PROFESSOR RAMSAY ON LAKES*

II.

III.—*The Waters of the Cambrian and Silurian Epochs and the Lakes of the Old Red Sandstone*

THE lecturer first briefly summarised the reasoning and the conclusions contained in his two preceding lectures on the origin of fresh and salt water lakes, and then proceeded to apply them to explain certain phenomena of the above geological epochs as deduced from the rocks belonging to those periods. He was about to endeavour to prove that certain of the formations included in a table of the stratified rocks were not formed in the open sea as usually supposed, but were formed in great lakes. The small numbers of fossil shells found in fresh-water strata and in some cases their total absence rendered absolute demonstration very difficult. The Cambrian strata, seen in England, in North Wales, Shropshire, and other parts consist of red and mottled sandstones and slates, and contain but few fossils; trilobites and one or two fossil shells have been found, not in the red strata, however, but in blue and grey shades. Above these the Lingula flags (a member of the Lower Silurian) contain fossils in great numbers, and of such creatures as must have lived in the open ocean of that period. In the Upper Silurian, too, fossils are very numerous, and all inhabitants of the sea. But above these, in the Old Red sandstone, the numbers have declined both in genera and species and individuals, and the shells, &c., which remain are small and dwarfed in size. Yet the strata of the Old Red sandstone lie conformably on the Upper Silurian, showing that the passage from the one set of beds to the other was gradual, and the change in the fossils is likewise gradual.

The Old Red strata consist of red sandstones (forming about two-thirds of the whole strata) and a red marl developed in England, in South Wales, Herefordshire, &c., throughout the whole of these strata fossils are very scarce, chiefly occurring in the uppermost and lowermost portion. In the Ludlow rocks, at the upper portion of the Silurian strata, are found fragments of stones and seed vessels of land plants for the first time. Not that land plants did not exist before that period; the lecturer thought they had done so, but that their remains were not preserved in the rocks, inasmuch as they had been formed in the open sea, far from land. But their occurrence in the Ludlow rocks evidently proves that those strata, although truly marine, were formed in the neighbourhood of land, and, as the lecturer believed, in waters more or less land-locked. These passage beds also contain the remains of fish of various genera—Cephalaspis, Onchus, &c. But passing upwards into the beds of the Old Red sandstone, the fish which occur have their nearest living analogies in inland fresh-water areas; *e.g.* the Lepidosteus of the North American rivers, the Polypterus of the Nile, and the recently discovered Ceratodus in the rivers of Australia. Large crustaceans—Eurypterus and Pterygotus—occur higher up in the formation, and in all cases where they are found, and in the majority of cases where fish are found in these strata, shells are not associated with them. Hence from the absence of shells, and their dwarfed forms when they do occur, especially as compared with the underlying Silurian beds, and from the presence of those peculiar kinds of fish, we are entitled to infer that the strata were deposited in inland lakes. Again, examination of a piece of the red sandstone will show it to be composed of a number of minute grains, each surrounded by a thin pellicle of peroxide of iron, to which the red colour of the rock is due, for when this iron is discharged by chemical means the rock remains purely white. All truly marine rocks that we know are in no case coloured red; they are black, blue, green, or yellowish, but never red, and there is no reason why in the sea iron should be deposited as a peroxide. But in certain lakes in Sweden there is a constant deposit of iron oxide; and though this is due to organic agency, still it occurs in lakes, but never in the sea. The Old Red sandstone is not a wide-spread formation, but has more of a local character.

The lecturer then showed by means of diagrams how he conceived that certain areas of the Silurian seas might be isolated and shut off from the ocean by elevation and depression of the land, that the gradual freshening of these inland areas would result in dwarfing and deforming the marine creatures in the waters, and rendering them gradually extinct. The lakes in the north of Europe, which must have been filled with sea-water just after the glacial epoch, are similar cases, for in some of them the marine forms are not yet totally extinct, but have become partly acclimatised, and so the occurrence of a few such forms in these rocks is no conclusive evidence against their being formed in inland and fresh-water lakes, but rather the contrary. At the top of the Old Red sandstone beds land-plants and fresh-water shells occur. In the north of Scotland the Old Red sandstone rocks are well developed, the Grampians at that time standing out of the waters. The bottom bed is a clay with angular boulders, much resembling the "boulder clay" formation, and evidently of glacial origin, and though the lecturer dare not assert that glaciers scooped out the lakes in which the rocks were deposited, still it was very interesting to have evidence of their connection with those lakes. He likewise pointed out that if this theory of the lake origin of certain formations, first suggested by Mr. Godwin Austen, were established, it would open out an entirely new field of geological research by revealing to us the conditions not only of the ancient seas, but also of old continental areas.

IV.—*Salt Lakes of the Permian Epoch*

Prof. Ramsay first explained that it was necessary, in attempting to demonstrate the truth of his assertions as to certain formations having been deposited in inland waters, to commence by considering the conditions of the preceding epoch, and trace the gradual change in the deposits resulting from the changed conditons. He therefore commenced by describing somewhat fully the rocks belonging to the carboniferous formation. The mountain limestone or carboniferous limestone, which lies at the base of the system in the south of England, is a nearly pure limestone, composed almost entirely of encrinites, corals, and other similar marine forms, and attaining a thickness of two or three thousand feet. Above that lies the millstone grit, about a thousand feet thick, likewise marine, but containing the remains of land plants; overlying that are the coal measures, consisting of an alternation of beds of sandstone, slate, coal, and ironstone. In the north of England and Scotland the base of the system consists of alternating beds of limestone, sandstone, and shale, with occasional beds of coal, and above that the true coal measures. The coal was formed by the life and death of land-plants—Lepidodendron, Sigillaria, Calamites, &c., and under every bed of coal is a layer of clay—"underclay," which is nothing more nor less than the ancient soil on which the plants grew, and contains the roots of some of the above plants, *e.g.* Stigmaria, the root of Sigillaria. The remains of the plants accumulated somewhat like existing peat bogs, and were at times submerged and covered with a layer of sediment, and again upheaved and overspread by vegetation. There must have been a large continental area in the latitude in which Britain now stands to furnish the gigantic rivers at the mouths of which many of these coal-measure forests grew.

Above the carboniferous strata lie the Permian seen surrounding some of the Midland coal fields, in a strip from Derbyshire into Cumberland, and forming the base rocks of a portion of the Vale of Eden. The beds lie unconformably on or against the coal measures, implying that a vast lapse of time, sufficient to allow for the denudation of thousands of feet of thickness of strata in some places, took place between the deposition of the two formations. At the base of the Permian strata lie beds of red conglomerate, sandstone, and marl, known on the Continent as *Rothliegende;* and above those lie the magnesian limestone. In the magnesian limestone a considerable number of marine forms of life occur, but compared with the great abundance of those forms in the carboniferous limestone, the fauna seems poor and the individuals are dwarfed; out of 1800 species of shells in the carboniferous genera only 38 genera and 180 species are found in the magnesian limestone. The latter strata also contain some fossil fish in its lower beds (marl slate), of the same genera as those found in carboniferous strata, and some show considerable resemblance to those living forms inhabiting inland fresh-water areas, mentioned in the last lecture. And there are various reptiles found—Labyrinthodont reptiles—which were truly amphibious, and which in some cases have left their skeletons, but far more frequently their foot-marks impressed upon the soft mud of some ancient shore, which likewise shows occasionally rain marks and sun cracks. Some of the reptiles belong to the Protosaurian genus, closely allied to the modern crocodiles or Thecodont saurians, and therefore probably ultimately connected with the land. And a very significant point in regard to the origin of these rocks is their chemical composition, the magnesian limestone consisting of the carbonates of lime and magnesia, often in about equal proportions. Now

* Continued from p. 313.

limestone is formed from the sea-water by the agency of animals, but no creature is known which secretes carbonate of magnesia from the sea waters to make its skeleton, and therefore we may conclude that it was precipitated from chemical solutions; and this could not take place in the open sea, but must have occurred, as in the case of rock-salt in confined inland waters. It is probable that by extensive changes in physical geography, large areas of the ocean were shut off, and in the lakes thus formed, the Permian rocks were deposited, the magnesian limestone being formed by the mixture of the carbonate of magnesia, precipitated by means of evaporation with limestone built up by organic agency. Crystals of gypsum too occur in these rocks, and pseudomorphous crystals of rock-salt pointing to evaporation, and consequently concentration of these salts in the waters of confined areas. A thin pellicle of peroxide of iron surrounds the grains in the sandstone and marl, which gives the red colour to the rocks, and which peroxide was formed by the reduction of the carbonate of iron, carried into the lakes by the rivers, by means of the oxygen of the air. The lecturer had no hesitation in saying that in all those formations which we know to be truly marine, the rocks are never red. So that from the paucity or absence of shells, from the remains of terrestrial or amphibious reptiles, and their foot-prints, from the occasional presence of true land plants (of the same genera, but not the same species, as in the carboniferous rocks), from the chemical composition of the rocks, from the presence of peroxide of iron, and from the presence of chemical precepitates, we are justified in concluding that the Permian rocks were deposited in great salt lakes, though perhaps not salt in every case. And a reflex of the conditions under which they were deposited may be seen in the state of the Caspian Sea (with a marine fauna like the North Sea, though the species are few and dwarfed), and of the salt lakes of Asia.

SCIENTIFIC SERIALS

THE *Lens* for November 1872, contains the following communications: "The preparation of Diatomaceæ," Christopher Johnstone, M.D.: a succinct account of the most usual and approved methods of cleaning Diatomaceous deposits. A short reply of Dr. J. J. Woodward to Dr. Lionel S. Beale; and a memorandum by Chas. Stodder, entitled "Draw-tubes *v.* Deep-eye-pieces." A continuation by Dr. J. N. Danforth of his communication on "the cell," treats of the theories of cell development. H. H. Babcock's "Flora of Chicago and its vicinity," Part IV. completes, we presume, the phanerogamic plants of Part III.; "Microscopical Memoranda for the use of Practitioners of Medicine," by Dr. J. J. Woodward, relates the results of the author's experience on "the Imbibition of the Tissues with Chloride of Gold and Osmic Acid." Prof. H. L. Smith gives a brief notice of the Bailey Collection of Diatomaceæ in the Museum of the Boston Society of Natural History. Dr. J. J. Woodward also advocates the employment of *Frussulia Saxonica* as a test of high-power definition in preference to *Amphipleura pellucida*. S. A. Briggs gives an enumeration of some of the Diatomaceæ of Upper Lake Huron and the Sault. The usual brief notes, with title-page and index, complete this number and the first volume of this American Quarterly Journal of Microscopy.

La Belgique Horticole, gives a short life of Redonté, the celebrated French painter of flowers. A description of a new tea rose, the "Pearl of Lyons," contains a short history of these plants, from which we learn that they were introduced into Europe in 1793 by an Englishman, Mr. Parsons, and reintroduced early in this century by others, Sir A. Hume being one of them. M. E. Morren describes, in a very clear and concise manner, the physiology of the nutrition of plants.

THE *Revue Bibliographique Universelle* contains short reviews of several botanical works, including that by Grisebach and Engelman, on the geographical distribution of plants, in which the world is divided into twenty-four botanical regions, several of these being, according to the reviewer, unnecessary. Referring to a work by M. Hamilton on the Botany of the Bible, the following occurs:—"Il a joint à chacun de ses articles une photographie prise sur nature, mais malheureusement dans les environs de Nice, et non point en Terre Sainte." Prof. Balfour's Introduction to the Study of Palæontological Botany is considered too deficient in detail and from the fewness of the references to other authors, the incompleteness of the Edinburgh libraries is presumed.

SOCIETIES AND ACADEMIES

LONDON

London Mathematical Society, Feb 13.—Dr. Hirst, president, in the chair. The following papers were read:—Prof. H. G. Smith, on the higher singularities of plane curves, and on systems of linear consequences.—Mr. J. Macleod, on the application of the hodograph to the solution of problems on projectiles.

Geologists' Association, February 1.—Henry Woodward, F.G.S., president, in the chair.—"On the Diprionidæ of the Moffat Shale," by Charles Lapworth, F.G.S. After reviewing the history of investigation among the biserial *Graptolites*, and the antagonistic opinions regarding their internal structure held by different palæontologists, the author stated that a careful decomposition and examination of specimen of *Chinacograptus* from the Moffat Shale, preserved in a state of relief, had forced him to the conclusion that the view of the duplicate nature of the polypary in this genus advocated by Professor Nicholson is substantially correct. The internal characters are identical with those in *Diplograptus*. The diprionidian polypary is in reality composed of two complete monoprionidian polyparies (each with its own cænosarc, virgula, and distinct hydrotheæ), placed back to back and coalescing along their flattened dorsal walls. There is certain evidence that this type of structure obtains among all, or nearly all, of the Moffat *Chinacograpti*. Nevertheless, he was not prepared to deny the accuracy of Professor Hall's interpretation of the internal characters of his *China*(?)*typicalis*. As long as a single doubt remained upon this point, it was argued that it would be unsafe to exclude *Retiolites* and its allies from the *Dipliotidæ*, which might meanwhile be considered as embracing three sub-families, *Diplograptidæ*, *Retiolitidæ*, and a third and intermediate sub-family, of which *C.*(?) *typicalis* is the only known example. The sub-family *Diplograptidæ* will include all those species at present referred to *Diplograptus* and *Chinacograptus*. Now that the type of structure in these two genera is proved to be identical, a new system of classification is necessary. The only remaining characters which can in all cases be employed for the purpose of separation at our command are the form of the polypary and the shape and arrangement of the hydrotheca. It was shown that the different species of the *Diplograptidæ* naturally arrange themselves into five groups, clearly individualised by striking distinctions in these characters. Each of these groups, it was contended, was of sufficient importance to be considered as forming a distinct and separate genus. In this way the genera *Climacograptus* (Hall) and *Cephalograptus* (Hopk.) would rumain untouched, and the author suggested that the generic term *Diplograptus* (M'Coy) should be restricted in future to those species of which *Dip. folium* (His.) is the type, and he proposed two new genera, viz., *Orthograptus*, to include those species resembling *Dip. quadrimucronatus* (Hall) and *Glyptograptus* for those formed after the pattern of *D. tamariosens* (Nich.). The second portion of the paper was devoted to a revision of the genera and species of Diplograptidæ found in the Moffat Shales, and the following new species were described:—*Orthograptus aculeatus*, *O. Carruthersi*, *O. fasilicus*, *O. Pageanus*, *O. explanatus*, *O. compactus*; *Glyptograptus gregarius*, *G. per excavatus*, *G. modestus*; *Chinacograptus styloidens*, *C. tubuliferus*, *C. Longicaudatus*, *C. Wilsoni*, *C. antiquus*, *C. brevicornis*, *C. mirabilis*.

Zoological Society, Feb. 18.—John Gould, F.R.S., V.P., in the chair.—The Secretary read a report on the additions that had been made to the Society's collection during the month of January, 1873. Amongst these were specially mentioned a pair of Fruit-Bats from Formosa, presented by the Rev. Mr. Ritchie of Takoo, and a tapir from Paraguay, which presented some points of distinction from the ordinary form of the American tapir.—Prof. Newton, F.R.S., V.P., exhibited a print by Adrian Collaert (*circa*, 1580) containing the figure of a bird, cepied in Leguat's "Voyages" (1708), and mentioned by the latter under the name of the "*Géant*."—Extracts were read from a letter received from Dr. John Kirk, H. B. M. Consul at Zanzibar, respecting a female koodoo, and other antelopes, of which he had obtained specimens for the Society.—Mr. Garrod gave a notice of the death of a kangaroo in the Society's gardens, which had been caused by strangulation of the small intestine, produced by the folding of the elongate caecum round a loop of the small intestine.—A communication was read from Prof. G. J. Allman, F.R.S., containing a report on the *Hydroida* col-