates of the mechanical theory would have to encounter.

A long and interesting discussion followed.

Professor Harkness, *on the Jointings and Dolomitization of the Lower Carboniferous Limestone of the County of Cork.* The district around Cork consists of a series of hills and valleys, the former composed of Devonian, and the latter of limestone belonging to the lower portion of the carboniferous series. In the latter are joints having three directions; one, the prevailing direction, being north and south, and of the other two, one is almost horizontal, and the other oblique. These joints occur in great profusion in most of the limestone localities; but in certain spots where the limestone is silicious and thin-bedded the jointings are imperfect and the stratification distinct. Among these limestones there are seen in some quarries in the neighbourhood of Cork dykes of dolomite, and then dykes in jointed limestone conforming to the main north and south joints. In the quarries where the stratification is distinct we often find also dolomites, and these agree with the planes of stratification. The production of these dolomites appears to be subsequent to the deposition of the strata in which they occur. From the observations of Regnault, it would seem that sea-water (containing sulphate of magnesia) is capable of exerting considerable influence on limestone, giving rise to carbonate of magnesia and sulphate of lime; and the phenomena exhibited by the district around Cork would lead to the inference that sea-water, finding access into rocks by joints, and in some instances along the planes of stratification, has produced the dolomitic masses.

Dr Clarke read a paper, in which he described *the elevation of an ancient sea-beach of the coast of the county of Waterford*, extending about 2¼ miles, and reaching at one part an elevation of 60 feet. He exhibited the cetacean remains found in it, and stated that it was obviously of the past era, though all its fossil shells had living representatives in the adjoining bay; and after comparing its age with the chief shelly deposits in Ireland, as the marls of Wexford and Wicklow, and of Londonderry, he added, that it was perhaps the most recent of which we have geological proof in Ireland. He next described an igneous protrusion (marked in Dr Griffith's map), with a view of fixing the geological age, and describing its effect on the adjoining strata. This rock presents itself in greatest force at Newtown Head, where it reached an elevation of 60 feet. To the elevating influence of this rock Dr Clarke assigned the upraised position of the ancient sea-beach, as it was evident, from the section of the coast exhibited, that the latter formed with the dyke a great anticlinal ridge, whose crest was immediately over the highest part of the igneous rock, and the surface of the beach was everywhere parallel to the trap protrusion beneath. He also remarked, that 200 yards north of the great dyke a smaller one existed, and it too was in the centre of another anticlinal ridge, in the surface of which the raised beach was everywhere parallel. The author then remarked, that as the igneous mass seemed to have upraised the beach, so it must itself be referred to a period during the same era, but antecedent to its close, or to the recent period of Sir Charles Lyell, but at present referable to the former, owing to the absence of human remains or works of art; and as the occurrence of traps in post-tertiary rocks is rare, he considered that the assignment of so recent a date to the igneous protrusion at Newtown Head would prove of interest to Irish geologists. Dr Clarke then described an extensive deposit of peat, four feet under the level of the tide, at a point commencing immediately adjoining the southern extremity of the raised beach. Dr Clark, added, that it would be well if it were generally known that the uncovering of parts of saline peat, and its use as fuel, is attended with danger, owing to the production of sulphuretted hydrogen, arising from the hydrogen of the decaying vegetable matter on the sulphur of the saline sulphate.

Professor Hennessy read a paper, in which he attributed *the changes of the earth's structure to the change of the sea-level at different times.* If the globe had solidified from a fluid state, judging from the appearance in the cooling of fused rocks, we should get a change in the distribution of matter within it. This would distribute land and water in a different manner, and a very small change in the elasticity of the liquid envelope of the globe would suffice to produce great changes.

Mr R. Godwin Austin read a paper *on the Occurrence of a Boulder of Granite in the White Chalk of the South-East of England.* He described the threefold division of the cretaceous series of the south-east of England, viz.,—1. The littoral shingle of the lower greensand at Farrington, in a sea not exceeding ten fathoms. 2. The gault in deep beds over the south-east of England, its littoral beds lying to the west, the Haldon Sands. 3. The area of the white chalk ranged as far north as from the north of Ireland to the Baltic at Riga, and extending to a broad zone over North Germany. In North Europe the conditions of the deposition were remarkably uniform over the whole of the Anglo-French basin; 800 feet is its average thickness, and it is all a deep-water deposit. Rolled shingle and fragments of extraneous rocks have been found in the chalk in many places. They are all of crystalline, mostly of granitic origin. Their size is not considerable, but yet beyond the moving power indicated by the white chalk: the means of transport usually employed to transport materials into great depths are floating seaweed and icebergs. He described the Croydon boulder; it is too large to have been carried by anything but ice. It was found in connection with other similar materials which had evidently been deposited at the same time. These rocks, so assembled, only exist in the Scandinavian mountains; and their being found in this position throws light on the distribution of land and water in the north of Europe as the epoch of the deposition of the chalk; there were these regions lying to the north of the Chalk Ocean, from which the boulders were borne by icebergs and floes, as at the present time. The reason that these boulders are not of more frequent occurrence in the chalk was explained, with reference to the present path taken by the icebergs in the Atlantic. During the drift period of the Pliocene division of geological history the set of the liberated ice was more eastern, dependent on considerations which are well understood, and can be made available for any period.

Professor Phillips remarked that the lump of granite which occurred in the chalk was of a very peculiar kind, and quite different to any of their English granites. It was composed of quartz and felspar, and without mica, in this and other respects accurately resembling the granite of Scandinavia. At the time of the deposition of the chalk the granite of Scandinavia may have been found in part of a range of mountains which extended to the Highlands of Scotland. In the oolitic deposits of Yorkshire the sediment in the rock pointed to some land which may have existed in the neighbourhood of Scandinavia. The late Professor Forbes, in his theory to account for the distribution of plants and animals, proved that there was a connection between the northern portions of Europe and the north of England.

Herr Herman Schlagintweit made some *observations in reference to Erosion and Cleavage*, particularly with reference to observations made by his brother Adolphe, who had paid particular attention to the science of geology during the travels of the three brothers in India. The erosion was said to amount on an average to a depth of 1500 feet in the Himalayas, and is proved to exist by the deposit of rocks and by the spoon-shaped excavations of the sides. Its most important consequences were detailed,—the change in the transporting power of rivers, drainage of lakes, and subsequent dryness of the atmosphere, which, for instance, explains the formation of salt lakes with a general revolution in meteorological conditions. Changes in climate and vegetation have been produced by the appearance of new deep vacancies which did not formerly exist.

These have an influence on currents of air and on the transparency of the air, which is limited in consequence of the currents of air at different temperatures. The chief cause of this erosion is the amount of the irregular distribution of rain in recent geological periods. In the Himalayas there are hardly any lakes. The principal and lateral valleys meet nearly in the same inclination ; waterfalls do not exist at all. All this is in consequence of the erosion having there existed to a much greater degree than in Central India or in the Thiarnshan chain of mountains. Besides the mass of water, also the great quantity of suspended mud was pointed out as increasing the erosion. On the subject of the cleavage, M. Schlagintweit pointed out the connection between the intersection of cleavage plains and the position of the poles in magnetic rocks. The apparent parallelism between certain cleavage planes, with the strata of stratified rocks in their divisions, and the several facts which tended to show that in many cases the cleavage planes have been produced by a force which had been decomposed, and resolved in different directions by meeting unequal resistance.

Mr Robert Chambers said—In the valleys of Scotland the glacial drift forms in some places the flanks of the valley, having a narrow channel at the bottom cut out by the existing river. The present river action is therefore not the origin of the valley, which must have been produced under quite a different set of conditions. He attributed it to sea action at different times. He alluded to the fact of the sea having, in many parts of the Scottish coast, excavated caves in the solid rock. When the roof of these falls in, and the land becomes elevated, valleys will be formed. He then proceeded to draw a comparison between the valleys of Scotland and India, and showed that the secondary valleys, or those excavated by means of the existing rivers in India through the solid rocks, were often 1500 feet in depth, though agreeing in a geological point of view with those of Scotland.

Professor Oldham confirmed to the fullest the statements of Herr Schlagintweit. He himself had seen valleys in the Himalayas of recent river formation, the depth of which were fully 4000 feet—those of 1500 to 1800, with perpendicular sides, were common. That such were not formed by sea action is quite evident, the sinuous character being of itself enough to show this. The wonder at the extraordinary power of rain water and river water to produce such an amount of erosion would, perhaps, be lessened when the enormous amount of rain which falls during four months of the year is taken into account. He himself measured thirty inches of rain as having fallen in 24 hours, and the total amount in four months was 600 inches (50 feet).

Mr Hopkins read his *Report on the Conductive Powers of various Rocks.* Mr Hopkins gave an account of the results of numerous experiments which he had recently made on the conductive power of various substances for heat. To explain the objects of these experiments, he stated that if a globe of any large dimensions, like the earth, were heated in any manner and in any degree, and then left to cool by the radiation of heat from the surface, the temperature of the mass at points not too remote from its surface, and after a great lapse of time, would follow a very simple law—the increase of temperature in descending below the surface would be proportional to the increase of depth, supposing the conductive power of the mass to be the same throughout. But if a stratum of another substance (as sedimentary matter, for instance, in the case of the earth) superimposed on the sphere, its horizontal extent being large in proportion to its thickness, the rate of increase of temperature in descending within this stratum would be greater or less than in the other parts of the sphere, according as the conductive power should be less or greater. It would be approximately in the inverse proportion of the conductive powers. The principal object of these experiment was to ascertain whether such be the case or not. The conductive powers of lime, clay, and sand, in the state of dry powder, are in the order in which they are now mentioned; calcareous rocks, from dry chalk to hard mountain limestone, vary in their conductive powers (on the numerical scale adopted) from 1·7 to 5·5 deg.; sandstone rock, from 2·5 to 7·5; granite, and very hard compact felspathic rocks, from 5 to 10. Hence it follows, that if the terrestrial heat observed at present in mines, Artesian wells, &c., be entirely heat transmitted from a central nucleus, the rate at which the temperature increases, as in descending below the surface of the earth, ought to be very different in different formations. It appears, however, that this rate, in known mining-shafts and Artesian wells which have penetrated to the greatest depths, and in which the observations are most trustworthy, in different parts of Western Europe, is nearly the same in different formations. The author compared the two cases of the well at Paris and a vertical coal shaft at Tuckenfield, near Manchester. He estimated the conductive power in the former case at one-half of that in the latter; while it was found by observation that there was an increase of one deg. F. for every 60 feet of depth in the former, and for about 64 feet in the latter instance; whereas these depths, instead of being in the ratio of 60 : 64, ought, according to the theory, to be at the ratio of 60 : 120. This proves that the temperature observed in these cases cannot be due merely to heat transmitted from the interior of the earth by ordinary conduction. The author stated also that he had investigated the influence of induration, pressure, moisture, and discontinuity on the conducting powers of various substances, referring for details to a paper lately read before the Royal Society.

Professor H. D. Rogers read a paper *on the Geological Survey of Pennsylvania, with Maps and Illustrations.* The author described the difficulties experienced in the execution of this survey, from the absence of accurate maps of the country, which compelled him to execute a partial topographical survey in addition to other work. During a portion of the time the Professor had to carry on the undertaking at his own expense. The paper was illustrated by some very good engravings of the localities and by the geological map of the State, and the methods adopted in conducting the survey were briefly sketched.

General Sketch of the Districts already visited by the Geological Survey of India. By Thomas Oldham, A.M., F.R.S., G.S., &c., Superintendent of Geological Survey of India.

The labours of the Geological Survey of India have been conducted hitherto under great difficulities. More recently, however, the liberality of the Government of India had greatly extended the establishment of the survey, and he trusted that their future progress would be rapid and effective. The only general sketch-map of the geology of India which they had was that published by the late Mr Greenough. This was a work of great value, and gave abundant proof of the extent and labour of its author in its compilation. As might be anticipated under the circumstances, it was full of errors; and perhaps few could speak more confidently of this than himself. But at the same time it was a most valuable contribution, and would prove a most useful guide to future observers. The officer of the geological survey had examined several districts of considerable area in detached positions, and the results which he was able to lay before the section might therefore appear less connected than he could wish. But every day would tend to unite them more closely; and his object was now simply to report progress, and to show that something had been done to elucidate the structure of India. Referring first to the districts to the east of the Bay of Bengal, the Tennasserim Provinces extend for about six degrees of latitude along the east shores of the Bay of Bengal. In breadth they seldom exceed more than one degree of longitude. From Siam, on the east, these provinces are separated by an interrupted range of mountains, occasionally rising to 7000 or 8000 feet high, but the general height of which is to the north about 4000, diminishing in passing southwards to 3000 feet or less. The main direction of this range is north and south: this being also the general direction of the coast line, of the minor and outlying ranges of hills, and, therefore, of the rivers. The geological structure is tolerably simple, although at first sight apparently complicated, from the great disturbances to which the rocks have been subjected. The central range is of granite, occasionally, but not frequently of syenitic character; itself traversed by thick veins of large crystalline felspathic granite, and often along its outer edges, or near its junction with overlying slates, characterized by the presence of tinstone as an ingredient of the mass disseminated among the other mineral constituents. This granite axis is succeeded by highly metamorphic rocks of gneissic and micaceous character, themselves cut up by numerous veins of granite, which, however, do not extend far from the junction. Upon these is a great accumulation of bluish and bluish-black earthy beds, thinly laminated, of thin-bedded grits, and of pseudo-porphyritic rock, the normal character of which is an earthy hard rock with small irregularly disseminated sub-crystalline felspar, passing, on the one hand, into slates, and, on the other, into grits, often coarse and conglomeritic. These harder rocks form all the higher grounds of the outer ranges of hills. This series being best seen in the southern province of Mergin, has been provisionally called the "Mergin" series. The total thickness is about 9000 feet. It is succeeded unconformably by hard sandstones in thick and massive beds, with their earthy partings, generally of reddish tints, occasionally deep red and yellowish. A few beds are slightly calcareous, and in the upper portion a few thin and irregular bands of earthy blue limestone occur. Above these rest about 200 feet of soft sandstone in thin beds, upon which apparently rests the massive limestone of the country so largely seen near to Moulmein. The thickness of the entire group is about 6000 feet, and as some of its members are but seen in the northern province of Moulmein, I have provisionally called it the "Moulmein" series. To determine the age of the older of these two groups (the Mergin) we have no data. The aspect of much of the rocks is very similar to the trappean ashes and felstones so abundant in the silurian rocks of this country, while others are lithologically like Devonian; but these resemblances are very deceptive. The age of the Moulmein series is, however, tolerably defined by its organic contents. These appear to fix the age of the group as distinctly carboniferous. The whole of these rocks were, subsequently to their induration and disturbance, widely and greatly denuded, and on their upturned edges at intervals is found a series of conglomerates and sandstones and imperfectly coherent shales, with thick beds of coal, generally of lignitic character. None of the conglomerates are coarse; the sandstones are fine, gritty, and pebbly, or clean white quartzose grits; the shales thinly laminated; the coal itself thinly disposed in thin flaky laminæ, with earthy streakings marking its structure. In addition to the total unconformity of these rocks, the imbedded organic remains are quite distinct. They consist of dicotyledonous plants (leaves) belonging to the group of the Laureaceæ, and probably to the genus Laurophilum of Goppert. In the thin papery shales which overlie the coal are also remains of fish (scales, &c.) of fresh-water character; the whole referring the beds to a very recent epoch, probably corresponding in part to the pliocene of European geologists. It is curious to notice here the absence of any coal in the carboniferous rocks below, and its abundant presence in those newer beds. The total thickness of these beds does not exceed 900 to 1000 feet. They are never continuously traceable; they occur heaped up against and separated by the projecting ridges of the higher grounds, and must have been deposited when the physical conformation of the country was very similar to that now existing. They appear to be the result of a series of fresh-water deposits, formed in small lake-like expansions along the lines of the great drainage valleys of the country, and to mark a line of general and greater depression between the main ridge of hills dividing Siam from the British dominions, and the outer ridges which occur between this and the sea. The direction of the main drainage of the country is determined, as already remarked, by the direction of these ranges, and is discharged into the sea through narrow rocky gorges, which have a direction nearly east and west, and which are due to lines of breakage and dislocation. To this is due the sudden alteration in the direction of the courses of the larger rivers, as may be seen on maps. Rocks similar to those situated in the Tenasserim provinces extend northwards up the course of the Salween River, and into the adjoining districts of Burmah, to the north-east of Pegu. And, again, close to the capital of Burmah, and stretching nearly north and south, as far as examined, high ridges of metamorphic rocks are again met with, consisting of gneiss, micaceous schists, and highly crystalline limestones, occasionally of a fine white colour, and largely used by the Burmese for sculpture. But the great valley of the Irrawady is, throughout a very large extent of its course, bounded on either side by a thick series of rocks, chiefly sandstones, but with massive limestones also, which are locally rich in fossils, and which, from this evidence, may be clearly referred to the eocene period. These stretch on both sides of the river as far north as Pugahu, beyond which the higher grounds recede from the river banks; but they are in all probability continued thence into Munipoor, and so united with the nummulitic rocks of the Khasi and Cachar Hills. These rocks have been considerably disturbed and broken, but have a general and prevailing strike nearly north and south, which strike, throughout many miles, has determined the general course of the River Irrawady. Their thickness is considerable, certainly exceeding 5000 feet. Above these eocene rocks, and resting upon them with slight unconformity, is a series of beds of no very great thickness, characterized by an abundance of gypsum disseminated in thin layers and veins, and in the lower beds of which occur the deposits of clays and of vegetable matter, from which are derived the larger supplies of petroleum. These rocks are well seen at Senan Kyoung ("stream of fœtid water"), and are traceable northwards to near Amarapura. In the beds which appear to form the uppermost part of this group, but which may possibly belong to another and distinct series, are found some of the fossil bones of the larger animals which occur abundantly in this district. About forty miles north of Amarapura we again meet with sandstones, shales, and coal, resting unconformably on the metamorphic rocks, and characterized by remains of dicotyledonous trees similar to, if not identical with, those found in the coal-yielding group of the Tenasserim provinces, and which are therefore referred to the same age (pliocene). This series, so far as examined, proved of no great extent or thickness. We pass now to the Khasi Hills, which form a comparatively isolated range, rising suddenly from the great plains of Bengal in the south, and divided in the north by the valley of Assam from the great Himalaya or Bhotan range. On the southern face of this range rises almost perpendicularly from the plains, which are continual from the Bay of Bengal, with scarcely a perceptible change of level to the very foot of the hills, and, with the exception of a comparatively small thickness of metamorphic rocks at the base, are composed of nearly horizontal beds of sandstones, a few shaly layers and limestone, long known for the abundance and beauty of the nummulites it contains. These beds dip slightly to the south, and die out towards the north, when the metamorphic rocks come to the surface in the hills. Disregarding here any details as to the older rocks, the age of the sandstones and limestones is unquestionably fixed by their organic contents, and therefore, also, the epoch of the coal, which is associated with them, as belonging to the great eocene period of geologists. No newer group of rocks is definitively seen in these hills. Along the southern face of the range there is evidence of a great dislocation extending for many miles, and possibly along the entire scarp, which has brought down to the level of the plains the rocks which are seen at the top of the hills. This line of dislocation has in all probability tended to give the nearly rectilinear direction of the escarpment; its date is fixed as at least subsequent to the formation of all the eocene rocks here seen. An older group of sandstones, considerably altered, is seen further to the north, within the hills, and also a series of highly metamorphosed schists and grits resting upon the gneissic and granitic rocks; but the details of these are reserved. Passing thence still further to the north and east, at the base of the Sikkim Himalayas, under the hill station of Darjiling, another section was described. The great mass of the lofty hills is here composed of schistoze rocks of various characters, considerably disturbed and contorted. These, although hitherto coloured similarly, and considered as of the same age, were decidedly different from, and more recent than, the gneissoze rocks of the greatest portion of India. Near the base of the hills, and faulted against these rocks at high angles, there is a small extent of sandstone and black shales, which contain vertebrata, pecopteris, &c., similar to those occurring in the great coal-fields of Bengal. These fossils are peculiarly interesting, from the fact of their being changed into graphite, and occurring in beds which themselves have a very strongly marked graphitic character. They are of very limited extent; the greater portion of the sandstones, which in this section exhibit a thickness of some thousand feet, belonging to a series of much more recent date, and which has been subjected to a much smaller amount of disturbance and alteration. The exact relation of these, too, it has not been possible to observe. This upper group contains many large stems, in all observed cases prostrate, and in most cases giving evidence of great wear and long exposure previously to being imbedded; and in some of the finer and more earthy deposits an abundance of leaves occur, of the same general character as those already noticed as occurring in Burmah and Tenasserim. This group was therefore provisionally referred to the same age (pliocene). No traces of the great nummulitic series had been observed in this district. In the more central portions of India three very large districts had been examined, to which he would now refer. One of these was to the south of Calcutta, in the district of Cuttack; the second included all the country between the great coal-field of the Damoodah, which had previously been mapped by Mr Williams, and the River Ganges, extending northwards to Rajmahal and Bhagulpore; and the third extended along the valley of the Nerbudda from west of the Hosungabad to many miles east of Jubbulpur. For the details of the first of these he was indebted chiefly to his able assistants, the Messrs Blandford; for the last to Mr Jos. Medlicott, who had very zealously worked it out, having to carry on the formation of a topographical map at the same time. In all these cases the sedimentary rocks, to which he would refer, formed portions of a series once more widely extended, and probably continuous over the whole country, now separated by denudation, from removal by which they have been in great part protected, by being faulted into and against the highly metamorphose gneiss, &c., which surround them. The Talcheer field extends for about 70 miles from east to west, with an average breadth of 15 to 20 miles, and is bounded both on the north and south by great parallel faults, the former of which has an aggregate throw of upwards of 2000 feet; these faults are not truly east and west, but to the south of east and north of west. The section in ascending order of the basin shows at the base sandstone and blue shale, but slightly fossiliferous in thickness from 500 to 600 feet; over these is a series of shales and sandstones often micaceous, occasional beds of ironstone, and thin layers of coal and coally shale, giving a total thickness of about 1800 feet; and over these again is a distinct series of quartzose grits, conglomerates, and sandstones, in thickness from 1600 to 2000 feet. These three groups are unconformable each to the other; the unconformity between the two lower being, however, much less marked than that between the two upper. To the lower group, as having been first recognised and described in this district, the name of "Talcheer" series has been given; the second group, which, from its imbedded vegetable remains, was proved to be identical with the rocks of the extensive Damoodah coal-field when these were first described, has been denoted the "Damoodah" series; while the upper group, supposed to represent the great series of rocks, so magnificently seen in the Mahadeva Hills of Central India, has been called the "Mahadeva" series. Thus these series can be recognised in each of the extensive fields referred to, although with varying developments and thicknesses. At the base of the Talcheer series there is a remarkable bed, consisting of very large and only slightly rounded masses of granite and gneiss, imbedded in a fine silt, and occurring under such conditions as induce the opinion that the action of ground ice has been the cause of its formation. In the Rajmahal district there is a very limited development of the lower beds, above which unconformably comes the Damoodah series, here exhibiting a greater extension upward than in Cuttack; but unfortunately the sequence of the rocks is interrupted by the intercalation of several successive floes of basaltic trap, the intervals between which have been marked by the continued and tranquil deposition of the mechanical rocks going on. These floes have been repeated six or seven times, and the phenomena of contact are in all cases marked; the upper layers of the mechanical deposits in contact with the trap being in all cases greatly altered, while the lower layers are in no cases changed, but rest unaltered on the degraded surface of the underlying trap. But while the actual physical sequence of the deposits cannot be here traced, the fact of their all belonging to the same great series is attested by the occurrence of some identical fossils throughout. A few species pass upwards through the series, but there is a very marked change in the general facies of the flora in the upper as compared with the lower portion of the group; the latter characterized by the abundance of vertebrata, pecopteris, trizzgia, &c., the former by the abundance of zamia-like plants. The series, therefore, has been divided into Upper and Lower Damoodah rocks. For the details of the structure of the district, reference was made to the maps. In the Nerbudda district the series was less interrupted, and there also the same general results were obtained. The southern boundary of this great field was for a large part of its course produced by a great fault, having, *quam proxime*, the same general direction as that of the faults bounding the Talcheer field. The age, geologically considered, of these Damoodah rocks was briefly referred to. A large series of drawings of the fossil plants from them were exhibited, and the fact of the general oolitic facies of this group, especially of those from the upper beds, pointed out. The difficulty of the question was alluded to, especially in connection with the discovery, on the one side, of several species identical with those found in these Indian rocks in the Australian coal-fields, associated with numerous animal remains distinctly referable to the lower carboniferous era, and, on the other hand, to the discovery in Cutch of other species, also identical with some of these Indian forms, in beds associated with animal remains, undoubtedly referable to the oolitic epoch. It must, however, be borne in mind that the latter forms, or those which the evidence of associated animal remains would show to be oolitic, are only found in the upper beds of the Damoodah series, while those which are common to the Australian fields are those chiefly found in the lower beds. Unfortunately, no animal remains whatever have been found with these plants in the districts examined, excepting some annelide tracts useless as distinctive forms. He preferred, under these circumstances, waiting for further evidence before giving any definite opinion as to the age of this widely-extended and important group of rocks. Mr Oldham then stated that there seemed good reason for separating altogether from the several groups of rocks to which he had referred the whole of the great thickness of sandstones which formed the great Vindhyan range, extending almost entirely across India, from the mouths of the Nerbudda to the Ganges at Monghyr. These appeared to be of prior date, and there was a probability that there was a great line, or a group of lines, of dislocation passing along the general line of the valley of the Nerbudda, and the effects of which might be traced over a very large area, extending towards the north-east, possibly even into the Valley of Assam. Besides the examination of these districts, which together included an area of more than 30,000 square miles, the geological survey had been able to add to the knowledge of the structure of the country in other ways. An excellent selection of fossils from the neighbourhood of Verdchellum in Madras, for which they were indebted to Brooke Cunliffe, Esq., who had been associated with the Rev. Mr Cay in the first examination of these fossils, had enabled them to add largely to the lists of Forbes, and to establish more conclusively than before the cretaceous age of these deposits. The exertions of Captain Keatinge at Mundlaiser, to whom Mr Oldham had pointed out the interest of the inquiry, had collected a good set of organic remains from the limestone at Bang, to the west of Mhow, which had enabled him to fix the age of those deposits as contemporary, or nearly so, with the cretaceous beds of Trichinopoly and Verdachellum. This discovery gives rise to many important speculations as to the age of other beds, and also as to the epoch of the elevation of all Central India, but more data were required before these could fairly be entered upon.

Mr W. H. Baily, *on the Carboniferous Limestone Fossils from the County Limerick.* The fossils described by the author were collected by the Geological Survey; there are several new forms among them, and they are all well preserved. Zoophytes.—Of this class of organic beings, usually so common in carboniferous rocks, there are only a few specimens, chiefly belonging to the division *Zoantharia tabalata* of Milne Edwards, amongst which are the genera Michelenea and Chœtetes; also the common and characteristic coral, *Amplexus coralloides.* Echinodermata.—These are chiefly Melocrinidæ, consisting mainly of detached bodies of Platycrinus and Actinocrinus, almost exclusively confined to this formation. Bryozoa.—Several forms, chiefly Reteporidæ, amongst which are fine specimens of the well-known *Fenestella membranacea* of Professor Phillips. *Brachiopoda-terebratulidœ,* only one species; *T. Hastala*, of which there are fine specimens. Spiriferidæ.—Several characteristic forms, including *Sp. Roemerianus* (de Köninck), a form new to Britain; and *Athyris roissii,* a singular and rare species, in which the lines of growth are developed into expansions, giving it a fringed appearance. Rhynconelidæ.—The common forms *R. pugnus* and *R. pleurodon.* Orthidæ.—The well-known *O. restipinata* and the very rare *O. radialis.* Productidæ.—Several characteristic and rare species, including *P. aculeatus* and a new species. Chonetes.—Several rare varieties, as *C. Koninckii*, new to Britain; *C. variolata* (D'Arbigny); *C. papillionacea.* Conchifera.—Several new forms, including species of the genera Aviculopecten and Pteronites (M'Coy), shells having an oblique axis like the so-called pectens of the coal measures. Of the singular shell *Conocardium Hibernicum* (Pleurorhgynchus of Professor Phillips), there are several good specimens, showing the extended keel and siphuncle in some species still more extended, being analogous (as suggested by Mr Woodward) to those of cockles inhabiting salt inland seas, as Lake Aral and the Caspian. A second species, *C. Koninckii*, of which several very perfect specimens were found, contains even a larger size than *C. Hibernicum.* Professor De Köninck agreed with the author in considering it an undescribed form. He proposes to call it after that distinguished palæontologist. There are several species of Cardiomorpha, one of which, *C. Koninckii*, is new to Britain, and another, a new species of large dimensions. Gasteropoda.—Many genera and species, including a new species of Macrocheilus and other undescribed forms. Of the Nucleobranchiata, supposed to be allied to existing floating shells, several species of Bellerophon, together with *Porcellia puzio*, a very rare discoidal form. Cephalopoda.—This, the most important order of the mollusca, is represented by large and rare specimens, all belonging to the order Tetrabranchiata. Nautilidæ.—Fine specimens; some new. Orthoceratidæ.—*O. muensterianum*, and fine examples of *O. dactylophorum*, with the peculiar forms of *Gomphoceras* (*Poterioceras*) *fusiforme* and *Ptychoceras verneuillatum.* Goniatites.—Several species, including *G. crenistria* and *fasciculatus*, some showing external markings, and others being new forms.

Mr W. H. Baily also read a paper *on a New Fossil Fern, from the Coal Measures near Glin, County Limerick.* This fern was discovered by Mr G. H. Kinahan in the black shale above the coal in the townland of Ballygilternan Lower, County Limerick, together with ordinary coal plants. It appears to be the central portion of a frond, with about 20 alternate pinnules, which are apparently covered by thecæ or cases of the reproductive germs, presenting an appearance somewhat resembling rows of small flowers. This plant is unlike any present or fossil fern, and has organs of fructification—an occurrence rare among carboniferous ferns. It is exceedingly interesting, and may possibly be a new generic form.

Dr Gladstone read Mr G. F. Habershon's *Account of the Barbary Coast, with Fossils.*

Mr J. Birmingham read an abstract of a paper *on the Drift of West Galway and the Eastern parts of Mayo.* The author set out by alluding to the interest and importance of the Irish drifts in general, which are well developed in the district to which his paper refers. They differ from the drifts of other countries by containing no fossiliferous evidence of their comparative date; and to account for the absence of shells or any traces of boring molluscs in their materials, the author suggests that the remains of those great drifts, which are now exposed, probably never formed the surface of the former sea-bottom. He divides the drift of his district into three principal divisions, namely:—1. The Clay Drift, from the south-west, forming cliffs on the north, east, and south shores of Galway Bay; 2. The Great Boulder Drift, from the north-west, overlying the former; 3. The Escar Drift, forming the chains of gravel hills in the interior of the country, and derived, like the clay drift, from the south-west. The direction and sequence of those drifts is inferred from their mineralogical characters and relative position. The perfect round forms of the Escar Hills, and the complete curves their beds or layers exhibit in any stratified section, not only prove their subsequency to the other drifts, but furnish a strong argument against the glacial hypothesis; for, if icebergs had been floating about and grooving the rock-bottom of the shallowing sea, the Escars would scarcely have escaped their action, which would be recognised in the tabulation of their summits or other significant appearances. The long ranges of those gravel hills he believes to be the effect of eddies, as the land approached the surface; and their lines may often show the resultants of currents subdivided from the main stream beyond the limits of opposing hills. He maintains that it is to the power of moving water, and not either to glaciers or floating icebergs, that the phenomena of the drift of this district are to be ascribed. Nothing can be more marked than the regular increase in number, as well as in size and angularity, of the erratic blocks as they are followed towards their source. Their decrease in numbers, according to their remoteness from their parent rocks might indeed be accounted for by the glacial hypothesis, but not so simply their diminished size; for though the ice-raft may waste away by degrees, and its powers of buoyancy become less, still this must be thought to affect the total quantity rather than the individual parts of the load that it bears. As its cliffs succumb in its progress through the warm sea waves, its burden may gradually be reduced; but there is no reason why the largest masses should not be found among the mixed materials which are carried on its contracting area. The striation of the surface rocks, which the author observed in some parts of his district, he considers to have been effected by the pushing forward before the breakers of large flat masses of the stratified rocks of these localities, and referred to the early notice of this subject by our eminent Irish geologist, Mr Griffith.

Frederick J. Foot, Esq., read a paper describing a *Section from Bird Island, at the mouth of the Shannon, to the village of Castlemaine, in the County Kerry.* In this paper Mr Foot described the rocks from the coal measure shale to the upper conglomerate of the old red sandstone. He mentioned that the drift was generally from the north, and that granite boulders (some of them of large size) were frequent in it. The principal points of interest were the conformability of all the rocks described, and the variableness of the conglomerate bed, both in thickness and character. He also exhibited some stems of plants from the yellow sandstone, or upper subdivision of the old red sandstone.

Professor Harkness, after referring to the great services rendered by Professor Sedgwick to the geology of Cumberland, read a paper *on the Geology of Caldbeckfells and the Lower Sedimentary Rocks of Cumberland.* The district alluded to in this communication forms the northern portion of the mountainous area of the lake district of Cumberland. Caldbeckfells, including their eastern extremity Carrickfell, consist of masses of a plutonic and an igneous nature. On the southern slopes of these hills there is seen Skiddaw slate, which generally has a south dip, and this Skiddaw slate, as it approximates the granite of Skiddaw Forest, passes into chiastolite slate, chiastolite rock, and a pseudo-gneiss. On the south side of the granite area the same phenomena occur; but on this side hornblende rock and actinolite rock also appear. In the metamorphic rocks, and likewise in the ordinary Skiddaw slates, which succeed them in position, the strike of the strata is nearly east and west, and the general arrangement of the strata seems rather to indicate that the plutonic masses of Caldbeckfells form the axis of the group rather than the granite of Skiddaw Forest. With respect to the unaltered rocks of the Skiddaw district, these have been referred by Professor Sedgwick to three groups—black Skiddaw slate grits, seen in the masses of Grassmere, and gray Skiddaw slate, containing fossils described in the palaozoic fossils of the Woodwordian Museum. The upper gray slates are the deposits which have hitherto afforded organic remains. Last year the author obtained trails of worms from the black Skiddaw slate, the lowest number of the unaltered series, at Bralkeld; and from a communication which the author had received recently from Professor Sedgwick, it would appear that in these low strata graptolites have been lately obtained by Mr J. Ruthven. With regard to the lithological nature of these Skiddaw rocks, it would seem that there is a considerable change according to locality. Westward gray slates, with intercalated grits, obtain on the line of the strike of the black Skiddaw slates, leading to the inference that coarser beds supply the place of the finer black slates on the eastern margin of the area.

The Rev. W. S. Symonds read a paper *on a Fossil of the Severn Drift.* The excavation of the alluvial drift of the Severn at Tewksbury Horn is nearly forty feet deep, and the river-bed itself has been dredged to the depth of seven feet. The river-bed contains relics of the human race several feet below the present gravel. These are associated with the remains of Roman pottery, the vertebræ of a whale, and many irregular round-shaped glass bottles of great thickness. The alluvial drift is a mass of clay and brick earth, 39 feet thick, resting upon an ancient river-bed of gravel and shingle. About 37½ feet from the surface we find the fossilized antler of a large stag (Cervus), which the author imagines may have been of the Irish elk. This antler is at the base of the brick earth a few feet above the gravel. It is interesting to observe the difference in the state of fossilization between the vertebræ of the whale, which is little altered, and the antler of the deer, which has been nearly entirely converted into stone. The antler is in much the same state as the mammalian remains found by Mr Strickland in the drifts of the Avon Valley; while the vertebræ of the whale may be compared with the large crooked-horned head of a bison obtained by Mr Strickland sen. from the Avon river-bed. From comparison of the fossils, the author is inclined to believe that the cervus antler of the Severn is the relic of an animal that lived in the period of the *Bos primigenius* (a fine skull of which is in Mr Strickland's possession); whether it belonged to the *Magaceros Hibernicus* or not remains to be proved.

Arthur B. Wynne, Esq., read a paper *on the Tertiary Clay and Lignite of Ballymacadam, in the County of Tipperary.* In this paper the author called attention to an extremely interesting and very isolated deposit of white clay and lignite, supposed to be of tertiary age, found about a mile to the east of Caher, in the county of Tipperary. He stated that the clay occurred in a small hollow in the carboniferous limestone, though not at the lowest point. It was not discoloured by burning, and was capable of being manufactured into pipes and many articles of finer ware. A singular circumstance is the occurrence at this place of some of those natural drains so common in the carboniferous limestone of Ireland, called by the peasantry "swallow-holes." The place where the clay was found had a strong odour of sulphuretted hydrogen gas. It is, he observed on the authority of Dr Griffith, similar to the large and distant deposits of Tyrone, Armagh, and Roscommon, in Ireland, and Devonshire in England.

Section D.—ZOOLOGY AND BOTANY, INCLUDING PHYSIOLOGY.

Dr Daubeny read a *Final Report on the Vitality of Seeds.* He stated that about sixteen years since Mr Strickland and others and himself suggested the advisability of instituting experiments for the purpose of ascertaining, by way of experiment, as far as possible, the terms to which different seeds would retain their vitality. They were all well aware of the statements as to the germination of mummy seeds, and it was with the view of determining the various questions which arose that a committee was formed in 1840 to make experiments, which were made in the following manner:—A considerable number of seeds of as many kinds as could be procured were placed in porous stone jars, covered so as to exclude insects and rapid circulation of air, and so as to secure a slow circulation. The experiment had been carried on for seventeen years, and each year a report was given, stating the number of seeds which had germinated, which were resown until their vitality ceased. As the seeds which had originally been procured had, with the exception of four, lost vitality, the inquiries were considered to have come to a close, and the final report was brought forward. He submitted a paper to the meeting containing a general summary of the experiments from 1841 to 1857, and a tabular statement, showing the relative vitality of different kinds of seeds, from which it would be seen that the greater number of seeds lost their vitality at eight years, and that forty-three years was the longest period to which they retained it. The experiments made by the Association did not confirm the common belief regarding the indefinite vitality of certain seeds, for instance, the mummy seed. If any naturalist would suggest a better mode of preserving the plants, it would be well to institute a new set of experiments; but as far as was at present known, the plan that was adopted was the most likely to preserve their vitality.

Dr Lankester observed that the Report was very valuable, but that the result was not in accordance with what vegetable physiologists would expect. The question, however, was, whether the Report settled the mooted point of the duration of vitality in seeds. As to the mummy seeds, too much care could not be taken in relating such cases. It was not sufficient to get a parcel of seeds from a mummy and put them in the ground; the mummy should be got out of the tomb, because no one could say what might not occur during the transfer of the mummy-case; so that unless some person quite capable of making the experiment should unrol the mummy with his own hands, plant the seeds, and keep them constantly under his own supervision, the experiment should not be considered satisfactory.

Dr Steele, in confirmation of Dr Daubeny's observation, said, that in the course of last year Mr John Ball sent through his brother to him (Dr Steele) a packet of wheat which had been taken out of a mummy-case. He sent the wheat, which was in a vase in the case, to Mr Moore, the curator of the Royal Dublin Society's Gardens at Glasnevin, who had tried them with all the knowledge and skill which he possessed, but not one of them vegetated.

Dr Daubeny observed that he should have mentioned that they had tried seeds taken from mummies, and in no instance did they vegetate.

Mr Moore stated that he had tried those seeds mentioned by Dr Steele with the greatest care in the garden stove-house and in the open ground. He also experimented on them by placing them in boiling water, by which means he had raised very old seed, but he failed altogether in raising them. He had no doubt but that many persons present were aware that seeds could be raised of a greater age than that stated in Dr Daubeny's report, and he had no doubt but that he would be able to raise plants for forty years hence.

In reply to a question from Dr Lankester,

Dr Steele said that the seeds were sealed in his presence by Mr Thomas Ball. He (Dr Steele) transmitted them to Mr Moore. They were from the mummy of Thebes, he thought, and had a fragment of the pottery of the vaults attached.

Mr Moore related a circumstance, that during the storm of 1839, a tree, 100 years old, was blown down, and in the centre of the trunk was found a quantity of seeds, which were set, and having vegetated, turned out to be the common laburnum.

The Rev. Mr Higgins stated that seeds which had been given to him as having been taken from a mummy did germinate, but he should confess that the circumstances under which he received them did not give him confidence. They were given to him with the intimation that they were found wrapped up in a mummy-cloth, with a quantity of bitumen about it. He asked if any experiments had been made of seeds inclosed in hermetically sealed cases?

Dr Daubeny replied that it had been tried, and that the conclusion had not been favourable.

Professor Archer observed that it was believed that some seeds, melons for instance, were better for being kept for a long time, and that gardeners actually kept melon seeds in their pockets for a considerable time to improve them.

Mr Moore said that such was the case, although he could not account for it. He mentioned that a friend in India, being unable to procure some of the beautiful plant berberis which he promised him, sent him a pot of jam made of it by the natives, and that he sowed the jam, and not one seed missed, and a new and beautiful plant was by that means introduced into the country.

Mr Ogilby remarked that the great question was, how were the seeds to be preserved before the experiment was made?

Mr Nevin, in reference to the vitality of melons, stated that he once raised a crop of that fruit, and from the seeds a second set of seeds was sown, from which there was an abundant crop, if not a more abundant one, than from the seeds which produced the first crop.

The President remarked that it was with the idea of ripening them that melon seeds were retained in the pocket for a time, and it was probable that they became more fruitful after having been kept over for some time, for the same reason that plants were more likely to come to full flower after a lengthened season of rest.

Mr Emerson referred to the fact, that if a forest of pine trees was cut down in New England, a forest of oak trees was sure to spring up in its place. He was inclined to think that acorns were carried great distances by several species of squirrels, who, having eaten all except the germinating part, in some manner left it after them; and then, when the old pine forest was cut down, and the influence of the sun let in, the seeds of the oak thus deposited germinated. In reference to the influence of heat on seeds, he said that wherever the process of burning down the branches of trees took place, a small species of wild cherry was sure to spring up in the vicinity in great numbers, though forty miles from any cherry tree; but if the ground was not burned over, and if the stumps were allowed to rot and be broken up by the plough, the same number of plants would spring up, but of a different species.

Professor George Wilson read a paper *on the Employment of the Living Electric Fishes as Medical Shock Machines*, of which the following is an abstract:—The author, in prosecuting inquiries into the early history of electrical machines, did not originally contemplate going farther back than the seventeenth century, or commencing with any earlier instrument than that of Otto Guerick. His attention had been turned to the living torpedo as a remedial agent, and he now felt satisfied that living electrical fish were the most familiar and earliest electrical instruments employed by mankind. He adduced the testimony of Galen and others in proof of the practice, and as proving that "shocks" had been used as a remedy in paralytic and neuralgic affections before the Christian era. Still higher antiquity had been claimed for the electric Silurus, on the supposition that its Arabic name, "Raad," signified "Thunder Fish," and implied the nature of the shock; but the best Arabic scholars had shown that this was not the case. In proof of the generality of the practice of employing zoo-electrical machines, he alluded to the remedial application of the torpedo by the Abyssinians—of the gymnotus by the South American Indians, and the recently discovered electrical fish by the dwellers on the Old Calabar River, which falls into the Bight of Benin. The native women, he said, had a habit of keeping one or more of those fishes in water, and of bathing their children therein, with the view of strengthening them by the shocks which they received, which were very powerful. Having observed on the proofs of the antiquity as well as generality of the practice under notice, he concluded by directing the attention of naturalists to the probability of additional kinds of electrical fishes being discovered, and to the importance of obtaining the views of the natives familiar with them in reference to the sources of their power, and to their therapeutic employment.

Mr Hyndman then read *a Provisional Report of the Belfast Dredging Committee*, including a list of Foraminifera, by Professor Williamson; and of shells found in shell sand, by Mr Waller and Mr Hyndman.

Mr Patterson read a Report by Professor Dickie, M.D., *on the Mollusca of Strangford Lough and part of the Irish Channel.* The Report stated that one hundred species were dragged, viz., 57 bivalves and 43 univalves. The locality which yielded the greatest number was near the junction of the narrow channel (half a mile broad by three in length) with the wider part of the lough, the proportion being—bivalves, living, 29; dead, 17—46 species: univalves, living, 22; dead, 29—51 species. Two miles farther up, and five or six from the open sea, the numbers dragged were—bivalves, living, 10; dead, 22: univalves, living, 10; dead, 8—18 species, being about half the number in the former locality. In the wide part of the lough, still farther from the sea, the numbers were—bivalves, living, 21; dead, 5: univalves, living, 8; dead, 5. In the open sea, opposite the entrance of the lough, the drag afforded proof of very regular distribution to the distance of seven miles from the bar. The report then went on to state that in taking a general review of the molluscan fauna of Strangford Lough, and of part of the Irish Channel immediately opposite, the absence of the Lusitanean and South British types was remarked, and the general occurrence of those of the European types, with a large proportion of those called Celtic, and some of those considered as more peculiarly British were also plentiful. Those of the Atlantic type were generally rare, the Arctic type being just very partially represented. The general conclusions arrived at were, that the mollusca secured here belonged mainly to the European and the Celtic types, with a moderate proportion belonging to the Atlantic, and a very few Arctic forms.

The Rev. F. O. Morriss then read a paper *on the Specific Distinctions of Uria troile and Uria lachrymans.* He showed that in the *Uria lachrymans* the eye is larger than in the *Uria troile*, and this in addition to the permanent white streak from which the bird derives its name in the Latin, French, and English languages; and the darker colour of old birds he considered to establish the species as distinct. He pointed out the *Corrus coronæ* as only distinguishable from *Corrus cornix* in a portion of the plumage; and though the birds were different in habits, so were the young and the old birds of one and the same species, *Arus marinus*, the former being gregarious and the other not. On the whole, he concluded that neither in the shape nor size of the bill or feet was there any but accidental or temporary difference between individuals of the two species, as imagined by Macgillivray and others; but the distinctions he had pointed out, existing as they did *semper ubique et in omnibus*, were permanent specific characteristics, and marked the individuality of the species.

Professor Kinahan read a paper, and exhibited *a new species of Galathea*, for which he proposed the name *Galathea Andrewsii*. The species is remarkable for its elongated slender fore legs, which in their character approach the genus Munida. The species is exceedingly common in Dublin Bay, where it is frequently captured by the dredges.

Mr Patterson read a note of the quantity of Litorina, littoral periwinkles, shipped at Belfast during the years 1853, 1854, 1855, and 1856, which had been furnished to him by Edward Getty, Esq., secretary to the Harbour Commissioners of that port. In 1853 there were exported 1034 bags, containing 181 tons, or 3102 bushels; in 1854, 2626 bags, or 459½ tons, or 7878 bushels; in 1855, 2286 bags, or 400 tons, or 6858 bushels; in 1856, 786 bags, or 137 tons, or 2358 bushels. Such of these as are not yet in the Bay of Belfast are principally collected on the coasts of the county of Down, but the banks from which they have been derived are becoming exhausted, and are no longer capable of supplying the demand. The quantity of periwinkles deficient is now imported from Stranraer to Belfast, and thence reshipped for London. The local term in the north of Ireland for the periwinkle is "whelk." The whelk (*Buccinum undatum*) is known as the "buckie." Mr Patterson stated that they were shipped to London, and that they were got on the banks in Belfast Lough, and on the coast of the County Down.

Dr Wyville Thompson stated that he had been informed that from the islands of Scotland great numbers of periwinkles were also shipped for London.

Dr Lankester said it would be of great importance that this section of the Association should take up the subject, and draw up some rules for the preservation and propagation of animal life.

Mr Patterson said that the Commissioners of Fisheries were anxious to get information on this important subject, which they found one of great difficulty to deal with. If they had any competent authority on the habits of fish and the mode of their development, they would be able to determine the times at which they should be taken. If the government would therefore employ an eminent zoologist to collect and arrange information on the subject it would be the way to promote the object, and the association should therefore direct their attention to it. The Board of Trade were, he believed, at present engaged in investigating the oyster banks, on which there was some dispute, with the view of determining the close and open seasons.

Professor Wyville Thompson said that there were certain circumstances and seasons in which the ova of animals were not developed; and with regard to marine animals, this fact was not so well ascertained as it was in reference to others. It was well known that in certain seasons butterflies disappeared from some localities, and that the seasons had a great effect on the production of all kinds of animals. The variations in them should therefore be attended to, and their effects guarded against by greater attention being devoted to the artificial propagation of fish.

The President stated that one of the commissioners of fisheries had expressed to him his great anxiety that zoological information should be collected which might serve as an authoritative guide on the subject.

Mr J. R. Green read a paper *on British Naked-eyed Medusæ, with notices of six Undescribed Forms.* He glanced at the progress which had been made in this department since the publication of Professor E. Forbes's monograph. He also read a list of all the Acalephæ hitherto observed by him in Dublin Bay, in all amounting to 24 species. He then entered into a description of his six new naked-eyed forms, with observations on the study of their development, and concluded by calling the attention of the members to the study of this interesting group of animals.

Mr Patterson made some observations on the subject, and stated that a work, part of which he held in his hand, was nearly ready for publication, by the late lamented Dr Edward Forbes, entitled, "The Natural History of the European Seas," from which valuable information would be obtained.

Mr George Hyndman made some observations *on a Remarkable Specimen of Fusus despectus*, which he exhibited.

Mr Ogilby read a paper *on the Dispersion of the Particular Breeds of Domestic Animals as connected with the great Ethnological Divisions of Mankind.*

Mr D. Moore, Curator of the Royal Dublin Society's Garden, Glasnevin, read a paper entitled *Observations on Plants which, by their Growth and Decomposition, form the Turf in Ireland.* He observed that, although much has been written and reported on the bogs of Ireland, singularly enough no person had yet given any intelligible account of the plants which form them. He divided the varieties of bog into red bog, brown, black, and mountain bog, carefully stating the plants which formed each. He considers the red bog to have been formed on the sites of ancient lochs or deep morasses, of which upwards of one million of acres exist in Ireland, more than two-thirds of which are situated west of the River Shannon, according to the reports of the commissioners. The black bog he considered to have been formed on the sites of ancient forests, as was evident from the number of roots and stems he has found therein. He did not consider the idea correct, of species having once flourished on those bogs which have since died out and been replaced by others. His opinion was, that the Irish bogs were of too recent a date, and that we had all the plants existing yet in Ireland which have formed them, with the exception, probably, of Lough Neagh, which may have been anterior to the glacial epoch of geologists; but he thought it must be exceedingly hazardous to state what the species were which formed the fossilized wood found there. Mr Moore, in allusion to this portion of his paper, stated that there still exist a few trees of the ancient Scotch fir on the Earl of Arran's property in the County Mayo, which once formed such extensive forests in Ireland.

Mr N. Niven, Garden Farm, Drumcondra, then read a paper *on the Remarkable Results of Experiments on a Fruit-bearing Tree.* This paper went to show what, from an idea gathered from the last chapter of the Revelation of St John, the experimenter was led to anticipate, that he might succeed in so far realizing a certain portion of the remarkable description of the wonderful tree therein alluded to. His subject for the experiment was the pear, on which he commenced his operations in 1855, and at the present time (1857) has nearly realized the remarkable result of a succession of fruit from the one tree for each month in the year. The tree in question has been grafted with forty varieties of the finest pears, and is in great vigour of bearing.

Dr Redfern read a *Notice of a Simple Method of Applying the Compound Microscope to the Examination of the Contents of Aquavivaria.* He stated that he had for some time made use of a very simple and convenient arrangement for examining objects in aquaria with magnifying powers up to those given in the half circle objective. It consisted of a vertical stem of one-inch brass tubing, about two feet long, supported by a heavy cast-metal foot. In this stem a three-inch piece of tube slides, and is supported at any height by a ring and pinching screw below it. This short sliding tube has another like piece attached to it, and rotating on an axis at right angles to the vertical stem. Through this second piece a tube, two feet long, slides horizontally, its best working position being such that three-fourths of its length projects on one side of the vertical stem, and the other fourth on the opposite. To the shorter end of this horizontal tube a stem, carrying the tube of the body of the microscope, is attached by a ball-and-socket joint, admitting of a coarse adjustment by a sliding tube, and of a fine adjustment by acting on the long arm of the lever formed by the transversely sliding tube to the end of which it is attached. By this means the compound microscope is capable of being applied to any part of the surface of the side of an aquarium measuring two feet, or to the surface of the fluid which it contains. The whole arrangement can be made by a gas-fitter for the sum of about 25s., with sufficient accuracy for the uses for which it was designed. Abundant illumination may be obtained in cylindriform vessels by a small flat mirror let down into the aquarium, and moved into any position by wires, which can be attached to it in a very simple manner.

Mr J. S. Bowerbank read a *Further Report on the Vitality of the Spongiadæ.* The author referred more especially to the vital powers of the dermal membrane, and to the imbibing pores of *Spongilla fluviatilis.* These organs have the power of opening and closing at the pleasure of the animal, in a similar manner to the oscula described in the previous report on the same subject, but, unlike those organs, which are situated on elevated bladder-formed portions of the dermal membrane, and which are constant in their action and continuous in structure, the pores, when once closed, rarely open again in precisely the same situation. The essayist concluded by stating that the structure and habits of the fresh-water sponges were strictly in accordance with those of the marine Spongiadæ.

Professor Kinahan read *Notes on Certain British Genera of Isopoda.* He gave a lengthened description of the structure and habits of the Isopoda.

Mr E. Percival Wright, director of the College Museum, gave an account of *a Visit to Mitchelstown Cave, in the county of Tipperary*, in the early part of the present month, by Mr Halliday and himself, on their return from a short entomological tour in the south and south-east of Ireland. It was pretty generally known, he believed, to all present, that various living animals had been discovered inhabiting the deep recesses of caves. About a century ago the *Proteus anguinus* was found in the caves of Carniola, and since that time various insects and crustaceans, and even fishes, have been discovered, both in Europe and America. Those animals were found very far in the interior of the caves. In those of Carniola none were found within two miles of the mouth, and hence they never see light; and as, under these circumstances, eyes would be quite useless to them, they are not provided with any, so that they are quite blind, and never stray into the upper world. This is a deeply interesting fact in relation to the theory of single centres of creation, for here is a species with its centre of creation and the extent of its wanderings all within the limits of one small district—resembling those plants and animals which inhabit some of the small islands in the Pacific and other oceans, and are found nowhere in the world besides. The caves of Carniola were visited by Schiodte in 1851, and he subsequently published a very interesting account of his researches. Mr Murray had visited some of the large natural caves in Derbyshire, but no blind animals had been found in England. Mr Wright went on to say that Mr Halliday and he, after an hour's drive from Cahir, arrived at the foot of the small mountain within which the caves are found, the geological aspect of which and the surrounding country he briefly described. The townland of Coolnagarranroe lies in the valley which separates the Galtees and Knockmildown chains of mountains—the former constituting its northern, and the latter its southern boundary. The prevailing rock at this extremity of the Galtees is conglomerate, which occasionally passes into sandstone ; while that which composes the opposite chain of hills is an intermediate between sandstone and schist. The material of the decomposed valley is compact gray limestone, and this rock, in the townland already mentioned, forms the small rounded hills, within both of which cavities of considerable magnitude exist. One has been known from the remotest antiquity ; the other was discovered about twenty four years ago by a man engaged in quarrying. Having penetrated the cave by a narrow passage about four feet in width and thirty-three in length, and which gradually declined until it terminated in a vertical precipice many feet deep, down which they descended by means of a ladder, they proceeded onwards until they reached the lower middle cave. This is upwards of thirty-five feet high ; the roof is covered with small stalactites, and the floor is strewn with large tetrahedral blocks of limestone. About the entrance of the cave some specimens of a macrotoma (*Podua Linnæus*) were running over the rocks. They appeared to be bewildered by the light as it approached, and stood still, so that by putting a quilt over the spot one or two of them were caught ; but unless this was done dexterously, they leaped away. Advancing farther, at one time down precipices dangerous enough to make one distrust the guides, then creeping for many yards along the ground, which was covered with a fine red clay, so fine as to resemble red paint, and then along places where they could neither walk nor creep, but were obliged to crawl flat upon the ground and wriggle through,—at the farthest end of the long cave they discovered a species of the same group as that which they had previously noticed, but one about which there could be no mistake, as it was decidedly a native indigenous to the caves. This was a Lipuva somewhat larger than the *Lipura fimetaria*, which abounded on the surface of some little pools formed by drippings from the roof. They clustered especially on floating lumps of soft calcareous concretions, and also in the moist rocks of the sides of the caves, especially about some dusky stains of the incrusted rocks. The surface of these rocks was scraped ; but after being dried the matter appeared to consist chiefly of fine earth, with a smaller proportion of vegetable granular matter, apparently the first state of some algoid growth, presenting no trace of regular organization. They were inclined to identify this Lipuva with the species which Schiodte found in the Adelsberg grottos, although there are some points in which his description does not exactly correspond. The true specific distinctions, however, of this long-neglected group of insects are scarcely so well understood as yet as to induce them to propose a new specific name for it on the ground of the differences which they noticed. They brought home a good number of specimens from the Mitchelstown caverns in excellent preservation, and some were yet alive ; but unfortunately they found it impossible to pay any attention to them for a fortnight, and by that time their bodies were completely dissolved away. A few specimens were preserved in alcohol, and alone furnished the materials for examination; and those who knew the fragile and watery consistence of insects of this group must be aware that some of the characters of external form, and all those of internal organization, were liable to be somewhat affected by their being kept. Only one of the specimens appearedto be quite mature, owing, probably, to defective manipulation in the microscopical examination. There seemed to be a very important difference between their and Schiodte's species, for, on opening the head and taking out the contents, they could not discover the least trace of eyes, whereas he detected fourteen ocelli on each side quite white, from which he inferred that they were useless for vision. Near the Garret Cave, while engaged in turning over some stones, he found the skeletons of several bats, most probably not of very ancient date, as this portion of the cavern was the nearest to the surface, and it was quite possible there may be some slight communication with the open air. He expressed a hope that these caves, as well as those of Dunmore, would be examined with greater care than had been hitherto bestowed upon them. Even in the Mitchelstown caves many places are still unexplored; and perhaps if the river were throughout its length carefully dredged with a water net, crustacea might be found. He attempted to wade it, but its icy coldness, and rapid deepening of its stalagmitic strand, prevented him from going in far. Mr Wright stated, in conclusion, that the paper which he had read could not have been presented to the section without the assistance of Mr Halliday.

The Rev. Mr Higgins suggested the possibility that the blind beetles noticed in the paper might belong to a species that had lost their organs of sight so as to fit them for the circumstances and place in which they were discovered.

Mr Halliday observed that the insects found in the cavern had other peculiarities besides their want of the organs of sight, which showed them to be a distinct species. There could be no doubt that they had been formed without eyes, which fitted them for the places which they inhabited.

Mr Halliday then exhibited a beautiful specimen, inclosed in a bottle, of the migratory locust, which had been found in the College grounds some minutes previously. He observed that it very rarely visited this country, as it seldom came so far north, but inhabited Western Europe and the basin of the Mediterranean.

Dr Kinahan read a paper *on the Honey Lobster*; and

Professor Macdonald offered a few remarks upon some crustaceous species.

Professor Kinahan read a paper, communicated by Dr Buist, *on the Lotus or Sacred Bean of India.*

Mr R. Schlagintweit read a paper containing remarks *on some Animals of Thibet and India.*

Mr William Andrews read a paper containing some remarks *on the Sea Fisheries of Ireland*, with reference to their investigation practically and scientifically. Having stated that the object of the paper was to create an investigation into the Irish fisheries, with a view to their greater development, he alluded to the importance of those fisheries, especially the west and south-west coast. He said the British fisheries in Newfoundland did not receive the attention to which they were entitled, and that on our own coast the cod fishery had much declined—that fish seldom being seen in our markets except in winter or spring. He then referred to the practice of sounding as a mode of discovering, by means of the marine animals caught in the process, the particular localities which particular fish frequented and their habits. He said that the ling season was the most important in connection with our fisheries, but that in consequence of the smallness of the boats it was carried on only during the spawning season. He then referred to the practice of trawling, which he said was most useful and profitable, and to the objections of the fishermen to adopt it. He said that he attended in June 1852, at the investigation in Galway into the fishery on the west coast. The Rev. Peter Daly presided at that inquiry, and everything was carried on with the greatest impartiality. A number of Claddagh fishermen were there examined, who showed that they knew nothing of the spawning of fish, and that they merely fished as their forefathers did before them. Mr Andrews exhibited a specimen, which he said it was insisted by the fishermen was spawn which the trawlers took up, but which he discovered was sponge, and not spawn. He then alluded to the erroneous views that were formed of the migratory habits of fish, and in conclusion he said that science should come to the aid of practical knowledge so as to develop the fisheries of the country, and while such eminent scientific men were in existence as those which were attached to this section, there should be every hope that some scheme would be shortly devised with that object.

Professor Allman said that this very valuable paper proved the importance of bringing scientific knowledge to bear on the every-day pursuits of life. By his discovery in reference to the sponge which was supposed to be spawn of fish, Mr Andrews had dissipated a phantom that was exercising a most injurious effect on the development of the fisheries of the country.

Dr DAUBENY read a paper by T. MAXWELL MASTERS, *on Contributions to Vegetable Teratology*, in which an account was given of various vegetable monstrosities.

Dr Steele instanced the case of *Mejacapœa Polyandria*, that flowered in the Glasnevin Gardens, which was, perhaps, the only instance in the whole order of the crucifera in which so many as twelve stamens were developed.

Mr Percival Wright instanced a case of monstrosity in a fuchsia.

Dr STEELE read a paper by Professor BRICKMAN *on the Occurrence of Cuicus tuberosus.*

Mr E. BIRCHELL communicated a list of additions to Irish Lepidoptera.

M. M. NEVEN read a paper on the importance of a thorough understanding of the root principle in the cultivation of trees.

SUB-SECTION D.—PHYSIOLOGICAL SCIENCE.

Professor LAYCOCK read an abstract of a paper, by Professor Alison of Edinburgh, *on Certain à priori Principles of Biology.* This paper went to show that there are certain principles which must be admitted, although inconceivable to our minds, and that these principles present the same basis for physiological science as the axiom of geometry for geometrical science, or as certain intuitive principles for the science of morals. It may be said that the paper was an attempt to apply the doctrines of the Scottish School of Metaphysics to physiological science. On account of the recent illness of the distinguished author of this paper, Professor Laycock was unable to do more than communicate an outline of his views.

Dr Gairdner, of Edinburgh, as a pupil of Dr Alison's, explained the nature and tendency of his distinguished master's views, which were chiefly directed to oppose the modern tendency of medical investigators to degrade their science to that of a subordinate department of chemistry on the one hand, or of mechanical science on the other, omitting all considerations of that higher, though less intelligible class of phenomena which are known as vital.

Dr Haughton read his paper *on the oriental Bath.* This bath, he observed, was of very great antiquity, for we read of its existence amongst the ancient Egyptians, Chaldeans, and Persians. A notion prevailed that the Eastern bath was not to be used except in particular climates, but it would be found that the ancient Greeks and Romans were acquainted with it, and were in the habit of using it frequently. It was introduced by the Romans into Spain, and was afterwards brought into France and the British islands. He felt confident that if proper search were made sufficient evidence would be found of its having been extensively used in these countries. Having expressed his surprise at the disuse into which the ancient bath had fallen among civilized nations, he proceeded to give a description of the mode in which it was used, and to offer some observations upon the physiology of the process. He regarded the eastern bath as a pleasure free from vice, and a luxury which was not injurious. It only required sufficient demand in this country to become so cheap as to be accessible to all classes. The price of a bath in ancient Rome was about one-eighth of a penny of our money. There was no drug to be compared to it in a sanitary point of view as a purifier of the system. Gout, rheumatism, and chronic and skin diseases were not known among the Turks, who were seldom ill. The physicians believe that those effects were owing to the great attention which they bestow upon the functions of the skin, which the most eminent physiologists now consider to be analogous to the functions of the lungs. Deformed people were also rarely to be met with amongst the Turks. He was of opinion that something more than bathing was required to produce a fine race of men, and the people of Europe should follow the practice of their ancestors and adopt the ancient bath. Our own country, he observed, had led the way in this movement; for the only building of the kind in the west of Europe was opened recently near Cork, and was used as a remedial agent with great success.

Dr Laycock observed that in Liverpool there is a plunge bath where boys can gambol about every day for a very small sum, and without actually adopting the Turkish bath in all its details, he thought they might erect baths suitable to the wants and circumstances of this country.

Mr Wrenfordsley stated that similar baths to that alluded to at Liverpool, had been established in Paris and Bordeaux.

M. l'Abbe Moigno communicated in French, on the part of M. Le Baron Heurteloup, *a New Method of Administering Chloroform.*

Dr Poznanski read a paper *on the Relations of Atmospheric Vicissitude with Epidemic Diseases*, and exhibited a very ingenious instrument for estimating the rate and force of the arterial pulse.

Dr Hayden made a communication *on the Physiological Relations of Albumen.*

Dr W. T. Gairdner read a paper *on the Mortality of Certain Diseases.* The object of this paper was to show the prevalence of certain causes of death among the population of a great city, as shown by the analysis of somewhat less than 300 cases of death in the population of Edinburgh. The author commented on the most frequent causes of mortality, and showed the sources of fallacy attaching to the returns of causes of death hitherto made. He made a suggestion with regard to the observation of causes of death in hospitals, but said that the registration of deaths on the large scale is a work of difficulty and labour so great, that any interference with the present system was not within the scope of the paper.

Drs Laycock and Lankester made observations at considerable length on the very valuable communication of Dr Gairdner.

Dr Carte communicated some observations in reference to *the Relation of the Nervous System to the Functions of the Skin.*

Professor Hayden read a paper *on the Physiological Relations of Albumen in the Body.* His views were supported by a number of experiments which he performed on the lower animals, and illustrated by microscopic demonstration of the action of urea on the elements of the blood.

Dr Lankester read a paper *on Alternation of Generations, and Parthenogensis* in plants and animals, pointing to the numbers of instances in which reproduction takes place, both in plants and animals, by means of asexual and sexual individuals.

Mr Lister brought before the section the result of some observations which he had made in the year 1853 *on the Flow of Chyle* through the lacteals and mysentery of the mouse.

Dr Lyons made a communication, on the part of Dr Hardy of Dublin, with respect to *an Apparatus for the Production of Local Anæsthesia,* by which it appeared that an instrument for this purpose was invented by Dr Hardy in 1853; and subsequently a more complete and perfect apparatus, by which the vapour of hot water can be combined with that of chloroform, thereby making the vapour of the anæsthetic agent more effective for the alleviation of pain.

Dr Robert M'Donnell read a paper *on the Valvular Apparatus connected with the vascular system of certain abdominal viscera.*

Professor Carlisle, in some observations *on the Junctions of the External Ear,* described in detail the exquisite arrangements by which vibrations of sounding bodies are received and transmitted by the external ear.

Dr W. T. Gairdner read a paper *an the Action of the Auriculo-ventricular valves of the Heart.*

Dr M'Clintock brought forward a series of observation made by him in his official capacity in a maternity hospital, as to *the Average Weight of the Heart in Children* who survived birth seven days, two hours, and others still-born.

Mr John Pope Henessy read a paper *on some Changes in Blood-corpuscles.* He stated the results of some of his microscopical observations.

Professor Lyons read a paper *on the importance of introducing a new and uniform standard of Micrometric Measurement.*

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MATHEMATICS AND PHYSICS.

Captain Wilkes *on the Zodiacal Light.* Observations made by the Exploring Expedition under his command, proved that the light has not changed its character since its discovery, more than two centuries ago. He mentioned various theories regarding its origin; that it is derived from the atmosphere of the sun; that it is a nebulous ring, with the sun as a centre; a nebulous ring with the earth as a centre; a nebulous matter floating in space, from which the showers of stars may be traced,

* This abstract has been prepared chiefly from notices of the proceedings given in the Boston Daily Advertiser and the New York Tribune.

when the matter comes in contact with the earth; but he thought it is impossible to reconcile these theories with the facts. He described the various phenomena of the light, different from the extended light of sunset and of twilight. It varies with the position of the observer, the morning light does not correspond with that of evening, but the inclination to the ecliptic of the former, is tranverse to that of the latter. The light is the result, in his opinion, of the light of the sun falling perpendicular to the earth's atmosphere, in the plane of the ecliptic. He compared it to the effect produced by letting the rays of the sun enter a hole in the shutter of a room which would be otherwise dark, making visible that portion of the atmosphere which is illumined by the rays.

Professor E. S. Snell *upon the Vibrations of the Fall over the Dam across the Connecticut River, at Holyoke, Mass.* At the time of observation there was a sheet of water two feet deep, 1017 feet in width, and 30 feet high. By going behind the sheet, it is at once seen that the currents of air rush in and out alternately, with a vibrating motion. The fall of the water causes a rarefaction of the air behind, which in turn produces the pulsatory motion of the sheet.. The vibrations vary with changes in the atmosphere or in the depth of the water over the dam. At one observation he had counted 137 vibrations, and at another 256 vibrations in one minute. The vibrations are communicated to the land and buildings in the neighbourhood. A count of the vibrations of a window-sash, gave the same result as a count at the base of the fall.

Professor Bache *on the Measurement of a Base Line on Epping Plains, Washington County, Maine*, for the primary triangulation of the Eastern section of the coast of the United States. The selection of this interior site (between Bangor and Calais) was rendered necessary by the absence of any long beach upon the coast of Maine. He described the physical character of the plain, and of the whole line, which is five and four-tenths miles in length. The measurement was taken with great care, and was a work of considerable labour, requiring the uninterrupted attention of all the operators, and continuing for eight days. The mean level of the line is 257 feet above tide-water, and the fact of its height, coupled with the novelty of establishing a line so far inland, constituted the chief interest of the paper.

Rev. Thomas Hill laid upon the table *a Chart of the Annular Eclipse of March* 14, 1858, showing that its beginning will be visible only East of longitude 69° west from Greenwich, and its close visible only east of a line joining the western end of Lake Superior and the city of Mobile.

Mr Hill then read a note upon *a new form of Arithmetical Complements* which he had been led to use in constructing *a Calculating Machine.* He is enabled to subtract and divide by the same mevements as those by which he adds and multiplies.

The same gentleman, having at the Cambridge meeting, presented a paper upon "Peirce's circular co-ordinates," now added some remarks upon other possible systems of co-ordinates in one plane. He obtains twenty-two couples of quantities defining infinitesimal curves, either member of each of which may be considered as the independent variable, and the other as its function; thus obtaining, in one sense, forty-three general systems of co-ordinates by which a curve may be represented without the use of anything more than ordinary algebra. He regarded about one-fourth of his systems as worthy of investigation.

Rev. George Jones, U.S.N., read *an Account of One Hundred and Twenty-three Observations on the Zodiacal Light, made at Quito, Ecuador.* Quito itself is 9800 feet above the sea, and the observations were made from a hill 10,000 feet above the sea. Some interesting facts are given to show the great brilliancy of the atmosphere; Humboldt was able to see his companion at a distance of seventeen and one-third miles. The various appearances of the light were described, and the following deductions were drawn :—(1.) That the substance giving the light forms a complete circle across the sky; (2) This circle is a great circle in the heavens, with a width of 28°, and at a distance of 100,000 miles, and taking its central light as our guide, its descending node, at the time of observation, was in longitude 242°; (3.) It is a complete circle, distinct by itself, geocentric (or having the earth for its centre), and not very far distant from the earth. Mr Jones said that if the brilliancy of the Milky Way be represented by an ascending scale from 0 to 20, the zodiacal light will be represented by 6 or 7; that it is not observed by the people of Ecuador, nor was it seen by Humboldt when in that country.

Professor Peirce showed that by his investigations on Saturn's ring, the sun could not sustain a ring except between Mars and Jupiter; and even there, the great tides produced by those planets would break up the ring in small portions, forming, perhaps, the asteroids. To hold a permanent ring requires satellites or planets of a certain number and weight, such as Saturn has around him. In regard to our zodiacal light, it cannot be composed of small pieces, because it can readily be shown that they would pass in conflicting currents. But if gaseous, why does it not show the great tides which our large and heavy moon would produce? That it is really a ring is manifest, but there is a difficulty in reconciling the existence of a ring with the non-appearance of tides in it.

Professor Bache read a paper *upon the Winds of the Pacific Coast of the United States*, giving the results of observations made in connection with the Coast Survey at Astoria, San Francisco, and San Diego. There is a great preponderance of westerly winds at those places, while easterly winds preponderate on our eastern coast; there, however, the west winds are to east as 8 to 1; the west winds increase in summer and decrease in winter; the east winds occur in the winter, and hardly at all in the summer; the north-west wind prevails at Astoria and San Diego, while the south-west prevails at San Francisco; the summer months are windy, and those of winter calm; March and September, our most windy months, are the calmest there.

Professor Henry read *an Explanation of the Physical Conditions determinate of the Climate of the United States.* He first treated of the winds, and explained the preparations which have been made for observing and recording their direction; the results of these observations will greatly aid the philosopher in determining the laws and effects of the winds. The currents of water exercise an influence; the revolution of the earth causes the cold descending currents to take a westerly direction, while the warm ascending currents tend to the East. The topographical character of the country was also considered. The Appalachian range in the eastern portion has no effect upon the atmosphere; because the wind is dry when it ascends, and after expanding in the cold, contracts again on its descent, and is restored to its original temperature. On the Rocky Mountains, however, the temperature is far warmer than in the same latitudes below, because the west wind, coming moist from the ocean, is condensed, and thus heat is evolved, so that the wind comes down upon the plains hot and dry. The great power of tornadoes comes from their course, which are onward and upward, not gyrating. He refuted the idea that north-easterly storms move from south-west to north-east, although it first begins to rain at the south. The storms themselves move from the north-east to south-west, acquiring, however, a general motion as a whole, towards the east. This may be represented by placing a rod upon the western part of the map of the United States, with a direction from N.N.E. to S.S.W.; then if we give this whole rod (along which the current and storm are supposed to flow), an easterly motion, such as it would acquire from the motion of the earth, it will be found that the lower part of the rod will reach the coast first; that is, the inhabitants of the south-eastern portion of the coast will be visited by the storm in advance of those north-east of them.

Dr Wynne *on the Influence of the Gulf Stream upon the Atlantic Coast of the United States*, treating the subject in a hygienic light. He added that the peculiar conformation of the bottom of the sea has its effect upon the Gulf Stream, and therefore upon the climate.

Professor W. M. Gillespie, of Schenectady, N. Y., *on the Warped Surfaces occurring in Road Excavations and Embankments.* He shewed the precise nature of such a surface to be a hyperbolic paraboloid, and decided that the familiar "prismoidal formula" can be applied with perfect accuracy to the solid bounded on one face by a warped surface, the other faces being planes.

Professor John Leconte, of South Carolina College, gave an account of some preliminary researches *on the Alleged Influence of Solar Light on the Process of Combustion.* Most physicists have regarded as a fallacy the popular opinion that the action of the sun upon fire tends to retard the process of burning. Dr M'Keever, after a series of careful experiments, came to the conclusion that the rate of combustion in the dark exceeds the rate in the sunlight, by from 5 to 11 per cent.; while moonlight has no such influence. Dr Leconte gave an account of some careful experiments made by himself, to test the same thing. The results convinced him that the rates of combustion in the sunlight and dark, other things being equal, are precisely the same.

In conducting his experiments Prof. Leconte endeavoured to secure two conditions, viz.:—

1. Absolute calmness in the atmosphere.
2. Exposure of the flame to the influence of intense solar light without heating the surrounding air.

The first condition was secured by performing all the experiments in a large lecture-room, with all the doors and windows closed. To secure the second condition, he employed a portion of the apparatus belonging to a large solar microscope, consisting of the reflecting mirror, the condensing lens and tube, together with the mechanical arrangements for adjusting the direction of the light. As the condensing lens was upwards of four inches in diameter, the intensity of the light could be increased nearly tenfold; so that its effects ought to be enormously exaggerated. This arrangement cut off all of the influence of exterior agitations of the atmosphere; while the concentrated pencil of light, thus thrown on the flame, traversed it, as well as the surrounding air, without imparting a sensible amount of heat to the latter.

In his experiments, Professor Leconte used the best wax-candles. These were found to burn with remarkable uniformity, provided the air was calm, and they be allowed to continue burning a sufficient length of time to form a well-defined cup for the melted wax, and to establish regularity in the process of combustion. The rate of burning was determined by securing a portion of the wax-candle to the bottom of one of the scale pans of a tail balance, and accurately noting the time it required to consume a given weight, say 60 or 100 grains. It will be observed that his arrangements enabled him to ascertain the rapidity of consumption of the candle alternately in the darkened room, and with a pencil of concentrated sunlight directed on the flame, without moving any portion of the apparatus, and therefore to test its influence under the same external conditions.

In the present stage of the investigation, Professor Leconte thinks that two deductions are warranted: 1. That solar light does not seem to exercise any sensible influence on the process of combustion. 2. That variation in the density of the air does exercise a very decided influence on the rapidity of the process: the rate of burning increasing with every increment of density, and *vice versa;* but the exact ratio between them remains to be determined.

Professor H. L. Smith, of Kenyon College, described *an Improvement in the Construction of Achromatic Telescopes,* which allows them to be furnished at from one-half to one-eighth of the former cost.

Professor Stephen Alexander, of Princeton, New Jersey, treated of *Some Special Relations of the Straight Line and the Various Orders of Curves.*

Dr J. H. Gibbon, of the Mint at Philadelphia, read a paper *upon the Diverse Weights employed in Modern Coinage, treating especially of Karat Grain Weights.*

Colonel G. C. Forshay of Texas, *on some of the Phenomena of the Texas "Norther" and Climatology.* The prevailing sea-breeze is from the south during the entire summer. It originates only a few miles from the coast, but extends far interior. It is a constant mitigation of the extreme summer heats, and never dies, except occasionally from 6 to 9 o'clock A.M. The trade-winds never reach Texas, as they originate at 20 to 23° north latitude; but the reflux furnishes from above all the rain-producing air of the Mississippi Valley. It flows back above the inward bound trades, sinks to the earth north of them, and laden with vapours from the Gulf of Mexico, travels north-eastwardly over Texas and the Mississippi Valley, and perhaps the Northern and North-eastern United States. A high stratum lies over it, whose course is rarely disturbed, and is always marked by the cirrus clouds. It comes from W.S.W. to S.W. This stratum having crossed the Cordilleras and discharged its vapours on the western slope, is perfectly dry, and from its height of about three miles must be colder than surface air by nearly 40°. From this stratum the western portion of Texas and all the rainless region of the plains, receive their supply, and hence the general barrenness in that quarter without irrigation. This air has no water to impart, and hence the American deserts.

The boundary between these two characters of climate every traveller recognizes at once, as it is marked by the growth of the cactus, as well as by the dryness of the air he breathes. It lies near a line drawn northwardly, tangent to the western fundus of the Gulf of Mexico, and San Antonio and Austin, lie very near it. Westwardly of this line cultivation of the great staples is not always practicable except by irrigation.

The Norther is a name given to a class of storms occasionally occurring in summer, but generally in winter or early spring. They usually commence in the morning, though they may not reach the observer's position till late in the day. The sky suddenly grows black in the north, the air is still and sultry, and in a few minutes a north wind strikes one. Generally there is a dash of rain, and afterwards a dry wind which sinks the thermometer very rapidly, in some instances 1° per minute for twenty minutes, but more generally 20° in an hour or two. It blows at the rate of 30 to 40 miles per hour, and lasts 24 to 30 hours. It is much deprecated by the inhabitants, who are compelled to provide winter clothing as much as for a latitude 10° further north. Its exceeding dryness exaggerates the cooling effect experienced, by evaporating all the moisture in the skin. Everything dries at once under its influence, books warp their backs, papers curl, furniture cracks, boards split, and the whole surface of the ground yields its dust to fill the air.

What can be the cause of this sudden and long-continued rush of air to the south? How are its sudden coldness and extreme dryness to be explained? Suppose the whole air of Texas, or the region of the Norther, covered by the stratum of air, derived from above, by the reflux of the Trades; this air, having a temperature of about 70° at the south, and with a high dew point and nearly at rest, would be overlaid by a stratum of air two or three miles above, some 30° or 40° colder, and almost perfectly dry. Contrary to the common impression, dry air is heavier than moist air, and consequently there must be a tendency of the superstratum to descend, and return to feed the Trades, no longer supplied from the warm and saturated margins. Suppose, then, a plunge or cataract of the higher, cold, dry air, to take place, and to discharge itself southwardly upon the earth and sea. After the jet first broke through the stratum and pushed its way beneath it, the current would enlarge on both sides, and assume, perhaps, the form of a wedge, widening and sweeping over a large space.

The current from the north lifting up the humid, warm air, the latter would have its vapour condensed, and a sudden shower of rain would be the consequence, and in some instances the fall through the cold stratum of air would freeze the rain drops into sleet or snow. This condensation always happens south of the original plunge. North of that point, rain and mist sometimes occur, but the Norther often sets in perfectly dry and clear. He further remarked that the Northers seemed to have a weekly periodicity,—of 12 which he noted last winter, 11 returned on Saturday or Sunday or both. It is always very warm just before the appearance of a Norther.

The periodicity of storms on the Atlantic coast, was also remarked by several gentlemen. Professor Henry accounted for it, by supposing that a given storm, required about a certain period of time to go through its various stages, and reform itself for repetition,—taking, of course, about the same amount of time in each case to go through its several stages.

Mr E. S. Ritchie, of Boston, *on an improved construction of Ruhmkorff's Induction Apparatus.* The improvements consist in making the strata of the wire in the secondary helix perpendicular, instead of parallel, with the axis; in making the insulation more perfect, and obviating in great measure the danger of a discharge of the spark from one stratum to another; in substituting for De la Rive's interruptor one which makes the breaks instantaneously and is entirely under the operator's control. In the apparatus exhibited by Mr Ritchie, the length of wire is 60,000 feet, and he has obtained from it a spark of 10½ inches, with a battery of four elements. The largest spark yet obtained in Europe has been 4½ inches. The original machine is the result of the researches of Faraday, Henry, and Fizian, and gives a current of high intensity, with a quantity immensely greater than can be obtained from the electrical machine.

Professor D. Olmsted, of Yale College, *on the Electrical Hypothesis of the Aurora Borealis.* It is his opinion that the aurora is cosmical in in its nature, or derived from matter connected with the planets: (1.) Because of its great extent, often extending far above our atmosphere; (2.) The same phenomena occurs simultaneously in places widely different in longitude; (3.) From the velocity of its motion; (4.) From its periodicity, especially its secular periodicity; which he regarded as well established. He thinks it may have a revolution round the sun, and is perhaps connected with the zodiacal light. He thought that the arguments of those who ascribe an electrial origin to the phenomenon, could not all stand the test of inquiry. One reason for disputing them is found in the fact that the aurora prevails in those latitudes where the amount of electricity is least.

Professor A. D. Bache *on the Heights of the Tides of the Atlantic Coast of the United States.* A comparison of the heights of the tides along the coast, leads him to form three groups of figures corresponding with three great bays on the coast, the tides being least at the outermost extremities of the bays and greatest at the heads. The first of these bays, which he calls the "Southern," extends from Cape Florida (where the tide is 1·3 feet in height), to Cape Hatteras (2 feet), with Port Royal (7 feet) as the head. The second extends from Cape Hatteras to Nantucket (1·2 feet), with Sandy Hook (about 5 feet) as the head. The third includes Massachusetts Bay and the Bay of Fundy, or from Nantucket to Cape Sable (8 feet), with its vertex at the head of the Bay of Fundy (36 feet).

Professor Stephen Alexander *upon the Special Harmonies in the Distances and Periods of the Planets.* Too perfect a symmetry in nature is not to be expected. He proposed a modification of Laplace's nebular hypothesis, by supposing the centre of the mass to radiate heat more rapidly than the periphery, so that the Sun separated first, then Mercury, then Venus, &c. He went on to show that the distances and periods of the planets follow certain arithmetic laws of geometrical progression more accurately than they follow Bode's analogy or Pierce's suggestion of the phyllotactic series. This he attempted to show by a careful arithmetical comparison of all the statistics of the actual systems of the Sun, Jupiter, and Saturn, with the arithmetical results of his hypothesis. In addition he showed that his hypothesis led at once to Kirkwood's Analogy (presented at the Cambridge meeting of the Association), both in its general truth and special features. The Moon and the Earth also bore testimony with peculiar force and relation to the truth of his hypothesis. The inclination of the planets to their orbits in its general law and its exceptions flows from the same fertile thought. The Zodiacal light, as observed by Mr Jones, is also explained in the same manner, and even the cosmical origin of the *Aurora Borealis* is made plausible by it. Professor Alexander thought that at all events the number of numerical coincidences here brought forward made it probable that we had in his theory a glimpse of the plan by which the great Disposer of all things had arrayed the worlds.

Dr J. H. Gibbon, of the United States Mint, read the third of his historical papers *on the Diverse Weights employed in Modern Coinage.* The avoirdupois ounce and pound was originally used in Babylon, a city of merchants; thence carried to Phœnicia and to Spain, whence it came to England and America. The Hebrew shekel was at least very nearly half an ounce avoirdupois, and it seems to be the oldest weight known in human history. According to tradition it weighed 320 grains of barley. The purchase by Abraham of the cave of Machpelah is distinctly stated to be a cash transaction, to be settled by the payment of a certain weight of silver of a certain fineness "current with the merchants." The sum paid to Joseph's brethren by the Egyptians, in payment for the boy, was twenty of silver; doubtless twenty avoirdupois pounds. Wherever the precious metals are mentioned by Hebrew writers, we are to understand the numbers as referring to avoirdupois weights. These weights came into use in England in the 14th century. A conventional avoirdupois ounce was adopted by the United States from Spain as the value of our moneyed unit. The word *dollar* and the word *coin* are both probably of Greek origin, *eidolon* and *eikon*, each signifying an image or idol, and the first coins having been stamped with the images of gods or kings. The "images" which Rachel stole from her father, and hid in the camel's furniture, were probably coins—not of Hebrew coinage, but of neighbouring *idol*atrous nations. The law requiring a hireling to be paid at sundown, and Jonah's paying his fare to Tarshish, indicate the use of small coins among the Hebrews. Our arbitrary unit does not agree exactly with any ancient or modern weight. The ancient Tyrian ounce contained 438 grains of very great fineness; while our modern dollar contains only 384 grains of inferior silver, as coined in halves. It was originally 416 grains. The half shekel of the Hebrew was, therefore, worth 63 cents of our modern American money. A Troy ounce is 480 grains, taking all the grains the same. The sterling—that is, Easterling—ounce was still different. Thus, all our modern weights and coinage are the remains and vestiges of ancient civilizations, now lost. In ancient times coinage was common in every colony and city. The ancient laws of Deuteronomy are similar to those Newton sought to establish when master of the English Mint, and declare emphatically that justice and accuracy in dealings are favourable to longevity.

Professor Stephen Alexander, of Princeton College, gave some further statistics and inquiries with respect to *the Forms and Magnitudes of the Asteroids.*

George M. Dexter, Esq. of Boston, read a paper *On Weights and Measures.* He spoke of the various attempts which have been made to establish a uniformity of weights and measures. A new system should embrace not only uniformity, but also a standard to which reference may be made without a scientific test, which shall so compare with the present system as to be easily learned; it should be labour-saving and computed by decimals. He reviewed the character and origin of the measures now in use in this country. He proposed to make an inch (one tenth of our present foot) the standard of measure, and an ounce, derived from the inch, the standard of weight.

Mr Franklin B. Hough of Albany, gave a *Sketch of a Plan for Reducing Observations upon Periodical Phenomena to a Series of Mean Dates,* and set forth the advantages of this method for developing the laws of climate. He divides the State in which observations are to be made into sections according to the physical condition of the country, and "at the same sime preserving county lines so far as may be." The plan will give a knowledge of the relative forwardness of particular seasons; the comparative climate of different sections, also showing what crops are adapted to each, and enabling us to obtain the average time of the flowering of plants, or the breeding of birds, and thus to determine the laws of their species. In illustration of the first point, he read a table comparing the occurrence of similar phenomena in the various districts of New York, in 1842 and 1838, showing that the former season was earlier than the latter, by an average of $18\frac{3}{5}$ days.

Dr J. H. Gibson read his *Fourth Essay; on the Metrical System of France, and its adaptation to the Commerce, Coinage, and Science of the World,* beginning with a sketch of the ancient coinage and the fluctuations of value, and gradual debasement of pennies until they became pure copper. The great variety of measures and weights in the different provinces of France almost exceeded enumeration. The diversities of measures in Germany were equally perplexing. Dr Gibbon gave a sketch of the origin of measures from the personal diversions of kings and princes, or even barons and ladies. He then reviewed the history of attempts to find a perfect measure of length in nature (as the day is a perfect measure of time). The system of France is the only scale thoroughly scientific. Our American coinage is not even consistent with itself. A silver dollar contains 27 grains more than two half dollars. An agreement between mints of different countries would be valuable in furnishing bullion to the silversmiths, and thus save our coinage from destruction. Ten millions per annum of coins are melted up in America. The decimal system of France has been adopted in several continental mints. The adoption in mints would lead to its adoption in weights and measures. Weights and moneys were originally equivalent, and both should be kept rigidly invariable by the general governments of the world. In introducing the French weights and measures in Bavaria, not the slightest compulsion was necessary. By simply having all public business done with the new weights, the people were drawn into them by their convenience.

NATURAL HISTORY AND GEOLOGY.

Professor Peirce. *The Principal Lines of the Continents are arcs of great circles, tangent to the Polar Circles; with the exception of three lines, two of which are tangents to the Tropical Circles, viz., the North Coast of South America and the Islands of the Pacific.* This fact seems to indicate that the sun had an influence in the formation of Continents. It is evident that while the sun is in the vicinity of the solstices—about two-thirds of the year—those circles which are tangent to the polar circles separate the illuminated portion, under the influence of the sun, from the unilluminated portion which is free from its influence; they are therefore the circles of greatest variation of temperature, so that when in the process of cooling, the formation of solids first began, they would be the lines of separation between the frozen and molten portions of the surface, and finally the lines of cleavage. When therefore the solid began to shrink, the first separation of continent from ocean would take place on these lines, and this separation would always continue, because the bottom of the continent would be cooled by the water and the top by the cold air. With the first crisping of the surface in shrinking, these lines would give direction to the currents of the ocean. These currents would consist chiefly of the Gulf Stream in the Atlantic, and the corresponding current in the Pacific. The Atlantic current would keep the surface of Europe more open than the rest of the earth, and would cause that peculiar irregularity observable in the mountains of that country.

Professor Guyot thought that the coincidence observed by Professor Peirce might be merely accidental. He had himself, some years previously, grouped the reliefs of the world into a series of slopes and counterslopes at right angles to each other; making the triangle the fundamental form of the continent. The line of fracture between the North and South Continents, forming the Mediterranean, nearly coincides with a great circle parallel to the polar circles; and the volcanoes of the earth can be arranged about the great surfaces of sinking and of this line of fracture. He had also published an opinion that the present continents correspond in their main features with the original contents.

Professor James Hall *on the Direction of Ancient Currents of Deposition and the Source of Materials in the Older Palæozoic Rocks, with Remarks on the Origin of the Appalachian Chain of Mountains.* It is observable that the Laurentian chain of mountains north-east of us have a trend but slightly different from the direction of the Appalachian chain. The same must have been the direction of the great current (N. E. to S. W.) which formerly swept along that portion of the earth's surface which is now occupied by the Eastern and Middle United States. The Appalachian chain, including the mountains from Gaspe Bay, through New Hampshire and Vermont, until they die out away at the South, he conceives to have been the result of the deposits made by that current, and this conclusion is based upon or fortified by the observation that the strata, as we advance south-westerly, grow thinner and die out. Thus the Hudson River group, 10,000 feet in thickness at Gaspe Bay, is hardly 500 feet in the Mississippi Valley; the Devonian, 7000 feet at Gaspe, not half that in New York, and less than 200 feet in the Mississippi

Valley. This thinning out of the strata he conceives to be owing to the ever increased distance from the source of the materials. We have, then, along this line a coincidence with an ancient current; and if, as is doubtless the case, these ranges of mountains are the effect of deposition of materials, those ranges are no more uplifted than is the whole extent of the continent upon which they stand. True, we find strata folded and plicated, but they were before the upper Silurian rocks, as is shown by their metamorphism, but there is nothing in the Appalachian chain lower than the Potsdam sandstone. He denies any special upheaval in these chains, because in no case is their elevation equal to the thickness of the original strata whence their materials come; they rose from no influence from below through a crack in the earth's crust—they are but deposits.

Professor Dawson, of Montreal, *on the Variety and State of Preservation of the Fossils known as Sternbergia.* He proved that they are formed of the pith of plants whose wood easily decays. He formed the opinion, from various careful observations, that the coal-fields of eastern America are composed of the pith and bark of coniferous, rush-like plants, of the coal era.

Sir W. E. Logan *on the Division of the Azoic Rocks in Canada.* The Azoic rocks of Canada cover nearly a qnarter of a million of square miles. They extend from the northern shore of Lake Superior to Labrador. He finds superposed upon deeply-dipping gneiss a slate conglomerate at Lake Temiskaming, and also fifty or sixty miles west along the Maskinonge River. East of this out-crop, Canada has 200,000 square miles, but nowhere has there been found a repetition of it. It seems to be distinctly marked, and is exceedingly important, bearing copper. He has given it the name of Huronian System, in distinction from the other Azoic rocks of the Provinces, which he proposes to call Laurentian, from the Laurentine mountains, which stretch through it. He said that the lowest Silurian was composed of the debris of these Huronian conglomerates. The Silurian rested above them unconformably.

Professor T. Sterry Hunt, of Montreal, *on some Mineral Waters,* and *on the Origin of Magnesian Rocks.* He developed his theory of the origin of magnesian rocks, such as dolomites and magnesites, regarding them as produced by the action of carbonate of soda upon sea-water, which first eliminates the greater part of the lime held in solution, and then gives precipitates of pure magnesian carbonates. He attributes the existence of carbonates of magnesia in rocks, either to direct precipitation, or the evaporation of the magnesian waters. In his opinion the occurrence of dolomite as the cement of coralline limestones, supports his theory of the origin of magnesian sediments.

Professor George H. Cook, of Rutger's College, *on the Subsidence of the Coast of New Jersey, and some of the adjoining States.* The fact of such a subsidence is established by the occurrence of the stumps of trees in the place of their original growth, below the tide-level, on the shore of New Jersey, the south shore of Long Island, and other places. This subsidence is distinct from a former subsidence and elevation, which leaves its mark in the shape of fossils, shells, &c., which are now above the sea and buried in the ground. That the subsidence of which his paper treated is now going on, is proved by the killing of trees by salt water, by the burying of islands of upland in the salt marsh, and by its effect upon the efficiency of mills located in tide-water. He estimates that this subsidence of the coast, amounts to two feet in a century.

T. Sterry Hunt read a paper containing *General Considerations on the Metamorphism of the Sedimentary Rocks.* He contended that a dry heat, producing fusion of the sediments, cannot be admitted to explain the changes which they have been found to have undergone, from the fact that such a temperature is incompatible with the existence of alkaline silicates and graphite in the limestone. The influence of hot water alone is equally inadmissible, for the silica being dissolved by water before it could act upon the bases, we should find the quartzites rendered vitreous and crystalline. He regards the changes as having been produced by the action of small amounts of carbonate of soda in aqueous solution, forming with the quartz, silicate of soda, which is afterward decomposed by the carbonate of lime, the yielding silicates of these bases reproducing the alkali soda. A portion of the alkali is, however, always fixed, and rendered insoluble in the process, so that with a limited portion of soda, the action is at last exhausted. These reactions, resulting in the production of silicates of lime, magnesia, &c., take place even at 212° Fahr., and the intervention of alumina gives rise to garnet, chlorite and epidote. The absence of iron from some felspathic and quartzose sediments, and its accumulation as beds of iron ore, he regards as effected by the agency of organic matters, which reduce the iron to protoxide, and render it soluble in water, which afterward deposits it as oxide or carbonate. The same process produced the fire clays and ironstones of the coal period, and is now operating in bogs and marshes. In this way we have beds of argillaceous and felspethic materials freed from iron.

Mr Berthold Sieman *upon the Parthenogenesis of Animals and Plants,* showed that cases of parthenogensis occur in some lower orders of animals, and is quite frequent among plants.

Sir William E. Logan, of Montreal, read a letter from Sir Roderick Murchison, *on the Place in the Geological Series, of the Great Crystalline Rocks in the North Highlands of Scotland.* In a late visit thither, Sir Roderick had confirmed his previous opinion that they are anterior to the Old Red Sandstone, and are of the Lower Silurian age.

Sir William Logan *on the Probable Subdivision of the Laurentian Series of Canadian Rocks.* The Canadian rocks are now divided into two grand divisions,—those with much lime, and those without. His paper was intended to show, from observations which have been made upon a limestone deposit which emerges in two bands at Grenville, L. C., and which he has traced some eighty miles, the probability that the first grand division may be sub-divided, and that the Labradorite may be found to extend from one end of the British provinces to the other, and, with the rocks associated with it, may be marked upon the map, and receive some new appellation.

Professor Dana exhibited some trilobites collected at Keeseville, N. Y. These are very small, but of great importance, being the first that have been found in the Potsdam sandstone, within the State of New York. The discovery of other shells with them seemed to prove that the Potsdam sandstone had an extensive fauna.

Professor Hall considered these trilobites the same, generically, with those of Bohemia, and specifically with those of Scandinavia.

Professor Daniel Wilson, of Toronto, read a paper *on the supposed Uniformity of Cranial Type throughout all Varieties of the American Race.* In common with other investigators, he had at first accepted the theory of Dr Morton implicitly, but in the course of his investigations, and especially in an examination of twenty-eight skulls of Canadian aborigines, he had been led to place less confidence in Dr Morton's generalization. Dr Morton had stated that there is a recognizable uniformity of type among all the ante-Columbian inhabitants of this continent, with the Esquimaux. Professor Wilson, however, had found several skulls near Detroit, which approximated to the elongated Esquimaux type ; and he believed that the distinction between the Esquimaux and the other former inhabitants, was less in the form of the cranium than in the configuration of the face. Several other gentlemen expressed the opinion that further investigation would tend to weaken rather than confirm the opinions of Dr Morton.

Professor Dawson *on the Newer Pliocene Fossils of the St Lawrence Valley.* He did not find reason to think there was any very great difference in climate between their time and the present. They were found at different heights. Here on Montreal Island there was a deposit of them about 470 feet above the level of the sea. The place where they are found seems to have been a sea-beach, formed at a time when a strait ran between the two elevations of Montreal Mountain. Another locality of them has been discovered by Sir William Logan at Beaufort, where they are but about 400 feet above the sea-level. The limits of the sea at these times must have been very different from the present. If the levels of the shores were the same, the sea on whose beach the bed first spoken of was deposited must have extended up as far as Niagara Falls on the west. On the north, owing to the greater height of the intervening hills, it could only have connected with the Arctic Sea by the eastward as at present. Then we have these shells again at about 120 feet above the sea-level. Here we have beds of sand resting upon beds of stiff clay, on the surface of which is a sandy clay which is full of these shells, and this sandy clay is pretty clearly a littoral deposit, but could not have been contemporaneous with the shore first spoken of, from the great difference of level, and as soon as we get into the stiff clay, we lose almost all traces of these shore shells. Hence Professor Dawson inferred that the clay was deposited in deep water, probably when the sea stood at the level of the first bed, and was then elevated so as to receive the latter bed of shells, thus decreasing the extent of the sea from the great extent which it had at first.*

Dr A. A. Gould, of Boston, was inclined to doubt the correctness of Sir Charles Lyell's theory, that the fossil shells of Beaufort indicate a much colder climate than now exists.

Mr C. Whittlesey *on the Fluctuations of Level in the American*

* The American Editor of this Journal has shown (see Proceedings of American Association for 1849,) that the newer pliocene fossils found in Montreal Island, at an elevation of 470 feet above the tide level, were not originally deposited there, but were swept thither from a much lower level at the epoch of the *Second Drift.*—(Edit.)

Lakes.—He had had access to observations on the stage of the water at Cleveland, Buffalo, Oswego, Detroit, Rochester, and the Sault Ste. Marie Canal. From these he found three kinds of fluctuations; a general rise and fall extending through long periods, but without regularity; a general fluctuation occurring within each year, without reference to the stage of the water; and an irregular oscillation of from a few inches to a few feet, continuing from one to twenty-four hours.

The general rise and fall, no doubt proceeds from the changes of the seasons, the lakes being merely the reservoirs of the drainage of large areas. On short streams, rains produce high water in a short time, but on the Mississippi, the Orinoco, the Ganges, &c., it is months before the rise is perceived in the lower parts of the river, and the same result would be perceived in the St Lawrence, the outlet of all the lakes, which receives its waters from as far as the Mesabi range and the prairies of Wisconsin, especially in consequence of the checks which the water meets with at the various lakes.

As to the changes in the height of the water from one year to another, the average in Lake Erie from the highest in 1838 to the lowest in 1819 is about seven feet. On Lakes Huron and Michigan, there are evidences of a change of twelve feet. The fluctuation on Lake Superior since 1845 has been about three feet. In Lake Ontario, from 1838 to 1854, the greatest range was four feet nine inches. The yearly changes are not more than a foot and a-half. The highest water does not come at the same time of the year in all the lakes, but occurs in Lake Superior in September or October, and the lowest water in February or March; while in Erie, June is the high water month, the low water months being the same, and nearly the same with Ontario. They are lower in the winter, because their streams bring in less water then. The late climate of Lake Superior tends to make its high water later, though low water is about the same. The thaw on Lake Superior comes some four or six weeks behind that of Erie, and its greater size and smaller streams require more time to fill it up.

The irregular fluctuations have been noticed ever since the times of the Jesuit explorers. They have been attributed to sudden atmospheric changes. Mr Whittlesey had noticed none of more than two feet high in stormy weather, and a foot and a-half in calm weather, during ten years' exploration on Lake Superior, and two years' residence at Eagle River. He found the average of a complete oscillation about four and a-half minutes, the vertical range of the wave being about four inches, and coming in a line parallel to the shore. The pulsations are less regular in stormy than in windy weather; but they occur in all conditions of the atmosphere, and at all times of the day. They are not confined to the great lakes, but are also in the smaller lakes of New York, and perhaps might be found in the ocean. Mr Whittlesey found no connection between them and any barometric change, but was inclined to look to electro-magnetic influences. If there is such a barometric wave, it would, he thought, be due to causes seated on the land.

Mr T. Sterry Hunt, of Montreal, *on the Parallelism between the Laurentian and Silurian Metamorphic Rocks.* He traced first a similarity between the felspathic rocks of the two series; the talcs of the silurian series are represented by the Rensellærite of the Laurentian.

A. C. Ramsay, Esq., of the Geological Survey of Great Britain, described the physical breaks and the breaks in the succession of life in the British rocks. He exhibited a chart to show the successive fossiliferous strata of Great Britain, marked with the number of genera and species of fossils found in each, as well as the number of genera and species which pass from one series to the next above. He thought that the extinction of the animal and vegetable species of fossils was owing to similar physical changes to those which are constantly working at present.

Dr J. H. Gibbon, of the U. S. Mint, Charlotte, N. C., next read an essay *on Troy Weight*, giving a historical sketch of the weight and coinage of earliest nations, the origin of sterling money and the Troy weight of Great Britain, and of the present use of the latter weight. The design of the paper was to show the advisability of moving toward the final adoption of a uniform system of weights, measures, and coins. The U. S. Mints introduced several changes in the English systems, but while some of these changes have simplified the matter, others have not, and our own coinage, measures, and weights are in a state of confusion. It is highly desirable that a uniform system should be devised and made common at least to the coinage of Great Britain, her dependencies, and the United States.

Mr E. W. Hilgard, *on the Quantitative Assay of Chromium by the Blowpipe.* The object of quantitative blowpipe assays is mainly a practical one; they are to enable the explorer in the field to determine not only the kind but the absolute value of ores on the spot, so as to guide him in further investigations. To serve this purpose the process of determination must be both short and capable of execution by means of such compendious apparatus as that composing the admirable micro-laboratory, Plattner's blowpipe chest. The processes themselves, as devised by Plattner, are mostly conducted in the dry way by the aid of the blowpipe. The metals are obtained in the shape of beads, easily cleansed and weighed, thus avoiding the tedious operations of precipitation and filtration, so often recurring in the usual wet way of analysis. Processes of this kind have been described by Plattner for gold, silver, lead, copper, tin, bismuth, cobalt, and nickel. With metals difficultly fusible and reducible, which cannot be obtained in beads, we are obliged to resort to mixed methods, partially employing the wet way. Chromium is one of these metals; it has now become of considerable practical importance, yet its quantitative determination has been thus far confined to the laboratory. The first step is the fusion of the ore or substance with alkalies, preferably nitre, by which chromium is so readily separated from most bases. This is done in a small platinum crucible over the spirit lamp. When lead or analogous metals are present, silica must be added to the flux, to prevent an inversion of the process, when, subsequently, the mass is dissolved in water. This solution, when filtered, will contain most of the acid elements present in the ore, silica and manganic acid having been eliminated by nitrate of ammonia and alcohol respectively, previous to filtration. Were the chromic acid to be precipitated by one of the metallic salts usually employed, the precipitate would be contaminated with the other elements referred to; besides, such a precipitation is never complete until after several hours. A ready process of separation from almost all the acid substances, is in the evaporation to dryness of the filtrate with an excess of sulphuric acid and bisulphate of potash, and subsequent heating until all the chromium has passed into the insoluble modification of chrome alum. After this, most of the acid elements will still remain soluble in an acid solution, while the double sulphate of chromium and potash may be collected on a filter; being subsequently ignited, a residue remains, consisting of the sulphate of potash and chromic oxide in the same proportions as in the original salt; being weighed, therefore, the amount of oxide is found by a simple calculation.

The evaporation is carried on simultaneously with the first filtration in a little evaporator of platinum covered with a glass, framed so as to allow of keeping the fluid violently boiling without loss. The powdery precipitate of the chromo-potassic salt, which clogs the filter, is involved in a precipitate of chlorosulphide of mercury formed in the acid solution, and is washed by a solution of corrosive sublimate. The ignition is performed in a Plattner's charcoal furnace, before the blowpipe, in a platinum crucible. When all precautions are observed, results rarely varying one-tenth per cent. may be arrived at in the space of one and a half to two hours.

Professor A. C. Ramsay, of London, read a paper written by J. W. Salter, Fellow of the Geological Society of London, in which he describes a newly discovered genus of fossil coral, or Polyzoa, which is allied to the Graptolites, and which he calls *Graptora*.

Professor Hitchcock, of Amherst, *on the Age and Dip of the Connecticut River Sandstones, and the intercalation of the Associated Trap.* The identification of fossil foot-prints, especially those of insects, has led him to conclude that the middle series of these sandstones is of the Jurassic period. There are three series—the underlying heavy sandstone; a middle series of shales and micaceous sandstones above the trap; and a coarse conglomerate or breccia over all. The trap is intercalated between two layers of sandstone, of which the dip of the upper is less than that of the lower, and how the trap can occur in such a position, without breaks or faults in the sandstone, is a remarkable fact, difficult to explain.

Professor Swallow, Geologist of Missouri, exhibited *a Geological Map of that State.* Below the carboniferous rocks they had used the nomenclature of the New York Survey—above they had had some difficulty. The state is, to speak generally, divided by a narrow line of carboniferous limestone from north-east to south-west. To the north-west of this lie the coal measures; to the south-east Lower Silurian. Scattered mountains of trap lie to the south-east of St Louis; in the south-east corner the New Madrid district of alluvium stretches forty miles by sixty, and a narrow lane of alluvial deposits lies along the line of the Missouri and Mississippi Rivers. The coal measures are 1500 feet thick, with from eight to ten beds of workable coal. The beds of limestone in the coal measures are thick and numerous. He found coal all along the Missouri line, and he thought that the coal measures extended westward a hundred miles or more in Kansas. They had a patch of a hundred thousand square miles of coal-measures in Missouri, Nebraska, Kansas, Illinois, and Iowa.

Dr T. C. Hilgard *on the Structure of the Head in Vertebrata.* Oken has considered the skull as consisting of four modified vertebræ; Carus as consisting of six. Dr Hilgard shows, by a critical examination and comparison of the skulls of men with those of other mammals, and also birds and fishes, that the skull consists of five modified vertebræ, thus bringing it into one of the phyllotactic numbers. An embryological examination of the development of the brain shows also in that organ a phyllotactic generation in position as well as in the number five. In a second part of the same paper he shows that the embryonic development of the whole body is in accordance with phyllotactic law, both in number and order of position. Many of the anatomical facts elicited in these investigations are extremely curious. He has found, for instance, in the heads of fishes, bones similar in form to the wings of birds and the paws of rabbits; and he shows that this resemblance is not accidental, but actual, in relation to the vertebræ.

SCIENTIFIC INTELLIGENCE.

ZOOLOGY.

On the Anatomy and Physiology of the Spongiadæ. By J. S. Bowerbank, F.R.S.—The arrangement of the *Spongiadæ* by Lamarck, based entirely on external form, is wholly inadequate for the discrimination of species. The classification adopted by Drs Fleming, Grant, and Johnston, dependent more especially on the chemical constituents of those bodies, is far too limited to be applied to generic characters. The author has, therefore, for this purpose rejected both systems, and has retained the latter one for forming primary divisions only, and he purposes founding the generic characters principally on the organic structure and mode of arrangement of the skeleton, in accordance with the practice so generally adopted by naturalists with regard to many of the higher classes of animals. *Tethea*, *Geodia*, *Dysidea*, and a few others, are the only well-defined genera that have yet been established; while others, such as *Halichondria*, even in the narrow circle of the list of British species, contain at least ten distinct modes of arrangement of the skeleton, each of which is constant and well-defined in its character.

It is not intended to propose the rejection of any of the well-established genera of preceding authorities, but to confine each genus strictly within the bounds indicated by the peculiar mode of structure of the skeleton which exists in that species of sponge which is the oldest-established and best-known-type of the genus, and to refer all others that may distinctly differ from that type to new genera founded on structural principles.

It is proposed to characterize the elementary tissues in the following order:—1. Spicula. 2. Keratode or horny substance. 3. Membranous tissues. 4. Fibrous tissues. 5. Cellular tissues. 6. Sarcode.

And, in the second place, to treat of the organization and physiology in the following order:—1. The skeleton. 2. The sarcadous system. 3. The interstitial canals. 4. The intermarginal cavities. 5. The dermal membrane. 6. The pores. 7. The oscula. 8. Inhalation and exhalation. 9. Nutrition. 10. Cilia and ciliary action. 11. Reproduction, gemmules, &c.

And to conclude with observations on the generic characters.

The author then proceeds to describe the spicula, which he states are essentially different in character from the fibres of the sponge; although the latter may be equally siliceous with the former. However closely the spicula may be brought into contract with each other, or with siliceous fibre, they appear never to unite or anastomose; while the fibre, whether siliceous or keratose, always anastomoses when it comes in contact with other parts of its own body or with those of its own species. A detailed description is given of the origin and progressive development of these organs, from which it is inferred that they are the homologues of the bones in the higher classes of animals, and that the forms they assume are always of an organic type, never crystalline or angular; and the same forms of spicula are found composed of either silex or carbonate of lime, demonstrating the fact that the deposits of earthy matter are influenced by the laws of animal organization only, and never by those of inorganic or crystalline arrangement.

Each species of sponge has, not one form of spiculum only, equally dispersed throughout its whole substance, but, on the contrary, separate parts have their appropriate forms; and thus we find that there are often three, four, or even more forms of spicula in the same individual. The author therefore, in describing them, proposes to treat of these organs in the following order:—1. Spicula of the skeleton. 2. Connecting spicula. 3. Defensive spicula. 4. Spicula of the membranes. 5. Spicula of the sarcode. 6. Spicula of the gemmules.

1. The spicula of the skeleton in the siliceous sponges are usually simple, elongate in form, slightly curved, and are occasionally more or less furnished with spines. They are either irregularly matted together, collected in fasciculi, or dispersed within or upon the keratose fibres of which the skeleton is to a great extent composed. All these elongate forms of spicula are subject to extreme variety of length. In some species they maintain a great degree of uniformity, while in others they vary to a very considerable extent, according to the necessities arising from the mode of the construction of the skeleton.

2. The connecting spicula are not necessarily a part of the skeleton; they are a subsidiary portion of it under especial circumstances, in a few genera only, as *Geodia*, *Pachymatisma*, and other sponges which have a thick crustaceous surface, which the spicula serve to support and retain in due connection with the mass of the animal beneath. The normal form of these spicula is very different from that of the general mass of those of the skeleton, and they are much more complex and varied in their structure. They usually have a long, stout, cylindrical or attenuating shaft terminating either acutely or hemispherically at the base, while the apex is divided into three equiangular radii, which assume in different species a considerable amount of variety as regards form and direction. The triradiate apices are usually cemented firmly to the inner surface of the crustular coat of the sponge; while the stout and elongated shaft is intermingled with, and firmly cemented by keratode to the general mass of the skeleton.

3. The defensive spicula are divisible into two classes: those of the exterior, and those of the interior of the sponge. They are neither of them necessarily present in every species, nor are they confined to particular genera, but occur occasionally, and in certain species of various genera, apparently as the necessities of the animal may render their presence requisite. Their office is evidently to defend the sponge from the attacks of predacious animals. They are projected for about half or two-thirds of their length at various angles from the surface of the sponge, or they are based on the fibre of the skeleton, and are projected at about right angles into its interstitial cavities.

4. The spicula of the membranes are of two distinct classes. The office of the first of these is to strengthen and support those delicate tissues, and to communicate to them a certain amount of tension. The forms are few in number, and their structure comparatively simple. The office of the second class is that of assisting in the retention of the sarcode on the interstitial and other structures. They are usually minute in size, and often very complicated in form.

5. Spicula of the sarcode. The numerous and beautiful tribe of stellate spicula appear to be devoted to connect and give substance to the gelatinoid sarcode which so abundantly covers the whole of the interior membranous structures of the sponges in which they occur. They are often exceedingly minute, and are occasionally remarkably complex and beautiful in structure, and we frequently find more than one form imbedded in the sarcode of the same sponge.

6. The spicula appropriated to the gemmules of sponges occur in various modes of disposition. First, they are imbedded irregularly in an external envelope of the gemmule, or on the surface of the gemmule itself at right angles to lines radiating from its centre. Secondly, they are arranged symmetrically in the crust of the gemmule parallel to lines radiating from its centre. Thirdly, they are disposed in fasciculi in the substance of the gemmule from the centre to the circumference.—(*Proceedings Royal Society.*)

Researches on the Intimate Structure of the Brain, Human and Comparative.—Part. I. *The Medulla Oblongata.* By J. Lockhart Clarke, Esq., F.R.S.—The medulla oblongata, as described in this memoir, extends from the first cervical nerve to the lower border of the Pons Varolii. Of its elementary parts, the author first traces the *arciform fibres*, which may be divided into a superficial and a deep layer. Those of the superficial layer may in turn be divided into three sets. The connections of these are first followed out in detail; the fibres of the deep layer are described further on. In all mammalia these fibres are very distinct, but less intricate than in man. They may be found also in birds, reptiles, and fishes.

The *anterior pyramids* are found to be composed of *four* orders of fibres:—

1. *Decussating fibres* from the *lateral columns*, forming their chief bulk.

2. *Decussating fibres* from the *posterior columns* and *posterior grey substance*, chiefly at the upper part.

3. *Decussating fibres* from the *anterior gray substance.*

4. *Non*-decussating fibres of the *anterior columns*, separate on their outer side, and on their inner side incorporated with those which form the decussation.

In mammalia generally the decussating fibres are much less numerous than in man. In birds there is an evident but feeble decussation.

Of the *corpora olivaria* it is remarked, that they are to be found not only in all mammalia, but also to a certain extent in birds. In man, the surface of each olivary body consists of two layers of fibres—transverse and longitudinal; the former in part belong to the arciform system,—the latter are continuous with the antero-lateral column. A broad transverse commissure unites the two bodies. The *corpus dentatum* is a convoluted vesicular sac, consisting of nucleating cells of small and rather uniform size, from $\frac{1}{1300}$th to $\frac{1}{1700}$th of an inch in diameter, but varying in shape, and many of them sending out processes,—some one, others two, three, or more. The connection of the fibres with the convolutions of the sac is extremely complicated, and not to be made intelligible without the aid of diagrams. It may be stated, however, that the fibres which are confined to the cavity of the sac, with some others, take their origin from the cells.

In mammalia generally the olivary bodies are nearly concealed behind the paramids, and vary in their appearance at the surface in different animals. The vesicular sac, or *corpus dentatum*, is thrown into only a few comparatively large convolutions. On the outer side of each olivary body, and separated from it by a groove which lodges the hypoglossal nerve, is another vesicular column, not hitherto described by anatomists, and of which the analogue is found in the human medulla.

As the fibres of the lateral columns cross over to the anterior pyramids, the posterior cornua sink as it were forwards, while their terminal tufts —*the gelatinous substance*, gradually increasing in bulk, reach the surface, and form the grey tubercles of Rolando. At the same time, and close to the posterior median fissure, the gray substance is raised into a small conical projection, from which a network of blood-vessels and fibres extends backwards into the posterior pyramid. Within the projection, and amongst the network, cells are developed, which are circular, pyriform, or irregular in shape, and give off one process or several. Further outwards, another, but larger projection, and another network, extend backwards into the restiform body, containing cells of the same character, but of superior size. These additional productions may be called respectively the *post-pyramidal* and *restiform* ganglia.

As the medulla ascends, the *root* of the *posterior cornu* and the *whole* of the *anterior cornu* are gradually resolved or spread out into a beautiful and complicated network, containing a multitude of variously-shaped cells, which communicate and surround with their processes the longitudinal bundles of the white columns enclosed in the meshes. The post-pyramidal and restiform ganglia continue to increase in size, as do also the terminal tufts of the posterior cornua, which, like the former, are traversed by an extension of the network, and interspersed with cells. At the lower extremity of the olivary bodies, the decussation of the anterior pyramids, although still considerable, is very much reduced; for while its fibres derived from the lateral columns have been gradually decreasing in number, those which proceed from the posterior columns and posterior gray substance have been increasing, though not in the same proportion. These latter fibres may be traced backwards from the decussation chiefly to the restiform body and its ganglion, in which they wander in various directions, crossing each other, and becoming longitudinal.

In front, and at the side of the central canal, a new group or column of cells begins to make its appearance,—the nucleus of the hypoglossal nerve; and *behind* and on each side of the canal appears the nucleus of the spinal-accessory nerve, which is connected with its fellow of the opposite side, at the bottom of the posterior fissure, by a transverse band of fibres,—the continuation of the posterior commissure of the medulla spinalis. Of the spinal-accessory nerve, some of the upper roots proceed to their own nucleus, while others bend forwards into the hypoglossal nucleus, and in part join its fibres, to decussate through the raphè with those of the opposite nerve. The *vagus* nerve arises from a continuation of the spinal-accessory nucleus, and, on its way outwards, passes through the terminal tufts of the posterior cornu, or the so-called *gelatinous substance.* The vagal and spinal accessory vesicular nuclei or columns, after appearing in the fourth ventricle, and diverging so as to expose the hypoglossal nucleus, sink abruptly beneath a new mass of vesicular substance which makes its appearance on each side of the ventricle. This is the auditory ganglion. It commences by a point on the outer side of the vagal nucleus, with which it is intimately connected, and is developed from the inner part of the post-pyramidal ganglion. Its cells are various in shape, and as they are developed from the inner part of the posterior pyramid, the outer side of the latter undergoes a remarkable change of structure, and becomes the chief origin of the *anterior division* of the auditory nerve, which in its course outwards runs between the restiform body and the *gelatinous substance* or posterior cornu. The posterior division of the nerve winds transversely inwards over the restiform body to reach the auditory ganglion.

Intimately connected with the auditory nerves and ganglia is the structure which, in animals, is called the trapezium, and which the author has found to inclose a remarkable vesicular sac resembling that of the olivary bodies. The analogue of the trapezium exists in the human medulla.

The facial nerve, or portio dura of the seventh, after passing through the trapezium, proceeds transversely inwards to the *fasciculus teres*, which contains a mass or column of stellate cells, and through which it spreads, exchanging fibres or forming loops with the sixth or *abducens* nerve, which arises from the same nucleus. The glossopharyngeal nerve has more than one origin. It passes out in several bundles through the gelatinous substance or posterior cornu, *in* which it forms a plexus with longitudinal fasciculi of fibres which may be traced upwards to the larger root of the fifth nerve.

The connecting fibres between the anterior and posterior portions of the medulla are very numerous and complicated. For convenience of description, they may be divided into two parts,—superficial and deep. The superficial are the superior layers of the arciform system, and arise from the restiform body and its ganglion; the deep fibres, more or less blended with the first, arise from the remains of the post-pyramidal and the restiform ganglia. Together they form a complicated network, or plexus, interspersed with innumerable and variously shaped cells, which frequently communicate around the longitudinal bundles of the lateral columns, through which and the olivary body the fibres of the plexus proceed forwards and inwards to the raphè, where they decussate with those of the opposite side, and become continuous with the arciform fibres which were traced to the raphè round the anterior pyramids as the superficial set. The raphè, therefore, is the seat of a very complicated decussation between the posterior halves of the medulla, on the one hand; and on the other, between each of these and the olivary body of the opposite side.—(*Proceedings of the Royal Society.*)

On the Anatomy of Tridacna. By John Denis Macdonald, Assistant-Surgeon, R.N.—The author first explains the peculiar position which the animal of *Tridacna* occupies in its shell, in which it differs from bivalves in general. He then describes the mantle and its borders, the membranous interpallial septum, the respiratory and wide pedal openings communicating with the interpallial space, the two pairs of branchiæ, the mouth with the anterior and posterior lip and the four oral palps, the foot, the extensive cloacal cavity with its subdivisions, and the circular contractile cloacal orifice opening on the dorsal surface. He next gives an account of the form and arrangement of the alimentary canal, and its relations to the liver and large ovary; and describes a large viscus situated in the space between the ovary, the adductor muscle, the base of the foot and the pericardium, divided into a central and two lateral portions, and secreting a dark brown liquid loaded with fatty matter. This body he thinks may be connected with the secretion of the byssus, but, at the same time, remarks that it may be homologous with the organ of Bojanus. Lastly, the anatomy of the heart and great arteries is given, and is in substance as follows.

On cutting through the floor of the cloaca, the pericardium is laid open, and in it is seen the large, rather square-shaped ventricle, with a capacious but thin-walled auricle opening into it on either side, through an orifice guarded by semilunar valves. From the thick-walled ventricle, a short tube conducts into a conical dilatation or *bulbus arteriosus*, with muscular walls having its base included in the pericardium, and giving rise near its narrow end to the anterior and posterior pallial arteries; whilst a visceral artery passes from the ventricle to the ovary and adjacent parts. As in other bivalves, the intestine, before its termination, passes through the heart: in coming through the pericardium, surrounded by the membrane, it forms a short round pedicle which joins the fore part of the ventricle; it is then continued through the ventricle and bulbus arteriosus, and finally opens into the cloaca. The blood from the ventricle flows between the outer surface of the intestine and the inside of the sanguiferous channel; and that part of the intestine which traverses the bulbus arteriosus is closely surrounded with elongated membranous valvulæ, which arise from the anterior part of the chamber where the gut enters, and are fixed by a number of cordæ tendineæ to the posterior wall, where it makes its exit; a contrivance which permits the blood to pass between the rectum and the little valves, but prevents its reflux.—(*Proceedings of Royal Society of London.*)

Fauna der Wirbelthiene Deuchlands und der angrenzenden Länder von Mitteleuropa. Erster Band. Naturgeschichte der Säugethiere. Von J. H. Blasius. 8vo. 1857.—The first volume of the above work containing the Mammalia, has just been published; it is an excellent Manual. The text, German, illustrated by numerous, well executed woodcuts, representing some of the smaller animals, but chiefly devoted to the skull and dentitions, and other details, such as the head and ears of the bats, &c. These are nearly all slightly enlarged, and give a very distinct idea of what are considered the specific distinctions. The second volume, said to be in the press, will be devoted to the birds; the third and last, to the reptiles and fishes.

Einhundert Tafeln colorirter Abildungen von Vogeleiren. Zur Fortpflanzungsgeschichte der Gesammten Vögel. Von Friedrich August Ludwig Thienemann. (4to completed). 1856.—This is the most extensive series of coloured figures of the eggs of birds that has yet been published. It is now completed as a first series, and contains good coloured representations of the eggs of *nine hundred species.*

Die parasiten der Chiroptern. Von Prof. Dr E. A. Kolenati. Dresden. 8vo, plates. 1857.—Descriptions of 69 species of internal and external parasites found on the Chieroptera.

BOTANY.

Vegetable Parthenogenesis.—The production of perfect germinating seeds in plants without the contact of pollen was noticed long ago by various vegetable physiologists, but the occurrence of this vegetable parthenogenesis was considered doubtful by subsequent authors, and the statements were attributed to imperfect observations. Of late, however, these statements of old authors have been confirmed by very careful examination of plants of *Cœlebogyne, Cannabis, and Mercurialis;* and Dr Radlkofer has recently published a paper, in which he states, from very accurate experiments and dissections, that he is satisfied that true parthenogenesis does take place in plants. To Mr Smith at Kew the botanical world is indebted for the first observation on the plants of Cœlebogyne, and these plants have been made the subject of experiment by Radlkofer.

Economical Use of Oak and other kinds of Timber.—M. Kreuter, in reporting on the timber shown at the late Paris exhibition, states, that France requires annually for the Imperial navy 1,120,000 cubic feet of oak timber, and for the commercial navy 1,400,000 cubic feet. Britain requires five times as much, and America still more. There was at the Exhibition the model of a ship at present being built in Britain under the direction of M. Brunel, and intended for the Australian trade, which requires 644,000 cubic feet of solid timber for its construction. The timber consumed for railway sleepers is now enormous. A sleeper measures 3 cubic feet, and one mile of single rails requires about 8000 sleepers, which last on an average five years. Hence 1600 of these sleepers require changing annually. For 100 miles this will amount to 160,000.

Turmeric.—M. Milne, botanist to the United States Herald, and formerly of the Botanic Garden, Edinburgh, in giving an account of an excursion into the interior of Naviti Levue, the principal of the Feejee Islands, writes as follows :—" In passing along, we came to a place where we found several women manufacturing turmeric (from the rhizome of a species of *Curcuma*), and upon the sides of the river were large quantities of refuse. In a small house close to the water there were two pits, 18 inches deep, lined with Bavaria leaves, and made water-tight; also a number of posts set into the ground, having rough bark, to be used as graters. When a quantity of the rhizome is grated, it is committed to the pits, where it remains for some time, and is afterwards carried to a canoe, then strained through a close-worked basket lined with fern leaves, and then put into short bamboos, where it remains for four nights and four days. It is then fit for use, and proves one of the principal articles of food, being made into puddings, mixed with grated sugar-cane. It is used also for covering children after birth, and for painting the bodies of women previous to strangulation.—(*Hooker's Kew Journal.*)

Mode of Drying Succulent Plants.—M. Motley, in writing from Borneo, states, that he believes he has hit on the right way of drying succulent plants, and such as are apt to come to pieces. He had previously tried hot water, but that made the specimens mould; then a hot iron, but that was tedious, and it spoiled the flower; pricking the leaves with a penknife or fork was of use, but the specimens looked unsightly after it; and chloride of calcium was too troublesome. He now puts the plants into a large bottle of weak spirit for one night. This kills them, and an endosmose goes on in the tissues, which breaks them up, and makes them dry as quickly as other plants.—(*Hooker's Kew Journal.*)

Pteris aquilina, as an Esculent Vegetable.—The rhizome of this plant is used in the north of Europe to form a coarse kind of bread, in the same way as *Pteris esculenta*, a variety of it, is used in New Zealand. The rhizome is washed and peeled, scraped and formed into a pulp, all the slime being washed away. The pulp thus procured forms palatable bread. The very young fronds, completely blanched, may be used as a vegetable like asparagus.

Colouring Matter on Fronds of certain Ferns.—M. Prillieux has examined the colouring matter on the fronds of certain ferns belonging to the genus *Gymnogramma*. Some of these ferns have the under surface of their fronds of a pure white, while others are of a sulphur yellow. The colour is produced by a matter deposited on the surface of the frond. This matter is easily removed by the fingers, and is of a fatty nature. When held on paper it stains it like grease. It is dissolved in alcohol, oil of turpentine, and in oil. The alcoholic solution on evaporation yields a crystalline matter, which has not been examined chemically as yet. On examining the colouring matter with the microscope, it was found to consist of a mass of interlaced filaments. These filamentous bodies are produced apparently by capitate glandular hairs which are seen covered with minute threads. On removing these threads by alcohol, the hairs are shown of a balloon-like form, with an elongated neck,—the rounded upper portion formed of a single cellule, the stalk or neck of one or two cellules. In *Gymnogramma chrysophylla farinosa*, and *dealbata*, the summit of the hair is spherical; in *G. calomelanos* and *hybrida* it has a more ovate form. The terminal cell of the hairs is perforated with very minute holes, through which it appears the secreted matter passes from the interior in the form of filaments. In *G. hybrida* the punctuations or holes are about $\frac{1}{700}$th of a millimetre.—(*L'Institut.*)

Mannite.—The mannite which is developed on the surface of many marine algæ when they are dried in the air is considered by M. Phipson as the result of a particular kind of fermentation, by which the mucilage of the leaves is deoxydised. He does not consider it as a secretion of the living plant.

Ophioglossum vulgatum.—M. Schrietzlein states that the Ophioglossum vulgatum possesses a horizontal rhizome, on which are developed several buds at the distance of 2 or 3 inches, which give rise to stems and leaves.

Cuscuta.—M. Schrietzlein has observed at the end of the embyro of Cuscuta, two germinal leaves distinctly visible. The plant is therefore not acotyledonous, as has been generally supposed.

Spilanthes oleracea.—In the capitules of this plant M. Schrietzlein has noticed florets with five styles, and others with three or four, a remarkable anomaly in the order Compositæ.

Action of Pollen in the Development of Fruit.—M. Maudin, Assistant Naturalist in the Museum of Natural History of Paris, has made experiments on four Cucurbitaceæ, viz., *Ecbolium elaterium*, *Cucurbita pepo*, *Cucurbita melanosperma*, and *Cucumis abyssinicus*, with the view of ascertaining whether or not the action of the pollen on the stigma is necessary for the development of fruit containing either no seeds or abortive ones. He found that when these plants were placed in circumstances where to all appearance the pollen could not come into contact with the stigma, the fruit was developed in a much less complete manner than in ordinary circumstances; and that when the plants were fertilized by the pollen of different species, they developed their fruits, but for the most part without having seeds with an embryo. He concludes that the pollen acts therefore not only on the ovules but also on the ovaries and fruit.

Hygrometric Filaments or Hairs in Capsules of Orchids.—M. Prillieux states that the internal surface of the valve of the capsule of *Pleurothallis obtusifolia* is covered with filaments or hairs which are disposed in an irregular manner amidst the seeds. After the dehiscence of the capsules the filaments appear free—having no adhesion to the walls. The filaments are formed of long fibres, arranged in pairs. These filamentous hairs are very hygrometric, and when breathed upon show marked movements. They probably assist in scattering the seeds in the same way as elaters do. The same sort of hygrometric hairs exist in the capsules of *Fernandezia acuta*, *Leptotes bicolor*, *Vanda multiflora*, *Angræcum fragrans*, *pusillum*, *&c.*—(*L'Institut.*)

Juice of Chinese Green.—Decaisine finds that the plants whence the Chinese derive their Indigo *Lokao*, a substance known in commerce as Chinese green, are species of Rhamnus, which he describes under the names of *Rhamnus chlorophorus* and *Rhamnus utilis*.

Canella.—M. Grisebach, from an examination of Caribbean plants in the collection of Dr Duchassaing of Guadeloupe, has shown that the genus *Canella* is allied to the genus *Tasmannia*, and ought to be placed among the *Magnoliàceæ*. This seems to explain the reason why it has been confounded with Drimys.—(*L'Institut.*)

Alpine Vegetation of the Colony of Victoria.—In order now to accomplish the examination of the Alpine Flora on the Eastern frontiers, I started for the Coborras Mountains, the most prominent points of the great dividing range within the borders of this colony. Not only these mountains, but also the greater part of the interjacent plains or plateaux, are of a truly alpine or subalpine nature, ranging in elevation from 5000 to 6000 feet above the level of the ocean. As some of the highest sources of the Murray and of the Gipps Land rivers rise in this vicinity, the supply of water is plentiful. The valleys are either covered with spongy mosses (chiefly *Sphagnum*), which become transformed into peat, or they produce nutritious grasses, some luxuriant enough to recommend their introduction into countries of the arctic zone —(*Hierochloe antarctica*, *H. submutica*, *Agrostis frigida*, *nivalis*, &c.) The vegetation of the Coborras Mountains does neither fully agree with that of Mount Buller, examined last year, nor with the Alpine Flora of Van Diemen's Land; although the following series of its plants may indicate its partial identity with both:—*Ranunculus pimpinellifolius*, *R. scapiger*, *Geranium brevicaule*, *Acacia bossiœoides*, *Hovea gelida*, *Oxylobium alpestre*, *Anisotome glacialis*, *Didiscus humilis*, *Celmisia astelifolia*, *Eurybia megalophylla*, *Brachycome nivalis*, *B. multicaulis*, *Ctenosperma alpinum*, *Ozothamnus Hookeri*, *O. cinereus*, *Antennaria nubigena*, *Senecio pectinatus*, *Goodenia cordifolia*, *Gaultheria hispida*, *Leucopogon obtusatus*, *Lissanthe montana*, *Richea dracophylla*, *Prostanthera rotundifolia*, *Euphrasia alpina*, *Gentiana Diemensis*, *G. montana*, *Grevillea australis*, *Pimelea gracilis*, *Podocarpus montana*, *Exocarpus humifusa*, *Juncus falcatus*, *Restio australis*, *Oreobolus Pumilio*, *Lomaria alpina*, *Polytrichum dendroides*, &c. Here all these plants are alpine, notwithstanding some of them descend in Tasmannia to the low land. But to those already known I had the gratification of adding several new species, probably peculiar to the Alpine Flora of Australia, namely:—*Phebalium phylicoides*, *Asterolasia trymalioides*, *Mniarum singuliflorum*, *Bossiœa distichoclada*, *Centella cuneifolia*, *Anisotome simplicifolia*, *Eurybia alpicola*, *Ozothamnus planifolius*, *Gnaphalium alpigenum*, *Hierochloe submutica*, *Glyceria Hookeriana*, *Agrostis gelida*, &c.—(*Report of Dr Mueller, the Government Botanist.*)

Woods of the Colony of Victoria.—The woods stand in this regard prominent in importance. The Blue Gum tree of Van Diemen's Land (*Eucalyptus globulus*) is found abundantly in some of the forest districts, principally of the south, and is already so well known for its colossal size, as to render it superfluous to quote the statements made of its vast dimensions. Of the circumference of the stem instances are on record, by which this tree ranks only second to the famous Boabob from the Senegal. The experiments instituted in Van Diemen's Land have shown "that its elasticity and strength exceed generally those of all woods hitherto tested;" "it is equal in durability to oak, and superior to it in size;" and therefore highly esteemed for ship-building. Other *Eucalypti* likewise claim attention, on account of the beauty and durability of their wood, in consequence of which qualities one of them, from the south-eastern frontiers, received there the name of the Mahogany tree. The wood of *Callistemon salignus*, although the tree is seldom of large dimensions, stands here, perhaps, unrivalled for hardness. The fragrant Myall wood, so well adapted for delicate ornamental work, is obtained from *Acacia homalophylla*, and some allied species in the Mallee desert. The well-known Blackwood (*Acacia melanoxylon*), in some localities called Lightwood, attains in the Fern-tree gullies an enormous size, and yields a splendid material for furniture, at once most substantial, and capable of a high polish, being also recommended for the finishing work of vessels. The Myrtle tree of Sealer's Cove and the Snowy river (*Acmena floribunda*) is also remarkable for its straight growth and its excellent wood. The Australian evergreen beech (*Fagus Cunninghami*) forms a noble tree, sometimes more than 100 feet high, of which the wood takes a beautiful polish. Omitting such kinds as are more generally known, I may yet mention as useful, chiefly for ornamental work, the Sassafras wood (from *Atherosperma moschatum*), the Lomatia-wood (from *Lomatia polymorpha*), that of the Tolosa-tree (*Pittosporum bicolor*), the Musk-wood (from *Eurybia argophylla*), the Iron-wood (from *Notelæa ligustrina*), that of the Oil-fruit tree (*Elæocarpus cyaneus*), the Zieria-wood (from *Zieria arborescens*), that of the Heath-tree (*Monotoca elliptica*), and of the Australian Mulberry-tree (*Pseudomorus Australasica*). Samples of those kinds, which are met with on Wilson's Promontory, have been procured for the Paris Exhibition, and may give some additional proof that we possess woods here for any purpose, with the exception perhaps of such as are fit for larger ships' masts.—(*Report of Dr Mueller, the Government Botanist.*)

Flora of Oregon and California contrasted with that of the Eastern Side of America.—A proper discussion of the relations existing between the vegetation of the eastern and western sides of the continent would demand a notice of the remarkable *absence* west of the Rocky Mountains of a great variety of genera, tribes, and even orders, which are eminently characteristic of the flora of the Eastern States. For example, Oregon and California have no *Magnoliaceæ*, *Anonaceæ*, *Menispermaceæ*, nor *Cabombaceæ*, no *Nymphæa*, although a Nuphar is plentiful, no *Tilia* or Bass-wood, no *Camelliaceæ*, no indigenous Grape-vines, except one in California, only one *Polygala*, no Locust or other Leguminous trees, no Passion-flowers, no *Hydrangea*, no *Hamamelaceæ*, few *Rubiaceæ*, no *Vernoniaceæ*, and very few *Eupatoriaceæ*, very few *Asters* and *Solidagoes* (but the numerous *Compositæ* tend strongly to *Helenieæ*, and are mostly of genera which are neither Eastern, North American, nor European in type), no *Lobelia*, no true Huckleberries (*Gaylussacia*) nor *Vaccinia* of the Blueberry type (the section *Cyanococcus*), no *Clethra*, and few *Andromedeæ*, no *Aquifoliaceæ*, *Ebenaceæ*, nor *Sapotaceæ*; no true *Bignoniaceæ*, no *Acanthaceæ*, nor Gerardias, no *Sabbatia*, no *Dirca* nor *Podostemon*, solitary representatives here of their respective orders; no *Empetraceæ*, no Elms (although there is a *Celtis*), no Mulberry, no Walnuts, Hickories, or other *Juglandaceæ*, nor a Beech, Hornbeam, nor Ironwood; no true *Araceæ*, *Hydrocharidaceæ*, *Hæmodoraceæ*, *Burmanniaceæ*, *Dioscoreaceæ*, *Pontederaceæ*, *Commelinaceæ*, *Xyridaceæ*, or *Eriocaulonaceæ*; few *Orchidaceæ*, and still fewer *Cyperaceæ*, none of the latter, either *Rhynchosporeæ* or *Sclerieæ*; and Paniceous and Andropogineous Grasses are altogether absent.

How these failures are made up by a large increase of peculiar generic and specific forms in a few families, I will not stop to illustrate. But it is worth noticing that, while our eastern flora possess so many orders which are not represented in the western, no order represented in Oregon or California is wanting in the flora of our Northern States, unless *Hydroleaceæ* and *Garryaceæ* be counted as independent orders; and both of these occur in the Atlantic states south of our geographical limits. —(*Asa Gray, in Silliman's Journal*, May 1857.)

The Prominent Characteristics of the Flora of the Northern United States.—To answer the question as to what are the leading characteristics of the vegetation of the Northern United States, taken as a whole, we should have to consider, first: What are the more remarkable peculiarities of our flora, as discovered by the instructed botanist, with the whole field systematically displayed to his mental view; and secondly, what are the plants or the forms of vegetation which, by their abundance or their prominence, impart to our flora its dominant features. The first is a matter of deduction from a variety of facts, many of which would never arrest the attention of the casual observer: the second relates to points which would most attract the notice of the passing botanical traveller or the ordinary observer. The answer to the former no less than to the latter inquiry, would depend upon the point of view. To the traveller from the Southern States, or from the great plains of the West, the novel features of our vegetation are those which it has in common with Europe. To the European visitor the striking peculiarities are those which we share with the southern part of the country, and these would increase in prominence as he proceeded southward and westward. And, in forming his idea of a flora, the botanist naturally, if not inevitably, takes that of Europe as his standard of comparison.

In comparing, as the botanist naturally would, our flora with that of Northern and Western Europe, the following would appear to be leading characteristics.

1. Our comparative richness in ordinal types;—our flora having, as already remarked (vol. xxii. p. 216), 26 orders which are absent from that of Europe; while the latter, exclusive of the Mediterranean basin, has only seven orders which are wanting here.

2. The prevalent subtropical character of our extra European orders;—which has been already referred to, and which will be manifest to the botanist inspecting the list of such orders given in a former article (vol. xxii. p. 215).

3. Our richness in species of woody plants, and especially of trees; as already alluded to (p. 84). This will strikingly appear from a comparison of our flora with an equivalent European one—with the German flora, for example. In Koch's *Flora Germanica* (excluding the Adriatic region), I count 60 indigenous species of trees, belonging to 27 genera, and comprised in fourteen orders. In our own *Flora of the Northern United States*, adopting the same estimate as to what constitutes a tree, I count 132 trees, in 56 genera, and belonging to 25 orders; as follows:—

Magnoliaceæ,	2	genera, and	6	species of trees.
Anonaceæ,	1	„	1	„
Tiliaceæ,	1	„	2	„
Camelliaceæ,	1	„	1	„
Anacardiaceæ,	1	„	1	„
Sapindaceæ,	3	„	8	„
Leguminosæ,	6	„	7	„
Rosaceæ,	4	„	15	„
Hamamelaceæ,	1	„	1	„
Araliaceæ,	1	„	1	„
Cornaceæ,	2	„	4	„
Caprifoliaceæ,	1	„	1	„
Ericaceæ,	2	„	2	„
Aquifoliaceæ,	1	„	1	„
Ebenaceæ,	1	„	1	„
Sapotaceæ,	2	„	1	„
Oleaceæ,	3	„	8	„
Lauraceæ,	2	„	2	„
Urticaceæ,	4	„	8	„
Platanaceæ,	1	„	1	„
Juglandaceæ,	2	„	9	„
Cupuliferæ,	5	„	21	„
Betulaceæ,	1	„	5	„
Salicaceæ,	2	„	7	„
Coniferæ,	7	„	18	„

The only natural order containing trees in the German flora and not in ours is the *Rhamnaceæ;* the only order in which the German flora exceeds ours in arboreous genera is that of *Betulaceæ* (which comes from our not counting any of our Alders as trees); the only order in which the German flora has more species of trees than ours is that of the *Salicaceæ* (10 to 7), we counting but one truly arboreous indigenous Willow. On the other hand, our flora surpasses the German, not only in the twelve additional orders (one of which is represented by nine species and another by six), but also in having a greater number of species in ten out of the thirteen orders common to the two countries, and of genera likewise in all but three of them. That is, we possess of

Sapindaceæ (including Hippocastanaceæ and Aceraceæ),	2	more genera, and	3	more species of trees.
Leguminosæ,	5	"	6	"
Rosaceæ,	0	"	2	"
Cornaceæ,	1	"	3	"
Ericaceæ,	1	"	1	"
Oleaceæ,	2	"	6	"
Urticaceæ,	2	"	5	"
Cupuliferæ,	0	"	11	"
Betulaceæ,	0 (—1)	"	3	"
Coniferæ,	3	"	10	"

4. Our flora, it may be seen, accordingly predominates in its species of Pine, Fir, Oak, Birch, Elm, Ash, arboreous as well as shrubby *Cornaceæ*, *Cratægi*, and of arboreous *Leguminosæ;* and its characteristic trees are the *Taxodium*, the Overcup, Willow and Chesnut-Oaks, the Hickories and Walnuts, the Plane-tree and two *Sapotaceæ*, which barely reach us from the South, the Persimmon, the Gum-trees (both *Nyssa* and *Liquidambar*), the Common and Honey Locusts, *Cladrastis*, and the Kentucky Coffee-tree, the Negundo, and three species of Buckeye, the Sumac, the Loblolly Bay of our south-eastern border, the Papaw-tree, the Tulip-tree, and our five species of Magnolia. We might have added *Zanthoxylum*, but no Prickly Ash fairly forms a tree within our geographical limits.

5. Our flora is equally rich in shrubs, of a great variety of families, especially in those which make an undergrowth in forests; and, among them, in *Vaccineæ*, *Andromedeæ*, and *Rhodoreæ*, while it has no *Arbuteæ* rising above the surface of the ground, and no *Ericeæ* or Heaths at all.

6. It is also rich in *Compositæ*, especially Helianthoid *Compositæ*, *Eupatorinæ*, Asters, and Solidagoes, in the latter genera outnumbering any other region; but it is poor in *Anthemideæ*, true *Senecioneæ*, and in *Cynareæ*, and especially so in *Cychoraceæ*.

7. It has an unusual number of *Cyperaceæ*, which is owing partly to the remarkable number of extra-European genera, and partly to the number of species of *Cyperus*, *Rhynchospora*, and *Carex*.

8. From the position of *Rosaceæ* on the list of the larger orders, our flora would be supposed to be unusually rich in that order also; but this result happens in consequence of our remarkable comparative poverty in *Cruciferæ*, *Umbelliferæ*, *Labiatæ*, and *Caryophyllaceæ*. Other orders in which our flora is much deficient, as compared with Europe, are *Boraginaceæ*, *Campanulaceæ*, *Liliaceæ* in the larger sense, and *Iridaceæ*, *Crassulaceæ*, *Chenopodiaceæ*, *Primulaceæ* and *Geraniaceæ*. Those in which we are correspondingly rich are *Asclepiadaceæ*, *Polemoniaceæ*, *Smilaceæ*, *Melanthaceæ*, *Araliaceæ*, and *Onagraceæ*.

9. To present the elements of the 26 orders represented in our flora, but wanting in that of Europe, and in which characteristic features are necessarily comprised, would still further extend an article already inconveniently protracted. The botanist can readily gather the needful details respecting them, and respecting our extra-European genera generally, from the data given in a former article.

As regards the plants most striking and important in the physiognomy of our vegetation, the first rank is undoubtedly held by the trees of social growth; and of these the principal are *Coniferæ.* The characteristic tree of the proper Northern States is, therefore, *Pinus Strobus.* This, the tallest and once the most plentiful of our trees, when the country lay in all the wildness of nature, must have given the dominant feature to a great part of the landscape. White Pines may probably be distinguished by their port and aspect from a greater distance than any other of our forest trees, except perhaps the *Taxodium* of our Southern "Cypress" swamps, and the long-leaved Pine which so strikingly marks a belt of low and barren country stretching from the south-eastern borders of Virginia to the Gulf of Mexico and the Mississippi.

Pinus Tæda, near our southern limits, and, more northward, *P. rigida* and the other Pitch Pines, give a predominant feature to the "pine-barrens" of the Northern States.

Our Arbor Vitæ (*Thuja occidentalis*), of intensely social growth, is the physiognomic tree of our cold swamps at the North, and of Canada. Large tracts of cold and poor marshy land at the north, and on the mountains, are occupied with the well-marked Balsam Fir, or, where less damp, with the more sombre and stiff Black Spruce, or with the closely related White Spruce; the latter, however, only along our northern frontier. *Abies Fraseri* replaces the common Balsam Fir in the Alleghanies south of Pennsylvania, and has just the same aspect. Hemlock Spruce woods (*Abies canadensis*) cover hill-sides and sharp ridges of a light and thin soil, where water never stands, throughout the northern part of the country, with a truly characteristic forest-growth. Larch or "Tamarack" swamps are strongly marked in aspect, but are never large.

No other species of forest trees that I know monopolize the ground in so marked a manner, and impress their single features upon a tract of country. The Beech woods of elevated tracts, and the Sugar Maple in richer and lower grounds, make the nearest approach to it; but ordinarily our woods of deciduous trees consist of a mixture of several species, in which different kinds predominate according to the situation. In enumerating, as I have done farther back, the trees most characteristic of our three principal districts, I have mentioned those which more than any other give character to our arboreous vegetation. As trees which possess marked peculiarity, and which may be known from far, I barely mention the common American Elm of our intervales, the Button-wood or *Platanus* on the banks of rivers and streams, the Sugar Maple, the various Hickories, the Black Walnut, and several Oaks, the White and the Paper Birch, conspicuous from the ghastly white bark of their trunks, as well as by their light and handsome foliage, the Sassafras, the Cucumber-tree, the Tulip-tree, the Honey Locust with its remarkably light and feathery foliage, and the *Gymnocladus* or Kentucky Coffee-tree, with its thick and stout branchlets, and its remarkably decompound foliage, rendered the more striking in aspect by the oblique or almost vertical position which the leaflets generally assume.

Of trees conspicuous in blossom, *Cornus Florida*, the two Umbrella-leaved Magnolias, the Locust, the *Cladrastis*, the Red-Bud, and the Crab-Apple, hold the first place, and the Umbrella-trees with their rose-coloured cones are equally conspicuous in fruit. The Loblolly-Bay, *Rhododendron maximum*, and the *Chionanthus* or Fringe-tree, are equally showy, but they are generally shrubs rather than trees.

Considering our great variety of trees and shrubs, there is a remarkable absence of broad-leaved evergreens. The American Holly is our only tree of the sort of considerable size, and that is not a common one. Of large shrubs or small trees, *Rhododendron maximum* and *Kalmia lati-*

folia—our "Laurels"—are our principal and truly characteristic evergreens, as they are among the most social of our woody plants.

The herbaceous plants which most strike the eye are of course the *Compositæ*, especially towards the close of summer, when golden Solidagoes, and purple, blue, and white Asters, are everywhere conspicuous. Of vernal flowers—peculiarly delightful to us after a winter which destroys all herbaceous vegetation—the most common species which strike the eye over the whole country (in their appropriate stations) are *Caltha palustris*, *Aquilegia canadensis*, *Anemone nemorosa*, with *Thalictrum anemonoides*, *Sanguinaria canadensis*, *Saxifraga virginiensis*, *Viola cucullata*, *sagittata*, or one or two other stemless Violets, *Claytonia*, one or the other species, *Oldenlandia* (*Houstonia*) *cærulea*, *Senecio aureus*, *Smilacina bifolia*, *Erythronium americanum*, *Uvularia sessilifolia*, and, a little later, *Geranium maculatum*.

The part which introduced-plants take in our flora, with some kindred topics, must be considered in a future article.—(*Asa Gray*, *in Silliman's Journal*, May 1857.)

On the Mode of Formation of Cannel Coal. By J. S. Newberry.—1st, Cannel coals always exhibit a tendency to assume the foliated structure of slates and shales,—a structure which they must have derived from aqueous deposition. They are frequently found shading into bituminous shale, into which they are converted, simply by accessions of earthy matter. Bituminous shale and cannel coal may, therefore, be considered as the same substance in different degrees of purity; that is, carbonaceous paste, deposited from aqueous suspension with different admixtures of earthy matter. The carbonaceous matter in bituminous shale, as in cannel, exhibits a preponderance of volatile matter over fixed carbon, and the gases furnished by it contain a larger proportion of the more volatile hydro-carbons, and possess a higher illuminating power than those derived from ordinary bituminous coal.

2d, The chemical composition of cannel coal—so rich in volatile ingredients—and its homogeneity, are such as would naturally follow the decomposition of vegetable matter while constantly submerged. Plants when deprived of their vegetative life, and exposed to the action of the air, are slowly decomposed by the process of decay; a process which, unattended by the sensible phenomena, heat and light, is however really a combustion, and consists in the union of oxygen with their hydrogen to form water, with their carbon to form carbonic acid, and of their carbon and hydrogen to form carburetted hydrogen, &c. When vegetable matter is covered with wet earth or clay, these changes are both modified and retarded, and an intermediate state, that of bituminization, is assumed by a portion of the organic matter. Under water the changes terminating in decay go on still more slowly, and a larger portion of the vegetable tissue becomes bituminized. The process of bituminization in such circumstances consists in the oxidation of a small portion of carbon,—which escapes as carbonic acid,—of hydrogen to form water, the union of carbon and hydrogen to form carburetted hydrogen and other hydro-carbons, and the combination and removal of a portion of the alkaline carbonates, of nitrogen, &c., all of which go to make up the loss, which is relatively small. The residuary hydrogen and oxygen unite with a portion of the carbon to form bitumen, which closely resembles, physically and chemically, the resins produced by the vital functions of many plants. This bitumen unites mechanically with the uncombined or fixed carbon, the remaining alkalies and inorganic matter, to form coal. It is evident, that the more ready the access of oxygen to the carbonaceous matter during the process of bituminization, the larger proportion of the products of complete combustion will be mingled with those of this process; and the more perfectly the oxygen is excluded, the larger proportion of the more volatile (*i. e.* more oxidable) constituents of the wood will be retained. Of the conservative influence of water on vegetable matter we have evidence, not only in the great durability of wood when constantly submerged, but in coal itself. In all coal strata, except where the process of volatilization is complete, as plumbago and perfectly gasless anthracites, the work of decomposition is constantly going on. To this as to ordinary combustion, water is an extinguisher. Coal mines are commonly opened in America by penetrating the coal on some hill-side where it is not covered by water. In these circumstances a progressive change, both chemical and physical, is noticeable in the coal from its outcrop to the point where atmospheric influences cease to act. Near the surface it is friable, lustreless, and nearly destitute of gas, having much the appearance and character of decayed wood. As it is more deeply penetrated it becomes harder and more brilliant, and contains more volatile matter, till under water or a sufficient cover of incumbent rock, it is protected from the action of oxgyen. On the contrary, whenever the outcrop of a coal stratum is constantly covered with water, even though it have no other covering, it will be found hard and bright, and containing nearly its maximum quantity of volatile ingredients.

3d, The higher illuminating power of the gases of cannel coal is a natural consequence of the preservation of the more volatile constituents of wood, by its continued submersion in a hydrogenous liquid. It is also probable that the illuminating power of cannel gas is often somewhat increased by the animal matter which it contains. I have found remains of fishes in slaty cannel, surrounded by bitumen having in a high degree the characteristics of the bitumen of cannel. That a more resinous vegetation has given cannel this character is, I think, not probable. I have often found unchanged resins in common bituminous coal but never in cannel.

4th, The greater relative proportion of earthy matter in cannels would be a necessary result of the submersion of the vegetable matter in a fluid having a greater specific gravity than air, and, of course, greater power for the suspension and transportation of sediment. In the few instances known where the cannel is of equal purity with bituminous coal, we may I think discover evidences that the vegetable matter has been deposited in confined bodies of quiet water, entirely without currents, or, at least, receiving little or no surface drainage.

5th, The fossils contained in cannel coal are among the most significant indications of its aquatic origin. Fishes are found in cannel in abundance, scales, teeth, spines, coprolites, and entire individuals being, in some localities, so profusely scattered through its substance as to prove conclusively that they must have lived and died in great numbers in waters, at the bottom of which comminuted vegetable matter was accumulating as a carbonaceous paste with which their remains have mingled, and the whole, consolidated, has become a stratum of cannel. I have before me as I write, pieces of beautiful cannel from England, in which are impacted teeth of *Megalichthys*, scales of *Palæoniscus*, and many other forms of aquatic life. And in Ohio I have found fishes in large numbers in a thin stratum of cannel underlaying a thick seam of bituminous coal; which last contains none. Shells too are not unfrequently found imbedded in the middle of a stratum of cannel. The vegetable remains which I have observed in cannel are *Stigmariæ*,—roots and rootlets of trees which grew in the coal-marshes,—generally occurring in detached fragments—shapeless portions of the trunks of *Lepidodendra* with their markings nearly obliterated, *Lepidostrobi* reduced to their woody skeletons, fern fronds of which nothing but rachis and veins remain, all evidently macerated till only their most resistant tissues are left. Strata of ordinary bituminous coal usually consist of thin layers of brilliant bitumen alternating with others of bituminous shale or cannel. This arrangement I consider due to the variable quantity of water saturating and overflowing the coal-marshes : the cannel layers having been deposited during the prevalence of high water.

MISCELLANEOUS.

Ascent of Chimborazo.—The *Echo du Pacifique* of the 3d January, gives the following account of an ascent of Chimborazo, made on the 3d November 1856 by a French traveller, M. Jules Remy, accompanied by M. Brenchley, an English traveller.

"On the 23d June 1802, the illustrious Humboldt, accompanied by his friend Bonpland, made the first attempt to ascend Chimborazo. On account of a pointed rock, which presented an insurmountable barrier, they were unable to ascend above 5909 metres of the mountain, then regarded as the highest in the world, and which still occupies a principal place among the colossi of America.

"Thirty years later, on the 16th December 1831, M. Boussingault, after a long and skilful examination of the Cordillera of the equator, endeavoured to accomplish the ascent in which his predecessor had failed. He reached the enormous height of 6004 metres, that is to say, 95 metres higher than the others ; but he was arrested by rocks as they had been, and could not get beyond this limit, which was then the most elevated point ever attained by man on mountains.

"The accounts of these famous travellers had deprived us of all hope of reaching a height so considerable, but, after having observed the snowy and rounded summit of Chimborazo from Guyaquil, we could not help thinking that it was accessible from some point or other. M. Brenchley and myself were thus led to form the design of attempting a third ascent.

"On the 21st July 1856, as we crossed the plateau of the Andes on our way to Quito, we halted at the foot of this stupendous mountain. We employed two days in studying its outlines from a distance, with the view of discovering any peculiar places on the surface of its gigantic dome which might afford us a passage.

"The route followed by M.M. Humboldt and Boussingault, seemed to us at first to be greatly the most easy and desirable on account of its regular declivity ; but the barrier of rocks, which we readily distinguished, presented no outlet to the eye. When we had made nearly the entire circuit of this mighty mountain, and without success, we resumed our journey towards Quito, reserving the execution of our plan till we should be better fortified against the rigorous climate of the higher Cordilleras.

"After visiting Pichincha, Cotopaxi, and other giants of the Andes, we again found ourselves, on the 2d of November, at the foot of Chimborazo. We pitched our camp at a height of 4700 metres, a little below the line of perpetual snow, in a valley between Arenal and the point where the Riobamba route separates from that of Quito. We intended to spend the following day in collecting plants and hunting deer and birds, endeavouring, at the same time, to determine beforehand the places which might afford us the most easy access to the summit.

"We took up our quarters under a huge inclined rock, which afforded us sufficient protection against the north-west wind, but gave us no shelter in the event of rain. Rain had fallen in the afternoon. The weather cleared at night-fall, the sky became sprinkled with myriads of stars, and Chimborazo was delineated, in all its splendour, on the azure and sparkling vault of the firmament.

"On the morning of the 3d November, at five o'clock, when day had not yet dawned in the equinoctial regions, we left our camp in charge of our people, and departed on our exploring expedition, carrying with us a coffee-pot, two thermometers, a compass, matches, and tobacco. A steep hill, sandy and rough with pebbles, which separated us from the perpetual snow, occasioned us so much fatigue at our outset, that two of the natives who accompanied us became discouraged and turned back.

"When we had surmounted this hill, we descended on some soft sand to the bottom of a valley, which we followed, and from the extremity of which, we distinguished very clearly the summit of the mountain, entirely free from snow.

"After walking half an hour on the snow, vegetation suddenly ceased, and we saw no other living thing but two large partridges, and on the rocks a few lichens of the families Idiothalamus and Hymenothalamus. At this point of our ascent we collected some dry branches of chuquiragua, and made a bundle of them which we tied to our backs. We had still to scale an immense rock of trachyte, from the top of which the summit of Chimborazo appeared to us so near, that we thought we could reach it in half an hour.

"Our ascent was so rapid, that we were soon obliged, from fatigue, to make frequent stoppages to recover our breath. Thirst also began to be severely felt, and in order to moderate it, we almost always kept snow in our mouths. But we felt no symptoms of illness or any morbid affection, such as is spoken of by the majority of travellers who have ascended high mountains.

"After halting a few seconds, without even seating ourselves, we again started not only with renewed ardour, but even a kind of furious determination inspired by so near a view of the summit. It appeared evident to us, by this new instance confirming so many previous ones, that at these heights the atmospheric column is still sufficient to prevent any impediment to respiration, and that the shortness of breath and organic affections which are so generally complained of at considerable elevations, must be ascribed to some other cause.

"Always rapidly ascending, we now began to overlook the peaks of the Cordilleras, and to discover a distance furnished with immense valleys, when some light vapours, which at first appeared only like spiders webs on the sides of the mountains, soon began to detach themselves in the form of white flakes, stretching nearer and nearer to each other, till they at last arranged themselves like a girdle along the horizon.

"All of a sudden, about eight o'clock, this curtain enlarged itself, and approached Chimborazo; then in a few minutes, it mounted to us, thin at first, but becoming perceptibly more dense. We no longer could perceive the summit. We continued, however, to mount upwards, enticed by the hope of attaining our object much more easily than we had supposed on leaving our encampment.

"The fog continued to increase; we could not see twenty paces from us. At half-past nine, it had become so thick that it was almost as dark as night at the distance of a few metres. Confident of finding our footsteps again to guide our descent, we travelled on with additional stubbornness; but we had every moment to examine the compass, in order to avoid a precipice which we had left on our right before reaching the terminal depression by which we resolved to gain the summit.

"It seemed to us that the declivity became less steep, we breathed more freely, and walked with less effort. Some dull detonations began at intervals to be heard in the distance. At first we ascribed them to the explosions of Cotopaxi; but soon reverberating peals, such as are heard only in the vicinity of the equator, convinced us that thunder was rolling in the lower regions. A terrible storm was in preparation.

"In the fear that the hail or snow would efface the marks of our feet, and thereby expose us to the risk of losing ourselves in the descent, we determined, with regret, to halt for a while. We hastened to kindle our chuquiragua wood, in order to melt the snow in our coffee-pot. At ten o'clock, the thermometer which, at five feet above the snow, indicated 1·7, was plunged in boiling water where the mercury stood at 77·5.

"At five minutes past ten, our observations terminated, and we began to descend with giant strides in order to regain our encampment as speedily as possible. We arrived there in the midst of the thick fog about an hour after noon. The thunder rolled almost without interruption, the flashes of lightning describing dazzling zigzags around us, never seen elsewhere so distinctly defined except in pictures.

"About three o'clock, a fearful tempest of rain, hail, and wind assailed us under our rock. It continued throughout a part of the night with a fury which seemed as if it could never be allayed. We were literally lying in water. On the morrow, at day break, our eyes rested everywhere on a vast field of hail.

"Certain indications of another tempest made us abandon the idea of trying again the ascent of Chimborazo, which we henceforth regarded as quite impracticable. We made all haste to break up our camp and make for Guaranda, where we arrived about three o'clock, travelling through a cold and dense fog, which prevented us for that day admiring one of the most beautiful views in the world.

"When we calculated our observations, we were not a little surprised to find that we had reached the summit of Chimborazo without being aware of it. According to personal researches, made at first in the Archipelago of Hawaii, and afterwards repeated among the Cordilleras of the equator, the co-efficient of the sum of degrees or fractions of a degree in the centigrade thermometer, reckoning between the point to which the mercury rises when the instrument is immersed in boiling water, and the boiling point of water at the level of the sea, is found to be 290·8; that is to say, each degree below 100 indicates a difference of level equal to 290·8 metres, or about 29 metres for the tenth of a degree, hence the formula

$$x = (100 - \mathrm{B})\ (290{\cdot}8)$$

which gives us 6543 metres for the absolute vertical height we had reached on Chimborazo. This figure places us quite on the summit, the altitude of which, above the sea level, according to Humboldt's triangulations, is 6514 metres. But whatever degree of confidence may be conceded to our calculations, the unquestionable fact resulting from our ascent is, that the summit of Chimborazo is accessible!!

On the Early Stages of Inflammation. By JOSEPH LISTER, Esq., F.R.C.S., Eng. and Edin., Assistant Surgeon to the Royal Infirmary of Edinburgh. In this communication the author gives an account of an investigation with which he has been recently occupied, into the process of inflammation in the frog's foot.

The first section of the paper is devoted to the discussion of the aggregation of the corpuscles of the blood. It is shown by the author that the *rouleaux* "are simply the result of the disk-form of the corpuscles, together with a certain, though slight degree of adhesiveness, which retains them pretty firmly attached together when in the position most favourable for its operation, namely when flat surface is applied to flat surface, but otherwise allows them to slip very readily upon one another." The aggregating tendency of the red disks is thus regarded as a phenomenon similar in kind, though inferior in degree to the well-known adhesiveness of the white corpuscles. It is further shown, from numerous experiments, that the re l corpuscles vary remarkably in adhesiveness, in consequence of changes in physical circumstances, or very slight chemical action.

Section II. is on the structure and functions of the blood-vessels.

Allusion is made to a paper by the author, which will shortly appear in the "Transactions of the Royal Society of Edinburgh," where he has recorded the observation, that in the smallest arteries of the web of the frog's foot, the middle coat is composed of muscular fibre cells wrapped spirally round the internal membrane. The parietes of the minute arteries are thus provided with a most efficient mechanism for diminution of calibre, and contrast in this respect very strikingly with the delicate nucleated membrane which constitutes the wall of a capillary. The functions of the two sets of vessels are described as being in harmony with these differences in structure; the arteries being specially characterized by contractility, while the capillaries exhibit only such changes of calibre as are explained by elasticity.

The thinness of the capillary wall is believed to favour the mutual interchanges between the blood and the tissues, but the consideration of some facts of physiology leads the author to the conclusion, that notwithstanding the distending force of the current of blood, the liquor sanguinis is not effused as a whole among the tissues in the state of health; and this is thought to imply that there subsists a mutual repulsion between the materials of the capillary wall and the elements of the liquor sanguinis, preventing the passage of the latter into the pores of the former, except in so far as they are attracted by the tissues for the purposes of nutrition.

The heart is believed by the author to be the sole cause of the circulation of the blood in the frog's foot, and it is proved experimentally that other sources of movement cannot have more than a very trivial influence, and that their cessation, supposing them to exist at all, does not give rise to arrest of the blood or accumulation of corpuscles in the capillaries.

Distinct evidences of muscularity and contractility have been detected in the veins of the frog's foot, but compared with the arteries, the veins show very little spontaneous contraction.

Regarding the influence of changes in arterial calibre upon the blood in the capillaries, the author is led to conclude that "the arteries regulate by their contractility the amount of blood transmitted in a given time through the capillaries, but neither full dilatation, extreme constriction, nor any intermediate state of the former, is capable *per se* of inducing accumulation of corpuscles in the latter."

The influence of the nervous system upon the arteries has formed the subject of a special experimental inquiry, the results of which are given in a supplement to the paper. It is there shown that the contractions of the arteries of the frog's web are regulated by a part of the spinal cord, the irritation of which induces complete constriction of the vessels, while its destruction is followed by permanent dilatation. Neither stimulation nor removal of the nervous centre for the arteries produces any perceptible change in the quality of the blood, as respects adhesiveness of its corpuscles or otherwise.

Section III., "on the effects of irritants upon the circulation in the frog's web," commences with an account of some experiments performed with tepid water applied for a brief period to the foot. This agent, which was selected as the mildest possible stimulant, produces in a very beautiful manner constriction of the arteries, followed by dilatation, with corresponding changes in the amount of blood transmitted through the capillaries, as explained at the close of Section II. When, however, such experiments were frequently repeated upon the same animal, and especially if the temperature of the water was more elevated, effects of a different kind began to show themselves; the corpuscles of the blood expeperiencing obstruction to their progress even while the arteries were fully dilated, and the vessels consequently in the state most favourable, so far as their calibre was concerned, for transmitting the current of blood. If the irritation was still continued, the minute vessels became choked with closely packed corpuscles.

Subsequent experiments, with a variety of other irritating agents, showed that the corpuscles, both red and white, were obstructed in their progress through the irritated part, in consequence of their tending to adhere in an abnormal degree to one another, and to the walls of the vessels. The effects upon the blood were always similar, although the means employed to produce irritation were exceedingly various, such as solutions of salts, mustard, essential oils, chloroform, heat, galvanic shock, mechanical violence, &c.

The irritant was generally so applied as to act only upon a small area of one of the webs, and it was found that the abnormal adhesiveness of the blood-corpuscles was in the first instance always precisely limited to the spot which had been thus acted on, though it frequently extended afterwards more or less to surrounding parts. At the same time the vessels of the irritated spot did not differ materially in calibre from those in its vicinity which participated in the arterial dilatation induced by the stimulus. The exact correspondence between the extent of the irritant application, and that of the effect upon the blood, showed that the latter must be due to direct action either upon the blood itself or the tissues of the web. That it was not the result of direct action upon the blood, was evident from the two following considerations. In the first place, most of the agents employed to cause irritation, when applied to freshly drawn blood, either had no effect upon the corpuscles, or destroyed instead of increasing their adhesiveness. Secondly, if employed so as to act mildly on the web, they induced an abnormal condition of the blood, short of actual stagnation though very apparent, namely, slow movement of numerous and adhesive corpuscles; and this state of things might last, although the time of operation of the irritant was often limited to a few seconds, or even a still briefer period. Long after all the blood which could possibly have been directly acted on had left the vessels of the part, successive fresh portions continued to experience precisely similar changes in passing through the irritated area. Hence the author considers the conclusion to be inevitable, "that the tissues, as distinguished from changes of calibre in the blood-vessels, are the primary seat of inflammation, and that the effects on the blood are secondary results of such derangement."

The remarkable fact discovered by Dr H. Weber of Giessen, but observed independently by the author, that accumulation of corpuscles occurs in the vessels of a part irritated, after circulation has been arrested by a tight ligature round the thigh, furnished the opportunity for careful comparison between the conditions of blood in healthy and irritated parts uncomplicated by the effects of rapid movement. A series of experiments conducted in this way confirmed the conclusion previously arrived at, that the accumulation of the blood-corpuscles was simply the result of their abnormal adhesiveness. At the same time these experiments brought out the remarkable fact, that mere quiescence of the blood does not give rise to aggregation of the red corpuscles within the vessels, unless the tissues are in an unhealthy condition in consequence of irritation. It further appeared that the corpuscles never exhibit greater adhesiveness within the vessels of an inflamed part, than do those of blood from a healthy part when drawn from the body. Also, the well-known adhesiveness of the white corpuscles within the vessel does not occur according to the author, unless some degree of irritation is present, and never exceeds that which is always seen in blood outside the body. Hence the inference is drawn, that the tissues of a healthy part exert an influence on the blood in their vicinity, by means of which the corpuscles, both red and white, are preserved free from adhesiveness; but that in an inflamed part this influence is more or less in abeyance.

This view has been confirmed by observations made on the wing of the bat.

Also the comparison of drops of blood from healthy and inflamed parts in the human object showed, that so soon as the blood was withdrawn from the vessels, the corpuscles of the former presented precisely the same degree of adhesiveness as those of the latter.

At the commencement of Section IV., "on the state of the tissues in inflammation," it is stated that "the conclusion arrived at in the latter part of the last Section, that blood flowing through an inflamed part behaves itself in the same way as when separated from the living body, naturally leads to us infer that the tissues of the inflamed part are in some degree approximated to the condition of dead matter, or, in other words, have suffered a diminution of power to discharge the offices peculiar to them as components of the healthy animal frame. This inference is strongly supported by considering what common effect is likely to be produced upon the tissues of the frog's web, by all the various agents known to cause inflammatory disturbance of the circulation." It is then pointed out that all these agents, though differing greatly in their nature, agree in their tendency to inflict a lesion on the part to which they are applied, and impair the functional activity of the tissues. "But strong as are the arguments thus obtained by inference, it would be very desirable to confirm them by direct observation of the tissues. It fortunately happens that the pigmentary system of the frog is a tissue which, from its peculiar form and colour, is very apparent to the eye, so that it is easy to trace the remarkably active functions with which it is endowed, and their modifications under the influence of irritation."

The author then mentions the circumstances which led him to notice that the dark pigment of the frog presents remarkable differences of appearance at different times in one and the same animal; each dark patch being sometimes of stellate figure with minutely ramifying rays, at other times in the form of a small rounded spot. These changes had been before observed by some German writers, who attributed the rounded form to contraction of the branching rays of a stellate cell. This, however, the author finds to be erroneous, and in a supplementary section "on the anatomy and physiology of the pigmentary system of the frog," shows that the cells never change in form or size, but that the pigment-granules which are suspended in a colourless fluid are capable of being, on the one hand, attracted by a central force into a small space in the body of the cell, and, on the other hand, dispersed by a repulsive power into the minutest recesses of the ramifying rays. Both concentration and diffusion of the pigment may take place with great rapidity, implying remarkable energy in the attractive and repulsive forces, both of which appear to reside in a nucleus. The supplementary section concludes with some remarks on the physiological importance of the actual observation of such attractions and repulsions in one of the animal tissues.

This paper continues with an account of an experimental investigation into the effects of irritants upon this function of the pigmentary system. Many experiments are related, all tending to support the general proposition, that "all agents, without any exception, which have the power of inducing accumulation of corpuscles and stagnation in the blood-vessels when applied to the web, paralyse at the same time the functions of the pigment-cells." It is also shown, from experiments upon amputated limbs free from blood, that this effect is independent of the state of the circulation. In cases of slight irritation in which the blood resumes, after a while, its natural characters (re-solution taking place), the paralysis of the pigment-cells is only temporary. "Thus the pigmentary system of the frog is a remarkably sensitive index of the condition of the affective tissue, and it is fortunate that its physical characters render it so easy to read its pointings. . . . . . The only other tissue of the frog's web, the functions of which can be observed by the eye, is that of the arterial muscular fibre cells," and it is found that arteries passing through an inflamed area lose their power of contraction within the limits of that area, whereas the same vessels may be often seen to contract in other parts of their course.

"Thus, direct observation of the structures of the frog's web which discharge functions apparent to the eye, furnishes unequivocal support to the inference derived from other considerations, that in inflammation the tissues of the part, the primary seat of the affection, are in a state of diminished functional activity."

The "conclusion" consists of an inquiry how far the views expressed in the paper regarding the early stages of inflammation harmonize with the more advanced phenomena of the morbid process and with other facts of pathology.—(*Proceedings of the Royal Society.*)

Gold in British Guiana.—Considerable excitement has been caused here by the arrival of a vessel from the Spanish Main, bringing letters, and also a copy of the *Guayana Gazette*, containing extraordinary reports of the discovery of a new gold field about 90 miles from Upata, where it will be recollected that about three or four years ago a large quantity of gold was taken from the river. One of these letters states that nearly all the clerks and labourers are leaving Cuidad Bolivar (Angostura) for the new mines which are at a place called Tupugun. The river steamers had been obliged to cease working, in consequence of all their hands having left and started for the gold fields. The average find is two ounces per day for each man; but there have been instances where much larger quantities have been taken; as much as twenty-four ounces having been found in between seven and eight hours; and two men who were working at the same time obtained forty-four ounces.

This gold field is said to be within the British territory of British Guiana, according to the line ran some years since by Sir Robert Schomburgh, by order of the British Government. The gold lies at a depth of between five and six feet from the surface. Large orders have been received here for pick-axes, shovels, and other implements for digging.—(*Port of Spain Gazette, May* 9, 1857.)

Magnetism.—Professor Hansteen of Christiania, the eminent Magnetical Philosopher, has presented a memoir to the Swedish Academy, proving, from his own observations, that the magnetic dip partakes of the daily, annual, and eleven-yearly periodic changes (the last coinciding with Schwabe's period of the solar spots), which have been already detected in the other magnetic elements. The same distinguished philosopher (who is now in his 73d year) expects soon to complete the reduction and publication of the magnetical results of his Siberian journey in the years 1828–30, which have been so long desired by the scientific world.

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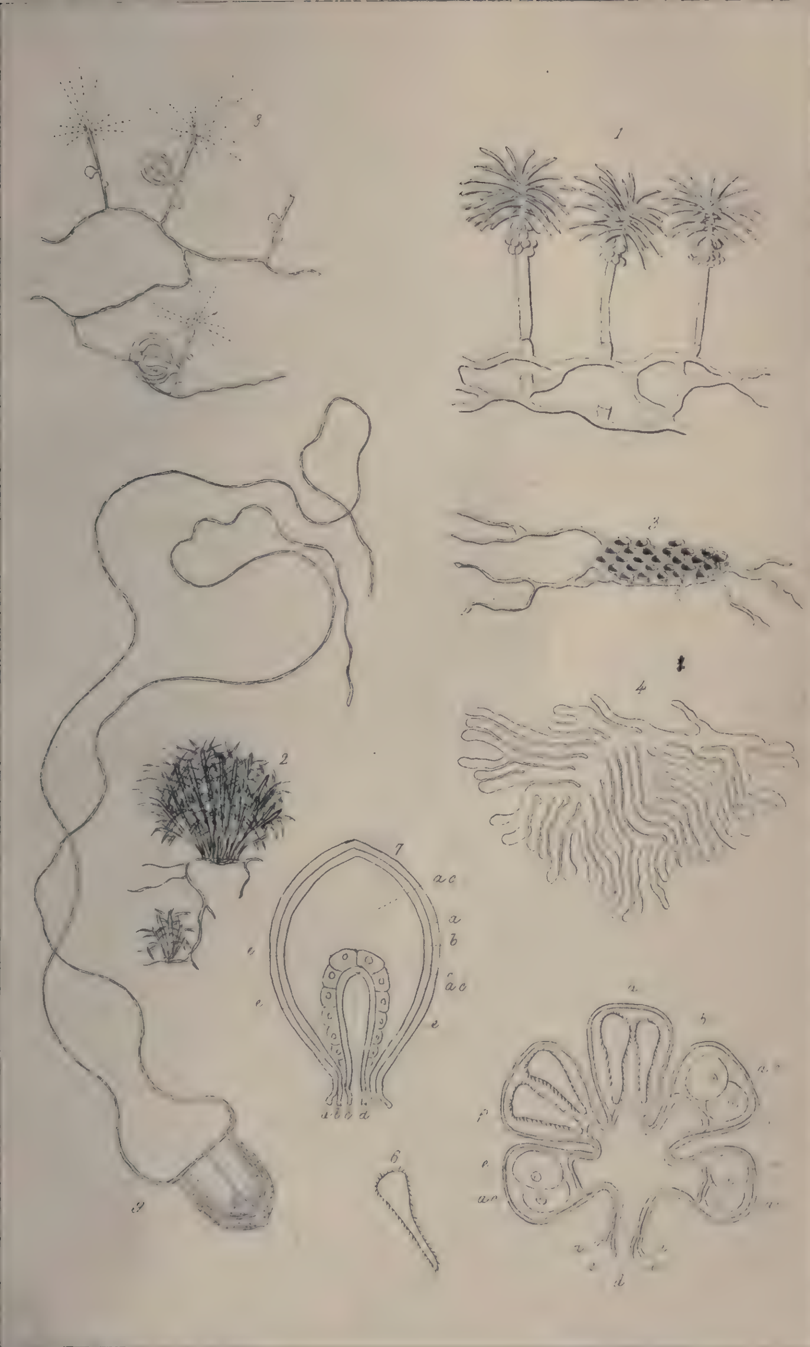
Fig. No 1.

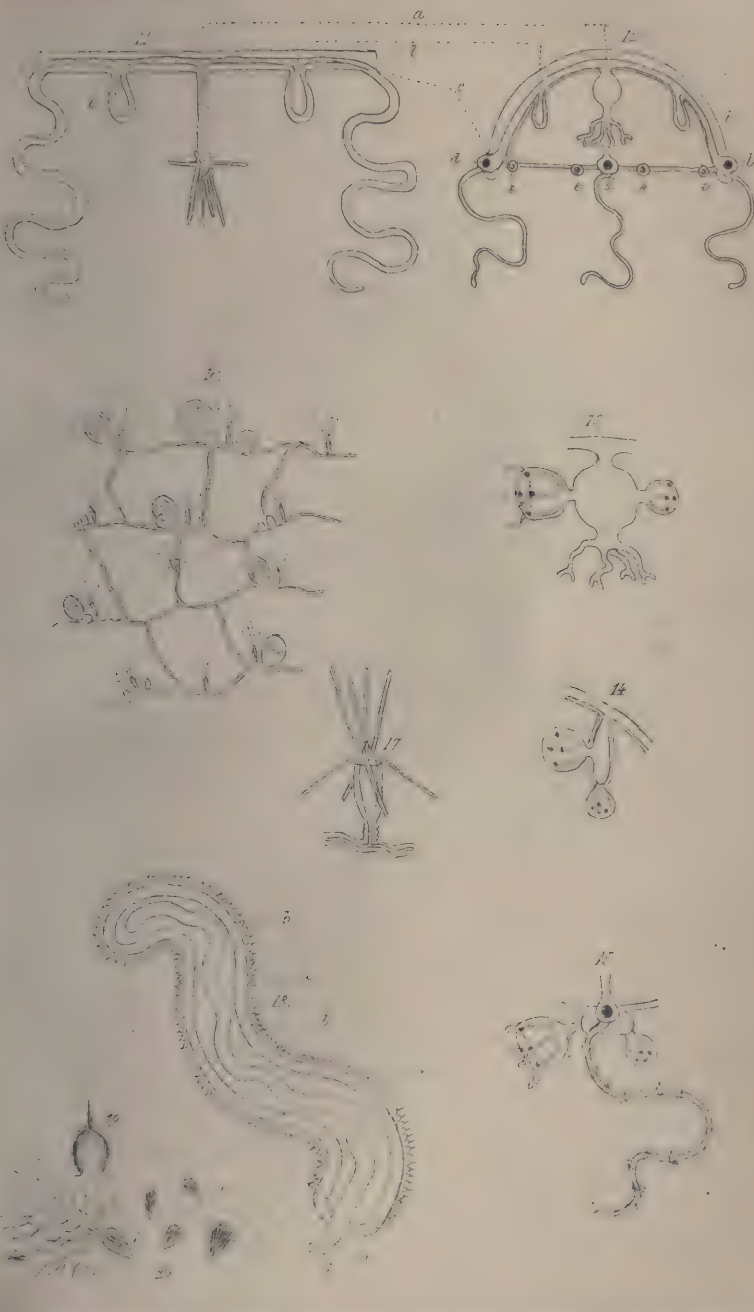
THE SOUTHERN HEMISPHERE *supposed to be divided into six equal (reckoning the bases by degrees) triangular spaces, shewing that in three is all the Land, and three contain nothing but Water, and that the main ridges of the land are towards the centre of the land spaces.*

Fig. No 2.

There are three internal and three external rents. The internal it is supposed would be filled with the molten interior, and the external, with the same more or less solidified.



Clava 1_7. Eudendrium 8_9.



T. Wright etched on stone.

udendrium 11_1

W. H. LIZARS, LITH. EDIN^R