depression of base-level in New England reached 2,700 feet at least. As there was a Mid-Pliocene (our separation of Pliocene and Pleistocene formations being largely arbitrary) elevation of undetermined amount, and as there have been several minor oscillations of level of land and sea, there is great latitude in the application of the phenomena to the Glacial epoch not yet determined—only that great elevation of measurable amount did obtain in Pleistocene days. With alternations of elevation between the North Atlantic and American plateaux, the changes of currents would further modify the climatic conditions of the period, so that this paper only suggests one phase of physical changes—tending to produce the phenomena of the Glacial period.

NOTICES OF MEMOIRS.

I.—The Affinities of *Hesperornis*.[1] By O. C. Marsh.

In the autumn of 1870, I discovered in the Cretaceous of Western Kansas the remains of a very large swimming bird, which in many respects is the most interesting member of the class hitherto found, living or extinct. During the following year, other specimens were obtained in the same region, and one of them, a nearly perfect skeleton, I named *Hesperornis regalis*.[2] In subsequent careful researches, extending over several years, I secured various other specimens in fine preservation, from the same horizon and the same general region, and thus was enabled to make a systematic investigation of the structure and affinities of the remarkable group of birds of which *Hesperornis* is the type. The results of this and other researches were brought together in 1880, in an illustrated monograph.[3]

In the concluding chapter on *Hesperornis*, I discussed the affinities of this genus, based upon a careful study of all the known remains. Especial attention was devoted to the skull and scapular arch, which showed struthious features, and these were duly weighed against the more apparent characters of the hind limbs, that strongly resembled those of modern diving birds, thus suggesting a near relationship to this group, of which *Colymbus* is a type. In summing up the case, I decided in favour of the ostrich features, and recorded this opinion as follows:—

"The struthious characters seen in *Hesperornis* should probably be regarded as evidence of real affinity, and in this case *Hesperornis* would be essentially a carnivorous, swimming ostrich." ("Odontornithes," p. 114.)

This conclusion, a result of nearly ten years' exploration and study, based upon a large number of very perfect specimens and a comparison with many recent and extinct birds, did not meet with

[1] From the American Journal of Science, vol. iii, 1897.

[2] Silliman's Journal, vol. iii, p. 56, January; and p. 360, May, 1872.

[3] "Odontornithes: a Monograph on the Extinct Toothed Birds of North America." 4to, 34 plates; Washington, 1880.

general acceptance. Various authors who had not seen the original specimens, or made a special study of any allied forms, seem to have accepted without hesitation the striking adaptive characters of the posterior limbs as the key to real affinities, and likewise put this opinion on record. The compilers of such knowledge followed suit, and before long the Ratite affinities of *Hesperornis* were seldom alluded to in scientific literature.

Several times I was much tempted to set the matter right as far as possible by reminding the critics that they had overlooked important points in the argument, and that new evidence brought to light, although not conclusive, tended to support my original conclusion that *Hesperornis* was essentially a swimming ostrich, while its resemblance to modern diving birds was based upon adaptive characters. On reflection, however, I concluded that such a statement would doubtless lead to useless discussion, especially on the part of those who had no new facts to offer, and, having myself more important work on hand, I remained silent, leaving to future discoveries the final decision of the question at issue.

It is an interesting fact that this decision is now on record. A quarter of a century after the discovery of *Hesperornis*, and a decade and a half after its biography was written in the "Odontornithes," its true affinities, as recorded in that volume, are now confirmed beyond dispute. In the same region where the type-specimen was discovered, a remarkably perfect *Hesperornis*, with feathers in place, has been found, and these feathers correspond with the typical plumage of an ostrich.[1]

II.—On the Relations and Structure of certain Granites and associated Arkoses on Lake Temiscaming, Canada.[2] By A. E. Barlow, M.A., and W. F. Ferrier, B.Sc., Geological Survey of Canada.

THE rocks to which the following facts relate outcrop on both the eastern and western shores of Lake Temiscaming immediately north of the "Old Fort" Narrows on the upper Ottawa river, the deep channel of which forms the boundary-line between the Provinces of Ontario and Quebec.

On the eastern side of the lake the granite forms a strip along the shore half a mile wide, extending from a point three-quarters of a mile north of "The Narrows" on which is situated the now abandoned Fort Temiscaming, a fur-trading post belonging to the Hudson Bay Company, to the steamboat wharf near the village of Baie des Pères. It also constitutes the rocky promontory known as Wine Point to the west of Baie des Pères, extending inland in a north-easterly direction for about one mile and a quarter. On the western side of the lake the first outcrop is noticed about half a mile west of "The Narrows," continuing along the shore for about four miles as far as

[1] Williston, Kansas University Quarterly, vol. v, p. 53, July, 1896.

[2] Abstract read before the British Association, Section C (Geology), Toronto, 1897.

Paradis Point, and varying in breadth from half a mile to one mile. The whole area thus underlain by the granite is approximately about six square miles.

Macroscopically the fresh rock is a rather coarse, though very uniformly even-grained aggregate of felspar, quartz, and a dark-coloured mica, probably biotite. Felspar is by far the most abundant constituent, and the abundance of red oxide of iron disseminated through all the cracks and fissures of this mineral gives to the rock its beautiful deep flesh-red colour. The quartz is, as usual, allotriomorphic, but a decided tendency is noticed to segregate in more or less rounded areas or individuals which, especially on surfaces worn and polished as a result of glacial action, gives to the rock a porphyritic or pseudo-conglomeratic appearance; a fact first made note of by Sir William Logan in 1844 on his manuscript map of this portion of the Ottawa river.

The microscope shows the rock to be composed essentially of orthoclase, microcline, plagioclase (oligoclase?), quartz, and biotite almost completely altered to chlorite. The microcline has evidently been derived from orthoclase as a result of pressure, and all the gradations of this change may be noted, from the "moire structure" characteristic of the imperfectly or only partially developed mineral, to the fine and typical "cross-hatched structure" peculiar to this mineral. The felspar shows only incipient alteration to sericite, and scales and flakes of this mineral are developed especially abundantly in the central portion of the individuals, leaving a comparatively fresh periphery almost altogether free from such decomposition products.

The arkose with which this granite is associated and surrounded is a beautiful pale or sea-green quartzite or grit, passing occasionally into a conglomerate, the pebbles of which are chiefly grey and red quartz with occasional intermixed fragments of a hälleflinta-like rock.

Under the microscope the finer-grained matrix appears to be almost wholly composed of pale yellowish-green sericite in the form of minute scales and flakes, although occasional individuals are macroscopically apparent. Most of this sericite has originated from the decomposition *in sitû* of felspar originally present, and irregular portions or areas of the unaltered felspar may be occasionally detected.

The line of junction between this granite and arkose shows a gradual and distinct passage outward or upward from the granite mass. The series of thin sections examined, as well as the hand-specimens themselves, show every stage in the process, which has been carefully studied.

In the first place, as a result of dynamic action, the orthoclase is converted into microcline with the incipient development of sericite, which gradually increases in those specimens where the greatest perfection of the "cross-hatched" microcline structure is reached. In these the individuals of quartz and felspar have undergone rather extensive fracturing, but with little or no movement apart of the fragments. This breaking up of the original larger individuals is,

as usual, much more apparent in the quartz than in the felspar, and beautiful examples of "strain-shadows" may frequently be seen in those quartz areas which have not yielded altogether to the pressure. A further stage in the process is reached when the sericitization of the felspar has proceeded so far as to permit of the "shoving apart" of the fragments by the various forces which have acted in bringing about the degradation of the whole rock mass. This gradual decomposition of the felspar and movement of the rock constituents can be perfectly traced in the series of thin sections examined until the rock cannot be distinguished from an ordinary arkose, while the arrangement on the large scale, and the more or less parallel alignment of rounded and waterworn quartzose fragments, amply testify to the final assortment and rearrangement of the disintegrated material as a result of ordinary sedimentation.

The relations between this granite and arkose are of rather unusual scientific interest, showing, as they do, the Pre-Huronian existence of a basement or floor upon which these sediments were laid down, and which in this portion at least has escaped the movements to which the Laurentian gneisses have been subjected. The granite is also somewhat different, both in composition and appearance, from the granites and gneisses classified as Laurentian, and which are so frequently referred to as the Fundamental Gneiss or Basement Complex, although during recent years the assumption implied in these terms has been considerably weakened by the fact that the contact between such rocks and the associated clastics is, wherever examined, one of intrusion. On the other hand, the composition of the Huronian strata furnishes indubitable evidence of a pre-existing basement or floor essentially granitic in composition, while the abundance of red granite pebbles and fragments, which are so pre-eminently abundant in the breccia-conglomerate lying at the base of the Huronian system, are very similar in composition and appearance to the granite described above. This granite is, therefore, regarded by the authors as the only instance at present known in which the material composing the Huronian clastics can be clearly and directly traced, both macroscopically and microscopically, to the original source from which it has been derived.

III.—The Fossil Phyllopoda of the Palæozoic Rocks. Thirteenth Report of the Committee, consisting of Professor T. Wiltshire (Chairman), Dr. H. Woodward, and Professor T. Rupert Jones (Secretary). (Drawn up by Professor T. Rupert Jones.)[1]

§ I. 1889–1892. Anomalous Silurian Phyllopods (?) from Germany and America.—In the *Sitz.-Ber. Gesell. naturf. Freunde zu Berlin*, 1890, p. 28, Dr. A. Krause described a small fossil carapace of doubtful alliance, but possibly related to the Phyllopods, from the North-German gravel of Scandinavian *Beyrichia*-limestone (Upper Silurian). In the *Zeitsch. Deutsch. Geol. Gesell.*, vol. xliv, 1892, p. 397, pl. xxii, figs. 19 *a–c*, Dr. A. Krause redescribed and figured this anomalous little fossil.

[1] Read before the British Association, Section C (Geology), Toronto, 1897.

Its lateral moieties are not free, separate valves, but united by an antero-dorsal suture for a third of its length, and by an antero-ventral suture for half of its length, the posterior region remaining open at the edges. It also shows in front a round aperture, with a sulcus formed by the somewhat inverted edges below it. The test is nearly oval and compressed; thickest and subacute in front; bearing a small, low, subcentral swelling. The surface has some reticulate ornament along the margins for the most part, succeeded by linear, radiating, and concentric sculpture towards the more convex area, which is finely punctate. It is 6 mm. long, 4 mm. high, and 1·5 mm. thick.

In S. A. Miller's "North-American Geology and Palæontology," 2nd edition, 1889, p. 549, fig. 1,009, an allied form is described and figured as *Faberia anomala*, n. sp. et gen., from the Hudson-River group, Ohio (Lower Silurian). This has evidently some analogy to the foregoing Upper Silurian form. It has a compressed, ovoidal, smooth shell, consisting of two moieties, partially sutured above and below, and is rather smaller than the German specimen.

§ II. 1885–1894. Cambrian Phyllopoda (?).—Dr. G. F. Matthew, of St. John, New Brunswick, has discovered several very small organisms in the Cambrian rocks of North-Eastern America, some of which he regards, with doubt, as having been carapace-valves of Phyllopodous Crustaceans. He has described and figured them in the Transactions of the Royal Society of Canada.

To this group of small subtriangular valve-like bodies, obliquely semicircular or semi-elliptical, with straight hinge-line and more or less definite umbo, belong (1) *Lepiditta alata*, M., Trans. Roy. Soc. Canada, vol. iii, 1885, sect. 4, p. 61, pl. vi, figs. 16, 16*a*; (2) *L. curta*, M., p. 62, pl. vi, fig. 17; (3) *Lepidilla*[1] *anomala*, M., p. 62, pl. vi, figs. 18, 18*a*, *b*, *c*; (4) *Lepiditta sigillata*, M., xi, 1894, sect. 4, p. 99, pl. xvii, fig. 1; (5) *L. auriculata*, M., p. 99, pl. xvii, figs. 2, 2*a*, *b*. Some of these were referred to by us in the Sixth Report (for 1888), p. 174.

§ III. 1889. *Rhachura venosa*, Scudder, 1878, Proc. Boston Soc. Nat. Hist., vol. xix, p. 296, pl. ix, figs. 3, 3*a* (referred to in our Report for 1883, p. 216). Dr. A. S. Packard, having received from M. Gurley some imperfect specimens found in the Middle Coal-measures, Danville, Illinois, describes them as being parts of a carapace, probably a little over three inches long, and three caudal spines, also rather obscure (Proc. Boston Soc. Nat. Hist., vol. xxiv, 1889, pp. 212, 213).

§ IV. 1893. *Rhinocaris columbina.*—Mr. J. M. Clarke has contributed a paper "On the Structure of the Carapace in the Devonian Crustacean *Rhinocaris*, and the relation of the Genus to *Mesothyra* and the Phyllocarida," with illustrative cuts, published in the *American Naturalist*, Sept. 1, 1893, pp. 793–801. The carapace-valves of *Rhinocaris columbina* (J. M. C., "Palæont. New York,"

[1] Dr. G. F. Matthew, in a letter of November 5, 1897, expresses a "wish to withdraw *Lepidilla*, as not being a Crustacean; more perfect specimens seem to show a fan-like structure of internal tubes."

vol. vii, 1888, pp. lviii and 195–7) are described from better specimens, which show it to be a bivalved (not univalved) form, and as having a narrow, median plate, of which there is evidence in *Mesothyra*, making a double dorsal suture. There is also a long, narrow, leaf-like rostrum inserted between the valves in front. The relationship of this form with *Mesothyra* and *Tropidocaris* is dwelt upon. The author thinks that *Dithyrocaris* and *Emmelezoe* have some affinity with it. *Rhinocaris* and *Mesothyra* are regarded as typical members of the family Rhinocaridæ. We may mention that Dr. Matthew regards his *Ceratiocaris pusilla* from the Silurian of New Brunswick (see Trans. Roy. Soc. Canada, vol. vi, 1888, sect. 4, p. 56, pl. iv, fig. 2; and our Seventh Report, for 1889, p. 64) as *Rhinocaris*.

§ V. 1895. *Emmelezoe Lindstroemi*.—Since our Twelfth Report, presented to the British Association at Ipswich in 1895, the Swedish Phyllocarids mentioned in that Report as having been found by Dr. Gustav Lindström in the Upper Silurian beds at Lau, Gothland, have been duly described and figured in the Geological Magazine, Decade IV, Vol. II, No. 378, December, 1895, pp. 540, 541, Pl. XV, Figs. 2*a*–2*d*, as *Emmelezoe Lindstroemi*, J. and W. The fish-remains (*Cyathaspis*) and other fossils associated with it are mentioned in detail by G. Lindström in the *Bihang till K. Svensk. Vet.-Akad. Handl.*, vol. xxi, part 4, No. 3, 1895, pp. 11, 12.

Mr. J. M. Clarke has suggested at p. 801 of his memoir, mentioned in § IV, that the oculate genus *Emmelezoe* may have some relationship to the group to which *Rhinocaris* belongs.

§ VI. 1895. *Pinnocaris Lapworthi*.—This genus, represented by its only known species, *P. Lapworthi*, has been carefully examined by Woodward and Jones, and several specimens described, selected from a large number in Mrs. Robert Gray's collection at Edinburgh. This memoir appeared in the Geological Magazine, Decade IV, Vol. II, 1895, pp. 542–5, Pl. XV, Figs. 5–10. Excepting one specimen from the Upper Silurian of Kendal, Westmoreland, all the known specimens are from the Lower Silurian of Girvan, Ayrshire, where Mrs. Gray has made a large collection.

The peculiar "corded" dorsal margin of the valves may have reference to some longitudinal, narrow, intermediate ligament or plate as in *Rhinocaris* and *Mesothyra*.

§ VII. 1895. A new species of *Ceratiocaris* (*C. reticosa*, J. and W.), preserved in the Museum of the Geological Survey, was described in the Geological Magazine, Decade IV, Vol. II, 1895, pp. 539, 540, Pl. XV, Figs. 1*a*, 1*b*. It is from the Silurian beds of Ludlow, Shropshire, and is allied to *C. cassioides*, from that locality. Traces of a peculiar reticulate sculpture constitute its distinguishing feature.

§ VIII. 1895. *Lingulocaris*.—In the same number (378) of the Geological Magazine, 1895, at pp. 541, 542, a specimen *Lingulocaris lingulæcomes*, Salter, belonging to the Rev. G. C. H. Pollen, S.J., F.G.S., was figured and described. It came from Capel Arthog, North Wales, probably from the Ffestiniog or middle division of the

Lingula-flags. Hence we may add "*Lingulocaris*" to "*Hymenocaris*" for that formation at p. 425 of our Twelfth Report (fifth line from the bottom).

§ IX. 1896. Devonian species of *Ceratiocaris* (?). — In the "Monograph of the Devonian Fauna of the South of England," Palæont. Soc., vol. iii, part 1, 1896, the Rev. G. F. Whidborne describes and figures three obscure casts of *Ceratiocaris*, one *C.* (?) *subquadrata*, sp. nov., p. 7, pl. i, fig. 5, from East Anstey; another, *Ceratiocaris* (?) sp., p. 8, pl. i, fig. 6, from Sloly; and the third, somewhat indistinct specimen, namely *Ceratiocaris* (?) sp., p. 8, pl. ii, fig. 12, from Croyde.

§ X. 1896. *Entomocaris* and *Ceratiocaris*. — A collection of *Ceratiocaris*-like Crustaceans from the Lower Helderberg Formation (Upper Silurian), near Waubeka, Wisconsin, has afforded Mr. R. P. Whitfield, of the American Natural History Museum, New York, the opportunity of determining two new species of *Ceratiocaris*, and a new genus (*Entomocaris*), allied to *Ceratiocaris*, but differing from it by the carapace-valves being "strongly curved in front and behind on the dorsal margin," and by the posterior margin not being truncate, as in *Ceratiocaris*, but obtusely rounded. *Entomocaris Telleri*, Whitfield (p. 300), is figured in pl. xii, of full size, but slightly distorted by pressure. Including the four exposed body-segments and the trifid appendage, it is about 21 centimetres (about 8 inches) long; and the valves are about 13½ centimetres long by about 6½ high. Some indications of the swimming-feet attached to the body are visible where one valve has been partially broken away from the internal cast. Some mandibles, supposed to belong to this species, are shown in pl. xiv, figs. 1, 2; and the caudal appendages in fig. 9.

Ceratiocaris Monroei, Whitfield (p. 301, pl. xiii, figs. 1–5, and pl. xiv, figs. 3–8), is carefully described from one nearly perfect and an imperfect specimen, together with body-segments, caudal appendages, and some mandibles. The carapace-valves seem to have been about 7½ centimetres long and 4 high.

Ceratiocaris poduriformis, Whitfield (p. 302, pl. xiv, fig. 10), is represented by a small specimen of abdominal segments and caudal spines.

§ XI. 1896. *Echinocaris Whidbornei*, J. and W., noticed in our Seventh Report (for 1889), p. 63, has been redescribed and refigured by the Rev. G. F. Whidborne in the "Monogr. Devonian Fauna, S. England," Pal. Soc., vol. iii, part 1, 1896, p. 6, pl. i, fig. 3.

Within the last few months Ananda K. Coomáry-Swámy, Esq., of Warplesdon, has fortunately obtained a very interesting specimen of this *Echinocaris* from the Sloly mudstone, showing on the two counterparts of the little split slab, two individuals, each having the same characters as the specimen first described in the Geological Magazine, Decade III, Vol. VI, 1889, p. 385, Pl. XI, Fig. 1. Though rather narrowed by oblique pressure, the valves are equal in breadth to those of the first specimen. An additional feature of interest is seen in some body-segments, five in one individual and

three in the other. In each case, though the series of segments is not complete either at beginning or end, they are characteristically like those of *Echinocaris*, the distal edges bearing tubercles, the equivalents of spinules.

§ XII. 1896. *Caryocaris.*—In the Journal of Geology, Chicago, vol. iv, 1896, p. 85, Dr. R. R. Gurley has described *Caryocaris* as the "lateral appendages" of the "polypary" of a Graptolite! *Caryocaris* was referred to by us in the First and Seventh Reports (for 1883 and 1891), and was described in detail and figured in the "Monogr. Brit. Palæoz. Phyllocarida," Pal. Soc. 1892, p. 89 et seq., pl. xiv, figs. 11–18.

§ XIII. 1897. A new locality in Nova Scotia has been determined by Sir William Dawson for *Estheria Dawsoni*, namely, East Branch, East River, Pictou County, Lower Carboniferous. Several casts and impressions of small valves, not more than two millimetres long, occur on the bed-planes of a dark-red Lower Carboniferous shale. Former occurrences of this species were noticed in our Report (Eleventh) for 1894.

REVIEWS.

PETROLOGY FOR STUDENTS: AN INTRODUCTION TO THE STUDY OF ROCKS UNDER THE MICROSCOPE. By ALFRED HARKER, M.A., F.G.S. Second edition, revised. 334 pp., 75 figs. (Cambridge: Messrs. C. J. Clay & Sons, 1897. Price 7*s.* 6*d.*)

THE appearance within two years of a second edition of so excellent a textbook as Harker's "Petrology for Students" is not a subject for surprise. In this revised edition the author states that he has endeavoured to profit by the criticisms of reviewers and private friends. The slight alteration, however, which the book has undergone shows how little cause for adverse criticism there was in the first edition. In general plan and scope the book remains precisely the same. Only about thirty pages have been added, and these are mainly due to the introduction of descriptions of American examples among the igneous rocks, one result of which is, that the reader makes the acquaintance of a number of those new names (Absarokite, Banakite, Carmeloite, Shonkinite, etc.) to the invention of which American geologists have of late been perhaps a little too prone.

The method of classification of the igneous rocks remains practically the same, but Brögger's name "hypabyssal" is substituted for "intrusive." As the author remarks, "petrology has not yet arrived at any philosophical classification," and certainly the attempt to pigeonhole the igneous rocks, both basic and acid, into the three groups, plutonic, hypabyssal, and volcanic, involves inconsistencies which are evident in the text. Thus three chapters intervene between the descriptions of such similar rocks as the pitchstones of Arran and the "pitchstones" (or, as the author prefers to call them, the Permian rhyolites) of Meissen; while the