Address to the Geological Society, delivered at the Anniversary, on the 15th of February, 1839, by the Rev. William Whewell, B.D. F.R.S. *President of the Society.*

Gentlemen,

The Reports which have been read show that the Society is still in a state of progression as to numbers, although in consequence of some oversights in preceding periods, the comparison of this year's statement with that of last year does not at first sight give an accurate view of our progress.

I venture also to speak of our pecuniary condition as prosperous, although, in the Estimates for the present year the expenses exceed the income. This excess admits of explanation: the estimated expenses include the cost of publishing a Part of our Transactions, and as this occurs only about once in two years, the whole expense ought not to be considered as belonging to one year. Stoves and other articles of furniture, expenses not likely to recur, have also inflamed the debtor side of our account.

There is one considerable article in our estimated expenses, of which payment may not be required, but from which I confess I should be sorry to see the Society liberated. I speak of the salary of our Curator. In my address last year I stated that the Council had it in contemplation to make some arrangement by which Mr. Lonsdale's labours, then far too heavy, should be lightened. This was done, I believe to the satisfaction of every one, by separating the office of Curator from that of Assistant Secretary, and to the former office Mr. Wood was appointed, with a salary of 125*l*. The Council found in Mr. Wood's zeal and knowledge every reason to congratulate themselves on the possession of such an officer; and have heard with regret that the state of his health compels him to resign his office. I trust, however, that the Council will be able to provide some means of rendering the Society's Collection useful, without allowing Mr. Lonsdale to be again burthened with a complication of duties injurious to him and inconvenient to the Society.

Although, as I have said, I look without any inquietude upon the state of our funds, it is impossible not to allow that such an aspect of them makes it necessary to attend to economy wherever it is

possible. There is one part of our establishment to which I am compelled, most reluctantly, to apply this remark; I mean, our Library and Museum. I fear that we must consider ourselves as under the necessity of confining within very narrow limits any assistance which can be rendered to those departments from our general funds. And yet we cannot look at these parts of our establishment, and especially at the Library, without seeing that they do in fact require very material additions. Our Library, which ought to possess all the best books and maps which bear upon our science, is destitute of many of them, especially of the more modern works, to an extent which we should hardly any of us find tolerable in our private libraries. This deficiency interferes materially with the utility of the Society, and is indeed inconsistent with its character. We shall, I trust, all agree that it is a state of things we ought to remedy. At no period of the history of this body has there been found wanting, when the occasion demanded it, a liberal and generous spirit among its members; and I am fully persuaded that at the present day the love of the Society has not waxed cold among the Fellows, nor have their purse-strings become rigid. It has appeared to me, that when a definite list of our deficiencies is laid before you, it will not be found difficult for each person to find in such a list some article, book or map, which it will gratify him that the Society should possess as his gift. In this or in some other way I do not doubt that we shall be able to bring up the condition of our Library to that which the time and our position require.

The Council have adjudged the Wollaston medal for the present year to Professor Ehrenberg, for his discoveries respecting fossil Infusoria and other microscopic objects contained in the materials of the earth's strata. We all recollect the astonishment with which, nearly three years ago, we received the assertion, that large masses of rock, and even whole strata, are composed of the remains of microscopic animals. This assertion, made at that time by Professor Ehrenberg, has now not only been fully confirmed and very greatly extended by him, but it has assumed the character of one of the most important and striking geological truths which have been brought to light in our time: for the connection of the present state of the earth with its condition at former periods of its history, a problem now always present to the mind of the philosophical

geologist, receives new and unexpected illustration from these researches. Of about eighty species of fossil Infusoria which have been discovered in various strata, almost the half are species which still exist in the waters: and thus these forms of life, so long overlooked as invisible specks of brute matter, have a constancy and durability through the revolutions of the earth's surface which is denied to animals of a more conspicuous size and organization. Again, we are so accustomed to receive new confirmations of our well-established geological doctrines, that the occurrence of such an event produces in us little surprise; but if this were not so, we could not avoid being struck with one feature of Prof. Ehrenberg's discoveries;—that while the microscopic contents of the more recent strata are all freshwater Infusoria, those of the chalk are bodies (*Peridinium*, *Xanthidium*, *Fucoides*,) which must, or at least can, live in the waters of the ocean. Nor has Prof. Ehrenberg been content with examining the rocks in which these objects occur. During the last two years he has been pursuing a highly interesting series of researches with the view of ascertaining in what manner these vast masses of minute animals can have been accumulated. And the result of his inquiries is*, that these creatures exist at present in such abundance, under favourable circumstances, that the difficulty disappears. In the Public Garden at Berlin he found that workmen were employed for several days in removing in wheelbarrows masses which consisted entirely of fossil Infusoria. He produced from the living animals, in masses so large as to be expressed in pounds, tripoli and polishing slate similar to the rocks from which he had originally obtained the remains of such animals; and he declares that a small rise in the price of tripoli would make it worth while to manufacture it from the living animals as an article of commerce. These results are only curious; but his speculations, founded upon these and similar facts, with respect to the formation of such rocks for example, polishing slate, the siliceous paste called *keiselguhr*, and the layers of flint in chalk, are replete with geological instruction.

As the discoveries of Prof. Ehrenberg are thus full of interest for the geological speculator, so have they been the result, not of any fortunate chance, but of great attainments, knowledge, and labour. The author of them had made that most obscure and difficult portion

* Abhandl. Kön. Ak. Wissensch. Berlin. 1838.

of natural history, the infusorial animals, his study for many years; had travelled to the shores of the Mediterranean and the Red Sea in order to observe them; and had published (in conjunction with Prof. Müller) a work far eclipsing anything which had previously appeared upon the subject. It was in consequence of his being thus prepared, that when his attention was called to the subject of fossil Infusoria, (which was done in June, 1836, by M. Fischer) he was able to produce, not loose analogies and insecure conjectures, but a clear determination of many species, many of them already familiar to him, although hardly ever seen perhaps by any other eye. The animals (for he has proved them to be animals, and not, as others had deemed them, plants) consist, in the greater number of examples, of a staff-like siliceous case, with a number of transverse markings; and these cases appear in many instances to make up vast masses by mere accumulation without any change. Whole rocks are composed of these minute cuirasses of crystal heaped together. Prof. Ehrenberg himself has examined the microscopic products of fifteen localities, and is still employed in extending his researches; and we already see researches of the same kind undertaken by others, to such an extent, as to show us that this new path of investigation will exercise a powerful influence upon the pursuits of geologists. We are sure therefore that we have acted in a manner suitable to the wishes of the honoured Donor of the medal, and to the interests of the science which we all in common seek to promote, in assigning the Wollaston medal to Prof. Ehrenberg for these discoveries.

Although it is not necessary as a ground for this adjudication, it is only justice to Prof. Ehrenberg to remark, that his services to geology are not confined to the researches which I have mentioned. His observations, made in the Red Sea, upon the growth of corals, are of great value and interest; and he was one of the distinguished band of scientific explorers who accompanied Baron von Humboldt in his expedition to the Ural Mountains. And I may further add, that even since the Council adjudged this medal, Prof. Ehrenberg has announced to the Royal Academy of Sciences of Berlin new discoveries; particularly his observations on the organic structure of chalk; on the freshwater Infusoria found near Newcastle and Edinburgh, and on the marine animalcules observed near Dublin and Gravesend; and, what cannot but give rise to curious reflections,

an account of *meteoric paper* which fell from the sky in Courland in 1686, and was found to be composed of Confervæ and Infusoria.

I now proceed to notice some of the most conspicuous names, both among our own countrymen and foreigners, which have been removed by death from our lists since last year.

In Sir Abraham Hume the Society has lost a member who was at all times one of its most strenuous friends and most liberal supporters, and especially in its earliest periods, when such aid was of most value. Indeed he may in a peculiar manner be considered as one of the Founders of the Society. English geology, as is well known, evolved itself out of the cultivation of mineralogy,—a study which was in no small degree promoted, at one time, by the fame of the mineralogical collections of Sir Abraham Hume and others. The Count de Bournon, exiled by the French revolution in 1790, brought to England new and striking views of crystallography, resembling those which Haüy was unfolding in France; and was employed to arrange and describe the mineralogical collections of Sir John St. Aubyn and Mr. Greville, and especially the collection of diamonds of Sir Abraham Hume, of which a description, illustrated with plates, was published in 1816. Some years before this period a few lovers of mineralogy met at stated times at the house of Dr. Babington, whose influence in preparing the way for the formation of this Society was mentioned with just acknowledgement in the President's Address, in 1834, by Mr. Greenough; and certainly he, more fitly perhaps than any other person, could speak of the merits and services of his fellow-labourers. Of the number of these Sir Abraham Hume was one; although not, I believe, one of those who showed their zeal for the pursuits which associated them by holding their meetings at the hour of seven in the morning, the only time of the day which Dr. Babington's professional engagements allowed him to devote to social enjoyments of this nature.

Out of the meetings to which I refer this Society more immediately sprung. The connection of mineralogy with geology is somewhat of the nature of that of the nurse with the healthy child born to rank and fortune. The foster-mother, without being even connected by any close natural relationship with her charge, supplies it nutriment in its earliest years, and supports it in its first infantine steps; but is destined, it may be, to be afterwards left in

comparative obscurity by the growth and progress of her vigorous nursling. Yet though geology now seeks more various and savoury food from other quarters, she can never cease to look back with regard and gratitude to the lap in which she first sat, and the hands that supplied her early wants. And our warm acknowledgments must on all due occasions be paid to those who zealously cultivated mineralogy, when geology, as we now understand the term, hardly existed; and who, when the nobler and more expansive science came before them, freely and gladly transferred to that their zeal and their munificence.

The spirit which prevailed in the infancy of this Society, and to which the Society owed its permanent existence, was one which did not shrink from difficulties and sacrifices; and among the persons who were animated by this spirit Sir Abraham Hume was eminent; his purse and his exertions being always at the service of the body. He gave his labours also to the Society by taking the office of Vice-President, which he discharged with diligence from 1809 to 1813. He died in March last at the great age of ninety, being then the oldest person both in this and in the Royal Society.

Mr. Benjamin Bevan was a civil engineer, and throughout his life showed a great love of science, and considerable power of promoting its purposes. He instituted various researches, theoretical and practical, on the strength of materials; and it was he who first proved by experiment the curious proposition, that the Modulus of Elasticity of water and of ice is the same. In 1821 he wrote a letter to the secretary of this Society, recommending that the form of the surface of this country should be determined by barometrical measurements of the heights of a great number of points in it,—the barometer which was to be used as a standard being kept in London. Mr. Bevan and Mr. Webster were commissioned to procure a barometer, and Dr. Wollaston recommended one of Carey's barometers, but it does not appear that any further steps were taken. I may remark that recent researches have further confirmed the wisdom of Mr. Bevan's suggestion, that heights should be measured, as all other measurements are made, from some fixed *conventional* standard, instead of incurring the vagueness and inconsistency which result from assuming the existence of a natural standard, such as the level of the sea.

Nathaniel John Winch was born at Hampton Court in the year 1769, and after a voyage into the Mediterranean, and travels in various countries in Europe, settled at Newcastle-upon-Tyne as a merchant. He had early paid great attention to botany, which he continued to cultivate during a long life, and kept up a correspondence with all the leading botanists in Europe. He was one of the earliest, and always one of the most active members of the Literary and Philosophical Society of Newcastle; and, in conjunction with a few of his friends, gave to that town a scientific and cultured character, which still distinguishes it. He was one of the honorary members of this Society; and contributed to its meetings, in 1814, "Observations on the Geology of Northumberland and Durham," and in 1816, "Observations on the Eastern Part of Yorkshire,"* which were printed in the fourth and fifth volumes of our Transactions. In these he stated his object to be to combine with his own observations much interesting information on the subjects of the quarries, and coal and lead mines, of those districts, which had long been accumulating, and was widely diffused among the professional conductors of the mines. And these memoirs, though not containing much of originality in their views and researches, were, at the time, of considerable utility. He died May 5th, 1838, and, by his will, left to this Society a very considerable and valuable mineralogical collection, now in our Museum.

Mr. William Salmond, of York, was one of the persons who was most zealously and actively engaged in the examination of the celebrated Kirkdale Cavern. He measured and explored new branches of the cave in addition to those first opened, and made large collections of the teeth and bones, from which he sent specimens to the Royal Institution of London, and to Cuvier at Paris. The bulk of

* Besides these papers, Mr. Winch published: "The Botanist's Guide through the Counties of Northumberland and Durham. By N. J. Winch, J. Thornhill, and R. Waugh." 2 vols. 1805.—"Flora of Northumberland and Durham." In the Transactions of the Newcastle Natural History Society, vol. 2.—"An Essay on the Geographical Distribution of Plants through the Counties of Northumberland, Durham, and Cumberland." First edition, 1820; second edition, 1825.—"Contributions to the Flora of Cumberland." 1833.—"Addenda to the Flora of Northumberland and Durham." 1836.

his collection was deposited in the Philosophical Society at York, then newly established.

I now proceed to notice our deceased Foreign Members.

François-Dominique de Reynaud, Comte de Montlosier, was born at Clermont in Auvergne, April the 16th, 1755, the year of the celebrated earthquake of Lisbon. He was the youngest of twelve children of a family of the smaller nobility of that province, and was remarkable at an early age for the zeal with which he pursued various branches of science and literature.

Count Montlosier must ever be considered as one of the most striking writers in that great controversy respecting the origin of basaltic rocks, which occupied the attention of mineralogists during the latter half of the last century; and to which, in so large a degree, the progress and present state of geology are to be ascribed. The theory of the extinct volcanos of Auvergne, the subject of his researches, was the speculation which gave the main impulse to scientific curiosity on this point. It is true that he was not the originator of the opinions which he so ably expounded. Guettard, in 1751, had seen, vaguely and imperfectly, that which it now appears so impossible not to see, the evidences of igneous origin in the rocks of that district: and the elder Desmarest, whose examination of them began in 1763, had made that classification of them, which is the basis, and indeed the main substance, of the views still entertained with regard to the structure of that most instructive region. His map of the district, published in 1774 (in the Transactions of the Academy of Paris *for* 1771, according to a bad habit of that body still prevailing), exhibits the distinction of modern currents of lava, ancient currents, and rocks fused in the places where they now are, which distinction supplies a key to the most extraordinary phænomena, while it reveals to us a history more wonderful still. But striking and persuasive as this view was, and fitted, apparently, to carry with it universal conviction, the theory which it implied, collected, as it seemed at the time, from one or two obscure spots in Europe, was for a while resisted and almost borne down by the opposite doctrine of the aqueous origin of basalt; which came from the school of Freyberg, recommended by the power of a connected and comprehensive system,—a power in science so mighty for good and for evil. Montlosier's Essay on the Volcanos of Auvergne, which ap-

peared first in 1788, was, however, not written with any direct reference to this controversy, but was rather the exposition of the clear and lively views of an acute and sagacious man, writing from the fullness of a perfect acquaintance with the country which he described, in which, indeed, his own estate and abode lay. In its main scheme, although Desmarest's is mentioned with just praise*, the object of this Essay is to criticise and correct a work of M. Le Grand d'Aussy, entitled *Voyage en Auvergne*. But as the main additions to sound theory which this work contains, (a point which here concerns us far more than its occasion and temporary effect), we may, I think, note the mode in which he traces in detail the effects which the more recent currents of lava (those which follow the causes of the existing valleys) must have produced upon the courses of rivers and the position of lakes; and the idea, at that time a very bold and, I believe, a novel one, that lofty insulated ridges and pinnacles of basalt, which tower over the valleys, have been cut into their present form by the long-continued action of fluviatile waters, aided by a configuration of the surface very different from the present. The striking and vivid pictures which Montlosier draws of such occurrences, are to the present day singularly instructing and convincing to those who look at that region with the geologist's eye. After publishing this essay, M. Montlosier, a man of varied and commanding talents, became involved in the political struggles of his time, and was an active member of the National Assembly, to which he was sent as Deputy of the Noblesse of Auvergne. In his place there he resisted in vain the proposals for the spoliation of the clergy; and one speech of his on this subject was very celebrated. After witnessing some of the changes which his unhappy country had then to suffer, he became an exile, and resided in London, where for some years he was the editor of the *Courier Français*, a royalist journal. Under the empire, he returned to France, and was employed in the Foreign Office of the Ministry, but recovered little of his property except a portion of a mountain, which was too ungrateful a soil to find another purchaser. The situation however could not but be congenial to his geological feelings; for

* After mentioning Guettard, he says, "Les mémoires de M. Desmarest, publiés quelques années après, entraînèrent tout-à-fait l'opinion publique." (p. 20.)

his habitation was in the extinct crater of the Puys de Vaches. The traveller, in approaching the door of the philosopher of Randane, had to wade through scoriæ and ashes; and from the deep basin in which his house stood, a torrent of lava, still rugged and covered with cinders, has poured down the valley, and at the distance of a league, has formed a dike and barred up the waters which form the lake of Aidat;—a spot celebrated by Sidonius Apollinaris, Bishop of Clermont in the fifth century, as the seat of his own beautiful residence, under the name of Avitacus. It is curious to remark that Sidonius does not overlook the resemblance between his own mountain and Vesuvius:

> "Æmula Baiano tolluntur culmina cono,
> Parque cothurnato vertice fulget apex."

In this most appropriate abode M. de Montlosier was, in his old age, visited at different times by several distinguished English geologists, some of whom are now present; and invariably delighted them with his unfading interest in the geology of his own region, his hospitable reception, and I may add, his lofty and vigorous presence, according well with his frank and chivalrous demeanour. His ardour of character had shown itself in early age: "From my first youth," thus his Essay opens, "I occupied myself with the natural history of my province, in spite of repulse and ridicule." The same spirit involved him in other struggles to the end of his life; and, indeed, we may almost say, beyond it. He took a prominent part in the political controversies of his day; and few works on such subjects, which appeared in France in modern times, produced a greater fermentation than his "Mémoire à consulter" on the subject of the Jesuits. In this work he maintained that the position of the Jesuits in France was dangerous and illegal; and he must be considered as the originator of that movement in consequence of which their body was, a few years later, suppressed by the government. The expression of his opinions respecting the conduct and influence of the clergy of his country was condemned by the ecclesiastical authorities, and was deemed by them of a nature to exclude him from that recognition of his being a son of the Catholic church, which is implied by the performance of the funeral rite according to its ordinances. This, however, did not prevent the inhabitants of the neighbourhood and the military stationed at Clermont from showing the regard which his

intercourse with them had inspired, by attending his sepulture in great numbers. He was buried in a spot previously selected by himself, in the crater of the extinct volcano in which his abode was, in the middle of the scenes which he had from his earliest years loved and studied, and taught others to feel a deep interest in. He died at the age of 83, on his way to Paris in order to take his seat in the Chamber of Peers, of which he was a member*.

Anselme-Gaëtan Desmarest, honorary member of the Royal Academy of Medicine, and Professor of Zoology at the Royal Veterinary College of Alfort, was the son of Nicolas Desmarest, who has just been mentioned as the predecessor of Montlosier in his theory of the volcanic origin of Auvergne. The son also employed himself upon the same district; and published an enlarged and improved edition of his father's map of Auvergne;—a work which is still spoken of with admiration, for its fidelity and skilful construction, by all who explore that country. But the labours of the younger Desmarest were principally bestowed upon the other parts of natural history. We possess in our Library, extracted from various journals, and presented us by the author, his "Notes on the impressions of marine bodies in the strata of Montmartre," published in 1809; his "Memoir on the Gyrogonite," published in 1810; to which he added, in 1812, the recognition of the analogy of this fossil with the fruit of the Chara, pointed out by his brother-in-law M. Léman; his review of a work by M. Daudebard de Ferrussac, on the Fossils of Freshwater Formations, in 1813; his memoir on Two Genera of Fossil Chambered Shells, in 1817; and his "Natural History of the Proper Fossil Crustaceans," published in 1822 along with M. Brongniart's "Natural History of Fossil Trilobites." In the "Dictionaire d'Histoire Naturelle," the article Ma-

* Besides his "Essay on the Extinct Volcanoes of Auvergne," M. de Montlosier was the author of the following works: "Memoire à consulter sur un Système Religieux et Politique tendant à renverser la Religion, la Société et le Trône" (1826). "Dénonciation aux Cours Royales rélativement au Système Religieux et Politique signalé dans le Mémoire à consulter," (1826). "Mémoires de M. le Comte de Montlosier sur la Révolution Française, le Consulat, l'Empire, et les principaux Evènements qui ont suivis 1755-1830." Of this work two volumes have appeared, which bring the narrative down to the author's quitting the National Assembly in 1790.

locostracés, which contains a complete account and classification of Crustaceans, is by M. Desmarest, with others on the same subject. In this work all the articles on Crustaceans had originally been assigned to Dr. Leach; but when the lamented illness of that distinguished naturalist prevented his finishing this task, it was committed to Desmarest, who carefully studied the labours of his predecessor; and, with most laudable industry and self-denial, made it his business to follow his method as closely as possible. He also published a separate work on Crustaceans in 1825.

Count Kaspar Sternberg was one of those persons, so valuable in every country, who employ the advantages of wealth and rank in the cultivation and encouragement of science. He belonged to a younger branch of one of the best and oldest families in Bohemia; and was closely connected with the persons of most elevated station in that country. He was born the 6th of January, 1761, and received a distinguished education at Prague; not only, as was then common among the Bohemian nobility, through private tutors, but by following the public course of the university. He was created Canon of the Chapter of the metropolitan church at Ratisbon, which, obliging him to receive the lower degree of holy orders, bound him to celibacy. At Ratisbon, then a considerable place, and the seat of the Diet of the German empire, he formed friendships with several eminent persons, and especially with Count Bray (afterwards Bavarian minister at various courts), a man of letters, and a distinguished botanist. Count Sternberg also cultivated botany, and became an active member of the Botanical Society of Ratisbon. During the time that Germany was a prey to the miseries of war, he retired to his hereditary country seat Brzezina, in the circle of Pilsen, in the north-western part of Bohemia. Here his attention was early drawn to the coal formation, of which mineral he possessed an extensive estate at Radnitz. He soon formed the intention of publishing representations of the fossil vegetables belonging to the coal strata. These had already begun to excite the attention of geologists. Some of these works, containing notices on such subjects, preceded the existence of sound geology, as the *Herbarium Diluvianum* of Scheuchzer, the *Sylva Subterranea* of Beutinger, and the *Lapis Diluvii Testis* of Knorr*. At the beginning of the present

* To the earlier works on this subject we may add Martin's *Petrificata*

century, Faujas de St. Fond had published in the Annales du Muséum some impressions of leaves, not indeed belonging to the coal, but to a later formation. These impressions were examined and determined by Count Sternberg, in the Botanical Journal of Ratisbon, in 1803. In the following year appeared the first truly scientific work on this subject, the "*Flora der Vorwelt*" of Schlotheim, in which the great problem which was supposed to demand a solution was, Whether the vegetables of which the traces are thus exhibited belong to existing or to extinct kinds? Count Sternberg was in Paris when he received the work of Schlotheim, and he studied it carefully by the aid of the collections which exist in that metropolis. He published in the Annales du Muséum a notice on the analogies of these plants, but concluded with observing, that a greater mass of facts was requisite; and that, these once collected, the general views which belong to the subject would come out of themselves.

Bearing in mind this remark of his own, when fortune, after the storming of Ratisbon in 1809, set him down in the midst of the great coal formations of Bohemia, he proceeded forthwith to manage the working of his mines, so as to preserve as much as possible the most remarkable impressions of fossils. Combining his own specimens with those found in other places, he began to publish, in 1820, his "Essay towards a Geognostic-botanical Representation of the Flora of the Pre-existing World." In this work he not only gave a great number of very beautiful coloured engravings of vegetable fossils, but also attempted a systematic classification of them. But he stated, in the first portion of his work*, that the problems, important alike for botany and geology, which offered themselves, could only be solved by combined labours on a common plan; and after mentioning the various European Societies to which he looked for assistance (among which he includes this Society), he adds, "Bohemia and the hereditary states of the Austrian empire, I am ready, with some friends of science, to make the subject of continued investigation." The specimens of which he published representations, with many more, formed the Count's collection at his castle of Brzezina; but he declared in the outset, that as soon as the National Bo-

Derbiensia, published 1809; and Parkinson's Organic Remains (1804), which contains many plates of vegetables.

* *Erster Heft*, p. 16.

hemian Museum at Prague was provided with the means of receiving and displaying this collection, the whole should be transferred from Brzezina to the capital. This was afterwards done; and in this and other ways he was one of the principal founders of the Museum at Prague. He also gave notice, that while the collection continued in his own residence, it was open to the inspection of every lover of science, even in the absence of the Count himself.

The publication of Sternberg's *Flora der Vorwelt* went on till 1825, after which it was discontinued till 1838, when two parts appeared, terminating the work. In this last publication he states that he is compelled to give up this undertaking, having been in a great measure deprived of sight for two years, so that he was obliged to devolve the greater part of such labours upon MM. Corda and Presl. His hearing also failed him. He adds, however, that though thus no longer able to pursue the path which he has trodden for twenty years, he shall not fail to render to the science, of which he was one of the founders, any service which may be in his power. This publication was the crowning labour of his life, for he did not long survive it; he retained, however, to the last the elasticity and activity of his mind. He died very suddenly at his country seat already mentioned, on the 20th of December, 1838, being carried off by apoplexy in his 78th year.

In his own country his influence was highly salutary: he directed his attention especially to the improvement of the national education; and we cannot be surprised at finding such a person very soon at the head of nearly all the institutions for literary and public purposes. He founded the National Museum of Bohemia, of which he was the President; gave to it his library and his various collections, and further enriched it at various periods of his life. He was, indeed, zealous in all that concerned Bohemian nationality, and was an accomplished master of the language and literature of his country: since his death I am assured that there is hardly one Bohemian of any class who does not mourn for him as for a most respected benefactor. Throughout Germany, he was looked to by all who felt an interest in science with a respect and regard which he well merited. The emperor Francis held him in the highest esteem; he gave him the title of Privy Councillor, and the Grand Cross of St. Leopold, held in that monarchy as a distinguished honour.

In the preceding sketch I have mentioned Schlotheim as one of

the predecessors of Count Sternberg in fossil botany. Although this writer died in 1832, and was an honorary member of this Society, he has never been noticed in the annual address; I may therefore here add a few words with reference to him. Baron E. F. von Schlotheim was Privy Councillor and President of the Chamber at the court of Gotha, and his collection of Petrifactions has long been celebrated throughout Germany. Besides his Flora of a Former World, or Descriptions of remarkable Impressions of Plants, which appeared in 1804, he published, in 1820, 'Petrifactenkunde, or the Science of Petrifactions according to its present condition, illustrated by the Description of a Collection of petrified and fossil remains of the animal and vegetable kingdom of a former world.' And in 1822 and 1823 he published Appendixes to this work. His collection was also further made known by articles in Leonhard's Mineralogical Pocket Book and in the Isis. After his death a new description of this collection was announced, but whether it appeared I am not able to say. Schlotheim's introduction to his account of his collection contains some extensive geological views.

It is only justice to M. de Schlotheim to add here what is said of him by M. Adolphe Brogniart, whose own labours on fossil vegetables have been of such inestimable value to the geologist, and are every year increasing in interest. "Almost half a century," he says, "elapsed, during which no important work appeared on this subject. It was not till 1804 that the 'Flora of the Ancient World,' by M. de Schlotheim, again turned the attention of naturalists to this branch of science. More perfect figures, descriptions given in detail and constructed with the precision of style which belongs to botany, and moreover some attempts at comparison with living vegetables, showed that this part of natural history was susceptible of being treated like the other branches of science: and we may say, that if the author had established a nomenclature for the vegetables which he described, his work would have become the basis of all the succeeding labours on the same subject."

In attempting a sketch of the subjects which have occupied the attention of the Society during the year, I should wish to retain that

distribution of the science of geology according to which I arranged my remarks in the Address which I had last year the honour of reading to the Society; I mean the primary division into *Descriptive Geology* and *Geological Dynamics*; the former implying a description of the rocks of the earth's surface according to an established classification of strata and formations; and the latter dealing with the study of those general laws and causes of change by which we hope to understand and account for the facts which Descriptive Geology brings before us;—in short, the present condition and the past history of the earth's crust. But as the laws of permanence and change, with regard to organized beings, differ very widely from the dynamics of brute matter, we may conveniently make a separate study of the relations of organic life to which geology conducts us, and may mark it by the name *Palæontology*, by which it is commonly known. I will add that it still appears to me convenient, for the present, to divide Descriptive Geology into two portions,—the Home circuit, in which the order of superposition has already been established with great continuity and detail; and the Foreign region, in which we are only just beginning to trace such an order. I shall also, as before, take the ascending order of strata. According to this arrangement of the science, I shall venture to bring to your recollection a few of the points to which our attention has mainly been called during the past year.

DESCRIPTIVE GEOLOGY.

1. *Home (North European) Geology.*—When I stated that Descriptive Geology has for its task the reference of the rocks of some portion of the earth's surface to an established classification into strata and formations, it was implied, that the more common employment of the descriptive geologist must be to refer the rocks which he examines to some classes *already fixed and recognized*; but it could hardly fail to occur to you, that from time to time the leaders in this study will be called upon to execute a more weighty and elevated office, in framing the classifications which other observers are to apply; in drawing the great lines of division and subdivision which fix the form of the subject; in setting up the type with which examples are to be compared; in constructing the language in which

others are to narrate their facts. Steps of this kind have formed, and must form, the great epochs in the progress of all sciences of classification, and especially in ours; and I need not remind you how great the importance and the influence of such steps amongst you have been. To pronounce at once upon the success of such steps must always be in some degree hazardous; since their success is in fact this, that they influence permanently and powerfully the researches, descriptions, and speculations of future writers; and there are few of us who can pretend to the foresight which might enable us to say, in any special case, how far this will be so. Yet the great works of Messrs. Murchison and Sedgwick, tending to the establishment of a classification of the strata below the old red sandstone (works which, on all accounts, we must consider as a joint undertaking), appear already to offer an augury which can hardly be doubtful, of this influence and permanence. Mr. Murchison's appellation of the "Silurian System" has already been adopted by MM. Elie de Beaumont and Dufresnoy, who have given it currency on the continent: M. Boué and M. de Verneuil announce the diffusion of "Silurian" rocks in Servia and the adjacent parts of Turkey in Europe; our own members, Mr. Hamilton and Mr. Strickland, have extended their range to the Thracian Bosphorus; M. Forchhammer, of Copenhagen, visited the "Silurian region" to endeavour to recognize the rocks of Scandinavia; and MM. Omalius D'Halloy and Dumont have just explored it, to establish a parallel between its deposits and those of Belgium. It will be observed that some of the districts thus mentioned are out of the limits of our geological Home circuit; and if the identification be really and permanently established in these cases, will extend the limits within which the parallelism of geological series can be asserted: and this is, in effect, what we have a right to look for, sooner or later, in the progress of geological science. As we must be careful not to apply our domestic types without modification to other regions, so must we take care not to despair of modifying our scheme, so that it shall be far more extensively applicable than it at first appeared to be. Of this progress of things examples are too obvious and too recent to require to be pointed out.

The labours of Professor Sedgwick refer to the "Cambrian System," which lies beneath the Silurian System, occupying much of North

Wales, Cumberland, and a great part of Scotland; while the Silurian System spreads over a great part of South Wales and the adjoining English counties. The classification of the rocks of this portion of our island to which Professor Sedgwick has been led, though laid before you only at a recent meeting, is the fruit of the vigorous and obstinate struggles of many years, to mould into system a portion of geology which appeared almost too refractory for the philosopher's hands; and which Professor Sedgwick grappled with the more resolutely, in proportion as others shrank away from the task perplexed and wearied. I need not attempt any detailed view of his system: his First Class of Primary Stratified Rocks occupies the Highlands of Scotland and the Hebrides, and appears in Anglesea and Caernarvonshire; the crystalline slates of Skiddaw Forest, and the Upper Skiddaw slate series come next. Above these is his Second Class, or Cambrian and Silurian System. The Cambrian is divided into Lower and Upper Cambrian, of which the former includes all the Welsh series under the Bala limestone; the two great groups of green roofing slate and porphyry on the north and south sides of the mineral axis of the Cumbrian mountains (of which groups the position had previously been misunderstood), and parts of Cornwall and South Devon. The Upper Cambrian System contains a large part of the Lammermuir chain; a part of the Cumbrian hills, commencing with the calcareous slates of Coniston and Windermere; the system of the Berwyns and South Wales; all the North Devon, and a part of the South Devon and Cornish series. Ascending thus through a series of formations distinguished and reduced to order by the indefatigable exertions and wide views of Professor Sedgwick, we arrive at the Silurian system; and here we must seek our subdivisions from the rich results of the labours of Mr. Murchison. These subdivisions were published in the summer of 1833. Like the Cambrian, the Silurian is divided into a Lower and an Upper System, the former including the Llandeilo flags and the Caradoc sandstones; the Upper Silurian Rocks being the Wenlock shale and limestone, the Lower Ludlow, the Aymestry limestone, and the Upper Ludlow, which finally conducts us to the Tilestones or bottom beds of the Old Red Sandstone.

That these various series of Cambrian and Silurian rocks are really superposed on one another; that they are justly separated into

these groups; and that the smaller groups are truly of a subordinate nature, divided by lines less broad than those which bound the great series of formations;—these are points, of which the evidence must be sought in the works to which I refer. The evidence adduced by Prof. Sedgwick is mainly to be found in the great fact of superposition, supported by the circumstances of dip, strike, cleavage, mineral character, and all the great incidents of mountain masses. To proofs of this kind Mr. Murchison is able to add the testimony of organic fossils, of which a vast and most instructive collection is figured in his work. These fossils of the Silurian system, amounting in all to about 350 species, are essentially distinct from those of the Carboniferous System and Old Red Sandstone. This being so, the establishment of these great divisions is supported by that geological evidence which properly belongs to the subject.

In detecting order and system among the monuments of the most obscure and remote periods of the earth's history, it may easily be supposed that it has been necessary to employ and to improve all the best methods of geological investigation. Prof. Sedgwick's classification of the oldest rocks which form the surface of this island has of course been obtained by a careful attention to the position and superposition of the mineral masses, and by tracing the geographical continuity of the strata, almost mile by mile, from Cape Wrath to the Land's End. In this manner he has connected the rocks of Scotland with those of Cumberland; these again with those of Wales; and the Welsh series, though more obscurely, with that of Devonshire and Cornwall. In this survey he has constantly kept before his eyes a distinction, known indeed before, but never before so carefully and systematically employed, between the slaty cleavage of rocks and their stratification; for the directions of these two planes, though each wonderfully persistent over large tracts, never, except by accident, coincide. He has taken for his main guide the direction of the strata, or, as it is called, the *strike* of the beds; and in such a course, the theory of Elie de Beaumont respecting the parallelism of contemporaneous elevations, whether true or false, could not fail to give an additional interest to geological researches, conducted on so large a scale as those of Prof. Sedgwick. Mr. Murchison's mode of investigation may be described thus: that he has applied, for the first time, to the rocks below the Old Red Sand-

stone, the method of classification previously employed with so much success for the Oolites. It is truly remarkable, that Nature has placed in this our corner of the world, series, probably the most complete which exist, of both these groups of strata; and as the Oolites of England have long been the type of that portion of European geology, the Silurians of Wales may perhaps soon be recognized as the standard members of a still more extensive range of deposits. As if Nature wished to imitate our geological maps, she has placed in the corner of Europe our island, containing an *Index Series* of European formations in full detail.

The Carboniferous, Old Red, Silurian and Cambrian systems have, by many writers, up to the present time, been all comprehended in the term "transition rocks", so far as that term has been used with any definite application at all. The analysis of this vague group into these distinct portions removes the confusion and perplexity which have hitherto prevailed in this province of geology. Prof. Sedgwick has further proposed to apply the term *Palæozoic*, and Mr. Murchison that of *Protozoic*, to the rocks which constitute the Cambrian and Silurian systems.

How far these appellations are useful, we shall see when we have had speculations presented to us in which they are familiarly used; for necessity is the best apology, and convenience the best rule, of innovations in scientific language. In the names applied to the members of the Silurian system, Mr. Murchison, following those examples of geological nomenclature which have been most clearly understood and most generally adopted, has borrowed his terms from localities in which standard types of each stratum occur. If the Silurian system be as exclusively diffused as some indications seem to imply, we may find the Ludlow Rocks in Scandinavia, and the Caradoc Sandstone even in Patagonia. Whether a like identification of the more ancient rocks of the Cambrian series with the lowest formations of other countries be possible, may perhaps be (for the present) more doubtful.

I have spoken of Mr. Murchison's work as if it had formed part of our Proceedings, as indeed almost every part of it has done, although it now appears in a separate form. And I will add, that it is impossible not to look with pleasure upon the form in which the work appears, enriched as it is in the most liberal manner, with

every illustration, map and section, picturesque view and well-marked fossil, which can aid in bringing vividly before the reader all the instructive and interesting features of the formations there described. The book must be looked upon as an admirable example of the sober and useful splendour which may grace a geological monograph.

Having been tempted to dwell so long on this subject from my conviction of its importance, I must the more rapidly proceed with the remainder of my survey. Mr. Bowman sent us, "Notes on a small patch of Silurian Rocks to the west of Abergele." In this investigation, which is interesting to us as the first application of Mr. Murchison's Silurian System, the author found strata of which some could be, by means of fossils, identified with the Ludlow rocks. Mr. Malcolmson has, by the remains of fossil fishes, shown that the calciferous conglomerate of Elgin represents the old red sandstone of Clashbinnie, as the Rev. G. Gordon had already supposed. Finally, proceeding to higher strata, we have to notice a trait of the fossil history of the coal strata near Bolton-le-Moors, contributed by Dr. Black. A stem of a tree thirty feet long, and inclined at an angle of 18° in a direction opposite to the strata, was discovered, having upon it a Sternbergia, about an inch in diameter, extending the whole length of the stem, which had been, while living, a parasite plant, like the mighty existing creepers of the tropical regions.

The most curious addition to our fossil characters of strata, are the footsteps discovered on the surface of beds of the new red sandstone. It is well known that several years ago such marks were discovered at Corncockle Muir, in Dumfries-shire. Since that time similar discoveries have been made at various places, and especially in 1834, in the quarries of Hesseberg near Hilbergshausen; and to the animal which had produced the impressions then discovered, the name of Chirotherium was provisionally applied by Professor Kaup. In the quarries of Storeton Hill, in the peninsula of Worrall, between the Mersey and the Dee, marks were discovered strongly resembling the footsteps of the Chirotherium of Kaup: these were described by a committee of the Natural History Society of Liverpool, and drawn by J. Cunningham, Esq. Mr. James Yates has also described footsteps of four other animals from the same quarries; and Sir Philip Egerton has given us a description

of truly gigantic footsteps of the same kind, which he terms the *Chirotherium Herculis*.

Mr. Strickland gave us a notice of some remarkable dikes of calcareous grit which occur in the lias schist at Ethie in Ross-shire, and which had already been remarked by Mr. Murchison, in his examination of the coast of Scotland, in 1826. They appear not to have been injected from below, but filled in from above.

Mr. Williamson's "View of the Distribution of Organic Remains in part of the Oolitic Series on the Coast of Yorkshire," was the welcome continuation of a labour of the same kind already executed for the lower portions of the series, and promised to be continued for the upper. Among the contributions to the fossil history of the oolites, we must also place Dr. Buckland's "Discovery of the fossil wing of an unknown Neuropterous Insect in the Stonesfield slate." This stratum, the Stonesfield slate, has, during the past years, occupied the Society in the consideration of its fossils in no small degree; but the speculations thus suggested belong to Palæontology rather than Descriptive Geology. Mr. Murchison's notice of a specimen of the Oar's rock, which stands in the sea off the coast of Sussex, nine miles south of Little Hampton, shows it to agree with some of the rocks in the greensand or Portland beds; and its thus belonging to the strata below the chalk falls in with the remark of its occurring between the parallels of disturbance which traverse the Wealden of Sussex on the north, and the Isle of Wight on the south; for these disturbances and other facts agree well with the notion of protruded strata between. The wealden strata themselves have been observed by Mr. Malcolmson, at Linksfield, near Elgin. It is remarkable, that these strata had already, very unexpectedly, been found by Messrs. Murchison and Sedgwick in the Isle of Skye.

I have also to notice Dr. Buckland's account of the discovery of fossil fishes in the Bagshot Sands at Goldworth Hill, near Guilford. As these fossils resemble those of the London clay, Mr. Lyell's opinion that the Bagshot Sands were deposited during the eocene period is strongly confirmed.

The freshwater beds of the Isle of Wight, which had already supplied specimens of some of the Pachydermata of the Paris basin, have furnished an additional supply of rich fossils, which have been

examined by Mr. Owen. He has found them to contain bones of four species of Palæotherium, and two species of Amplotherium; also a jaw of the Chæropotamus, a fossil genus established by Cuvier; and another jaw closely resembling that of a Musk Deer, which Mr. Owen refers to the genus Dicobune, a genus also established by Cuvier upon the fossils of the Paris basin. Such discoveries, falling in with the conclusions obtained by the researches of previous philosophers respecting the tertiary period of the earth's history, and supplying what they left imperfect, cannot fail to give us great confidence in the results of those investigations, and to enhance our admiration of the sagacity which opened to us this path of discovery.

Dr. Mitchell gave an account of his attempts to trace the drift from the chalk and strata below the chalk, as it exists in the counties of Norfolk, Suffolk, Essex, Cambridge, Huntingdon, Bedford, Hertford, and Middlesex. This drift I had occasion to notice in my Address last year, in reference to Mr. Clarke's elaborate geological survey of Suffolk; and I then stated that this diluvial deposit is known in the neighbourhood of Cambridge by the name of *brown clay*. Dr. Mitchell has shown that this deposit is of greater extent than we were before aware. But still to determine with precision its principal masses, total extent, and local modifications, would be a valuable service to the geology of the eastern part of our island.

As my order requires me to take the igneous after the sedimentary rocks, I must here notice Dr. Fleming's "Remarks on the Trap Rocks of Fife," which he distinguishes into three epochs;—those of the eastern extremity of the oolites, which are variously associated with the old red sandstone;—those which run from St. Andrew's to Stirling, which were produced after the coal-measures;—and those which occur along the shores of the Forth, which occur in the higher coal-measures.

2. *Foreign (South European and Trans-European) Geology.*—In the survey of the progress of our labours which I offered to your notice last year, I stated, that in proceeding beyond the Alps, and I might have added the Pyrenees, we no longer find that multiplied series of strata, so remarkably continuous and similar, when their identity is properly traced, with which we have been familiar in our home circuit. Yet the investigations of Mr. Hamilton and Mr. Strickland

appear to show, that we may recognise, even in Asia Minor, the great formations, occupying the lowest and highest positions of the series, which are well marked by fossils, namely the Silurian and Tertiary formations; and also an intermediate formation corresponding in general with the Secondary rocks of the north, but not as yet reduced to any parallelism with them in the order of its members. Besides these sedimentary rocks, in this as in most other countries, there are found vast collections of igneous rocks of various kinds, which interrupt and modify, and may mask and overwhelm, the fossiliferous strata. A paper has been communicated to us by Mr. Hamilton, "On a part of Asia Minor," namely, the country extending from the foot of Hassan Dagh to the great salt lake of Toozla, and thence eastwards to Cæsarea and Mount Argæus, and thus occupying a part of the ancient Cappadocia.

It appears that in this district the igneous rocks occupy a large portion of the surface, and the sedimentary strata which are associated with these are not easily identified with those which occur in countries already examined. The district examined by Mr. Hamilton contains a limestone belonging to the vast calcareous lacustrine formation of the central part of Asia Minor, and beneath this, a system of highly inclined beds of red sandstone, conglomerates and marls, which are perhaps connected with the saliferous deposits of Pontus and Galatia; but which could not be satisfactorily compared with the beds of the south of Europe, for want of the occurrence of organic remains. In only one instance did Mr. Hamilton observe the trace of organic bodies in the sandstone: these were impressions resembling fucoids, and similar to those found in the Alpine limestone near Trieste. Mr. Hamilton ascended to the summit of Mount Argæus, which had not previously been reached by any traveller, which rises abruptly from the alluvial plain of Cæsarea to the height of 13,000 feet.

We have another contribution to the geology of the countries exterior to the Alps and Pyrenees in Mr. Sharpe's memoir on the geology of Portugal. He has examined with great care the neighbourhood of Lisbon, and has traced the superposition of the strata, naming the most conspicuous of them from the places in which they are well exhibited. His series (exclusive of igneous rocks) consists of San Pedro limestone (which rests upon the granite),

slate clay and shale, Espichel limestone, red sandstone, hippurite limestone, a lower tertiary conglomerate, the Almada beds, and the upper tertiary sand. In the Memoirs of the Royal Academy of Sciences of Lisbon, for 1831, Baron Eschwege had examined a geological section taken across the mouth of the Tagus, and passing from the granite of the Serra of Cintra, to that of the Serra of Arrabida. But his identifications of the Portuguese beds do not agree with those of Mr. Sharpe, and have indeed the air of proceeding on the arbitrary assumption of a correspondence between this and other parts of Europe. Thus Baron Eschwege has referred both the San Pedro and the Espichel limestones to the magnesian limestone; the red sandstone formation he considers as Bunter Sandstein, while Mr. Sharpe refers it to the age of our Oolites: the hippurite limestone (now acknowledged to be the equivalent of our chalk and greensand) M. Eschwege makes to be Jura limestone; and the Almada beds he would have to be Plastic Clay and Calcaire Grossier. Mr. Sharpe is very properly attempting, by a further study of the organic fossils which he has procured, to confirm or correct the identifications to which he has been led. It is only by thus starting from different points, and tracing strata by their continuity, that we can hope to cover the map of Europe, and finally the world, with geological symbols of a meaning fully understood.

PALÆONTOLOGY.

The portion of our subject which we term Palæontology, might at first sight seem to form a part of zoology rather than of geology; since it is concerned about the forms and anatomy of animals, and differs from the usual studies of the zoologist only in seeking its materials in the strata of the earth's crust instead of upon its surface. Yet a moment's thought shows us how essential a part of our science the zoology of extinct animals is; for in order to learn the history of the revolutions which the earth has undergone, we must seek for general laws of succession in the remains of organic life which it presents, as well as in the position and structure of its brute masses. And since such general laws must necessarily be expressed in terms of zoology, it becomes our business to define those terms, so that they shall be capable of expressing truths which

include in their circuit the past as well as the present animal and vegetable population of the world.

An example of this process has occupied a large portion of our attention during the past year. It appeared to be a proposition universally true, that the oldest strata of the earth's surface contained cold-blooded animals only; and that creatures of the class mammalia only began to exist on the surface after the chalk strata had been deposited and elevated. And when, to a rule of this tempting generality, a seeming exception was brought under our notice, it became proper to examine, whether the anatomical line, which enables us to separate hot-blooded from cold-blooded animals, had really been rightly drawn; and whether, by rectifying the supposed characteristic distinction, the exception might not be eliminated. The exception on which this very instructive point was tried, consisted in a few jaw-bones of a fossil animal, which, though occurring in the Stonesfield slate near Oxford, a bed belonging to the oolite formation, had been referred by Cuvier to the genus Didelphys, and thus placed among marsupial mammals. In August last M. de Blainville stated to the Academy of Sciences of Paris his reasons for doubting the justice of the place thus assigned to the fossil animal. Founding his views principally upon the number and nature of the teeth of the fossil, he asserted that the animal, if a mammal, must come nearest the phocæ; but he rather inclined to believe it a saurian reptile; following, as he conceived, the analogies offered by a supposed fossil saurian described by Dr. Harlan of Philadelphia, and termed by him Basilosaurus. M. Valenciennes, on the other hand, asserted the propriety of the place assigned by Cuvier to the fossil animal, although he made it a new genus; and gave to the species the name *Thylacotherium Prevostii*. The controversy at Paris had its interest augmented when Dr. Buckland in September carried thither the specimens in question. From Paris the controversy was transferred hither in November, and principally occupied our attention at our meetings till the middle of January.

One advantage resulting from the ample discussion to which the question has thus been subjected, has been, that even those of us who were previously ignorant of the marks by which zoologists recognise such distinctions as were in this case in question, have

been put fully in possession of the rules and the leading examples which apply to such cases. And hence it will not I trust be deemed presumptuous, if, without pretending to any power of deciding a question of zoology, I venture to state the result of these discussions. It appears, then, that some of the marks by which the under jaws of Mammals are distinguished from those of Saurians are the following: (1) a convex condyle; (2) a broad and generally elevated coronoid process, (3) rising near the condyle; (4) the jaw in one piece; (5) the teeth multicuspid, and (6) of varied forms, (7) with double fangs, (8) inserted in distinct sockets, but (9) loose and not anchylosed with the jaw. In all these respects the Saurians differ; having, for instance, instead of a simple jaw, one composed of six bones with peculiar forms and relations, and marked by Cuvier with distinct names; having the teeth with an expanded and simple fang, or anchylosed in a groove, and so on. Of course, it will be supposed, by any one acquainted with the usual character of natural groups, that this line of distinction will not be quite sharp and unbroken, but that there will be apparent transgressions of the rule, while yet the unity of the group is indubitable. Thus the Indian Monitor and the Iguana, though Saurians, violate the *second* character, having an elevated coronoid process; but then it is narrow, and this seeming defect in our second character is further remedied by the third; for in those Saurians there is a depressed space between the condyle and the coronoid process quite different from that which a mammal jaw exhibits. Again, the teeth of Crocodiles, Plesiosaurs, and the like, are inserted in distinct sockets; but then they have not double fangs. The Basilosaurus was supposed to be a saurian with double-fanged teeth, but that exception was disposed of afterwards. And as there are thus saurians which trench upon the characters of mammals, there are mammals in which some of the above characters are wanting: thus the condyle is slightly or not at all convex in the Ruminantia; there is no elevated coronoid process in the Edentata; the Dolphin and Porpoise have not multicuspid teeth; the Armadillo has not varied forms of teeth, nor has it double fangs to its teeth, which also the fossil Megatherium has not. Still, upon the whole, the above appears to be the general line of distinction. Even if one or two of the above nine marks were wanting to prove the animal a mammal, still if the great ma-

jority of them were present, our judgment could not but be decided by the preponderance of characters. But if all the above characters of mammals are present, and all those of saurians absent, it seems to be a wanton scepticism to doubt that the animal was really warm-blooded.

Now it was asserted by Mr Owen, who brought this subject before us, that this is the case; that all the characters which I have enumerated above exist in the Stonesfield jaws. If we satisfy ourselves that this is the case, I do not see how we can avoid assenting to his opinion,—that the animal belonged to the class Mammalia.

Every such question of classification must resolve itself into two; that of the *value*, and that of the *existence* of the characters. If we assent to Mr. Owen in his view of the former, we are then led to consider the latter.

M. de Blainville, at least in his first examination, had laboured under the disadvantage of forming his judgments from casts and drawings only of the Stonesfield bones. Under these circumstances, he had denied several of the above characters; he had held that the teeth in the Thylacotherium are uniform; and that they are confluent with the jaw; and that the jaw is compound. These statements Mr. Owen, resting upon a careful examination of the specimens, contradicts. The assertion of the compound nature of the jaw is occasioned by a groove near the lower margin of the jaw, which however is not so situated as to represent the saurian sutures but is completely explained by supposing it to be a vascular canal, such as exists in the Wombat, Didelphys, Opossum, and similar animals.

Another specimen, at that time the property of Mr. Broderip, but now very properly placed in the British Museum, exhibits a jaw similar indeed to the Thylacothere, but belonging to a different genus; and to this species Mr. Owen has given the name *Phascolotherium Bucklandi*. Both these generic names imply that the animals are pouched animals; and in addition to the reasons which led Cuvier to this opinion, Mr. Owen has noticed in the fossils an inflection of the lower edge of the jaw, which, so far as has been hitherto observed, occurs in Marsupials, and in them alone.

As if this question had been destined to be settled at this time, the only remaining doubt with regard to the possible existence of

double fangs in the teeth of a saurian was removed by the arrival in London of Dr. Harlan with his "Basilosaurus." That gentleman, with great liberality and candour, allowed sections of the fossil to be made in such a manner as to expose the structure of the teeth. And these being examined by Mr. Owen, and compared with the general laws of dental structure which he has lately discovered, it appeared that Dr. Harlan's fossil was by no means a saurian, but an animal nearly allied to the Dugong, to which Mr. Owen proposes to apply the generic name of Zeuglodon, expressing the conjoined form of its teeth.

I have not hesitated to lay before you the view of this subject to which I have been led by the discussions in which we have been engaged, notwithstanding the very great authorities which incline to the other side of the balance. Among these I hardly know whether I am to reckon Mr. Ogilby, who laid before us a very instructive communication, in which, without deciding the point, he pointed out the difficulties which appear to him to embarrass both views, and especially to contradict the opinion of the marsupial nature of the animal.

I have dwelt the longer on this controversy, since it involves considerations of the most comprehensive interest to geologists, and, we may add, of the most vital importance. For—*de summâ reipublicæ agitur*,—the battle was concerning the foundations of our philosophical constitution; concerning the validity of the great Cuvierian maxim,—that from the fragment of a bone we can reconstruct the skeleton of the animal. This doctrine of final causes in animal structures, as it is the guiding principle of the zoologist's reasonings, is the basis of the geologist's views of the organic history of the world; and, that destroyed, one half of his edifice crumbles into dust. If we cannot reason from the analogies of the existing, to the events of the past world, we have no foundation for our science; and you, Gentlemen, have all along been applying your vigorous talents, your persevering toil, your ardent aspirations, idly and in vain.

Besides the important investigations thus referred to, we owe to Mr. Owen other palæontological contributions. The genus *Chæropotamus*, established by Cuvier from an imperfect fragment of the bone of a skull, was asserted by him to be a Pachyderm most nearly

allied to the Peccari. A fragment of a lower jaw of the same genus, found by Mr. Darwin Fox in the Isle of Wight, confirms this view, but indicates in some points an approach to the carnivorous type. And it was remarked as interesting, that the living genus of the hog tribe which most resembles the Chæropotamus, the Peccari, exists in South America, where the Tapir, the nearest living analogue of the Anoplothere and Palæothere, the associates of the Chæropotamus, also occur. Another jaw, found by Mr. Pratt in the Binstead quarries in 1830, and resembling that of the Musk Deer, Mr. Owen refers to a new species of Cuvier's genus Dicobune, under the name *Dichobune cervinum*. Mr. Owen has also given us a description of Lord Cole's specimen of *Plesiosaurus macrocephalus*, which he compares with Mr. Conybeare's *Plesiosaurus Dolichodeirus*, by establishing an intermediate species, founded upon a specimen existing in the British Museum, and termed by him *Plesiosaurus Hawkinsii*. Besides tracing the analogies which connect these with each other, and comparing them with the two great modifications of the saurian tribe, the crocodiles and the lizards, Mr. Owen presented his remarks on the form of the Plesiosaurian vertebræ, founding them upon a general view of the elements of which all vertebræ are constituted.

To the communications thus made to us, we may add Mr. Owen's determination of another animal, of which the remains brought from the neighbourhood of Buenos Ayres, are among the many treasures of this kind which we owe to Sir Woodbine Parish. This animal, of gigantic dimensions, appears to have been allied to the Megatherium, but with closer affinities to the Armadillos; and it probably possessed the characteristic armour, of which, in the Megatherium, the existence is perhaps problematical. Mr. Owen has termed it *Glyptodon*, from the furrowed shape of its teeth.

In another communication Mr. Owen endeavoured to account for the dislocation of the tail of the Ichthyosaurus at a certain point, which is observable in many of the fossil skeletons of that animal. This circumstance, so remarkable from its general occurrence, and which Mr. Owen was the first to observe, he is disposed to account for by supposing a broad tegumentary fin to have been attached to the tail for a portion of its length, the position of which fin must, he conceives, have been vertical.

I cannot close my enumeration of the valuable contributions for

which we are indebted to Mr. Owen, without remarking how well our anticipations have been verified, when, in awarding him the Wollaston medal last year, we considered the labours which we thus distinguished as only the beginning of an enlarged series of scientific successes; and how well also Mr. Owen's own declaration, that he should lose no available time or opportunity which could be applied to palæontological research, has been borne out by the services he has rendered that branch of our science.

In the remainder of my review of what has been done among us in Palæontology I must necessarily be very brief. I have already mentioned the discovery of fossil fishes in the Bagshot sand. These fishes have supplied three new genera, which Dr. Buckland has distinguished and has named *Edaphodon*, *Passalodon*, and *Ameibodon*; of which the two first offer combinations of the characters of bony and cartilaginous fishes. Mr. Stokes has given us his views of the structure of the animal to which belonged those fossils with which we are so familiar under the name of Orthoceratites. He is of opinion, that these fossils, in their living condition, existed as a shell, enveloped within the body of the animal to which they belonged. He has distinguished three genera of these shells, to which he assigns the names *Actinoceras*, *Ormoceras*, and *Huronia*. The Marquis of Northampton also has examined those minute spiral shells which occur in the chalk and chalk flints, and have been termed Spirolinites. And, finally, under this head I must mention Mr. Alfred Smee's paper on the state in which animal matter is usually found in fossils.

Mr. Austen's hypothesis of the origin of the limestone of Devon, though belonging in some measure to Geological Dynamics, may perhaps be mentioned here, since he explains the position of those beds by reference to the habits of the coral animal. Mr. Austen has already shown himself to us as an excellent observer; and in constructing geological maps, a task requiring no ordinary talents and temper, he has earned our admiration. We shall therefore not be thought, I trust, to depreciate his labours if we receive with less confidence speculations in their nature more doubtful. As we can hardly suppose the calcareous beds of Devon to have had an origin different from those of other countries, we cannot help receiving with some suspicion a doctrine which would subvert almost the

whole of our existing knowledge of the relations of fossiliferous beds of limestone.

GEOLOGICAL DYNAMICS.

In that part of geology which I have termed Geological Dynamics, and which investigates and applies those causes of change by which we may hope to explain geological phenomena, we may still observe that fundamental antithesis of opinion which has long existed on the subject;—the division of our geological speculators into *Catastrophists* and *Uniformitarians*;—into those who read in the rocks of the globe the evidence of vast revolutions, of an order different from any which those of man has survived;—and those who see in the condition of the earth the result of a series of changes which are still going on without decay, the same powers which produced the existing vallies and mountains being yet at work about us. Both these opinions have received their contributions during the preceding year: Mr. Darwin having laid before us his views of the formation of mountain chains and volcanos, which he conceives to be the effect of a gradual, small, and occasional elevation of continental masses of the earth's crust; while Mr. Murchison gathers from the researches in which he has been engaged, the belief of a former state of paroxysmal turbulence, of much deeper rooted intensity and wider range than any that are to be found in our own period; and M. de Beaumont, in France, has endeavoured to prove that Etna and many other mountains must have been produced by some gigantic and extraordinary convulsion of the earth. Both Mr. Darwin and M. de Beaumont refer to the same examples; and while M. de Beaumont conceives that the cones of the Andes must have been formed by an abrupt elevation, caused by subterranean force, Mr. Darwin has maintained the opinion, that these lofty summits have been gradually thrust into the place which they occupy by a series of successive injections of molten matter from below, each intruded portion of fluid having time to harden into rock before it was burst and again injected by the next molten mass. For how otherwise, he asks, can we conceive the strata to be thrust into a vertical position by a liquid from below, without the very bowels of the earth gushing out? Without attempting to answer this question, we may observe, that when we suppose, as Mr. Darwin supposes, a vast por-

tion of the earth's crust, the whole territory of Chili for example, to rest on a lake of molten stone, there is considerable force in M. de Beaumont's argument:—that when such a fluid is raised to the top of a mountain ten or twenty thousand feet high, the pressure upon the crust which is in contact with the fluid must be more than a thousand atmospheres; and who, *he* too asks, flatters himself that he knows enough of the interior machinery of volcanos, to be certain that this vast pressure, acting upon a large surface, may not, by some derangement of its safety-valve, the volcanic vent, produce effects to which we cannot assign any limit?

In speaking of Mr. Darwin's researches I cannot refrain from expressing for myself, and I am sure I may add for you, our disappointment and regret that the publication of Mr. Darwin's journal has not yet taken place. Knowing, as we do, that this journal contains many valuable contributions to science, we cannot help lamenting, that the customs of the Service by which the survey was conducted have not yet allowed this portion of the account of its results to be given to the world.

Although not communicated to us, but to our Alma Mater the Royal Society, I may notice Mr. Hopkins's endeavours to throw light upon such subjects as this by the aid of mathematical reasoning. The researches of Mr. Hopkins respecting the effects which a force from below would produce upon a portion of the earth's crust, have already interested you, and would be of still greater value if the directions of faults and fissures which result from his theory did not depend very much upon that which in most cases we cannot expect to know, the form of the area subjected to such strain. Mr. Hopkins has since been employing himself in tracing the consequences of another idea, truly ingenious and philosophical, and which a person in full possession of the resources of mathematics could alone deal with. Some of the effects which the sun and moon produce upon the earth (as the precession and nutation,) include the attraction of those bodies upon the interior portion of the earth, and have hitherto been deduced from the theory by mathematicians, upon the supposition that the earth is solid. But what if the central portion of the earth were fluid? What if it appeared, by calculation, that the fluid internal condition would make the amount of the precession of the equinoxes, or of the nutation of the axis, different

from that which the solid spheroid would give? What if it appeared that the precession and nutation thus calculated for a fluid interior agreed better with observation than the result hitherto obtained by supposing the earth solid? If this were so, we should have evidence of the earth's interior fluidity, evidence, too, of a perfectly novel and most striking nature. But to answer these questions is far from an easy task; the precession of the solid earth is a problem in which Newton erred, and in which the greatest mathematicians of modern times have not found their greatest strength superfluous. Yet how incomparably more difficult in all cases is the mechanics of fluid than of solid bodies! It may, therefore, require more than one trial before any satisfactory solution of the problem can be obtained. Mr. Hopkins has attacked it by the aid of certain hypotheses, and the result is, so far, not favourable to the decisiveness of this test of the interior condition of the earth; but notwithstanding this state of things, I venture to say on your behalf, Gentlemen, that an idea so full of promise of that which we so much desire, and which seems to be so utterly out of our reach, the knowledge of the condition of the centre of the earth,—that such an idea is not to be lightly abandoned*.

* The following are the results at which Mr. Hopkins has arrived, supposing the earth to consist of a homogeneous spheroidal shell filled with a fluid mass of the same density as the shell:—

1. The precession will be the same, whatever be the thickness of the shell, as if the whole earth were solid.

2. The lunar nutation will be the same as for the solid spheroid, to such a degree of approximation, that the difference would be inappreciable to observation.

3. The solar nutation will be sensibly the same as for the solid spheroid; unless the thickness of the shell be very nearly of a certain value, something less than one fourth the earth's radius, in which case this nutation might become much greater than for the solid spheroid.

4. In addition to the above motions of precession and nutation, the pole of the earth would have a small circular motion, depending entirely on the internal fluidity. The radius of the circle thus described would be the greatest when the thickness of the shell should be least; but the inequality thus produced would not, for the smallest thickness of the shell, exceed a quantity of the same order as the solar nutation; and for any but the most inconsiderable thickness of the shell, would be entirely inappreciable to observation.

Mr. Hopkins intends hereafter to consider the case of variable density.

M. Necker, of Geneva, offered an addition to the causes of convulsions of the earth, which are contemplated by our Geological Dynamics, in a paper in which he ascribed the earthquakes which took place in the southern provinces of Spain, in 1829, to the falling in of strata, the subjacent gypseous and saliferous masses being washed out by subterraneous currents. Without denying all influence to such a cause, we may observe that it does not appear likely that there would be thus produced, simultaneously, any greater effects than those which are known to have occurred from the falling in of unsupported mines; and these have never approached in their scale to any except the smallest earthquakes.

While geologists are thus looking in all directions for causes which may produce the phenomena which they study, it is natural that the powerful, but as yet mysterious influences of electricity should draw their attention. Mr. Robert Were Fox has endeavoured to show, that by voltaic agency, a laminated structure, and deposits of metal in cracks, resembling metallic veins, may be produced in masses of clay. The experiments are of an interesting kind, and it can hardly be doubted that voltaic agency had some influence in such cases as those described by Mr. Fox; although Mr. Henwood and Mr. Sturgeon have failed in attempting to reproduce his results, and although results much resembling these occur in cases where no electrical action is suspected. But we may remark that the conditions under which such voltaic effects are produced have not yet been attempted to be defined with any accuracy; and that till this is done, the reality of such agency can neither be verified nor applied to geological speculations.

A reflection which naturally offers itself upon this review of our recent career, is this:—that different portions of the science of geology advance with very different rapidity. Descriptive Geology is constantly and actively progressive: facts are accumulated by observers in every land; and though facts are, in truth, of no value, at least for any purpose of science, except so far as they are reduced to some classification, yet on the other hand, sound classifications are perpetually, almost necessarily, suggested, when observation is vigilant and persevering. Even if we at first express our facts in terms of a

false classification, we find afterwards the means of translating them into the language of a true one. And the spirit of geological observation is so widely diffused, and so thoroughly roused, that I trust we need not anticipate any pause or retardation in the career of Descriptive Geology. I confess, indeed, for my own part, I do not look to see the exertions of the present race of geologists surpassed by any who may succeed them. The great geological theorizers of the past belong to the *Fabulous Period* of the science; but I consider the eminent men by whom I am surrounded as the *Heroic Age* of geology. They have slain its monsters, and cleared its wildernesses, and founded here and there a great metropolis, the queen of future empires. They have exerted combinations of talents which we cannot hope to see often again exhibited, especially when the condition of the science which produced them is changed. I consider that it is now the destiny of geology to pass from the heroic to the *Historical Period.* She can no longer look for supernatural successes, but she is entering upon a career, I trust a long and prosperous one, in which she must carry her vigilance into every province of her territory, and extend her dominion over the earth, till it becomes, far more truly than any before, an universal empire.

Such are the prospects of Descriptive Geology;—of the geology of facts and classifications. To our knowledge of causes we can look with no such certainty of its progress being steady and rapid; or rather, we are certain that the advance must be slow, and may be often and long interrupted. For it is not an advance, to suggest one or another hypothetical cause of change, without assigning the laws and amount of the change: it is hardly an advance even to calculate the results of our hypotheses on assumed conditions. To obtain by induction, from adequate facts, the laws of change of the organic and inorganic creation,—this alone can lead us to those discoveries which must form the epochs of Geological Dynamics. And we have yet to learn, whether man's past duration upon the earth, whether even that which is still destined to him, is such as to allow him to philosophize with success in such matters;—whether, not individuals only, not a generation alone, but whether the whole species be not too ephemeral, to penetrate, by the unassisted powers of its reason, into the mystery of its origin:—whether man, placed for a few centuries on the earth as in a school-room, have time to strip the wall

of its coating, and count its stones, before his Parent removes him to some other destination.

And now, Gentlemen, I approach the close of my task, and of the office which has imposed it upon me; an office which has been to me a source of unmingled gratification. The good opinion implied by your selection of me, the good opinion of such a body of men, was an occasion of sincere and earnest self-congratulation,—a self-congratulation hardly damped by my consciousness of an imperfect acquaintance with your science;—since I trusted that you, though not unaware of my defects, had judged that good will, and a disposition to look at the subject in its largest aspect, might in some measure compensate for them. And if I needed other grounds of satisfaction in the employment which I am thus bringing to its close, I might find them in the reflections I have just been led to make in the progress and prospects of the science with which you are concerned. For it has ever been one of my most cherished occupations, and will, I trust, long be so, to trace the principles and laws by which the progress of human knowledge is regulated from age to age in each of its provinces. To have had brought familiarly under my notice, in a living form, the daily advance of a science so large and varied as yours, has been, as it could not but be, a permanent and most instructive lesson;—perpetually correcting lurking mistakes, and suggesting new thoughts. And if, while I have looked at your science in this spirit, you have thought me worthy to be called to preside over your body for two years; and if, during that time, you have not repented of your choice, as I have not found my views inapplicable to the subjects which have come before you; I may, I would believe, find in this some ground for confiding in the trains of thought which have thus led me to such a position; and may hope that, however arduous be the task of framing a philosophy of science suitable to its present condition, and of using such a philosophy as a means of furthering knowledge in general, still, that in this task, to which our age is so manifestly called, I too may be a helper.

I trust that you will excuse these few words uttered with reference to my own peculiar pursuits, since these include yours also, and are my only claim to your indulgence. And now, Gentlemen, that I may trespass upon that indulgence no longer, I once more thank

you in all earnestness and sincerity for your good opinion which placed me in this chair, and for the kindness and support which I have on all occasions received from you; and with my best wishes for your prosperity, and that of your science, I resign my office into abler hands.

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