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THE

CANADIAN NATURALIST

AND

Quarterly Journal of Science.

THE POST-PLIOCENE GEOLOGY OF CANADA.

By J. W. Dawson, LL.D., F.R.S., F.G.S.

SUB-KINGDOM MOLLUSCA.

Introductory.—In preparing this, the largest and most important part of my catalogue, I have to acknowledge my obligations to Dr. P. P. Carpenter, for his kind aid in comparing all the more critical species of shells, and in giving me his valuable judgment as to their relations and synonymy, which I have in nearly every case accepted as final. I am also indebted to Dr. Carpenter for all the notices of West-coast shells.

To Mr. J. F. Whiteaves, F.G.S., I am indebted for reviewing the Polyzoa and comparing them with Smitt's Norwegian catalogues, and also for many valuable facts as to shells obtained in his recent dredgings in the Gulf of St. Lawrence.

To Mr. J. Gwyn Jeffreys, F.R.S., and Mr. R. McAndrew, F.R.S., of London, my grateful acknowledgments are due for aid and information, and also for the opportunity of comparing my specimens with those in their collections.

My comparisons with recent species have been made to a great extent with specimens dredged by myself, in the Gulf of St. Lawrence, and especially at Murray Bay, where the marine fauna seems to be more nearly related to that of the Post-pliocene than in any part of the Gulf of St. Lawrence with which I am acquainted. I have also to acknowledge the use of specimens from Greenland, from Prof. Morch; from Norway from Mr. McAndrew; from Nova Scotia from Mr. Willis; as well as the use of the large and valuable collections of Dr. Carpenter and Mr. Whiteaves.

All the references in the following pages, except where authors are quoted, and many of these last, have been verified by myself by actual comparison of specimens.

The principal works to which I have referred in the publication of the catalogue are the following:

Beechey's Voyage, Natural History Appendix.
Belcher's Last of the Arctic Voyages, do.
Bell, Report on Invertebrata of Gulf of St. Lawrence.
Busk, Polyzoa of the Crag.
Crosskey on Post-pliocene of Scotland.
Fabricius, Fauna Grœnlandica.
Forbes and Hanley, British Mollusca.
Gould, Invertebrata of Massachusetts, edited by Binney.
Jeffreys' British Conchology.
Lyell on Shells collected by Capt. Bayfield; and Travels in North America.
Matthew on Post-pliocene of New Brunswick.
Middendorff, Shells of Siberia.
Packard on the Glacial Phenomena of Labrador and Maine.
Prestwich on the English Crag.
Sars on the Quaternary of Norway.
Stimpson, Shells of Hayes' Expedition, &c.
Whiteaves, Lists of Shells from Gulf of St. Lawrence, Canadian Naturalist.
Wood, Crag Mollusca.
Willis, Lists of Shells of Nova Scotia.

Class I.—Heterobranchiata.

Sub-Class I.—*Polyzoa.*

Hippothoa catenularia, Jameson.
Fossil—Beauport; Labrador; Rivière-du-Loup.
Recent—Gaspé*; Labrador (Packard).

* The references to Gaspé are from my list contributed to the Rept. Geol. Survey, 1858—Bell and Richardson, collectors; and from subsequent dredgings by myself and Mr. Whiteaves.

Hippothoa expansa, Dawson.
Fossil—Beauport; Rivière-du-Loup.
Recent—Gaspé; Labrador, Maine (Packard).

Tubulipora flabellaris, Johnston.
Fossil—Beauport; Rivière-du-Loup.
Recent—Gaspé, Labrador (Packard) (= *T. palmata*, Wood).

Lepralia hyalina, Johnston.
Fossil—Beauport; Rivière-du-Loup.
Recent—Gaspé.

Lepralia pertusa, Thomson.
Fossil—Beauport; Labrador; Rivière-du-Loup.
Recent—Gaspé, Labrador (Packard).

Lepralia quadricornuta, Dawson.
Fossil—Leda clay, Montreal.
Not yet found recent.

Mr. T. Curry, of Montreal, has recently found specimens in a very perfect state. They show that the cells are sculptured in a papillo-striate manner, and that the ovi-capsules are globular and granulate. Some cells have a projection for a vibraculum or avicularium at one side of the aperture. A few have two of these. Old colonies have a pitted calcareous deposit between the cells. The large size and narrow aperture with deep sulcas in front and four spines behind are as in the specimens formerly described.

Lepralia spinifera? Busk.
Fossil—Rivière-du-Loup.

L. violacea? Johnston.
Fossil—Rivière-du-Loup.

It wants the depression in front of the cell said to be characteristic of the species. (J. F. Whiteaves.)

L. variolosa, Johnston.
Fossil—Rivière-du-Loup.
Recent—Gaspé.

Dr. Smitt unites this with *L. trispinosa* of Johnston, and considers both as varieties of *L. Jacotini*, Audouin. *L. Jacotini*, Gray, is a very different species. (J. F. W.)

Lepralia Belli, Dawson.
Fossil—Rivière-du-Loup.
Recent—Gaspé; Labrador (Packard).

L. producta, Packard.
Fossil—Rivière-du-Loup.
Recent—Labrador (Packard); Gaspé; Murray Bay.

L. globifera, Packard.
Fossil—Rivière-du-Loup.
Recent—Labrador (Packard).

L. punctata ? Hassall.
Fossil—Rivière-du-Loup.
Recent—Gaspé.
The oral spines of this species cannot be made out in the fossil specimens I have seen. Smitt refers Hassall's species to D'Orbigny's sub-genus *Escharipora*. (J. F. W.)

L. Peachii, Johnston.
Fossil—Rivière-du-Loup.
Recent—Gaspé.
Rare in the Gulf of St. Lawrence. Smitt groups this species, together with *L. variolosa* (of Busk but *not* of Johnston) and *L. ventricosa*, as forms of *Discopora coccinea*. (J. F. W.)

Lepralia trispinosa, Johnston.
Fossil—Rivière-du-Loup.
Recent—Gaspé; Labrador (Packard).

Lepralia ventricosa, Hassall.
Fossil—Rivière-du-Loup.
Recent—Gulf St. Lawrence.

Diastopora obelia, Johnston.
Fossil—Rivière-du-Loup.
Recent—Gaspé.

Eschara elegantula, D'Orbigny.
Fossil—Rivière-du-Loup; Montreal (Curry).
Recent—Labrador (Packard); Gaspé.
Very fine and frequent in 10–30 fathoms opposite Cape Rosier Village. More abundant in the open river than in Gaspé and other bays. (J. F. W.)

Celleporaria surcularis, Packard.
Fossil—Rivière-du-Loup.
Recent—Labrador (Packard); Gaspé.
Smitt identifies this species with the *C. incrassata* of Lamarck. Abundant in 10–50 fathoms everywhere in the Gulf, and often drifted down to lower levels. (J. F. W.)

Myriozoum sub-gracile, D'Orbigny.
Fossil—Rivière-du-Loup.
Recent—Labrador (Packard); Gaspé.

Idmonea atlantica, Forbes.
Fossil—Rivière-du-Loup.
Recent—I believe this to be identical with a species found in the Gulf of St. Lawrence, and referred by Dr. Packard and Mr. Whiteaves to the above.

Crisia eburnea, Ellis.
Fossil—Montreal. A specimen collected by Mr. Curry is referred to this species by Mr. Whiteaves.
Recent—Labrador (Packard). In 96 fathoms, Trinity Bay, N. Shore St. Lawrence R. J. F. W.

Alecto, sp.
Fossil—Rivière-du-Loup.

Membranipora Lacroixii, Busk.
Fossil—Rivière-du-Loup.
Recent—Gaspé; Labrador (Packard).
Entirely agrees with recent examples from Gulf of St. Lawrence. One of the six forms referred by Smitt to *M. lineata* Linn. (J. F. W.)

Membranipora lineata, Linn.
Fossil—Rivière-du-Loup.
Recent—Gaspé.

Discoporella hispida, Johnston.
Fossil—Rivière-du-Loup. Patches on shells, somewhat worn, but referable to this common North Atlantic species.

Sub-Class II.—*Brachiopoda.*

Rhynchonella psittacea, Gm.
Fossil—Montreal; Beauport; Rivière-du-Loup. Abundant.
Recent—Murray Bay and Gaspé. Abundant. Labrador (Packard); Gulf St. Lawrence. Generally on stony bottoms 10 fathoms and over. Arctic seas generally; also Crag of England and glacial beds.

In a bed of stony clay at Rivière-du-Loup, this shell is very abundant, with less abundant specimens of the next species. It occurs living in precisely the same relations and in great abundance at Murray Bay, in about 20 fathoms.

Terebratella Spitzbergensis, Davidson.

Fossil—Rivière-du-Loup.

Recent—Murray Bay; also deeper parts of Gulf of St. Lawrence (Whiteaves); Nova Scotia (Willis).

This species has been found in the Post-pliocene of Canada, hitherto only at Rivière-du-Loup, and is rare. It was called *T. Labradorensis*, Sowerby, in former lists, which seems to be a synonym. It appears to be a rare shell in every part of the Gulf where it has hitherto occurred, except at Murray Bay, where it is not uncommon, and is found attached to stones in 20 to 25 fathoms, associated with *Rhynchonella psittacea*.

Class II.—Lamellibranchiata.

Pholas (Zirphea) crispata, Linn.

Fossil—Maine (Packard).

I have not found this species fossil in Canada, but it exists as a living shell on the New England coast generally, in Northumberland Strait; Gulf of St. Lawrence, and according to Bell as far to the north-west as Rimouski. Puget Sound (U. S. Expl. Exped.)

It has perhaps extended its northern limit to Canada since the glacial period. On the European coast it is a northern shell, reaching south to the Mediterranean.

Saxicava rugosa, Linn (and var. *Arctica*).

Fossil—Saxicava sand and top of Leda clay, Montreal; St. Nicholas; Ottawa; Quebec; Murray Bay; Rivière-du-Loup; Trois Pistoles; Tadousac; Labrador; Lawlor's Lake, New Brunswick; Maine, &c.

Recent—Gulf St. Lawrence; coast of Nova Scotia; and New England and northern seas generally; also west coast of America as far as Mazatlan. (P. P. Carpenter).

Very abundant in the more shallow portions of the Post-pliocene throughout Canada, and presenting all the numerous varietal forms of the species in great perfection. It is relatively much more abundant in the drift deposits than in the Gulf of St. Lawrence at present. Pieces of limestone which have been bored probably by this shell, are not rare in the drift at Montreal.

This is a widely distributed Arctic species, and is found in the Post-pliocene deposits of Europe, and as far back as the Miocene.

Panopæa Norvegica, Spengler.

Fossil—Leda clay; Rivière-du-Loup. Very rare.

Recent—Dredged in Gaspé Bay, 30 and 40 fathoms, by Mr. Whiteaves; Halifax (Willis); Grand Manan (Stimpson); Arctic and northern seas generally.

It is very rare in the Post-pliocene, a few valves only having been found at Rivière-du-Loup. The specimens are small, and much inferior to those found in the Scottish Clyde beds, of which I have a specimen from Rev. H. Crosskey.

Mya truncata, Linn. (and var. *Uddevallensis*).

Fossil—Saxicava sand and Leda clay; Montreal; Quebec; Rivière-du-Loup; Portland; New Brunswick (Matthew); Labrador (Packard); Greenland (Möller); also in the Post-pliocene of Europe.

Recent—Gulf St. Lawrence, but rare in comparison with its abundance in the drift. Generally distributed in the Arctic seas and North Atlantic, American coast as far south as Cape Cod; Puget Sound (=*preciosa*, Gould, P. P. C.)

The variety found in the Post-pliocene of Canada is the short or *Uddevallensis* variety, which is that occurring in the Arctic seas at present, while in the Gulf St. Lawrence the ordinary long variety is found almost exclusively. At Portland, Maine, however, the long variety lived in the Post-pliocene, and occasional specimens are found at Rivière-du-Loup. The form *Uddevallensis* occurs living in Labrador (Packard), and I have found it at Tadousac.

It is interesting to observe that while the present species is more abundant than the next in the Post-pliocene, it is much more rare in the Gulf at present. It also occurs in deeper water.

Mya arenaria, Linn.

Fossil—Leda clay and lower part of Saxicava sand; Montreal; Upton; Quebec; Murray Bay; Labrador; Duck cove and Lawlor's lake, New Brunswick; Portland, Maine; Greenland (Möller); also in the Post-pliocene of Europe.

Recent—Very abundant throughout the Gulf St. Lawrence and coast of Nova Scotia and New England, also Arctic seas generally. Mr. Jeffreys considers it identical with *M. Japonica*, Jay. Not found yet in W. America. (P. P. C.)

In the Gulf this species grows to a large size; I have a specimen five inches long from Gaspé; but in the Post-pliocene it is small and often of a short and rounded variety. This is especially the case inland, as at Montreal. At Rivière-du-Loup a small thin variety with a strong epidermis and attenuated posteriorly, is found *in situ* in its burrows in the Leda clay. It may be a deep-water variety. Some large specimens in collections from this place, I have reason to believe are from Kitchen-middens and not fossils.

Kennerlia glacialis, Leach.

Fossil—Leda clay; St. John, New Brunswick; Saco, Maine.

Recent—Gaspé (Whiteaves); Murray Bay; Labrador (Packard).

This species, which was at first confounded with *Pandora trilineata* by Dr. Packard, is evidently quite distinct, and on the evidence of the hinge would belong to a different genus. Much nearer to *Pandora pinna*, Mont.; = *P. obtusa* Forbes and Hanley. J. F. W.

Lyonsia (Pandorina) arenosa, Möller.

Fossil—Leda clay; Montreal (rare and small); Rivière-du-Loup, common; Duck Cove, N. B.; Saco, Maine; also in Greenland (Möller).

Recent—Murray Bay and Gaspé; Halifax (Willis); Greenland (Möller); Labrador (Packard).

Some specimens from Portland are much larger than those from Rivière-du-Loup and Montreal, and Mr. Whiteaves finds individuals an inch long, living at Gaspé.

Thracia Conradi, Couthuoy.

Fossil—Saco (Packard).

Not yet found fossil in Canada, but recent, though rare, in Nova Scotia (Willis); and at Gaspé. Also, though apparently rare, at Labrador (Packard).

Has probably extended its northern limit to Canada, since the glacial period.

Macoma Grœnlandica, Beck.

Fossil—Saxicava sand and Leda clay; Montreal; Ottawa; Perth, Ont.; Pakenham Mills, Cornwall; Clarenceville; Upton; Quebec; Murray Bay; Rivière-du-Loup; Labrador; Lawlor's lake, N.B.; Campbellton, P. E. I.; Westbeach, Maine; Greenland (Möller).

Recent—Everywhere on the coasts of the Gulf and River St. Lawrence, as a common littoral shell.

A thin and delicate variety with smooth epidermis is found in the Leda clay; coarser and more wrinkled varieties in the Saxicava sand. Larger specimens are found at Quebec and Rivière-du-Loup than more inland.

In the modern Gulf, the small and depauperated varieties are littoral and near the brackish water, the finer varieties passing into *Macoma fusca* of Say, which is a southern variety, are found on the coast of Nova Scotia and in the Bay of Fundy. This shell is represented in the European seas and Post-pliocene deposits by the closely allied species *M. solidula* or *Balthica*, which seems to pass through a corresponding series of varieties, but to be distinct. On the western American coast it is similarly represented by *M. inconspicua.* Mr. Tryon and Mr. Whiteaves believe the three forms to be conspecific. (P. P. C.)

It is said to be the *Tellina Fabricii* of Hanley, and I have specimens from Greenland from Morch labelled *T. tenera*. The *T. tenera* of Leach, however, is *proxima*, Brown, teste Hanley. It is apparently the *Venus fragilis* of Fabricius.

It is one of the most common and abundant shells of the Post-pliocene, as it is of the American coast from Greenland to New England.

Macoma calcarea, Chemnitz.

Fossil—Leda and Boulder clays; Montreal; Quebec; Murray Bay; Rivière-du-Loup; Duck Cove, St. John, N.B.; Maine; Labrador; Greenland (Möller); also European Post-pliocene.

Recent—Arctic seas generally, and on the American coast south to Massachusetts.

This shell is is extremely abundant in the Leda and Boulder clays, and often occurs in the clay with the valves attached. It is also of large size and in fine condition, especially at Rivière-du-Loup. It is *Tellina proxima*, Brown, *T. sabulosa*, Spengler, and *T. sordida* of Couthuoy. According to Hanley, the *T. lata* of Gmelin was founded on a figure of this shell.

Macoma inflata, Stimpson.

Fossil—Montreal; Rivière-du-Loup. Rare.

Recent—Murray Bay, and dredged in deeper parts of the Gulf of St. Lawrence by Mr. Whiteaves.

I am not aware where this little shell has been described, nor what is its range. It seems identical with a specimen in Jeffrey's collection labelled *Tellina fragilis* Leach, from Spitzbergen.

The Post-pliocene specimens are larger and better developed than the recent, except some dredged by Mr. Whiteaves on the north shore, and I would infer from this that the shell is Arctic. (See Figure.)

Cyrtodaria siliqua, Daudin.

Fossil—Rivière-du-Loup; Labrador (Packard); Greenland (Möller). I have seen in the Post-pliocene of Canada, only an imperfect and decorticated specimen of the young shell from Rivière-du-Loup.

Recent—Gulf of St. Lawrence, and coasts of Nova Scotia and New England.

Mactra (Spisula) ovalis, Gould.

M. polynema, Stimpson.

Fossil—Boulder clay; Cape Elizabeth, Maine.

Recent—Gaspé; Labrador (Packard); also coast of New England.

I found, many years ago, a few specimens of this shell at a cove where a number of species of marine shells occur in Boulder-clay, and it was published in my list of shells from this place in my paper on the Post-pliocene of Labrador, Maine, &c. It is credited by Packard to "Zeeb's Cove," Cape Elizabeth, which may probably be the same place where I procured it. This species has not yet been found within the limits of Canada in the Post-pliocene, though this and the related species or variety, *M. solidissima*, are found living at Labrador. It has perhaps moved northward since the glacial period.

Mesodesma (Ceronia) deaurata, Turton.

Fossil—Matanne River (Bell.) I have not seen it in any other locality; and it occurs only on the lowest terrace, so that possibly it is modern.

Recent—Abundant at Tadousac and elsewhere in Gulf St. Lawrence; Labrador (Packard.)

This must be a modern species on our coasts; but according to Wood it is found in the Red Crag of England.

Venericardia (Cardita) borealis, Conrad.

Fossil—Labrador (Packard.)

Recent—Arctic seas to Long Island, and common throughout the Gulf of St. Lawrence. It would seem to have been much less generally distributed in the Post-pliocene. Western America as far south as Catalina Island. (P. P. C.)

Astarte Laurentiana, Lyell.

Fossil—Leda clay, Montreal, abundant; Beauport and Rivière-du-Loup, rare.

Recent—Greenland (Morch); Labrador (Packard); Murray Bay.

This shell may be a variety of the next species; but it is at least a very distinct varietal form. It is distinguished by its very fine and uniform concentric striation, passing to the ends of the valves and to the ventral margin. There are two varieties, a flatter, and more tumid. I have the former from Greenland named by Morch *A. Banksii*, and the latter named *A. striata*; but they are different from shells indicated by these names in Gould and elsewhere. The only recent specimens that I have seen from the Gulf of St. Lawrence, which can be referred to this species, are a few I dredged at Murray Bay. *A. Laurentiana* is very abundant at Montreal, but much more rare nearer the coast. It is evidently an Arctic form. (See Figure.)

Astarte Banksii, Leach.

Fossil—Leda clay, Rivière-du-Loup, abundant; Quebec, not infrequent; Montreal, very rare; Labrador (Packard); Portland, Maine, also Uddevalla, Clyde beds and Crag.

Recent—Abundant at Gaspé and elsewhere in Gulf of St. Lawrence, and also Arctic seas and coast of Nova Scotia.

This shell is that named *A Banksii*, in Gould's last edition, also in Beechey's voyages. It is easily distinguished from the last species by its coarser striation, fading toward the ends and also toward the margin of the shell. It is however about the same size, but less delicate and symmetrical in form. It is the common small Astarte of the Gulf St. Lawrence, and also of the Post-pliocene of Rivière-du-Loup; but becomes very rare at Montreal, where it is replaced by *A. Laurentiana*. This species was named *A. compressa* in my former lists, and it is certainly very near to European specimens of that species, especially to the fossils from the Clyde beds and the Crag. (See Figure.)

Astarte Elliptica, Brown.

Fossil—Labrador; Saguenay; Portland, Maine.

Recent—Labrador; Murray Bay; Gaspé; coast of Nova &c. Also Greenland; Norway (typical); Scotland.

Specimens from the Clyde beds are perfectly identical with ours. It is also found in the Post-pliocene of Norway and rarely in the Crag. It is a northern species meeting on the American coast the closely allied forms *A. Undata* and *A. lens*, into which however it does not seem to pass. The two latter species, being more southern forms, are not found in the Post-pliocene.

A. Omalii of S. Wood from the Crag, is very near to this species, but is at least a distinct variety.

Astarte Arctica, Möller, (var *Lactea*.)

Fossil—Labrador (Packard); Portland, Maine; also Greenland, (Möller).

Recent—Gaspé; also Arctic seas; Norway (typical).

This species has not yet been found in the Post-pliocene of Canada, except in Labrador; and it seems to be a rare shell in the Gulf of St. Lawrence. It is our largest Astarte and I believe it to be identical with *A. borealis*, Chem., *A lactea*, Brod. and Sow., and *A Semisulcata*, Gray. Fossil specimens from Portland, are precisely similar to recent ones from Gaspé dredged by Mr. Whiteaves, and referred by him to *A. lactea*. Specimens from Norway (*A. Arctica*) and from Clyde beds (*A. Borealis*) are smoother and less ribbed than ours.

Other species of Astarte.

At Murray Bay, there occurs very rarely a transversely elongated and regularly striated Astarte with delicately wrinkled epidermis, which seems to be identical with *A. Richardsonii* from the Arctic seas as described but not as figured by Reeve. It is not improbably a young state of *Astarte Arctica*. A similar species or variety occurs, but very rarely, fossil at Rivière-du-Loup. *A. sulcata* (undata), *A. lens*, *A. crebricostata*, *A. castanea*, and *A. quadrans* have not yet been found fossil, though the three former at least live in the Gulf of St. Lawrence.*

Cardium pinnulatum, Conrad.

Fossil—Leda clay, Lawlor's Lake, N.B.

Recent—Gulf St. Lawrence, and coast of Nova Scotia and New England.

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* *A. undata* Gould and *A. quadrans*, Gould, certainly occur in the Gulf of St. Lawrence N. of the Bay of Chaleurs. A shell dredged in deep water N. of Anticosti may be *A. crebricostata*. *A. lens*, Stimpson, and *A. castanea*, Say, have not yet occurred to me in dredgings from more than 60 localities N. of New Brunswick. J. F. W.

Cardium Islandicum, Linn.

Fossil—Rivière-du-Loup; Murray Bay; Saguenay; Portland, Maine; Lawlor's Lake, N.B.; Greenland, Möller).

Recent—From Greenland to New England.

Our fossil specimens are mostly small, and similar to the northern variety or sub-species named by Stimpson *C. Hayseii*, and which also occurs living as far south as Nova Scotia, and seems to be the *C. ciliatum* of Fabricius. Decorticated specimens are not distinguishable from *C. Dawsonii* of Stimpson, from the Post-pliocene of Hudson's Bay; of which I have seen only specimens in this state.

Serripes Grœnlandica, Chemnitz.

Fossil—Leda clay, and Boulder clay, Quebec; Rivière-du-Loup; Murray Bay; Lawlor's Lake, N.B.; Cape Elizabeth, Maine; Labrador, (Packard); Greenland (Möller).

Recent—Gulf St. Lawrence, sometimes of large size, Arctic seas, and Greenland to Cape Cod.

This shell is somewhat rare and of small size in the Post-pliocene, and has not yet been found higher up the St. Lawrence than Quebec. Specimens of good size occur at Portland.

Cryptodon Gouldii, Philippi.

Fossil—Montreal, rare.

Recent—Murray Bay; Gaspé (Whiteaves); Greenland to New England.

The European form *C. flexuosa* is usually regarded as distinct, and is found as far north as Spitzbergen, and in the Crag, the Clyde beds, and the Norway Post-pliocene. Jeffreys, however, considers the difference merely varietal, and it certainly seems to diminish or disappear in the northern and glacial specimens.

According to Mr. Whiteaves this species has a great range in depth in the Gulf St. Lawrence, being found, living, from 20 to 300 fathoms.

Sphaerium?

Fossil—Pakenham Mills, with fresh-water bivalves and *Tellina Grœnlandica*. The specimens were too imperfect for certain determination.

Unio rectus, Lamarck.

Fossil—Clarenceville, Lake Champlain (Dickson), with *Mya arenaria, Tellina Grœnlandica*, &c.

Recent—River St. Lawrence.

Unio Cardium? Rafinesque.

Fossil—With the preceding. This and the preceding species were represented by large and thick shells better developed than those of the River St. Lawrence at present. It is probably the same with *U. ventricosus*, Say.

Mytilus edulis Linn.

Fossil—Montreal; Acton; Rivière-du-Loup; Quebec; Labrador (Packard); Lawlor's Lake, N.B. (Matthew); Greenland (Möller).

Recent—North Atlantic and Arctic seas generally; North Pacific (=*trossulus*, Gould) as far south as Monterey.

The variety most commonly found in the Post-pliocene is a small, oval, tumid form, allied to variety *elegans* of British writers (see figure). This variety still lives at Tadoussac; and is apparently characteristic of situations where the water is cold and exposed to intermixture of fresh water. The ordinary variety occurs at Portland, and also in some of the upper beds at Rivière-du-Loup. At Montreal only the small oval variety occurs. This variety is also found in the Clyde beds and in the crag.

Modiola modiolus, Linn.

Fossil—Montreal, very rare.

Recent—Labrador to New England; very common on the coasts of Nova Scotia and New England; North Pacific; found sparingly along the Vancouver and Californian coasts till it is replaced in the Gulf fauna by *M. capax*, Conrad.

This species becomes rare to the northward; and this, as well as its being proper to rocky shores rather than to clays and sands, may account for its rarity in the Canadian Post-pliocene. It is, however, common in the glacial beds of Europe.

Modiolaria nigra, Gray.

Fossil—Montreal; Rivière-du-Loup (small variety *nexa*; also large and fine); very large and well preserved in nodules at Kennebeck, Maine; Labrador (Packard of his *M. discrepans* as I suppose.)

Recent—Gulf of St. Lawrence (Whiteaves). Very large and fine on coast of Nova Scotia (Willis), and as far north as Greenland (*M. discors*, Fabricius).

Modiolaria corrugata, Stimpson.

Fossil—Rivière-du-Loup.

Recent—Murray Bay and Cacouna; precisely similar to the shells from the Post-pliocene. Also Greenland (Moller); Labrador (Packard); and south to Cape Cod.

Modiolaria discors, Leach.

Fossil—Beauport, of good size; Greenland (Möller).

Recent—Labrador to New England. Specimens from Gaspé are precisely similar to the fossil. This shell is no doubt identical with *M. lævigata* of Gray, and possibly with the *M. discrepans* of some other authors. It is however the same with that figured in Binney's Gould as *M. discors.*

Crenella glandula, Totten.

This species, which is at present quite common in the Gulf St. Lawrence, is indicated in my formerly published lists as a Montreal fossil; but I have mislaid the specimens, and cannot therefore now repeat the comparisons with the recent shells.

According to Mr. Whiteaves this is quite distinct from *C. decussata*, Montagu, both being found living in Gaspé.

Nucula tenuis, Montagu.

Fossil—Leda clay, Montreal; Saco (var. *inflata*); Rivière-du-Loup?

Recent—North shore Gulf St. Lawrence to Gaspé (Whiteaves) type and var. *inflata*; also European coasts.

N. expansa, Reeve.

Fossil—Leda clay and Boulder clay, Rivière-du-Loup; Saco; Duck Cove, St. John, N.B.

Recent—Labrador (Packard); Murray Bay; Arctic seas.

I doubt if this is not a large and well-developed northern form of *N. tenuis.*

N. antiqua, Mörch, from Leda clay of Maine, seems to be a variety.

Leda pernula, Muller.

Fossil—Leda clay, Rivière-du-Loup; Portland; Saco; Lawlor's Lake, N.B. (Matthew).

Recent—Arctic seas and south to New England.

This shell occurs very abundantly at Rivière-du-Loup; and the specimens found there show that no specific line can be drawn between the forms known as *pernula*, *buccata* (Steenst.), *tenuisulcata*, Gould, and *Jacksonii*, Gould. Slender and flattened varieties are *pernula* and *tenuisulcata*, shorter and more tumid forms are *buccata;* and specimens decorticated so as to show the origin of the hinge teeth are *Portlandica*. Comparison of specimens from Greenland, Norway, Labrador, the Gulf St. Lawrence, and New England, confirms this conclusion. (See Figure.)

Leda minuta, Fabricius.

Fossil—Leda clay, Montreal; Rivière-du-Loup; Greenland (Möller); Labrador (Packard).

Recent—Arctic seas, Gulf St. Lawrence; coast of Nova Scotia.

The fossil specimens occur abundantly with the last species at Riviére-du-Loup, and are quite similar to those dredged at Murray Bay. This was called *L. caudata* in my former lists.

Lyda pygmæa, Munster.

Fossil—Leda clay. Green's Creek, Ottawa; Saco; Maine; also English Crag and other Glacial beds.

Recent—North European seas; but not yet recognized on the American coast. According to Mr. Jeffreys and Dr. Carpenter, our drift shells are referable to the variety or species *Yoldia abyssicola* of Torell.

Leda (Portlandia) glacialis, Gray; *truncata*, Brown.

Fossil—Leda clay and Boulder clay, Montreal; Quebec; Ottawa River; Rivière-du-Loup; St. John, N.B.; Portland and Saco, Maine; also in Post-pliocene of Norway (Sars), and of Scotland (Crosskey).

Recent—Arctic seas.

This shell is most abundant, and generally diffused in the Leda clay; and the variety ordinarily found at Montreal and Rivière-du-Loup is precisely identical with the ordinary Arctic form. A long variety, called *L. intermedia* by Sars, is also found at Montreal, though rarely. A short variety, common in the Post-pliocene at Murray Bay, is similar to the *L. siliqua* of Reeve from the Arctic seas; and young and depauperated varieties resemble *L. sulcifera* of the same author. The abundant material from the Post-pliocene shows that these are all varietal forms.

This shell is *Yoldia Arctica* of Sars, but not of Möller and Morch. It is *Y. truncata* of Brown. It is *Portlandia glacialis* of Gray, and *Leda Portlandica* of Hitchcock.

Yoldia lucida, Lovén (which is abundant living in the deeper parts of the Gulf of St. Lawrence) closely resembles the young, smooth form of this species, but I think the two may be distinct. J. F. W.

Leda (Yoldia) limatula, Say.

Fossil—Leda clay, Rivière-du-Loup.

Recent—Gulf St. Lawrence to Long Island.

This shell has been found as yet only at Rivière-du-Loup, where the specimens however are as good as those now living in the Gulf. (See Figure.) It will be observed, however, that though they have the number of teeth of *Y. limatula*, they approach in form to the allied species or variety *Y. sapotilla*, a shell which occurs in Greenland and thence to New England, and which I strongly suspect is merely a short variety bearing a similar relation to *Y. limatula* to that which *Mya Uddevallensis* bears to the ordinary *M. truncata*. *Y. sapotilla* is, I may mention, the *Y. Arctica* of Morch, as proved by a specimen from his collection now in my possession.

Leda (Yoldia) myalis, Couthuoy.

Fossil—Labrador (Packard).

Recent—Gaspé (Whiteaves) to south of Cape Cod. This shell is supposed to be identical with *N. hyperborea*, Lovén, from Spitzbergen.

Pecten Grœnlandicus, Chemnitz.

Fossil—Leda clay, Portland and Saco, Maine; not yet found in Canada.

Recent—Gulf St. Lawrence (Whiteaves) in deep water 200 to 300 fathoms.

This species is found in the Clyde beds and in Greenland; and if, as Jeffreys supposes, identical with *P. similis* (Laskey), it is a shell of very wide distribution in the Atlantic, as well as in geological time. Though not yet found in Canada as a Post-pliocene fossil, its occurrence as a fossil in Maine and recent in the Gulf St. Lawrence, renders it probable that it may yet occur in our Leda clays.

Pecten tenuicostatus, Mighels.

Fossil—Leda clay, St. John, N.B. (Matthew).

Recent—Labrador to Cape Cod.

This shell has not yet been found in the Post-pliocene of the

St. Lawrence valley; but since, according to Packard, it is common in Labrador, there is nothing remarkable in its occurrence in the Post-pliocene of St. John.

Pecten Islandicus, Chemnitz.

Fossil—Rivière du-Loup; Quebec; Labrador (Packard); St. John, N.B. (Matthew); Portland, Maine; Greenland (Möller); also Crag, Clyde beds, and Post-pliocene of Norway.

Recent—Gulf St. Lawrence, and from Greenland to Connecticut.

This is a shell which is very durable, and retains even its colour when imbedded in the clays. In this it excels the Tellinas, Astartes, Saxicava and Ledas; though these in turn are always much better preserved than the Mytili and Modiolæ.

Class III.—Gasteropoda.

Philine lineolata, Couthuoy.

Fossil*—Montreal, rare.

Recent—Gaspé; Grand Manan (Stimpson); Nova Scotia (Willis). It is *Philine lima*, Brown, according to Jeffreys.

Cylichna alba, Brown.

Fossil—Montreal; Rivière-du-Loup; also in the Clyde beds.

Recent—Gaspé; Labrador (Packard); Gulf St. Lawrence, common (Whiteaves); Arctic seas generally. Same or similar on West Coast at Sitka (P P.C.)

Cylichna oryza, Totten.

Fossil—Montreal.

Recent—Coast of New England.

Cylichna nucleola, Reeve.

Fossil—Montreal; rare, and perhaps doubtful.

Recent—Arctic seas.

Cylichna occulta, Mighels and Adams.

Fossil—Montreal; Murray Bay; Maine.

Recent—Greenland to New England.

Cylichna striata, Brown.

Fossil—Rivière-du-Loup and Clyde beds.

Recent—Arctic seas.

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* Except when otherwise stated, all the Gasteropods are found in the Leda clay, or at its junction with the Saxicava sand.

Bulla (Haminea) solitaria, Say.

Fossil—Montreal; rather common.

Recent—New England and northward.

If this species is rightly determined, it furnishes a curious instance of a somewhat southern species occurring in the drift of Montreal. The *Haminea*, however, can scarcely be identified by weathered or fossil specimens, so that this may possibly be a northern form distinct from *solitaria*.

Bulla (Diaphana) debilis, Gould.

Fossil—Montreal.

Recent—Gulf St. Lawrence (Whiteaves); Greenland to New England.

Jeffreys considers it the same with *B. hyalina*, Turton. If so, it is a shell of the Clyde beds and of the Arctic seas generally.

Bulla (Utriculus) pertenuis, Mighels.

Fossil—Montreal.

Recent—Labrador (Whiteaves); Gulf St. Lawrence, and south to Cape Cod. According to Jeffreys it is *U. turritus*, Möller, Greenland.

Helix striatella, Anthony.

Fossil—Pakenham, Saxicava sand.

Lymnea umbrosa, Say.

Fossil—Montreal.

Lymnea caperata, Say.

Fossil—Montreal.

Lymnea elodes, Say.

Fossil—Pakenham Mills, Saxicava sand.

Planorbis bicarinatus, Say.

Fossil—Pakenham Mills, Saxicava sand.

Planorbis trivolvis, Say.

Fossil—Pakenham Mills, Saxicava sand.

Planorbis parvus, Say.

Fossil—Pakenham Mills, Saxicava sand.

All of the above pulmonates are modern Canadian species, and seem to have been drifted by some fresh-water stream into the sea of the Saxicava sand and Leda clay.

Siphono-dentalium vitreum, Sars.

Fossil—Leda clay, Murray Bay; also Norway (Sars).

Recent—Gulf of St. Lawrence (Whiteaves); coast of Norway (Sars.) It is a rare deep-water shell.

Amicula Emersonii, Couthuoy.

Fossil—Montreal.

Recent—Murray Bay; Halifax; coast of New England.

My specimens are merely detached valves. They indicate an animal quite similar to specimens from Halifax referred to this species, but differ slightly from specimens from Murray Bay. Dr. Carpenter has labelled the drift form var. "*altior*." The differences among the recent specimens, as well as the fossil valves, will be discussed in the "Contributions to a Monograph of the Chitonidæ," about to be printed by the Smithsonian Institution.

Puncturella (Cemoria) Noachina, Linn.

Fossil—Quebec; Rivière-du-Loup; Clyde beds.

Recent—Gulf St. Lawrence generally; and throughout the Arctic seas and North Atlantic.

Acmæa testudinalis, Möller.

Fossil—Labrador.

Recent—Gulf St. Lawrence generally; and throughout the Arctic seas and North Atlantic.

My only fossil specimen, obtained from Dr. Packard, is of the small, elevated and depauperated variety so common at Murray Bay and the north shore of the Gulf. It is curious that this common modern species is so very rare in the Post-pliocene.

Lepeta cœca, Möller.

Fossil—Montreal; Riviére-du-Loup; Quebec; Labrador; European Post-pliocene.

Recent—Gaspé; Labrador; Arctic seas generally; and coast of New England rarely.

This shell is not at all rare, living at Gaspé, and fossil at Rivière-du-Loup. Carpenter remarks that some of my Montreal specimens have the characters of variety *striata* of Middendorff from Siberia.

Capulus commodus, Middendorff.

Fossil—Point Levi, near Quebec. One specimen only, found by Mr. Gunn and communicated by Dr. W. J. Anderson.

Recent—Scotland (Jeffreys).

This species is fossil at Uddevalla, and is supposed to be the same with *C. fallax* and *C. obliquatus* of Wood from the English Crag. It has not yet been recognized on the American coast. (See Figure.)

Margarita helicina, Fabricius.

Fossil—Montreal; Murray Bay.

Young specimens resemble *M. acuminata* of Mighels. Broad specimens resemble *M. campanulata*, Morse.

Recent—Arctic seas; Gulf of St. Lawrence; and coast of New England. It is *M. Arctica*, Leach.

Margarita argentata, Gould.

Fossil—Montreal, rare.

Recent—Labrador and Gulf St. Lawrence (Whiteaves); Murray Bay; Gaspé; coast of New England and Nova Scotia? Possibly the same with *M. glauca*, Möll., from Greenland.

Margarita cinerea, Couthuoy.

Fossil—Rivière-du-Loup, Portland.

Recent—Gaspé; Labrador; Greenland to New England; var. *striata*, Dall, Sitka.

Cyclostrema (Mölleria) costulata, Möller.

Fossil—Montreal; Clyde beds; Uddevalla.

Recent—Gaspé; Arctic seas to New England.

Cyclostrema Cutleriana, Clark.

Fossil—Montreal, rare.

This is an Arctic and British shell, as yet recognized only at Montrèal.

Turritella erosa, Couthuoy.

Fossil—Labrador; Rivière-du-Loup; Montreal?

Recent—Greenland to New England.

Turritella reticulata, Mighels.

Fossil—Labrador (Packard).

Recent—Labrador to Gulf St. Lawrence; also fishing banks, Nova Scotia (Willis).

My specimens received from Dr. Packard are marked *T. costulata*, but seem rather to be the above species.

Turritella acicula, Stimpson.

Fossil—Rivière-du-Loup; Labrador (Packard).

Recent—Murray Bay; coast of New England.

There may be some reason to doubt whether this is not a variety of *T. erosa*. It is quite possible that the above species should be regarded as *Mesaliæ*.

Paludina (Melantho) decisa, Say.

Fossil—Pakenham Mills, Saxicava sand.

Recent—Eastern America generally.

Valvata tricarinata, Say.

Fossil—Pakenham Mills, with the preceding.

Recent—Eastern America generally.

Amnicola limosa, Say.

Fossil—Pakenham Mills, with the preceding.

Recent—Hudson's Bay to Virginia.

This was *A. porata* of the previous lists.

Littorina rudis, Donovan.

Fossil—Rivière-du-Loup; also Clyde beds and Uddevalla.

Recent—Arctic seas to New England and European coasts.

L. tenebrosa, which may be regarded as a variety, is also found at Rivière-du-Loup.

Rissoa castanea, Möller.

Fossil—Montreal.

Recent—Gaspe; Labrador; Trinity Bay (Whiteaves).

Rissoa exarata, Stimpson.

Fossil—Montreal.

Recent—New England.

Rissoa scrobiculata, Möller.

Fossil—Montreal.

Recent—Greenland; Gulf St. Lawrence, 200 to 300 fathoms, large; and small, Gaspé, 30 fathoms (Whiteaves).

Bela harpularia, Couthuoy.

Fossil—Montreal; Quebec; Murray Bay; Rivière-du-Loup (large specimens).

Recent—Gulf St. Lawrence; very fine at Murray Bay, and similar to large specimens from Rivière-du-Loup; coast of New England. It is *B. Woodiana*, Möller (J. F. W.)

Bela elegans, Möller.

Fossil—Montreal.

Recent—Greenland and Norway; closely allied to next species.

Bela pyramidalis, Ström.

Fossil—Montreal; also Crag, Clyde beds and Uddevalla.

Recent—Labrador (Packard); Gulf St. Lawrence (Whiteaves); Murray Bay, and south to Cape Cod; Arctic seas generally. It is the *B. pleurotomaria* of Couthouy. and *B. Vahlii* of Beck.

Bela turricula, Montagu.

Fossil—Montreal; Rivière-du-Loup; Labrador; also Red Crag and Uddevalla (Jeffreys).

Recent—Gulf of St. Lawrence and coast of Nova Scotia and New England.

I include under this name *B. nobilis* of Möller; *B. Americana*, Packard; *B. scalaris*, Möller; *B. exarata*, Muller, Morch; and *B. angulata*, Reeve. The var. *nobilis* is found at Montreal and Gaspé; also young shells not distinguishable from *exarata*. Var. *scalaris*, occurs at Rivière-du-Loup and Labrador. This shell is a widely diffused and somewhat variable northern species. Mr. Whiteaves, however, regards *B. nobilis*, *B. exarata*, and *B. scalaris* as distinct.

Bela Trevelliana, Turton.

Fossil—Rivière-du-Loup; Labrador; also Clyde beds and Norway (Jeffreys).

Recent—Murray Bay; Arctic seas, and Greenland to Massachusetts. It is probably *B. decussata* of Couthuoy. *B. excurvata* from Puget Sound, may prove another variety.

Bela violacea, Mighels and Adams.

Fossil—Montreal.

Recent—Murray Bay; Labrador (Packard); Gaspé (Whiteaves; Fishing banks Nova Scotia (Willis); Massachusetts (Stimpson).

Bela cancellata, Mighels and Adams.

Fossil—Murray Bay; Labrador (Packard); Casco Bay (Gould). This shell may be *B. impressa*, Beck. In any case the fossils are identical with the modern Murray Bay specimens. It also occurs living in Gaspé Bay (Whiteaves).

Natica affinis, Gmelin.

(*Natica clausa*, Brod. and Sowerby.)

Fossil—Montreal; Quebec; Rivière-du-Loup; Labrador; Portland, Maine.

Recent—Greenland to Cape Cod.

Common and extensively distributed in the Post-pliocene of Europe, from Norway to Sicily, and found at an elevation of 1330 to 1360 feet in Moel Tryfaen, Wales. (Darbyshire).

Lunatia heros, Say.

Fossil—Beauport, a single specimen only, and this of small size.

Recent—Labrador and southward.

This species is as old as the Miocene Tertiary; and in the Post-pliocene, Canada was probably its extreme northern limit.

Lunatia Grœnlandica, Beck.

Fossil—Montreal; Quebec; Rivière-du-Loup; Maine; also Post-pliocene of England, Scotland, and Norway.

Recent—Arctic seas generally, and extending to Britain and New England.

L. pallida is the representative of this species on the west coast of America.

Choristes elegans, Cpr.

Fossil—Saxicava sand, Montreal, rare.

This shell was identified in my former papers with *Natica helicoides*; but it is now found to be quite distinct, and Dr. P. P. Carpenter describes it as a new species and genus as follows:

Genus Choristes.

Testa helicoidea, tenuis; epidermide induta; anfractus disjuncti; labrum postice angulatum, antice haud emarginatum; labium planatum; columella simplex. Animal ignotum.

Choristes elegans, n. s.

Ch. t. satis elevatâ, tenui, nitente; epidermide fulvâ, tenui, lævi, extus et intus omnino appressâ; anfr. iii. + ...?, vertice nucleoso decollato, spiraliter obsoletius striatis; lineis incrementi tenuissimis; spirâ superne planatâ, suturis maxime impressis, basi tumente; umbilico intus majore, extus modico; aperturâ sublunatâ, postice ad angulum circ. 30° inclinatâ, antice late rotundatâ; labro acuto, postice planato; labio acuto, planato, haud reflexo; columellâ postice regulariter arcuatâ, neque emarginatâ, nec angulatâ, nec insculptâ.

Long. (apice decollato) ·82, *long. spir.* ·32, *lat.* ·76. poll. *Div.* 90°.

Hab. Montreal, in strato glaciali, fossilis, rarissime reperta. Mus. Dawson, McGill Coll., Nat. Hist. Soc.

Dr. Carpenter adds the following remarks:

While almost all the other drift fossils are of species still living in the neighbouring seas, this is not known, even generically, to be at present in existence. It is hard to pronounce satisfactorily on its relationships. In its thin, coated shell it resembles Velutina; the striæ and loose whirls recall Naticina; the straight pillar lip reminds us of Fossarus; while the umbilicus and rounded base, with entire mouth, best accord with the Natica group. With Trichotropis and its congeners I can see no resemblance. One remarkable feature in all the specimens is the decollation of the upper whirls, seen even in a nearly perfect young specimen, ·2 across; other young specimens, even smaller, have only one whirl and a half remaining. The broken portion is filled up not so much by a septum as by a solid thickening. The separation of the whirls is complete from the beginning; and although, in the parietal portion, they are closely appressed, the smooth and somewhat glossy epidermis is distinctly seen between. The fracture of the mouth in most of the specimens, enables this feature to be distinctly observed; and would also reveal the "internal groove" and columellar callosity ascribed to Torellia, did any such exist.

The straightening of the inner lip, at an angle of 30° from the axis, makes the umbilicus by no means large (for a Naticoid shell) when viewed from the base in the line of the pillar; but the same cause enlarges it within, recalling the adult appearance of Amphithalamus. The flattening of the upper portion of the whirls gives the shell somewhat of an Ianthinoid aspect.

While the analogies of the shell point in so many different directions, it is impossible to assign it even to its family group. It is to be hoped, however, that the dredge will yet reveal its existence in a living state.

The above species may be supposed to resemble *Torellia vestita*, Jeffreys, from Norway. Our specimens differ however in form, as above noted, and also in the absence of the tooth in the inner lip, and in the smooth epidermis.

The shell in question presents the very unusual character of having the whirls appressed, yet quite disconnected; the smooth epidermis lining the umbilical chambers, and conspicuously preserved, even in these fossil specimens, between the closest parts of the parietal region. In this respect it bears the same relation to Torellia as does Latiaxis to Rapana, Separatista to Rhizochilus, or Zanclea to Torinia. It presents a rude resemblance to Separatista Chemnitzii (Add. Gen. pl. xiv. f. 6), or still more to S. Blainvilleana (Chènu Man. p. 172, § 853), but without the grooved pillar, or the keels of the latter species.

As to the "blunt tubercle" or "callous protuberance" of Torellia, described by Mr. Jeffreys, but scarcely to be traced in Mr. Sowerby's figure, it certainly does not exist in our fossils. It is not always a character of importance, as may be seen by comparing Purpura columellaris with P. patula, Cuma tectum with the remaining species of the genus, or the gradual transition from Isapis to Fossarus. The Naticidæ are often very irregular *in the callous region of the pillar, even in the same species.*

Velutina zonata, Gould.

Fossil—Montreal; Beauport.

Recent—Arctic seas to Massachusetts.

According to Jeffreys, this shell is the same with *V. undata*, Smith, from the Clyde beds, and is found in the Crag and in the Post-pliocene of Uddevalla.

Scalaria Grœnlandica, Perry.

Fossil—Rivière-du-Loup; Quebec; Saco; also Scottish Post-pliocene and English Red Crag, under same varietal forms as in Canada.

Recent—Arctic seas, and American coast, as far south as Massachusetts.

The specimens from Rivière-du-Loup are very large, one being nearly two inches long; and, as Dr. Beck has remarked, the varices of some of the specimens are more slender and lamellar than in recent specimens, others, however, are similar to the more common recent variety.

Acirsa Eschrichtii, Holboll.

Fossil—Quebec; Rivière-du-Loup; Montreal; most abundant at Rivière-du-Loup.

Recent—Murray Bay; Greenland; also Eastport (Verrill)

This shell was named in former papers *Menestho albula*, the eroded specimens found being referred to that species. It has, however, been correctly described by Dr. Beck in Lyell's paper on Beauport, and named *Scalaria borealis*. It is not this species of Gould, however.

Trichotropis borealis, Brod. and Sow.

Fossil—Montreal; Rivière-du-Loup; Labrador, &c.; very abundant at Montreal.

Recent—Labrador, Murray Bay, Gaspé, Arctic seas, and as far south as Massachusetts.

Trichotropis arctica? Middendorff.

Fossil—Montreal, very rare.

A single imperfect specimen represents this species, which is recent at Behring's Straits. The identification is perhaps doubtful.

The figure given by Reeve of *T. Kenseri* of Phillippi from Spitzbergen, resembles our shell, except in the small number of revolving bands.

Admete viridula, Fabricius.

Fossil—Montreal.

Recent—Labrador, (Packard); Murray Bay; Gaspé, (Whiteaves); also Greenland and Labrador. It is the *Tritonium viridulum* of Fabricius, and is a rare shell in the Canadian Post-pliocene, and in the Gulf of St. Lawrence.

Aporrhais occidentalis, Beck.

Fossil—Labrador (Bayfield); also Packard.

Recent—Labrador to Massachusetts.

It is remarkable that this species, which is found living from Labrador to Cape Cod, is so rare in the Post-pliocene.

Fasciolaria ligata, Mighels.

Fossil—Montreal, very rare.

Recent—Murray Bay; Mingan (Foote); Gaspé, (Whiteaves); Nova Scotia, (Willis); rare in all these localities.

A single mutilated specimen alone, as yet, represents this species in my Post-pliocene collections.

Astyris Holbollii, Möller.

Fossil—Rivière-du-Loup; also glacial beds Britain (Jeffreys).

Recent—Gaspé; Murray Bay; Labrador, (Whiteaves). If identical, as I suppose, with *Columbella rosacea*, Gould, it extends south to New England, and Gould's name has priority.

Buccinum undatum, Linn.
var. *undulatum*, Möller.
var. *Labradoricum*, Reeve.

Fossil—Saxicava sand and Leda clay, Rivière-du-Loup; Labrador; Duck Cove, St. John, N.B.; Maine (Packard).

Recent—Gulf St. Lawrence; south Greenland to Nantucket. (See Figure.)

I cannot satisfy myself that there is any good specific distinction between this shell and *B. undatum* of the European seas and glacial beds. It varies very much in size, in slenderness, in the fineness of the spiral striation, in the development of the ribs, in the extension of the mouth, and in the thickness of the shell. The coarser forms are *B. Labradoricum*, which passes into the ordinary *undatum*. Medium varieties are *B. undulatum*, and smooth varieties pass into *B. cyaneum* and *B. Tottenii*, which last is the *ciliatum* of Gould.

Buccinum Tottenii, Stimpson.

Fossil—Rivière-du-Loup, Saxicava sand and Leda clay.

Recent—Murray Bay and Tadoussac; also Newfoundland Banks. It has some resemblance to *B. Humphreysianum*, Bennet, but is specifically distinct. It is the *B. ciliatum* of Gould, but has no connection with the *ciliatum* of Fabricius, except a slight resemblance to the smoother forms of the latter. It is remarkable for its very regular spiral lines, absence of folds and convex whirls.

Buccinum cyaneum, Bruguière.

Fossil—Rivière-du-Loup, abundant.

Recent—Murray Bay and Tadoussac; deeper parts of Gulf St. Lawrence (Whiteaves); Arctic seas.

This species or varietal form is well represented in the Figure, which is taken from a large Rivière-du-Loup specimen. Being on the one hand very near to if not identical with the smooth varieties of *B. undulatum*, and on the other resembling *B. Grœnlandicum*, it has received many names. It is believed to be *B. boreale* of Leach, and *Grœnlandicum* of Morch. It is a very characteristic northern form. (See Figure.)

Buccinum Grœnlandicum, Chemnitz.

Fossil—Leda clay and Boulder clay, Montreal; St. Nicholas; Rivière-du-Loup.

Recent—Greenland. Specimens from Morch are identical with our fossils. This species is probably the *B. undatum* of Fabricius. It is allied to *B. cyaneum*, and may possibly pass into it. (See Figure.)

Buccinum tenue, Gray.

Fossil—Rivière-du-Loup, not uncommon; Greenland (Hayes); Labrador (Packard).

Recent—Murray Bay; Gaspé; Labrador (Packard); Arctic seas generally. A common Arctic species, but rare living in the Gulf, though much more plentiful in the Post-pliocene beds. (See Figure.)

Buccinum ciliatum, Fabricius.

Fossil—Montreal; Rivière-du-Loup.

Recent—Murray Bay; Greenland (Fabricius) to Nova Scotia (Willis).

This is the original *B. ciliatum* of Fabricius, and has been recognized as such by Dr. Stimpson. It is easily distinguished by its narrow Nassa-like mouth, armed with a tooth on the front of the pillar lip. It varies much in sculpture, especially in the longitudinal ribs. The variety found at Montreal is only slightly ribbed. That at Rivière-du-Loup is more distinctly ribbed, thus resembling the recent specimens from Murray Bay. It is quite distinct from *B. ciliatum*, Gould, which is very near the smoother varieties of *B. undulatum*. As it is a rare and little known shell, I have figured two extreme varieties, a fossil specimen from Montreal and a recent from Murray Bay.

Buccinum glaciale, Linn.

Fossil—Rivière-du-Loup; Montreal; Labrador; (Packard.)

Recent—Murray Bay; Greenland, and Arctic seas generally.

This shell has the aperture somewhat like that of *ciliatum* and a very peculiar sculpture of spiral striæ with intervening bands marked with finer striæ. It has also a carina angulating the body whirl, and sometimes more than one. In the latter case it passes into *B. Grœnlandicum*, Hancock (not Chemnitz) or *B. Hancocki* Morch. The ordinary variety is most common in the Modern Gulf, the latter in the Arctic seas and in the Post-pliocene. This shell, usually much decorticated, is the most common Buccinum in the Post-pliocene of Montreal. It was called *B. undatum* in previous lists.

Buccinum plectrum, Stimpson.

Fossil—Rivière-du-Loup; rare.

Recent—Murray Bay; Portland, Maine, (Stimpson); Behring's Straits, (Stimpson)

This may be a variety of the preceding species, but can be distinguished from it and grows to a larger size. It has the sculpture of *B. glaciale* with the aperture of *B. undulatum*. Recent and fossil specimens are quite similar.

The northern *Buccina* are involved in so much confusion that I have made them a subject of special study, and have sedulously collected all the forms recent and fossil. I have been very much aided in this by the abundance of specimens of the more Arctic forms at Rivière-du-Loup, and the the occurrence of most of them recent at Murray Bay and Tadousac, and I feel confident that the names given in this list represent forms actually occurring as distinct in nature, though some of them may not be distinct specific types. I believe, however, that *B. ciliatum B. glaciale*, *B. undatum*, *B. tenue* and *B. Grœnlandicum*, are probably entitled to this rank. The others appear to me on comparison of large numbers of specimens, to graduate into one or other of the above forms.

I have given in the engraved plate representatives of the more critical forms, which will enable them to be recognized.

In the drift the Buccinums often part with their outer coat of prismatic shell, and in this decorticated state are very difficult to determine.

Buccinofusus (Sipho) Kroyeri, Möller.

Fossil—Rivière-du-Loup; Labrador (Packard).

Recent—Gulf St. Lawrence and Arctic seas. First recognized as this species by Mr. Whiteaves. Specimens from Spitzbergen in Mr. McAndrew's collection are perfectly similar to ours. Packard found it not uncommon at Labrador, but it seems rare in other parts of the Gulf of St. Lawrence. In some previous lists it has appeared as *B. cretaceum*, Reeve, which seems to be an error.

Chrysodomus Spitzbergensis, Reeve.

Fossil—Montreal (small and rare.)

Recent—Murray Bay to Gaspé; also Spitzbergen, and probably Sea of Okotsk.

Only one specimen occurred at Montreal, and was an unknown form until I fortunately dredged a few specimens at Murray Bay. It is a beautiful species, evidently quite distinct from *C. Islandicus.* From Middendorff's description and figure, I think it not improbable that it may be the same with his *Tritonium Schantaricum*, from the Sea of Okotsk. I was not aware that it had been found on our coast, except at Murray Bay, until these sheets were going through the press. Young specimens are remarkably like in form and sculpture to *Fasciolaria ligata*, which is found with it at Murray Bay. Reeve's figure in Belcher's "Last of the Arctic Voyages," well represents our specimens, though perhaps a very little coarser in sculpture.

Chrysodomus tornatus, Gould.

Fossil—Montreal; Quebec; Rivière-du-Loup; Murray Bay; Labrador (Packard).

Recent—Gaspé Bay, large specimens (Whiteaves; Labrador (Packard).

This shell is not uncommon in the drift, and owing to its dense texture is generally in good preservation. It ranges from the typical *C. tornatus* of Gould to *Fusus despectus* of Linnæus, as described by Fabricius, from Greenland, and shells of similar form from the British Crag are considered by S. Wood as varieties of *F. antiquus.** Dr. P. P. Carpenter thinks that this and the British *F. antiquus* may prove to belong to one very variable species. The *C. despectus* is an Arctic form, and is found fossil in Canada. The *C. tornatus* is also fossil, and is the form now found in the Gulf. *C. decemcostatus* is more southern.

Chrysodomus decemcostatus, Say.

Fossil—Portland, Maine.

Recent—Magdalen Islands and Gaspé Bay (Whiteaves); coasts of Nova Scotia and New England.

This species has not yet been found in the Post-pliocene of Canada, where it is represented by *C. tornatus.* There are still two opinions as to whether Say's species is identical with *C. lyratus*, Mart. = *Middendorffii*, Cooper, from the Pacific coast. The latter is variable, and graduates towards *tornatus*, Gould, but the living New England shells are tolerably constant in character.

* The *C. despectus* of Reeve, however, is a very different species, from the Arctic regions of the North Pacific.

Trophon scalariforme, Gould.

Fossil—Montreal; Murray Bay; Rivière-du-Loup; Labrador.

Recent—Greenland (Hayes); Murray Bay; Nova Scotia (Willis); Gaspé and North Shore (Whiteaves).

It is a rare shell in the Post-pliocene, but of large size and in good condition.

Trophon clathratus, Linn.

Fossil—Montreal; Murray Bay; Rivière-du-Loup; also glacial beds of Europe.

Recent—Greenland and Arctic seas generally; Labrador; Gulf St. Lawrence (Whiteaves). The allied species or variety, *T. gunneri*, has been found living at Gaspé by Whiteaves, but not fossil as yet.

SUB-KINGDOM ARTICULATA.

Class I.—Annulata.

Serpula vermicularis, Linn.

Fossil—Montreal; Murray Bay; Rivière-du-Loup.

A small species of Serpula, apparently the above, though perhaps the determination may be regarded as uncertain.

Vermilia serrula, (Stimpson.)

Fossil—Rivière-du-Loup, on shells.

Recent—Gulf St. Lawrence. It is quite likely the Greenland species identified by Fabricius with *Serpula triquetra*.

Spiochætopterus typus, Sars.

Fossil—Labrador, (Packard).

Recent—Labrador (Packard); Norway (Sars.)

Spirorbis glomerata, Muller.

Fossil—Rivière-du-Loup; Labrador (Packard); Greenland (Fabr.); Gaspé.

Spirorbis vitrea, Fabricius.

Fossil—Montreal; Quebec; Rivière-du-Loup; Murray Bay Very common on stones and shells.

Recent—Greenland (Fabricius); Gulf St. Lawrence.

Spirorbis Spirillum, Lin.

Fossil—Rivière-du-Loup, on shells.

Recent—Gulf St. Lawrence; Greenland; Fabricius.

Spirorbis sinistrorsa, Montague.

Fossil—Rivière-du-Loup, on the inside of shells.

Recent—Gulf St. Lawrence; Fishing Banks, American Coast (Gould.)

Spirorbis carinata, Montague.

Fossil—Rivière-du-Loup, on shells.

This is a Spirorbis with one carina, found also in the Gulf of St. Lawrence, and possibly the same with the *S. contortuplicata* of Fabricius from Greenland.

The beautiful *Spirorbis cancellata* of Fabricius, so common in the Modern Gulf of St. Lawrence, and also in Greenland, has not yet been found in the Post-pliocene.

CLASS II.—CRUSTACEA.

The most abundant species are bivalve Entomostraca, which occur in great numbers in the Leda clay, associated with Foraminifera. The species in my collection have been kindly determined by Mr. J. S. Brady, who enumerates the following:

Cythere MacChesneyi, nov. sp.
" *Dawsoni* (Brady).
" *globulifera* (Brady).
" *Logani*, nov. sp.
Cytheridea papillosa (Bosquet).
" *punctillata* (Brady).
Cytheridea Sorbyana (Jones).
Cytherura Robertsoni (Brady).
Cytheropteron complanatum, nov. sp.
" *inflatum* (B., C., and R., MS.)
" *angulatum* (B., C., and R., MS.)
Eucythere argus.

As the paper was re-printed in the *Canadian Naturalist* (Vol. V., N. S.) it is unnecessary to notice these species further here, except to state that out of twenty-nine species of recent Ostracods obtained by Mr. Brady from material from the Gulf St. Lawrence, furnished by me, thirteen have been recognized in the Post-pliocene of Canada and Maine. though only three of these occur in the list above given. It is further remarkable that out of thirty-three fossil species from Maine and Canada, no less than twenty-three occur in the Scottish glacial beds and twenty-five are living in the British seas, while six are new species.

Balanus Hameri, Ascanius.

Fossil—Montreal; St. Nicholas; Quebec; Rivière-du-Loup; also, Uddevalla; Russia (Murchison); Greenland (Spengler).

Recent—Coast of Nova Scotia. I have obtained specimens from Mr. Downes of Halifax, but have not elsewhere seen the species recent. It is *B. Uddevallensis* of lists of Scandinavian fossils and *B. tulipa* of Muller. It is a widely diffused Arctic and North Atlantic species.

This Acorn-shell is very abundant at Rivière-du-Loup, and fine specimens are found entire, attached to stones and boulders in the Boulder-clay.

Balanus porcatus, DaCosta.

Fossil—Beauport; glacial beds of Europe.

Recent—Gulf St. Lawrence, and coast of New England; Labrador (Packard); and Arctic and northern seas generally. It is no doubt *Lepas balanus* of Fabricius from Greenland.

Much more rare in the Post-pliocene than the preceding species.

Balanus crenatus, Brug.

Fossil—Montreal; Quebec; Rivière-du-Loup; St. John, N.B. (Matthew); Labrador (Packard); Portland, Maine; glacial beds of Europe.

Recent—Arctic and northern seas, Greenland; Gulf St. Lawrence and American coast. It seems to be *Lepas balanaris* of Fabricius. Greenland.

Eupagurus Bernhardus? Fabricius.

Fossil—Rivière-du-Loup. A small specimen in a *Turritella* may be the young of this common species.

Hyas coarctata, Leach.

Fossil—Riviére-du-Loup. A few claws only found, but evidently of this common Gulf of St. Lawrence species.

SUB-KINGDOM VERTEBRATA.

The vertebrate animals of the Post-pliocene are few, and may be summed up as follows:

Mallotus villosas, Cuvier.

The common capelin is found in nodules at Green's Creek on the Ottawa.

Cyclopterus lumpus, Linn.

The lump sucker occurs in nodules at the same place.

Gasterosteus.

In nodules at the same place, found by Sheriff Dickson. It closely resembles the two-spined stickleback of the Gulf St. Lawrence, but is not sufficiently perfect for description.

Vertebrae and other fragments of fishes not determinable, have been found at Rivière-du-Loup, and a bird's feather in a nodule on the Ottawa.

The Mammalia are represented in the marine Post-pliocene of Canada by *Phoca Grœnlandica*, Muller, found in the Leda clay at Montreal, and *Beluga Vermontana* in the same situation, and also in the Saxicava sand at Cornwall (Billings). The latter I believe to be identical with the modern *Beluga* of the Gulf St. Lawrence.

In the superficial gravels of Ontario, probably more recent than the marine beds, remains of a fossil elephant, *Euelephas Jacksonii*, have been found, and have been described by Mr. Billings (Can. Nat. vol. VIII).

FOSSIL PLANTS.

The only locality where fossil plants in any considerable number have been obtained, is at Green's Creek on the Ottawa, where they owe their preservation to the nodules of calcareous matter that have enclosed delicate specimens which otherwise could not have been secured from the soft Leda clay in which the nodules are enclosed. In addition to specimens collected by myself, I have examined the collections made by the late Rev. Mr. Bell of L'Original, those of the late Sheriff Dickson, and those of the Geological Survey. The whole were described in my paper in the Canadian Naturalist for February, 1866, and since that time no new material of importance has come into my hands. The species recognized are:

Drosera rotundifolia, Linn.
Acer spicatum, Lamx.
Potentilla Canadensis, Linn.
Gaylussacia resinosa, Jones.
Populus balsamifera, Linn.

Thuja occidentalis, Linn. (found at Montreal.)
Potamogeton perfoliatus, Linn.
Equisetum scirpoides, Michx.
Carices and *gramineæ*, fragments.
Fontinalis, sp.
Algae.

These plants occur in the marine Leda clay, containing its characteristic fossils, and were probably washed from the neighbouring land by streams. They indicate to some extent the flora of the Laurentian hills bordering the valley of the Ottawa, at the time of the Post-pliocene subsidence. The inferences as to climate deducible from them are stated in the following extract from the paper above referred to:

" None of the plants above mentioned are properly Arctic in their distribution, and the assemblage may be characterized as a selection from the present Canadian flora of some of the more hardy species having the most northern range. Green's Creek is in the central part of Canada, near to the parallel of 46°, and an accidental selection from its present flora, though it might contain the same species found in the nodules, would certainly include with these, or instead of some of them, more southern forms. More especially the balsam poplar, though that tree occurs plentifully on the Ottawa, would not be so predominant. But such an assemblage of drift plants might be furnished by any American stream flowing in the latitude of 50° to 55° north. If a stream flowing to the north it might deposit these plants in still more northern latitudes, as the McKenzie River does now. If flowing to the sonth it might deposit them to the south of 50°. In the case of the Ottawa, the plants could not have been derived from a more southern locality, nor probably from one very far to the north. We may therefore safely assume that the refrigeration indicated by these plants would place the region bordering the Ottawa in nearly the same position with that of the south coast of Labrador fronting on the Gulf of St. Lawrence, at present. The absence of all the more Arctic species occurring in Labrador, should perhaps induce us to infer a somewhat more mild climate than this."

The climatic indications afforded by these plants are not dissimilar from those furnished by a consideration of the marine fauna of the period of the Leda clay.

Addenda to Echinodermata.

Mr. T. Curry of Montreal has been so fortunate as to find in the Leda clay near that city, in addition to fragments apparently of an *Ophioglypha*, a specimen probably of *Ophiacantha spinulosa*, Muller and Tr., and one of *Solaster papposa*, Linn. Both of these are species now found in the Gulf of St. Lawrence. Mr. Matthews has also obtained a second species of Ophiurid Starfish at St. John.

Summary of Fossils.

The above lists include, in all, about 205 species, being more than twice the number included in previous lists, and distributed as follows:

Plants	10
Animals—Radiata	24
Mollusca	140
Articulata	26
Vertebrata	5
	205

The whole of these, with the three or four exceptions, may be affirmed to be living Northern or Arctic species, belonging in the case of the marine species, to moderate depths, or varying from the littoral zone to say 200 fathoms. The assemblage is identical with that of the northern part of the Gulf of St. Lawrence and Labrador Coast at present, and differs merely in the presence or absence of a few more southern forms now present in the Gulf, especially in its southern part, where the fauna is of a New England type, whereas that of the Post-pliocene may be characterized as Labradorian. As might have been anticipated from the relations of the Modern marine fauna, the species of the Canadian Post-pliocene are in great part identical with those of the Greenland seas and of Scandinavia, where, however, there are many species not found in our Post-pliocene. The Post-pliocene fauna of Canada is still more closely allied to that of the deposits of similar age in Britain and in Norway. Change of climate, as I have shewn in previous papers, having been much more extensive on the east than on the west side of the Atlantic, owing to the distribution of warm and cold currents resulting from the present elevation of the land.

It cannot be assumed that the fauna of the older part of the Canadian Post-pliocene is different to any great extent from that of the more modern part. Such difference as exists seems to depend merely on a gradual amelioration of climate. The shells of the lower Boulder clay, and of those more inland and elevated portions of the beds which may be regarded as older than those of the lower terraces near the coast, are undoubtedly more Arctic in character. The amelioration of the climate seems to have kept pace with the gradual elevation of the land, which threw the cold ice-bearing Arctic currents from its surface, and exposed a larger area of land to the action of solar heat, and also probably determined the flow of the waters of the Gulf Stream into the North Atlantic. By these causes the summer heat was increased, the winds both from the land and sea were raised in temperature, and the heavy northern ice was led out into the Atlantic, to be melted by the Gulf Stream, instead of being drifted to the southwest over the lower levels of the continent. Still the cold Arctic currents entering by the Straits of Belle-isle and the accumulation of ice and snow in winter, are sufficient to enable the old Arctic fauna to maintain itself on the Northern side of the Gulf of St. Lawrence, and to extend as far as the latitudes of Murray Bay and Gaspé. South of Gaspé we have the warmer New England fauna of Northumberland Strait. I may add that some of the peculiarities of the Post-pliocene fauna in comparison with that of the St. Lawrence river, indicate a considerable influx of fresh water, derived possibly from melting ice and snow.

PART III.—GENERAL CONCLUSIONS.

This Memoir has already extended to so great length, that I shall be under the necessity of dwelling as little as possible on the general geological truths deducible from the facts which have been stated. I shall specially refer to only two points: (1) The relation of the Post-pliocene fossils to questions of derivation of species; (2) The bearing of the facts above stated on theories of land glaciation.

On the first of these subjects I may remark that whatever may have been the lapse of geological time from the period of the oldest Boulder Clay to that in which we live, and great though the climatal and geographical changes have been, we cannot affirm that any change even of varietal value has taken place in any of the 205 species of the above lists. This appears to me a fact of extreme significance with reference to theories of the modification of species in geological time. No geologist doubts that the Post-pliocene was a period of considerable duration. The great elevations and depressions of the land, the extensive erosions, the wide and thick beds of sediment, all testify to the lapse of time. The changes which occurred were fruitful in modifications of depth and temperature. Deep waters were shallowed, and the sea overflowed areas of land. The temperature of the waters changed greatly, so that the geographical distribution of marine animals was materially affected. Yet all the Post-pliocene species survive, and this without change. Even variable forms like the species of *Buccinum* and *Astarte* show the same range of variation in the Post-pliocene as in the modern, and though some varieties have changed their geographical position, they have not changed their character. This result is obviously independent of imperfection of the geological record, because there is no reason to doubt that these species have continuously occupied the North Atlantic area, and we have great abundance of them for comparison both in the Post-pliocene and the modern seas. It is also independent of any questions as to the limits of species and varieties, inasmuch as it depends on careful comparisons of the living and fossil specimens; and by whatever names we may call these, their similarity or dissimilarity remains unaffected. We have at present no means of tracing this fauna as a whole farther back. Some of its members we know existed in the Pliocene and Miocene without specific difference; but some day the middle tertiaries of Greenland may reveal to us the ancestors of these shells, if they lived so far back, and may throw further light on their origin. In the meantime we can affirm that the lapse of time since the Pliocene has not sufficed even to produce new races; and the inevitable conclusion is that any possible derivation of one species from another is pushed back infinitely, that the origin of specific types is quite distinct from varietal modification, and that the latter attains to a maximum in a comparatively short time, and then runs on unchanged, except in so far as geological vicissitudes may change the localities of certain varieties. This is precisely the same conclusion at which I have elsewhere arrived from a similar comparison of the fossil floras of the Devonian and Carboniferous periods in America.

The second leading point to which I would direct attention is the relative value of land ice and water-borne ice as causes of geological change in the Post-pliocene. On this subject I have for the last sixteen years constantly maintained that moderate view which has been that of Sir Roderick Murchison and Sir Charles Lyell, that the Post-pliocene subsidence and refrigeration produced a state of our Continent in which the lower levels and at certain periods even the tops of the higher hills were submerged, under water filled every season with heavy ice derived from glaciers, and that at certain stages of submergence the hilly ranges were occupied with glaciers, sending down their ice to the level of the sea. I need not reiterate the arguments for this view; but may content myself with a reference to the changes of opinion on the subject. The glacier theory of Agassiz and others may be said to have grown till, like the imaginary glaciers themselves, it overspread the earth. All northern Europe and America were covered with a mer-de-glace, moving to the southward and outward to the sea. This great ice-mantle not only removed stones and clay to immense distances, and glaciated and striated the whole surface, but it cut out great lake basins and fiords, ground even the tops of the highest hills, and accounted for everything otherwise difficult in the superficial contour of the land. It was even transferred to Brazil, and employed to excavate the valley of the Amazon. But this was its last feat, and it has recently been melting away under the warmth of discussion until it is now but a shadow of its former self. I may mention a few of the facts which have contributed to this result. It has been found that the glacial Boulder-clays are in many cases marine. Cirques and other Alpine valleys, once supposed to be the work of glaciers, are now known to have been produced by aqueous denudation. Great lakes, like those of America, supposed to be inexplicable except by glacier erosion, have been found to admit of being otherwise accounted for. The transport of boulders and direction of striation have been found to conflict with the theory of continental glaciation, or to require too extravagant suppositions to account for them in that way. Greenland, at one time supposed to be a modern example of an ice-clad continent, has been found to be merely a mass of rocky hills and table-lands with local glaciers. The relation of Greenland to Baffin's Bay and Davis Straits, proves to be similar to that which may have obtained between the Laurentide hills and the submerged valley of the St. Lawrence. Lastly, the power attributed to glaciers as eroding agents, has been found to be altogether fallacious. I was surprised, in visiting the Alps in 1865, to find that this boasted erosive power was little else than a myth; and I see that since that time many other observers have arrived at similar conclusions. I have recently seen a very sensible view of this question in a popular book by the well-known Alpine explorer, Whymper, of which I may quote the concluding paragraph, as precisely stating my own view as expressed in the Canadian Naturalist in 1866:

"If I were asked whether the action of glaciers upon rocks should be considered as chiefly destructive or conservative, I should answer without hesitation principally as conservative. It is destructive certainly to a limited extent; but like a mason who dresses a column that is to be afterwards polished, the glacier removes a small portion of the stone on which it works in order that the rest may be more effectually preserved."*

Some of the ablest of the advocates of the action of continental glaciers have recently in my opinion contributed largely to the overthrow or modification of the theory. I may refer to two examples.

Prof. Dana has given the *coup de grace* to the American continental glacier by his paper in the No. of Silliman's American Journal for November, 1871. In this paper he affirms that "the idea of a central glacier source for the continent is without foundation," so that it comes to be a question of local glaciers. He demands, however, one very large glacier of this kind. South-east striae occur on the mountains of New England to a height of 5000 to 5200 feet above the sea. A glacier to make these must, as he admits, have moved from a higher level. But N.W. of these striated mountains lie the valley of Lake Champlain and the great plain of the St. Lawrence, the latter with S. W. striæ at right angles to those on the mountains. Still farther in the same direction is the valley of the Ottawa, and between this and the great low region of Hudson's Bay is only the Laurentian watershed of about 1500 feet high. From this must have flowed the glacier which passed over the tops of the White Mountains. In order to effect this result, it is necessary to suppose an elevation of the Hudson's Bay watershed in the Post-pliocene period to at least

* Whymper, "Scrambles amongst the Alps."

4,500 feet above its present height, and considering the uneven nature of the intervening country this is far too little. From this imaginary plateau 6000 to 7000 feet high, flowed a glacier over an intervening valley at least 5000 feet deep and thence over the Green and White Mountains. The glacier must consequently have been itself at least 7000 to 8000 feet thick. Farther "on nearing the St. Lawrence the lower part of its mass yielded to the impulse of gravity according to the slopes of this transverse valley, so that along this valley only *southwest* scratches were made." But the southwest scratches of the St. Lawrence valley run from Labrador to the lake region and beyond, and have been produced by a force acting from the northeast, so that the actual fact must have been the flowing of a transverse glacier under the other up the slope of the country, then on the hypothesis probably greater than at present. But the whole assumption of an unequal elevation of the continent, so as to give a mountain region of the required elevation is destitute of proof; and not only so but contrary to the observed facts, which indicate very equable movements of elevation and depression as high at least as the terraces and raised beaches extend. In short, while our continental glacialists demand a glacier that shall move up the St. Lawrence valley and over the Niagara escarpment into Lake Erie, they also demand the creation of a mountain north of the St. Lawrence, high enough to enable a glacier to glide from it over the White Mountains. These extravagant assumptions are fatal to their theory, and shew that they will be driven to have recourse to floating ice to explain a large part at least of the phenomena.

Mr. J. Geikie, one of the most stubborn of land glacialists, is doing a similar service to the cause of truth, in a series of articles now appearing in the London Geological Magazine. He candidly admits that the "evidence which has been accumulating during recent years will compel us to modify materially" the views of the extreme glacialists. He further admits that the Boulder-clay or till contains stratified gravel, clay and sand, with marine shells. He still maintains that the Boulder-clay proper is moraine matter produced on land, though there is evidence that this Boulder-clay as well as the stratified beds included in it, sometimes at least holds marine shells. He further seems to maintain that Boulder-clay proper, being an unstratified deposit, cannot be of marine origin, though this assumption is controverted, first, by the fact that clays full of stones and boulders contain marine shells, and in Canada at least, the boulders imbeded in such hard clays of the nature of till, often have Bryozoa and Acorn-shells attached to them; and, secondly, by the fact that the clays holding numerous boulders sometimes are stratified. Holding, however, his peculiar views about the Boulder-clay, Mr. Geikie must account for it by land glaciers, and the facts, according to him, shew that these could not have been merely a number of small local glaciers, but a general *mer de glace*. To reconcile this with the occurrence of the marine beds, he is obliged to have recourse to a series of cold and warm periods, and of emergences and submergences, some of them of sufficient duration to enable the country to be occupied with forests and with terrestrial mammalia. Thus it becomes necessary to exaggerate the duration of the glacial period, and indeed to invoke the aid, not of one glacial period, but of many, separated from each other by long periods of ameliorated climate. All this would be avoided by at once admitting the existence of marine Boulder-clays, and endeavouring to separate these either by their fossils or by their chemical and mechanical character from the glacial moraines, which I have no doubt will be found in Scotland as in North America to belong merely to local glaciers flowing in the existing valleys. The kames or eskers, which used both in Scotland and this country to be confounded with moraine ridges, Mr. Geikie now, with all other good geologists, regards as marine, though he attributes some of them to an older date than that held by Home and others.

My general conclusion on this subject is therefore precisely what it was many years ago, and that on which I have proceeded throughout this paper; namely, that we have in Canada evidence of a glacial period in which all the hilly ranges above water, were covered with snow and had glaciers in their valleys; these glaciers terminating and giving off icebergs at the mouths of the valleys, where these opened on the plain of the St. Lawrence, then under water. In the earlier part of the period the elevated land of the Pliocene epoch gradually sunk under the waters, and the remainder of it became refrigerated and covered with snow and ice. At the period of greatest subsidence, nearly all the hills were submerged, and heavy ice from the north ground over their summits; while the upper part of the Boulder-clay and the lower beds of the Leda clay were deposited in the valleys.

As the land rose again, ice-clad hills returned, and new though perhaps less extensive glaciers were formed, and fresh crops of boulders were deposited in the shallowing seas of the Saxicava sand period. Snow still exists throughout the summer in the higher ravines of the White Mountains, and on the hills of Labrador, and a subsidence of a few hundred feet in the valley of the St. Lawrence and the country to the southward, would suffice to restore them to the condition of snow-clad hills giving off icebergs from their bases, so near are we yet to the glacial period; and so little did it really differ from that condition of the continent which still exists. I do not here enter into the question of possible astronomical causes of refrigeration suggested by Croll and others. These may have been influential both with reference to changes of level and of temperature; but I believe the changes of level are sufficient to account for the observed facts.

On my return from Europe in 1866, I endeavoured in a popular lecture, printed in Vol. III. N. S. of the Canadian Naturalist, and entitled comparisons of the "Icebergs of Belleisle and the Glaciers of Mont Blanc," to picture the condition of Post-pliocene Canada. I may refer to this paper as more fully stating my conclusions on the subject, and shall close this summary of the results of sixteen years' work in the Post-pliocene, with two extracts referring to the nature of the action of glaciers and the probable state of Post-pliocene Canada.[1]

"Glaciers are mills for grinding and triturating rock. The pieces of rock in the moraine are, in the course of their movement, crushed against one another and the sides of the valley, and are cracked and ground as if in a crushing-mill. Farther, the stones on the surface of the glacier are ever falling into crevasses, and thus reach the bottom of the ice, where they are further ground against one another and the floor of rock. In the movement of the glacier these stones seem in some cases to come again to the surface, and their remains are finally discharged in the terminal moraine, which is the waste-heap of this great mill. The fine material which has been produced, the flour of the mill, so to speak, becomes diffused in the water which is constantly flowing from beneath the glacier, and for this reason all the streams flowing from glaciers are turbid with whitish sand and mud.

"The Arve which drains the glaciers of the north side of Mont Blanc, carries its burden of mud into the Rhone, which sweeps it, with the similar material of many other Alpine streams, into the Mediterranean, to aid in filling up the bottom of that sea, whose blue waters it discolours for miles from the shore, and to increase its own ever enlarging delta which encroaches on the sea at the rate of about half a mile per century. The upper waters of the Rhone, laden with similar material, are filling up the Lake of Geneva; and the great deposit of 'loess' in the alluvial plain of the Rhine, about which Gaul and German have contended since the dawn of European history, is of similar origin. The mass of material which has thus been carried off from the Alps, would suffice to build up a great mountain chain. Thus by the action of ice and water—

> "The mountain falling cometh to naught
> And the rock is removed out of its place."

"Many observers who have commented on these facts have taken it for granted that the mud thus sent off from glaciers, and which is so much greater in amount than the matter remaining in their moraines, must be ground from the bottom of the glacier valleys, and hence have attributed to these glaciers great power of cutting out and deepening their valleys. But this is evidently an error, just as it would be an error to suppose the flour of a grist-mill ground out of the mill-stones. Glaciers it is true groove and striate and polish the rocks over which they move, and especially those of projecting points and slight elevations in their beds, but the material which they grind up is principally derived from the exposed frost-bitten rocks above them, and the rocky floor under the glacier is merely the nether mill-stone against which these loose stones are crushed. The glaciers in short can scarcely be regarded as cutting agents at all, in so far as the sides and bottoms of their beds are concerned, and in the valleys which the old glaciers have abandoned, it is evident that the torrents which have succeeded them have far greater cutting power."

"In conclusion, I would wish it to be distinctly understood, that I do not doubt that at the time of the greatest post-pliocene submergence of Eastern America, at which time I believe the greater part of the boulder clay was formed, and the more important striation effected, the higher hills then standing as islands would be capped with perpetual snow, and through a great part of the year surrounded with heavy field and barrier ice, and that in these hills there might be glaciers of greater or less extent. Further it should be understood that I regard the boulder clays of the St. Lawrence valley as of different ages, ranging from the early post-pliocene to that at present forming in the gulf of St. Lawrence. Further, that this boulder clay shows in every place where I have been able to examine it, evidence of sub-aquatic accumulation, in the presence of marine shells or in the unweathered state of the rocks and minerals enclosed in it, conditions which, in my view, preclude any reference of it to glacier action, except possibly in some cases to that of glaciers stretching from the land over the margin of the sea, and forming under water a deposit equivalent in character to the 'boue glaciare' of the bottom of the Swiss glaciers. But such a deposit must have been local, and would not be easily distinguishable from the marine boulder clay. I have not had opportunities to study the boulder clay of Scotland, which in character and relations so closely resembles that of Canada, but I confess several of the facts stated by Scottish Geologists lead me to infer that much of what they regard as of sub-aerial origin must really be marine, though whether deposited by ice-bergs or by the fronts of glaciers terminating in the sea, I do not pretend to determine. It must however be observed that the antecedent probability of a glaciated condition is much greater in the case of Scotland than in that of Canada, from the high northern latitude of the former, its more hilly character, and the circumstance that its present exemption from glaciers is due to what may be termed exceptional and accidental geographical conditions; more especially to the distribution of the waters of the Gulf stream, which might be changed by a comparatively small subsidence in Central America. To assume the former existence of glaciers in a country in north latitude 56°, and with its highest hills, under the present exceptionally favourable conditions, snow-capped during most of the year, is a very different thing from assuming a covering of continental ice over wide plains more than ten degrees farther south, and in which, even under very unfavourable geographical accidents, no snow can endure the summer sun, even in mountains several thousand feet high. Were the plains of North America submerged and invaded by the cold Arctic currents, the Gulf stream being at the same time turned into the Pacific, the temperature of the remaining North American land would be greatly diminished; but under these circumstances the climate of Scotland would necessarily be reduced to the same condition with that of South Greenland or Northern Labrador. As we know such a submergence of the land to have occurred in the Post-pliocene period, it does not seem necessary to have recourse to any other cause for either side of the Atlantic. It would, however, be a very interesting point to determine, whether in the Post-pliocene period the greatest submergence of America coincided with the greatest submergence of Europe, or otherwise. It is quite possible that more accurate information on this point might remove some present difficulties. I think it much to be desired that the many able observers now engaged on the Post-pliocene of Europe, would at least keep before their minds the probable effects of the geographical conditions above referred to, and enquire whether a due consideration of these would not allow them to dispense altogether with the somewhat extravagant theories of glaciation now agitated."

It is hardly necessary to add that I hold and have endeavoured to prove by modern facts, in the Memoirs above referred to, that heavy icebergs borne by powerful currents, are potent agents in the production of striated surfaces and glaciated stones, as well as in transporting boulders, and that cold ocean currents are powerful eroding agents, especially when aided by heavy ice. Witness the Straits of Belle-Isle in modern times. Mr Vaughan, for many years Superintendent of the Lighthouse at that place, states that for ten icebergs which enter the straits fifty drift to the southward, yet he records that on the 30th of May, 1858, he counted in the Strait of Belle-Isle 496 bergs, the least of them sixty feet in height, some of them half a mile long and two hundred feet high. Only one-eighth of the volume of floating ice appears above water, and many of these great bergs may thus touch the ground in a depth of thirty fathoms or more, so that if we imagine four hundred of them moving up and down under the influence of the current, oscillating slowly with the motion of the sea, and grinding on the rocks and stone-covered bottom at all depths from the centre of the channel, we may form some conception of the effects of these huge polishers of the sea-floor.

If this memoir had not already extended to too great length, I could have wished to notice the evidence as to the existence of ice-action in more ancient periods than the Post-pliocene. I would now merely state my belief that some of the considerations which render it necessary to invoke the action of frost and ice in the Post-pliocene period, apply also to the origin of *some rocks of much higher antiquity.* *Ramsay* has already noticed this in the case of the Permian conglomerates of England. In Canada an instance occurs in the conglomerate with boulders two feet in diameter, found in the Lower Silurian of Maimanse, Lake Superior.* A still more remarkable case is that of the New Glasgow conglomerate in the coal formation of Nova Scotia, which seems to be a gigantic esker, on the outside of which large travelled boulders were deposited, probably by drift ice, while in the swamps within, the coal flora flourished and fine mud and coaly matter were accumulated.†

A second indication of the existence of intense frost in ancient geological periods, is afforded by the occurrence of angular fragments of hard rocks cemented together. Such beds of angular fragments and chips, occur locally at various horizons, for example in the Upper Silurian and Lower Carboniferous in Nova Scotia, and the material of which they are composed seems precisely similar to that which is at present produced by the disintegrating action of frost on hard and especially schistose and jointed rocks. Such deposits may, I think, fairly be regarded as evidence of somewhat intense winter cold.

SUPPLEMENTARY NOTE.—A visit to Nova Scotia while these sheets were going through *the press enables me to add the following* facts: (1.) The discovery by Mr. G. F. Matthews of shells of Tellina Grœnlandica in the Post-pliocene gravel at Horton Bluff, Nova Scotia. (2.) The occurrence of Laurentian boulders, probably from Labrador, in the Carboniferous region of Nova Scotia. I may specially mention a very fine boulder of Labradorite near the mouth of Carribou River, Pictou County. In Nova Scotia, however, as well as in Prince Edward Island, native stones predominate in the lower Boulder-clay, and the foreign blocks appear more toward the surface; where also, in many cases the greater part of the blocks derived from neighbouring heights are collected. I had occasion often to notice the fact, referred to above, of drift from the south as well as from the *north*, and also *the great frequency in the boulder deposits* of glaciated stones.

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* Can. Nat. II, p. 6. † Acadian Geology, p. 324.

HISTORY OF THE NAMES CAMBRIAN AND SILURIAN IN GEOLOGY.

By T. Sterry Hunt, LL.D., F.R.S.

(*Concluded from page* 312).

III. Cambrian and Silurian Rocks in North America.

In accordance with our plan we now proceed to sketch the history of the lower paleozoic rocks in North America. While European geologists were carrying out the researches which have been described in the first and second parts of this paper, American investigators were not idle. The geological studies of Eaton led the way to a systematic survey of the state of New York, the results of which have been the basis of most of the subsequent geological work in eastern North America, and which was begun by legislative enactment in 1836. The state was divided into four districts, the work of examining and finally reporting upon which was committed to as many geologists. The first or south-eastern district was undertaken by Mather, the second or north-eastern by Emmons, the third or central by Vanuxem, and the fourth or western by James Hall; the paleontology of the whole being left to Conrad, and the mineralogy to Beck. After various annual reports the final results of the survey appeared in 1842. The whole series of fossiliferous rocks known, from the basal or Potsdam sandstone to the coal-formation, was then described as the New York system.

At that time the published researches of British geologists furnished the means of comparison between the organic remains found in the rocks of New York, and those then known to exist in the paleozoic strata of Great Britain. Prof. Hall was thus enabled in his Geology of the Fourth District of New York, to declare, from the study of its fossils, that the New York system included the Devonian of Phillips, the Silurian of Murchison, and the Cambrian of Sedgwick; meaning by the latter the Upper Cambrian, or Bala group, which alone was then known to be fossiliferous. From the evidence then before him, he concluded that the Upper Cambrian was represented in the New York system by the whole of the rocks from the base of the Utica slate, downward, with the probable exception of the Potsdam sandstone; while he conceived, partly on lithological grounds, that the Utica and Hudson-River groups represented the Llandeilo and Caradoc, or the Lower Silurian of Murchison [loc. cit. pages 20, 29, 31]. The origin of the Cambrian and Silurian controversy, and the errors by which the Llandeilo and a part of the Caradoc had by Murchison been classed as a series distinct from the Bala group, were not then known; but in a note to this report [page 20,] Hall informs us of the declaration of Murchison, already quoted from his address of 1842, that the Cambrian, so far as then known, could not, on paleontological grounds, be distinguished from his Lower Silurian.

Emmons meanwhile had examined in eastern New York and western New England a series of fossiliferous rocks, which on lithological and stratigraphical grounds, he regarded as older than any in the New York system; a view which had been previously maintained by Eaton. Holding, with Hall, that the lower members of the New York system were the equivalents of the Upper Cambrian of Sedgwick, he looked upon the fossiliferous rocks which he placed beneath them, as the representatives of the Lower Cambrian. By this name, as we have seen, Sedgwick, in 1838, designated all those uncrystalline rocks of North Wales which he subsequently divided into Lower and Middle Cambrian, and which lie beneath the base of the Bala group. When Murchison, in 1842, in his so often quoted declaration, asserted that "the term Cambrian must cease to be used in zoological classification, it being in that sense synonymous with Lower Silurian," he was speaking only on paleontological grounds, and, disregarding the great Lower and Middle Cambrian divisions of Sedgwick, had reference only to the Upper Cambrian. This however was overlooked by Emmons, who feeling satisfied that the sedimentary rocks which he had examined in eastern New York were distinct from those which he, with Hall, regarded as corresponding to the Bala group or Upper Cambrian, (the Lower Silurian of Murchison), and probably equivalent to the inferior portions of Sedgwick's Cambrian; and supposing that the latter term was henceforth to be effaced from geology (as indeed was attempted shortly after, in the copy of Sedgwick's map published in 1844 by the Geological Society) devised for these rocks the name of the Taconic system, as synonymous with the Lower (and Middle) Cambrian of Sedgwick. These conclusions were set forth by him in 1842, in his report on the Geology of the Northern District of New York [page 162]. See also his Agriculture of New York [I, 49] the fifth chapter of which, "On the Taconic system," was also published separately in 1844; when the presence of distinctive organic remains in the rocks of this series was first announced.

Meanwhile to Prof. Hall, after the completion of the survey, had been committed the task of studying and describing the organic remains of the state, and in 1847 appeared the first volume of his great work on the "Paleontology of New York." Since 1842 he had been enabled to examine more fully the organic remains of the lower rocks of the New York system, and to compare them with those of the old world; and in the Introduction to the volume just mentioned [page xix] he announced the important conclusion that the New York system itself contained an older fauna than the Upper Cambrian of Sedgwick. According to Hall, the organic forms of the Calciferous and Chazy formations had not yet been found in Europe, and our comparison with European fossiliferous rocks must commence with the Trenton group. He however excepted the Potsdam sandstone, which already, in 1842, he had conceived to be below the Upper Cambrian of Sedgwick, and now regarded as the probable equivalent of the Obolus or Ungulite grit of St. Petersburg. Thus Emmons, in 1842, asserted, on lithological and stratigraphical grounds, the existence, beneath the base of the New York system, of a lower and unconformable series of rocks, in which, in 1844, he announced the discovery of a distinctive fauna. Hall, on his part, asserted in 1842, and more fully in 1847, that the New York system itself held an older fauna than that hitherto known in the British rocks.

It is not necessary to recall in this place the details of the long and unfortunate Taconic controversy, which I have recently discussed in my address before the American Association for the Advancement of Science in August, 1871. It is however to be remarked that Hall, in common with all other American geologists, followed Henry D. Rogers in opposing the views of Emmons, whose Taconic system was supposed to represent either the whole or a part of the Champlain division of the New York system; which included, as is well known, all of the fossiliferous rocks up to the base of the Oneida conglomerate (and also this latter, according to Emmons); thus comprehending both the first and the second paleozoic fauna; as shown in the table on page 312.

Emmons, misled by stratigraphical and lithological considerations, complicated the question in a singular manner, which scarcely finds a parallel except in the history of Murchison's Silurian sections. Completely inverting, as I have elsewhere shown, the order of succession in his Taconic system, estimated by him at 30,000 feet, he placed near the base of the lower division of the system the Stockbridge or Eolian limestone, including the white marbles of Vermont; which, by their organic remains, have since been by Billings found to belong to the Levis formation. A large portion of the related rocks in western Vermont and elsewhere, which afford a fauna now known to be far more ancient than that of the Lower Taconic just referred to, and as low if not lower than anything in the New York system, were, by Emmons, then placed partly near the summit of the Upper Taconic, and partly not only above the whole Taconic system, but above the Champlain division of the New York system. Thus we find in 1842, in his Report on the Geology of the Northern District of New York (where Emmons defined his views on the Taconic system), that he placed above this latter horizon, both the green sandstone of Sillery near Quebec, and the red sandrock of western Vermont, (which he then regarded as the representatives of the Oneida and the Medina sandstones.) and described the latter as made up from the ruins of Taconic rocks [pages 124, 282]. In 1844–1846, in his Report on the Agriculture of New York [I. 119], he however adopted a different view of the red sandrock, assigning it to the Calciferous; and in 1855, in his "American Geology" [ii. 128], it was regarded as in part Calciferous and in part Potsdam. In 1848 Prof. C. B. Adams, then director of the Geological Survey of Vermont, argued strongly against these latter views, and maintained that the red sandrock directly overlaid the shales of the Hudson-River group and corresponded to the Medina and Clinton formations of the New York system. [Amer. Jour. Sci. II, v. 108.] He had before this time discovered in this sandrock, besides what he considered an *Atrypa*, abundant remains of a trilobite, which Hall, in 1847, referred to the genus *Conocephalus* (*Conocoryphe*), remarking at the same time that inasmuch as this genus was (at that time) only described as occurring in "graywacke in Germany" and elsewhere, no conclusions could be drawn from these fossils as to the geological horizon of the rocks in question. [Ibid. II, xxxiii, 371.] In September, 1861, however, Mr. Billings, after an examination of the rocks in question, pronounced in favor of the later opinion of Emmons, declaring the red sandrock near Highgate Springs, Vermont, containing *Conocephalus* and *Theca*, to belong to the base of the second fauna "if not indeed a little lower," and to be "somewhere near the horizon of the Potsdam." [Ibid. II, xxxii, 232.]

The dark colored fossiliferous shales which were asserted, both by Adams and by Emmons, to underlie this red sandrock, were, by the former, as we have seen, regarded as belonging to the Hudson-River group, while by the latter they were described as an upper member of the Taconic system; which was here declared to be unconformably overlaid by the red sandrock, a member of the New York system. These slates, a few years before, had afforded some trilobites, which after remaining in the hands of Prof. Hall for two years or more, were in 1859, described by him in the 12th "Report of the Regents of the University of New York," as *Olenus Thompsoni* and *O. Vermontana.* He soon however found them to constitute a distinct genus, for which he proposed the name of *Barrandia*, but finding this name preoccupied, suggested in 1861, in the 14th "Regents' Report," that of *Olenellus*, which was subsequently adopted by Billings, in 1865. [Paleozoic Fossils, pages 365, 419.] In 1860, Emmons, in his "Manual of Geology," described the same species, but placed them in the genus *Paradoxides*, as *P. Thompsoni and P. Vermontana.* Hall had already, in 1847, in the first volume of his Paleontology of New York, referred to *Olenus* the *Elliptocephalus asaphoides* of Emmons, and also a fragment of another trilobite from Saratoga Lake; both of which were described as belonging to the Hudson-River group of the New York system, or to a still higher horizon. The reasons for this will appear in the sequel. The *Elliptocephalus*, with another trilobite named by Emmons *Atops*, (referred by Hall to *Calymene*, and subsequently, by Billings to *Conocoryphe*,) occurs at Greenwich, New York. These were by Emmons, in his essay on the Taconic system (in 1844), described as characteristic of that system of rocks.

A copy of the Regent's Report for 1859 having been sent by Billings to Barrande, this eminent paleontologist, in a letter addressed to Prof. Bronn of Heidelberg, July 16, 1860 [Amer. Jour. Sci. II, xxxi, 212], called attention to the trilobites therein figured, and declared that no paleontologist familiar with the trilobites of Scandinavia would "have hesitated to class them among the species of the primordial fauna, and to place the schists enclosing them in one of the formations containing this fauna. Such is my profound conviction, etc." The letter containing this statement had already appeared in the American Journal of Science for March, 1861, but Mr. Billings in his note just referred to, on the fossils of Highgate, in the same Journal for September of that year, makes no allusion to it. In March, 1862, however, he returns to the subject of the sandrock, in a more lengthy communication [Ibid II, xxxiii, 100), and after correcting some omissions in his former note, alludes in the following language to Mr. Barrande, and to the expressed opinion of the latter, just quoted, with regard to the fossils in question and the rocks containing them: "I must also state that Barrande first determined the age of the slates in Georgia, Vermont, holding *P. Thompsoni* and *P. Vermontana*." He adds "at the time I wrote the note on the Highgate fossils it was not known that these slates were conformably interstratified with the red sandrock. This discovery was made afterwards by the Rev. J. B. Perry and Dr. G. M. Hall of Swanton."

Mr. Billings now blames me [Canadian Naturalist, new series, vi, 318] for having written in my address of last year, with regard to the Georgia trilobites, first described as *Olenus* by Prof. Hall, that Barrande "called attention to their primordial character, and thus led to a knowledge of their true stratigraphical horizon." I had always believed that the letter of Barrande and the explicit declaration of Mr. Billings, just quoted, contained the whole truth of the matter. My attention has since been called to a subsequent note by Mr. Billings in May, 1862, [Ibid II, xxxiii, 421] in which, while asserting that Emmons had already assigned to these rocks a greater age than the New York system, he mentions that in sending to Barrande, in the spring of 1860, the Report of Prof. Hall on the Georgia fossils, he alluded to their primordial character, and suggested that they might belong to what Mr. Barrande has called 'a colony' in the rocks of the second fauna. This is also stated in a note by Sir William Logan in the preface to the Geology of Canada [page viii.] As the genus Olenus, to which Prof. Hall had referred the fossils in question, was at that time (1860) well-known to belong, both in Great Britain and in Scandinava, to the primordial fauna, Mr. Barrande does not seem to have thought it necessary in his correspondence to refer to the very obvious remark of Mr. Billings.

Mr. Billings further showed in his paper in March, 1862, that fossils identical with those of the Georgia slates had been found by him in specimens collected by Mr. Richardson of the Geological Survey of Canada in the summer of 1861, on the Labrador coast, along the strait of Belisle: where *Olenellus* (*Paradoxides*) *Thompsoni* and *O. Vermontana* were found with *Conocoryphe* (*Conocephalus*) in strata which were by Billings referred to the Potsdam group. [See for the further history of these fossils the Geology of Canada, pages 866, 955, and Pal. Fossils of Canada, pages 11, 419.]

The interstratification of the dark-colored fossiliferous shales holding *Olenellus* with the red sandrock of Vermont, announced by Mr. Billings, was further confirmed by Sir William Logan in his account of the section at Swanton, Vermont [Geology of Canada, 281]. They were there declared to occur about 500 feet from the base of a series of 2200 feet of strata, consisting chiefly of red sandy dolomites (the so-called sandrock) containing *Conocephalus* throughout, while the shaly beds held in addition, the two species of *Paradoxides* (*Olenellus*) and some brachiopods. These beds, like those of Labrador, were referred by Logan and by Billings to the Potsdam group. The conclusions here announced were of great importance for the history of the Taconic controversy. The trilobites of primordial type, from Georgia, Vermont, which by Emmons were placed in the Taconic system, lying unconformably beneath a series of rocks belonging to the lower part of the New York system, were now declared to belong to the red sandrock group, a member of this overlying system. Much has been said of these fossils, as if they furnished in some way a vindication of the views of Emmons, and of the Taconic system; a conclusion which can only be deduced from a misconception of the facts in the case. Emmons had, previous to 1860, on lithological and stratigraphical evidence alone, called the Georgia slates Taconic, and placed them unconformably beneath the red sandrock. If now both he and Billings were right in referring the red sandrock to the Calciferous and Potsdam formations, and if the stratigraphical determination of Messrs. Perry and G. M. Hall, confirmed by those of Logan, were correct, viz: that the trilobites in question occur not in a system of strata lying unconformably beneath the red sandrock, but in beds intercalated with the red sandrock itself, it is clear that these trilobites must belong not to the Taconic, but to the New York system. We shall return to the question of the age of these rocks.

We have seen that Prof. James Hall, in 1847, and again in 1859, referred trilobites regarded by him as species of *Olenus* to the Hudson-River group, or in other words to the summit of the second paleozoic fauna, while it is now well known that they are characteristic of the first fauna. In this reference, in 1847, Prof. Hall was justified by the singular errors which we have already pointed out in the works of Hisinger on the geology of Scandinavia. In his *Anteckningar*, in 1828, while the colored map and accompanying sections show the alum-slates with *Paradoxides* to lie beneath, and the clay-slates with graptolites, above the orthoceratite-limestone, the accompanying colored legend, designed to explain the map and sections, gives these two slates with the numbers 3 and 4, as if they were contiguous and beneath the limestone, which is numbered 5. The student who, in his perplexity, turned from this to the later work of Hisinger, his *Lethaea Suecica*, found the two groups of slates, as before, placed in juxtaposition, but assigned, together, to a position above the orthoceratite-limestone. Thus, in either case, he would be led to the conclusion that in Scandinavia the alum-slates with *Olenus*, *Paradoxides* and *Conocephalus* (*Conocoryphe*) were closely associated with the graptolitic shales; and, upon the authority of the latter work, that the position of both of these was there above the orthoceratite-limestones, and at the summit of the second fauna. The graptolitic shales of Scandinavia were already identified with those of the Utica and Hudson-River formations of the New York system. The red sandrock of Vermont, containing *Conocephalus*, had been, both by Emmons and Adams, alike on lithological and stratigraphical grounds, referred to the still higher Medina sandstone; a view which, as we have seen, was still maintained and strongly defended by Adams. This was in 1847, and Angelin's classification of the transition rocks of Scandinavia, fixing the position of the various trilobitic zones, did not appear until 1854. Prof. Hall had therefore at this time the strongest reasons for assigning the rocks containing *Olenus* to the summit of the second fauna. Before we can understand his reasons for maintaining a similar view in 1859, we must notice the history of geological investigation in eastern Canada. So early as 1827, Dr. Bigsby, to whom North American geology owes so much, had given us [Proc. Geol. Soc. I, 37] a careful description of the geology of Quebec and its vicinity. He there found resting directly upon the ancient gneiss, a nearly horizontal dark colored conchiferous limestone, having sometimes at its base a calcareous conglomerate, and well displayed on the north shore of the St. Lawrence at Montmorenci and Beauport. He distinguished moreover a third group of rocks, described by him as a "slaty series composed of shale and graywacke, occasionally passing into a brown limestone, and alternating with a calcareous conglomerate in beds, some of them charged with fossils * * * * derived from the conchiferous limestone." (This fossiliferous conglomerate contained also fragments of clay-slate.) From all these circumstances Bigsby concluded that the flat conchiferous limestones were older than the highly inclined graywacke series; which latter was described as forming the ridge on which Quebec stands, the north shore to Cape Rouge, the island of Orleans, and the southern or Point-Levis shore of the St. Lawrence; where besides trilobites, and the fossils in the conglomerates, he noticed what he called vegetable impressions, supposed to be fucoids. These were the graptolites which, nearly thirty years later, were studied, described and figured for the Geological Survey of Canada by Prof. James Hall; who has shown that two of the species from this locality were described and figured under the name of fucoids by Ad. Brongniart, in 1828. [Geol. Sur. Canada, Decade II, page 60.] Bigsby, in 1827, conceived that the limestones of the north shore might belong to the carboniferous period, and noted the existence of what were called small seams of coal in the graywacke series of the south shore, which substance I have since described in the Geology of Canada [page 525.]

In 1842, the Geological Survey of Canada was begun by Sir William Logan, who in a Preliminary Report to the Government, in that year [page 19], says "of the relative age of the contorted rocks of Point Levis, opposite Quebec, I have not any good evidence, though I am inclined to the opinion that they come out from below the flat limestones of the St. Lawrence." He however subsequently adds, in a foot-note, "the accumulation of evidence points to the conclusion that the Point Levis rocks are superior to the St. Lawrence limestones." In 1845, Captain, now Admiral Bayfield, maintained the same view, fortifying himself by the early observations of Bigsby, and expressing the opinion that the flat limestones of Montmorenci and Beauport passed beneath the graywacke series. These limestones, from their fossils, were declared to be low down in the Silurian, and identical with those which had been observed at intervals along the north shore of the St. Lawrence to Montreal, [Geol. Journal, i. 455] the fossiliferous limestones of which were then well known to belong to the Trenton group of the New York system. The graywacke series of Quebec, which was still supposed by Bayfield to hold in its conglomerates fossils from these limestones, was therefore naturally regarded as belonging to the still higher members of that system; and, as we have seen, the green sandstone near Quebec, a member of that series, had already in 1842, been regarded by Emmons as the representative of the Oneida or Shawangunk conglomerate, at the summit of the Hudson-River group of New York.

It is to be noticed that immediately to the north-east of Quebec, rocks undoubtedly of the age of the Utica and Hudson-River divisions overlie conformably the Trenton limestone, on the left bank of the St. Lawrence; while a few miles to the south-west, strata of the same age, and occupying a similar stratigraphical position, appear on both sides of the St. Lawrence, and are traced continuously from this vicinity to the valley of Lake Champlain. These moreover offer such lithological resemblances to the so-called graywacke series of Quebec and Point Lévis, (which extends thence some hundreds of miles north-eastward along the right bank of the St. Lawrence,) that the two series were readily confounded, and the whole of the belt of rocks along the south-east side of the St. Lawrence, from the valley of Lake Champlain to Gaspé, was naturally regarded as younger than the limestones of the Trenton group. It was in 1847 that Sir William Logan commenced his examination of the rocks of this region, and in his report the next year [1848, page 58] we find him speaking of the continuous outcrop "of recognized rocks of the Hudson-River group from Lake Champlain along the south bank of the St. Lawrence to Cape Rosier." In his Report for 1850, these rocks were farther noticed as extending from Point Lévis south-west to the Richelieu, and north-east to Gaspé, [pages 19, 32]. They were described as consisting, in ascending sequence from the Trenton limestone and the Utica slate, of clay-slates and limestones, with graptolites and other fossils, followed by conglomerate-beds supposed to contain Trenton fossils, red and green shales and green sandstones; the details of the section being derived from the neighborhood of Quebec and Point Lévis, and from the rocks first described by Bigsby. As farther evidence with regard to the supposed horizon of these rocks, to which he subsequently (in 1860,) gave the name of the Quebec group, we may cite a letter of Sir William Logan, dated November, 1861, [Amer. Jour. Sci. II, xxxiii, 106,] in which he says "In 1848 and 1849, founding myself upon the apparent superposition in Eastern Canada of what we now call the Quebec group, I enunciated the opinion that the whole series belonged to the Hudson-River group and its immediately succeeding formation; a *Leptæna* very like *L. sericea*, and an *Orthis*, very like *O. testudinaria*, and taken by me to be these species, being then the only fossils found in the Canadian rocks in question. This view supported Prof. Hall in placing, as he had already done, the Olenus rocks of New York in the Hudson-River group, in accordance with Hisinger's list of Swedish rocks as given in the *Lethæa Suecica* in 1837, and not as he had previously given it."

The concurrent evidence deduced from stratigraphy, from geographical distribution, from lithological and from paleontological characters, thus led Logan, from the first, to adopt the views already expressed by Bigsby, Emmons and Bayfield, and to assign the whole of the paleozoic rocks of the south-east shore of the St. Lawrence, below Montreal, to a position in the New York system above the Trenton limestone. While thus, as he says, founding his opinion on the stratigraphical evidence obtained in Eastern Canada, Logan was also influenced by the consideration that the rocks in question were continuous with those in western Vermont. Part of the rocks of this region had, as we have seen, originally been placed by Emmons at this horizon, while the others, referred by him to his Taconic system, were maintained by Henry D. Rogers to belong to the Hudson-River group; a view which was adopted by Mather and by Hall, and strongly defended by Adams, at that time engaged in a Geological Survey of Vermont, with which in 1846 and 1847, the present writer was connected.

As regards the subsequent paleontological discoveries in these rocks in Canada, it is to be said that the graptolites first noticed by Bigsby in 1827, were re-discovered by the Geological Survey, at Point Lévis in 1854, and having been placed in the hands of Prof. James Hall, (who in that year first saw the rocks in question) were partially described by him in a communication to Sir W. E. Logan, dated April, 1855, and subsequently at length in 1858 [Report Geol. Survey for 1857, page 109, and Decade II.] They were new forms, it is true, but the horizon of the graptolites, both in New York and in Sweden, was the same as that already assigned by Logan to the Point-Lévis rocks. Thus these fossils appeared to sustain his view, and they were accordingly described as belonging to the Hudson-River group.

Up to 1856, no other organic remains than the graptolites and the two species of brachiopods noticed by Sir William Logan, were known to the Geological Survey as belonging to the Point Lévis rocks; the trilobites long before observed by Bigsby not having been re-discovered. In 1856, the present writer, while engaged in a lithological study of the various rocks of Point Lévis, found in the vicinity of the graptolitic shales, beds of what were described by him in 1857, [Report Geol. Surv. 1853-56, page 465,] as "fine granular opaque limestones, weathering bluish-gray, and holding in abundance remains of orthoceratites, trilobites, and other fossils; which are replaced by a yellow-weathering dolomite." In these, which are probably what Bigsby had long before described as fossiliferous conglomerates, the dolomitic matter is so arranged as to suggest a resemblance to certain beds which are really conglomerate in character, and were, at the same time, described by me as interstratified with the fossiliferous limestones, and as holding pebbles of pure limestone, of dolomite, and occasionally of quartz and of argillite; the whole cemented by a yellow-weathering dolomite, and occasionally by a nearly pure carbonate of lime. [Ibid 466.] The included fragments of argillite, (previously noticed by Bigsby) which are greenish or purplish in color, with lustrous surfaces, are precisely similar to those which form great beds in the crystalline schists of the Green Mountain series of the Appalachian hills, which extend in a north-east and south-west course along the south-eastern border of the rocks of the Quebec group. I conceive that these argillite fragments, (like those in the Potsdam conglomerate near Lake Champlain, referred to in my address of last year,) are derived from the ancient schists of the Appallachians.

This re-discovery of fossiliferous limestones at Point Lévis led to farther exploration of the locality, and in 1857, and the following years, a large collection of trilobites, brachiopods, and other organic remains was obtained from these limestones by the Geological Survey of Canada.

Mr. Billings, who in 1856, had been appointed paleontologist to the Geological Survey, at once commenced the study of these fossils from Point Lévis, and at length arrived at the important conclusion that the organic remains there found, belonged not to the summit of the second fauna, but were to be assigned a position in the first or primordial fauna. This conclusion he communicated to Mr. Barrande in a letter, dated July 12, 1860, [Amer. Jour. Sci. II, xxxi, 220] and gave descriptions of many of the organic forms in the Canadian Naturalist for the same year. I have already alluded, in describing the rocks of Point Lévis, to the peculiarities of aspect which probably led Dr. Bigsby, in 1827, to confound these fossiliferous limestones, penetrated by dolomite, with the true dolomitic conglomerates associated with them, and helped him to suppose the fossils to be derived from the limestones of the north shore, now known to be younger rocks. This mistake was a very natural one at a time when comparative paleontology was unknown.

Sir William Logan meanwhile made a careful stratigraphical examination of the rocks of Point Lévis, and notwithstanding the peculiarities of the limestones which there contain the primordial fauna, declared himself, in December, 1860, satisfied that "the fossils are of the age of the strata." In consequence of the discovery of Mr. Billings, Logan now proposed to separate from the Hudson-River group the graywacke series of Bigsby and Bayfield, and ascribed to it a much greater antiquity; regarding it as "a great development of strata about the horizon of the Chazy and Calciferous, brought to the surface by an overturn anticlinal fold, with a crack and a great dislocation running along the summit," by which the rocks in question were "brought to overlap the Hudson-River formation." This series, to which was assigned a thickness of from 5000 to 7000 feet, he named the Quebec group, which included the green sandstones of Sillery, regarded as the summit, the fossiliferous limestones and graptolitic shales at the base, which afterwards received the name of the Levis formation, and a great intermediate mass of barren shales and sandstones, called the Lauzon formation. The first account of this change in the stratigraphical views of Logan occurs in his letter to Barrande, dated December 31st, 1860. [Amer. Jour. Sci. II, xxxi, 216.]

This important distinction once established, it was found necessary to draw a line from the St. Lawrence, near Quebec, to the vicinity of Lake Champlain, separating the true Hudson-River group, with its overlying Oneida or Medina rocks, on the northwest side, from the so-called Quebec group, on the south and east. This division was by Logan ascribed to a continuous dislocation, which had disturbed a great conformable paleozoic series, including the whole of the members of the New York system from the base of the Potsdam to the summit of the Hudson-River group, and, throughout the whole distance of 160 miles, had raised up the lower formations in a contorted and inclined attitude, and caused them to overlie in many cases the higher formations of the system. This dividing line was by Logan traced north-eastward through the island of Orleans, the waters of the lower St. Lawrence, and along the north shore of Gaspé; and south-westward through Vermont, across the Hudson, as far at least as Virginia; separating, throughout, the rocks of the Quebec and Potsdam groups, with their primordial fauna, from those of the Trenton and Hudson River groups, with the second fauna. This is shown in the geological map of eastern America from Virginia to the St. Lawrence, which appears in the Atlas to the Geology of Canada, published in 1865. In an earlier geological map published by Sir William Logan at Paris in 1855, before this distinction had been drawn, the region in question in Eastern Canada is colored partly as the Oneida formation, and partly as the Hudson-River group; while in the accompanying text the Sillery sandstone is spoken of as the equivalent of the Shawangunk grit or Oneida conglomerate of the New York system. [Esquisse Géologique du Canada; Logan and Sterry Hunt, Paris, 1855, page 51.] These rocks were by Logan traced southwards across the frontier of Canada, into Vermont, where they included the red sandrock and its associated slates; which were thus by Logan, as well as by Adams, looked upon as occupying a position at the summit of the second fauna. When therefore in 1859, Prof. Hall described the trilobites found in these slates in Georgia in Vermont, he referred them to the genus *Olenus*, whose primordial horizon in Europe was then well determined, but in deference to the conclusions of Adams and of Logan, assigned them to a position at the summit of the Hudson-River group; Hall himself never having examined the region stratigraphically. [Amer. Jour. Sci. II, xxxi, 221.] In justification of this position he appended to his description the following note, [Ibid. pages 213, 221:] "In addition to the evidence heretofore possessed regarding the position of the slates containing the trilobites, I have the testimony of Sir W. E. Logan that the shales of this locality are in the upper part of the Hudson-River group, or forming part of a series of strata which he is inclined to rank as a distinct group, above the Hudson-River proper. It would be quite superfluous for me to add one word in support of the opinion of the most able stratigraphical geologist of the American continent." Paleontology and stratigraphy here came into conflict, and it was not till in 1860, when Mr. Billings, in the face of the evidence adduced from the latter, asserted the primordial age of the Point Lévis fauna, that Sir William Logan attempted a new explanation of the stratigraphy of the region; declaring at the same time, that "from the physical structure alone no person would suspect the break which must exist in the neighborhood of Quebec; and without the evidence of the fossils every one would be authorized to deny it." [Ibid. page 218.]

The typical Potsdam sandstone of the New York system, as seen in the Ottawa basin in northern New York and the adjacent parts of Canada, affords but a very meagre fauna, including two species of brachiopods, one or two gasteropods, and a single crustacean, *Conocephalites* (*Conocoryphe*) *minutus*, found at Keeseville, New York. In 1852, however, David Dale Owen found and described an extensive fauna in Wisconsin, from rocks which were regarded as the equivalent of the Potsdam sandstone; while the observations of Shumard in Texas, in 1861, and the latter ones of Hayden and Meek in the Black Hills, have since still further extended our knowledge of the distribution and the organic remains of the rocks which are supposed to represent, in the west, the Potsdam and Calciferous formations of the New York system.

As early as 1842, Prof. Hall, in a comparison of the lower paleozoic rocks of New York with those of Great Britain, declared the Potsdam to be lower than the base of the Upper Cambrian or Bala group of Sedgwick. In 1847, as we have seen, he extended this observation to the Calciferous and Chazy, both of which he placed below this horizon; which until a year or two previous had been looked upon as the base of the paleozoic series in Great Britain, and was subsequently made the lower limit of the second fauna of Barrande. Although from these facts it was probable that these lower members of the New York system might correspond to the primordial fauna of Barrande, we still remained, in the language of Prof. Hall, without "the means of parallelizing our formations with those of Bohemia, by the fauna there known. The nearest approach to the type of the primordial trilobites was found in the Potsdam of the northwest, described by Dr. D. D. Owen; but none of these had been generically identified with Bohemian forms, and the prevailing opinion, sanctioned as I have understood, by Mr. Barrande, was that the primordial fauna had not been discovered in this country until the re-discovery (in 1856) of *Paradoxides Harlani* at Braintree, Mass. The fragmentary fossils published in vol. I of the Paleontology of New York, and similar forms of the so-called Taconic system, were justly regarded as insufficient to warrant any conclusions." [Amer. Jour. Sci. II. xxxi, 225]. Such, according to Prof Hall, was the state of the question up to 1860. The *Conocephalus*, detected by him from the red sandrock of Vermont, in 1847, and subsequently recognized in Europe as an exclusively primordial type, seems to have been forgotten by Hall, and overlooked by others, until it was re-discovered in the sandrock by Billings in 1861. He had previously, in 1860, detected the same genus at Point Levis, together with Arionellus, and other purely primordial types. Associated with these, and with many other trilobites belonging to the second fauna, were found several species of Dikellocephalus and Menocephalus, genera first made known by Owen from the Potsdam of Wisconsin. It is by an error that Messrs. Harkness and Hicks, in a recent paper [Quar. Geol. Jour., xxvii, 395] have asserted that Owen, in 1852, found there, together with these genera, Conocephalus and Arionellus; the history of the first discovery of these genera in America, being as above given. The limestones of Point Levis thus furnished what was hitherto wanting, a direct connecting link between the fauna of the American Potsdam and the primordial zone of Bohemia.

The history of the *Paradoxides Harlani*, alluded to by Prof. Hall, is as follows: In 1834, Dr. Jacob Green received from Dr.

Richard Harlan, the cast of a large trilobite occurring in a silicious slate, which was in the collection of Francis Alger, of Boston, and, it was supposed, might have come from Trenton Falls, New York. Dr. Green, who at once pointed out the fact that the rock was wholly unlike any found at this locality, declared the fossil to resemble greatly the *Paradoxides Tessini*, Brongn.,—the former *Entomolithus paradoxus* of Linnaeus; from Westrogothia, —and named the species *P. Harlani*. [Amer. Jour., Sci. I, xxv, 336]. In 1856, the attention of Prof. William B. Rogers was called to a locality of organic remains in Braintree, on the border of Quincy, Massachusetts, where, on examination, he at once recognized the *Paradoxides Harlani* in a silicious slate similar to that of the original specimen. This was announced by him in a communication to the American Academy of Sciences [Proc., vol. iii], as a proof of the protozoic age of some of the rocks of eastern Massachusetts. Prof. Rogers then called attention to the fact that this genus of trilobites is characteristic of the primordial fauna, and noticed that Barrande had already remarked that, from the casts of *P. Harlani*, in the London School of Mines, and the British Museum (which had been made from the original specimen, and distributed by Dr. Green), this species appeared to be identical with *P. spinosus* from Skrey in Bohemia.

In 1858, Salter found in specimens sent to the Bristol Institution, in England, by Mr. Bennett, of Newfoundland, from the promontory between St. Mary's and Placentia Bays, in the southwestern part of the island, a large trilobite, described by him as *Paradoxide. Bennettii* [Geol. Jour., xv, 554], which appears, according to Mr. Billings, to be identical with *P. Harlani*. On the same occasion Salter described under the name of *Conocephalites antiquatus*, a trilobite from a collection of American fossils sent by Dr. Feuchtwanger of New York to the London Exhibition of 1851. This was said to occur in a boulder of brown sandstone from Georgia, and, as I have been informed by Dr. F., was found near the town of Columbus in that state.

The slates of St. John, New- Brunswick, and its vicinity have recently yielded an abundant fauna, examined by Prof. Hartt, who at once recognized its primordial character. This conclusion was first announced, on the authority of Prof. Hartt, in a paper by Mr. G. F. Matthew, in May 1865 [Geol. Jour., xxi, 426]. The rocks of this region have afforded two species of *Paradoxides*, and fourteen of *Conocoryphe*, together with *Agnostus* and *Micro-*

discus, all of which have been described by Prof. Hartt. It may here be noticed that in 1862, Prof. Bell found in the black shales of the Dartmouth valley, in Gaspé, a single specimen of a large trilobite, which, according to Mr. Billings, closely resembles *Paradoxides Harlani*, but from its imperfectly preserved condition cannot certainly be identified with it. [Geol. Canada, 882].

The geological examinations of Mr. Alexander Murray in Newfoundland since 1865, have shown that the south-eastern part of that island contains a great volume of Cambrian rocks, estimated by him at about 6,000 feet in all. No traces of the Upper Cambrian or second fauna have been detected among these, but some portions contain the Paradoxides already mentioned, while others yield the fauna which Mr. Billings has called Lower Potsdam. This name was first given in an appendix (prepared by Sir W. E. Logan,) to Mr. Murray's report on Newfoundland for 1865, published in 1866 [page 46; see also Report of the Geol. Survey of Canada for 1866, page 236.] The Lower Potsdam was there assigned a place above the Paradoxides beds of the region, which were called the St. John group,—the fossiliferous strata of St. John, New Brunswick, being referred to the same horizon; which corresponds to the Menevian of Wales, now recognized as the summit of the Lower Cambrian. The succession of the rocks containing these two faunas in south-eastern Newfoundland is not yet clear; the Lower Potsdam fauna is regarded by Mr. Billings as identical with that found on the strait of Bellisle, at Bic, (on the south shore of the river St. Lawrence, below Quebec,) at Georgia, Vermont, and at Troy, New York; but in none of these other localities is it as yet known to be accompanied by a Menevian fauna. The trilobites hitherto described from these rocks belong to the genera *Olenellus*, *Conocoryphe* and *Agnostus*; neither *Paradoxides*, which characterizes the Menevian and the underlying Harlech beds in Wales, nor *Olenus*, which there abounds in the rocks immediately above this horizon, having as yet been described as occurring in the Lower Potsdam of Mr. Billings. Future discoveries may perhaps assign it a place below instead of above the Menevian horizon.

The characteristic Menevian fauna in and near St. John, New Brunswick, is found in a band of about 150 feet, towards the base of a series of nearly vertical sandstones and argillites, underlaid by conglomerates, and resting upon crystalline schists, in a narrow basin. The series, the total thickness of which is estimated by Messrs. Matthew and Bailey at over 2000 feet, contains Lingula throughout, but has yielded no remains of a higher fauna. The same Menevian forms have been found in small outlying areas of similar rocks, at two or three places north of the St. John basin, but to the south of the New Brunswick coal-field. To the north of this is a broad belt of similar argillites and sandstones, which extends south-westward into the state of Maine. This belt has hitherto yielded no organic remains, but is compared by Mr. Matthew to the Cambrian rocks of the St. John basin, and to the gold-bearing series of Nova Scotia, [Geol. Jour. xxi, 427,] which at the same time resembles closely the Cambrian rocks of southeastern Newfoundland. This was remarked by Dr. Dawson in 1860, when he expressed the opinion that the auriferous rocks of Nova Scotia were "the continuation of the older slate series of Mr. Jukes in Newfoundland, which has afforded Paradoxides," and probably the equivalent of the Lingula flags of Wales. [Supplement to Acadian Geology (1860,) page 53; also Acad. Geol. 2nd ed., page 613.] Associated with these gold-bearing strata, along the Atlantic coast of Nova Scotia, occur fine grained gneisses, and mica-schists with andalusite and staurolite; besides other crystalline schists which are chloritic and dioritic, and contain crystallized epidote, magnetite and menaccanite. These two types of crystalline schists, (which, from their stratigraphical relations, as well as from their mineral condition, appear to be more ancient than the uncrystalline gold-bearing strata,) were in 1860, as now, regarded by me as the equivalents respectively of the White Mountain and Green Mountain series of the Appalachians; as will be seen by reference to Dr. Dawson's work just quoted. At that time, however, and for many years after, I held, in common with most American geologists, the opinion that these two groups of crystalline schists were altered rocks of a more recent date than that assigned to the auriferous series of Nova Scotia by Dr. Dawson; who was much perplexed by the difficulty of reconciling this view with his own. The difficulty is however at once removed when we admit, as I have maintained for the last two years, that both of these groups are pre-Cambrian in age [Amer. Jour. Sci. II, l. 83; address to the Amer. Assoc. Adv Sci. August, 1871.]

A notice by Mr. Selwyn of some of these crystalline schists in

Nova Scotia will be found in the Report of the Geological Survey of Canada for 1870, [page 271]. He there remarks moreover the close lithological resemblances of the gold-bearing strata to the Harlech grits and Lingula-flags of North Wales, and announces the discovery among these strata at the Ovens gold-mine in Lunenberg, Nova Scotia, of peculiar organic markings regarded by Mr. Billings as identical with the *Eophyton Linnæanum*, which is found in the Regio Fucoidarum, at the base of the Cambrian in Sweden. In the volume just quoted [page 269] will be found some notes by Mr. Billings on this fossil, which occurs also near St. John, New Brunswick, in strata supposed to underlie the Paradoxides beds. The same form is found in Conception Bay, in south-eastern Newfoundland, in strata regarded by Mr. Murray as higher than those with *Paradoxides*, and containing also two new species of *Lingula*, a *Cruziana* and several fucoids. Still more recently, *Eophyton*, accompanied by these same fucoids, has been found by Mr. Billings at St. Laurent, on the island of Orleans near Quebec, in strata hitherto referred by the Geological Survey, on stratigraphical grounds, to the Quebec group. The evidence adduced by Mr. Billings shows that this organic form, whatever its nature, belongs to a very low horizon in the Cambrian.

As regards the probable downward extension of these forms of ancient life, I cannot refrain from citing the recent language of Mr. Hicks. [Quar. Jour. Geol. Soc., May 1872, page 174.] After a comparative study of the Lower Cambrian fauna, including that of the Harlech and Menevian rocks in Wales, and the representatives of the latter in other regions, he adds:

"Though animal life was restricted to these few types, yet at this early period the representatives of the several orders do not show a very diminutive form, or a markedly imperfect state; nor is there an unusual number of blind species. The earliest known brachiopods are apparently as perfect as those which succeed them; and the trilobites are of the largest and best developed types. The fact also that trilobites had attained their maximum size at this period, and that forms were present representative of almost every stage in development, from the little *Agnostus*, with two rings to the thorax, and *Microdiscus* with four, to *Erinnys* with twenty-four; and blind genera along with those having the largest eyes; leads to the conclusion that for these several stages to have taken place numerous previous faunas must have had an existence, and moreover, that even at this time in the history of our globe, an enormous period had elapsed since life first dawned upon it."

The facts insisted upon by Hicks do not appear to be inconsistent with the view that at this horizon the trilobites had already culminated. Such does not, however, appear to be the idea of Barrande, who in a recent learned essay upon the trilobitic fauna [1871] has drawn from its state of development at this early period, conclusions strongly opposed to the theory of derivation.

The strata holding the first fauna in south-eastern Newfoundland, rest unconformably, according to Mr. Murray, upon what he has called the Intermediate series; which is of great thickness, consists chiefly of crystalline rocks, and is supposed by him to represent the Huronian. He has however included in this intermediate series several thousand feet of sandstones and argillites which, near St. Johns in Newfoundland, are seen to be unconformably overlaid by the fossiliferous strata already noticed, and have yielded two species of organic forms, lately described by Mr. Billings. One of these is an *Arenicolites*, like the *A. spiralis* found in the Lower Cambrian beds of Sweden, and the other a patella-like shell, to which he has given the name of *Aspidella Terranovica*. [Amer. Jour. Science, III, iii, 223.] These, from their stratigraphical position, have been regarded as Huronian; but from the lithological description of Mr. Murray, the strata containing them appear to be unlike the great mass of the Huronian rocks of the region. Their occurrence in these strata, in either case, marks a downward extension of these forms of paleozoic life.

Mr. Billings has described from the rocks of the first fauna certain forms under the name of *Archeocyathus*, one of the species of which, according to Dr. Dawson, belonged to a calcareous chambered foraminiferal organism similar in its nature to much of the *Stromatopora* of the second, and closely related *Coenostroma* of the third fauna. All of these Dawson shows to have strong affinities to *Eozoon*, which is represented by *E. Canadense* of the Laurentian, and by similar forms in the newer crystalline schists of Hastings, Ontario, as well as by the *E. Bavaricum* of the upper crystalline schists of Bavaria. The succession of related foraminiferal organisms, is farther seen in the Devonian limestones of Michigan, where occur great masses like Stromatopora, which present, according to Dawson a structure intermediate between the Eozoon of the Laurentian and the genera Parkeria and Loftusia of the Cretaceous and the Eocene. The details are taken from Dr. Dawson's recent presidential address to the Natural History Society of Montreal, in May, 1872, where he has announced some of the results of his studies, yet in progress, on the earlier foraminifera.

In 1856 the late Prof. Emmons described [Amer. Jour. Sci. II, xxii, 389] under the name of *Palaeotrochis*, certain forms regarded by him as organic, found in North Carolina in a bed of auriferous quartzite, among rocks referred to his Taconic system. Their organic nature has also been maintained by Prof. Wurtz, but from my own examinations, I agree with the opinion expressed by Prof. Hall, and subsequently supported by the observations of Prof. Marsh, [Ibid. II, xxiii, 278; xvl. 217] that the forms to which the name of Palaeotrochis has been given are nothing more than silicious concretions.

As regards the geological horizon of the series of strata to which Sir William Logan has given the name of the Quebec group, the Sillery and Lauzon divisions have as yet yielded to the paleontologist only two species of *Obolella* and one of *Lingula*. Our comparisons must therefore be based upon the fauna of the Levis limestones and graptolitic shales, which have already been compared with the Middle Cambrian or Festiniog group of Sedgwick, by the combined labors of Billings and Salter. The former has moreover carefully compared this fauna with that of the lower members of the New York system; in which the succession of organic life appears to have been very much interrupted. Thus, according to Mr. Billings, of the ninety species known to exist in the Chazy limestone of the Ottawa basin, only twenty-two species have been observed to pass up into the directly-overlying Birdseye and Black-River limestones. The break between the Chazy and the underlying Calciferous sandrock, in this region, is still more complete; since, according to the same authority, of forty-four species in the latter only two pass up into the Chazy limestone. This latter break in the succession appears to be filled, in the region to the eastward of the Ottawa basin, by the Levis limestone; which has been studied near Quebec, and also near Phillipsburg, not far from the outlet of Lake Champlain. This formation (including the accompanying graptolitic shales,) has yielded, up to the present time, 219 species of organic remains, (comprising seventy-four of crustacea, and fifty-one of graptolitidiæ) none of which, according to Mr. Billings, have been found either in the Potsdam or in the Birdseye and Black River limestone. Twelve of the species of the Levis formation are however met with in the Calciferous, and five in the Chazy of the Ottawa basin, and the Levis is therefore regarded by Mr. Billings as the connecting link between these two formations.

With regard to the British equivalents of these rocks, the Levis limestone, according to Salter, corresponds to the Tremadoc beds; although the species of *Dikellocephalus* found in the Levis rocks are by him compared with those found in the Upper Lingula flags or Dolgelly beds. The graptolitic strata of Levis however clearly represent the Lower Llandeilo or Arenig rocks of North Wales, the Skiddaw group of Sedgwick in Cumberland, the graptolitic beds which in Esthonia, according to Schmidt, are found below the orthoceratite-limestones, [Can. Naturalist, I. vi. 345] and those of Victoria in Australia, [Mem. Geol. Sur. III, part 2, 255, 304.] In the Lower Llandeilo and Upper Tremadoc beds there appears to be in North Wales, a mingling of forms of the first and second faunas, as in the Levis and Chazy formations. The latter was already, by Hall, in 1847, declared to be beneath the Silurian horizon then recognized in Great Britain. By its fauna it is comparatively isolated from the strata both below and above it, and stratigraphically as well as paleontologically it would appear to belong rather than to the lower than to the higher rocks. According to a private communication from Prof. James Hall, the Chazy limestone at Middleville, Herkimer county, New York, to the south of the Adirondacks, is wanting, and the basal beds of the Trenton group (the Birdseye limestone) there rest unconformably upon the Calciferous sandrock.

The relations of the various members of the Quebec group to each other, and of the group, as a whole, to the succeeding Trenton and Hudson-River groups, require further elucidation. If, as I am disposed to believe, the southeastward-dipping series of the older strata near Quebec, exhibits the northwest side of an overturned and eroded anticlinal, in which the normal order of the strata is inverted, then the Lauzon and Sillery divisions, which there appear to overlie the Levis limestones and shales, are older rocks, occupying the position of the Potsdam or still lower members of the Cambrian. Sir William Logan supposes the appearance of these rocks in their present attitude by the side of the strata of the Trenton and Hudson River-groups, in the vicinity of Quebec, to be due to a great dislocation and uplift, subsequent to the deposition of these higher rocks; but, as suggested in my address of last year, I conceive the Quebec group to have been in its present upturned and disturbed condition before the deposition of the Trenton limestones. The supposed dislocation and uplift, extending from the gulf of St. Lawrence to Virginia, is according to this view, but the outcrop of the rocks of the first fauna from beneath the unconformably overlying strata of the second fauna. The later movements along the borders of the Appalachian region have however, to some extent, affected these, in their turn, and thus complicated the relations of the two series. This unconformity, which corresponds to the marked break between the Levis and Trenton faunas, is farther shown by the stratigraphical break and discordance in Herkimer county, New York; and by the fact that beyond the limits of the Ottawa basin, on either side, the limestone of the Trenton group rests directly on the crystalline rocks; the older members of the New York system being altogether absent at the northern outcrop, as well as in the outliers of Trenton limestone seen to the north of Lake Ontario, and as far to the north-east as Lake St. John on the Saguenay. This distribution shows that a considerable movement, just previous to the Trenton period, took place both to the west and the east of the Adirondack region, which formed the southern boundary of the Ottawa basin.

The Levis and Chazy formations, as we have seen, offer a commingling of forms of the first and second faunas, which shows them to belong to a period of transition between the two; but it is remarkable that so far as yet observed, no representatives of the later of these faunas are known to the east and south of the Appalachians, along the Atlantic coast; the first fauna, whether in Massachusetts, New Brunswick or southeastern Newfoundland, being unaccompanied by any forms of the second. The third fauna, on the contrary, is represented in various localities both within and to the east of the Appalachian region, from Massachusetts to Newfoundland. In parts of Gaspé, and also in Nova Scotia, strata holding forms referred to the Clinton and Niagara divisions are met with, as well as other beds of Lower Helderberg age, associated with species of shells and of plants which connect this fauna with that of the succeeding Lower Devonian or Erian period. To this Lower Helderberg horizon (corresponding to the Ludlow of England) appear to belong certain fossiliferous beds found along the Atlantic coast of Maine and of New Brunswick, in Nova Scotia and (?) in Newfoundland; as well as others included in the Appalachian belt in Massachusetts, New Hampshire, Vermont and Quebec, along the Connecticut valley and its north-eastern prolongation. The fossiliferous strata just noticed, both in the Connecticut valley, and along the Atlantic coast, occur in small areas among the older crystalline schists, often made up of the ruins of these, and in highly inclined attitudes. The same is true in some places of the similarly situated strata of Cambrian, Devonian and Lower Carboniferous periods. These derived strata, of different ages, have, from their lithological resemblances to the parent rocks, been looked upon as examples of a subsequent alteration of paleozoic sediments; and by a farther extension of this notion, the pre-Cambrian crystalline schists themselves throughout this region have been looked upon as the result of an epigenic change of these various paleozoic strata; portions of which, here and there, were supposed to have escaped conversion, and to have retained more or less perfectly their sedimentary character, and their organic remains, elsewhere obliterated.

From the absence of the second fauna we may conclude that the great Appalachian area was, at least in New England and Canada, above the ocean during its period, and suffered a partial and gradual submergence in the time of the third fauna. This movement corresponds to the well-marked paleontological and stratigraphical break between the second and third faunas in the great continental basin to the westward, made evident by the appearance of the Oneida or Shawangunk conglomerate (apparently derived from the ruins of Lower Cambrian rocks) which, in some parts, overlies the strata of the Hudson-River group, The break is elsewhere shown by the absence of this conglomerate, and of the succeeding formations up to the Lower Helderberg division. This latter, in various localities in the valleys of the Hudson and the St. Lawrence, rests unconformably upon the strata of the second fauna, as it does upon the older crystalline rocks to the eastward.

In Ohio, according to Newberry, the base of the rocks of the third fauna (Clinton and Medina) is represented by a conglomerate which holds in its pebbles the organic remains of the underlying strata of the second fauna.

To the north-eastward, the island of Anticosti in the gulf of St. Lawrence, presents a succession of about 1400 feet of calcareous strata rich in organic remains, which, according to Mr. Billings, include the species of the Medina, Clinton and Niagara formations, and were named by him, in 1857, the Anticosti group. They rest upon nearly 1000 feet of almost horizontal strata, consisting of limestones and shales rich in organic remains, with many included beds of limestone-conglomerate. This series has by the Geological Survey of Canada been referred to the Hudson-River group, but notwithstanding the large number of forms of the second fauna which it contains, Prof. Shaler is disposed to look upon it as younger, and belonging rather to the succeeding division. There seems not to have been any marked paleontological break between the second and third faunas in this region; and it is worthy of note, in this connection, that in the outlying basin of paleozoic rocks, found at Lake St. John, to the north of Anticosti, *Halysites catenulatus* is met with in limestones associated with many species of organic remains characteristic of the Trenton and referred to that group. [Geology of Canada, page 165.]

The strata to which, in 1857, Mr. Billings gave the name of the Anticosti group were at the same time designated by him Middle Silurian, in which he subsequently included the local sub-division known as the Guelph formation, which in western Ontario succeeds the Niagara; the name of Upper Silurian being thus reserved for the Lower Helderberg division and the underlying Onondaga formation [Report Geol. Sur. Can. 1857, page 248, and Geol. Can. page 20.] Both the Guelph and the Onondaga have been omitted from the table on page 312; the Guelph because it was not recognized in the New York system, and is by some regarded as but a sub-division of the Niagara; and the Onondaga, for the reason that it is a local deposit of magnesian limestones, wiih gypsums and rock-salt, destitute of organic remains.

As to the name of Middle Silurian, it had some years previously been used by the officers of the government Geological Survey in Great Britain to designate the Lower and Upper Llandovery rocks; but is referred to in 1854 by Sedgwick as one that had, at that time, already been abandoned, (L. E. & D.

Philos. Mag. III, viii, 303, 367, 501,) and is also rejected by Lyell, (Student's Manual of Geology, page 452.) It is not used by Murchison, either in his *Silurian System* or in the various editions of *Siluria*, or by Ramsay, who however speaks of the Llandovery rocks as an intermediate series, (Mem. Geol. Survey III, part 2, page 2.) Inasmuch as the name of Silurian was erroneously applied to the rocks of the second fauna, and properly belongs to those of the third fauna only, that of Middle Silurian should b erejected from our nomenclature in North America, as has already been done in England. The strata to which it has been applied, on both sides of the Atlantic, are however important as illustrations of the passage from one fauna to another.

Tl: history of the introduction of the names of Silurian and Devonian into North American geology demands our notice. Prof. Hall, as we have seen, while recognizing in the rocks of the New York system the representatives alike of the British Cambrian, Silurian and Devonian, wisely refrained from adopting this nomenclature, drawn from a region where wide diversities of opinion and controversies existed as to the value and significance of these divisions. Lyell however in the account of his first journey to the United States, published in 1845, applied the terms Lower and Upper Silurian and Devonian to our paleozoic rocks. Later, in 1846, de Verneuil, the friend and the colleague of Murchison in his Russian researches, visited the United States, and on his return to France published, in 1847, (Bul. Soc. Geol. de Fr. II, iv, 12, 646) an elaborate comparison between the European paleozoic deposits and those of North America, as made known by Hall and others. He proposed to group the whole of the rocks of the New York system, up to the summit of the Hudson-River group, in the Lower Silurian, and the succeeding members, including the Lower Helderberg, and the overlying Oriskany, in the Upper Silurian ; the remaining formations to the base of the Carboniferous system being called Devonian. This essay by de Verneuil was translated and abridged by Prof. Hall, and published by him in the American Journal of Science (II. v. 176, 359; vii. 45, 218,) with critical remarks, wherein he objected to the application of this disputed nomenclature to North American geology.

Meanwhile the Geological Survey of Canada was in progress under Logan, who in his preliminary report in 1842, and in his subsequent ones for 1844 and 1846, adopted the nomenclature of the New York system, without reference to European divisions. Subsequently however, the usage of Lyell and de Verneuil was adopted by Logan, who in his report for 1848 (page 57) spoke of the Clinton group as the base of the "Upper Silurian series," while in that for 1850 (page 34) he declared the whole of a great series of fossiliferous rocks in Eastern Canada, including the Trenton, Utica and Hudson-River divisions, and the shales and sandstones of Quebec, (then supposed to be superior to these,) to "belong to the Lower Silurian." In the report for 1852 (page 64) the Lower Silurian was made by Mr. Murray to include not only the Utica and Trenton, but the Chazy limestone, the Calciferous sandrock and the Potsdam sandstone of the New York system. From this time the Silurian nomenclature, as applied by Lyell and de Verneuil to our North American rocks, was employed by the officers of the Canadian Geological Survey (myself among the others,) and was subsequently adopted by Prof. Dana in his Manual of Geology, published in 1863.

The Geological Survey of Pennsylvania, under the direction of Prof. Henry Darwin Rogers, was begun, like that of New York, in 1836, and the paleozoic rocks of the state were at first divided, on stratigraphical and lithological grounds, into groups, which were designated, in ascending order, by Roman numerals. Subsequently, as he informs us in the preface to his final Report on the Geology of Pennsylvania, Prof. H. D. Rogers, in concert with his brother, Prof. William B. Rogers, then directing the Geological Survey of Virginia, considered the question of geological nomenclature. Rejecting, after mature deliberation, the classification and nomenclature both of the British and New York Geological Surveys they proposed a new one for the whole paleozoic column to the top of the coal-measures, founded on the conception of a great paleozoic day, the divisions of which were designated by names taken from the sun's apparent course through the heavens. (Geology of Penn. I. vi, 105.) So far as regards the three great groups which we have recognized in the lower paleozoic rocks, the later names of Rogers, and his earlier numerical designations, with their equivalents in the New York system, were as follows:

Primal, (I.) This includes the mass of 2500 feet or more of shales and sandstones, which in Pennsylvania and Virginia, and farther southward, form the base of the paleozoic series, and rest upon crystalline schists. The Primal division was regarded by the Messrs. Rogers as the equivalent both of the Potsdam and the still lower members of the Cambrian.

Auroral, (II.) This division, which, with the last, includes the first fauna, consists in great part of magnesian limestones, and corresponds to the Calciferous and Chazy formations. Its thickness in Pennsylvania varies from 2500 to 5000 feet, and with the preceeding division, it includes the first fauna. The representatives of the Primal and Auroral divisions attain a great development in eastern Tennessee, where they have been studied by Safford.

Matinal, (III.) In this, which represents the second fauna, were comprised the limestones of the Trenton group, together with the Utica and Hudson-River shales.

Levant, (IV.) This division corresponds to the Oneida and Medina conglomerates and sandstones.

Surgent, *Scalent* and *Pre-Meridional* (V. VI.) In these divisions were included the representatives of the Clinton, Niagara and Lower Helderberg groups of New York, making, with division IV., the third fauna.

The parallelism of these divisions with the British rocks was most clearly and correctly pointed out by H. D. Rogers himself, in an explanation prepared, as I am informed, with the collaboration of Prof. William B. Rogers, and published in 1856, with a geological map of North America by the former, in the second edition of Keith Johnson's Physical Atlas. The paleozoic rocks of North America are there divided into several groups, of which the first, including the Primal, Auroral and Matinal, is declared to be the near representative of "the European paleozoic deposits from the first-formed fossiliferous beds to the close of the Bala group; that is to say the proximate representatives of the Cambrian of Sedgwick." A second group embraces the Levant, Surgent, Scalent and Pre-Meridional. These are said to be "the very near representatives of the true European Silurian, regarding this series as commencing with the May-Hill sandstone." The Levant division is farther declared to be the equivalent of the sandstone just named; while the Matinal is made to correspond to the Llandeilo, Bala or Upper Cambrian; the Auroral with the Festiniog or Middle Cambrian, and the Primal with the Lingula flags, the Obolus sandstone of Russia and the Primordial of Bohemia.

The reader of the last few pages of this history will have seen how the Silurian nomenclature of Murchison and the British Geological Survey has been, through Lyell, de Verneuil and the Canadian Survey, introduced into American geology in opposition to the judgment, and against the protests of James Hall and the Messrs. Rogers, the founders of American paleozoic geology.

Three points have I think, been made clear in the first and second parts of this sketch: First, that the series to which the name of Cambrian was applied by Sedgwick in 1835, (limited by him as to its downward extension, in 1838) was co-extensive with the rocks characterized by the first and second faunas. Second, that the series to which the name of Silurian was given by Murchison in 1835, included the second and third faunas; but that the rocks of the second fauna, the Upper Cambrian of Sedgwick, were only included in the Silurian system of Murchison by a series of errors and misconceptions in stratigraphy, on the part of the latter, which gave him no right to claim the rocks of the second fauna as a lower member of his Silurian. Third, that there was no ground whatever for subsequently annexing to the Silurian of Murchison, the Lower and Middle Cambrian divisions of Sedgwick, which the latter had separated from the Upper Cambrian on stratigraphical grounds, and which were subsequently found to contain a distinct and more ancient fauna.

The name of Silurian should therefore be restricted, as maintained by Sedgwick and by the Messrs. Rogers, to the rocks of the third fauna, the so-called Upper Silurian of Murchison; and the names of Middle Silurian, Lower Silurian, and Primordial Silurian banished from our nomenclature. The Cambrian of Sedgwick however includes the rocks both of the first and second faunas. To the former of these, the lower and middle divisions of the Cambrian, (the Bangor and Festiniog groups of Sedgwick,) Phillips, Lyell, Davidson, Harkness, Hicks and other British geologists, agree in applying the name of Cambrian. The great Bala group of Sedgwick, which constitutes his Upper Cambrian, is however as distinct from the last as it is from the overlying Silurian, and deserves a not less distinctive name than these two. Its original designation of Upper Cambrian, given when the zoological importance of Lower and Middle Cambrian was as yet unknown, is not sufficiently characteristic, and the same is to be said of the name of Lower Silurian, wrongly imposed upon it. The importance of this great Bala group in Britain, and of its North American equivalent, the Matinal of Rogers,—including the whole of the limestones of the Trenton group, with the succeeding Utica and Hudson-River shales,—might justify the invention of a new and special name. That of Cambro-Silurian, at one time proposed by Sedgwick himself, and adopted by Phillips and by Jukes, was subsequently withdrawn by him, when investigations made it clear that this group had been wrongly united with the Silurian by Murchison. Deference to Sedgwick should therefore prevent us from restoring this name, which moreover, from its composition, connects the group rather with the Silurian than the Cambrian. Neither of these objections can be urged against the similarly constructed term of Siluro-Cambrian, which moreover has the advantage that no other new name could possess, of connecting the group both with the true Silurian, to which it has very generally been united, and with the Cambrian, of which, from the first, it has formed a part. I therefore venture to suggest the name of Siluro-Cambrian, as a convenient synonym for the Upper Cambrian of Sedgwick, (the Lower Silurian of Murchison,) corresponding to the second fauna; reserving at the same time the name of Cambrian for the rocks of the first fauna,—the Lower and Middle Cambrian of Sedgwick,—and restricting with him the name of Silurian to the rocks of the third fauna,—the Upper Silurian of Murchison.*

The late Prof. Jukes, it may here be mentioned, in his Manual of Geology, published in 1857, still retained for the Bala group the name of Cambro-Silurian (which had been withdrawn by Sedgwick in 1854) and reserved the name of the "true Silurian period" for the Upper Silurian of Murchison. In his recent

* Dr. Dawson, in his address as president of the Natural History Society of Montreal, in May 1872, has taken the occasion of the publication in the *Canadian Naturalist*, of the first and second parts of this sketch, to review the subject here discussed. Recognizing the necessity of a reform in the nomenclature of the paleozoic rocks, in conformity with the views of Sedgwick, he would restrict to the rocks of the third fauna the name of Silurian, making it a division equivalent to Devonian; and while reserving with Lyell, Phillips and others, the name of Cambrian for the first fauna only, agrees with me in the propriety of adopting the name of Siluro-Cambrian for the second fauna.

and much improved edition of this excellent Manual (1872), Prof. Giekie, the director of the Geological Survey of Scotland, has substituted the nomenclature of Murchison; with the important exception, however, that he follows Hicks and Salter in separating the Menevian from the Lingula-flags, and uniting it with the underlying Harlech rocks (as has been done in the table on page 312), giving to the two the name of Cambrian [loc. cit., pages 526–529], and thus, on good paleontological grounds, extending this name above the horizon admitted by Murchison. Barrande, on the contrary, in his recent essay on trilobites (1871, page 250), makes the Silurian to include not only the Lingula-flags proper (Maentwrog and Dolgelly), but the Menevian, and even a great part of the Harlech rocks themselves (the Cambrian of Murchison and the Geological Survey), for the reason that the primordial fauna has now been shown by Hicks to extend towards their base. This, although consistent with Barrande's previous views as to the extension of the name Silurian, is a still greater violation of historic truth. By thus making the Silurian system of Murchison to include successively the Upper Cambrian and the Middle Cambrian of Sedgwick, and finally his Lower Cambrian, (the Cambrian system of Murchison himself,) we seem to have arrived at a *reductio ad absurdum* of the Silurian nomenclature; and we may apply to Siluria, as Sedgwick has already done, the apt quotation once used by Conybeare, with reference to the Graywacke of the older geologists, which it replaces; "*est Jupiter quodcunque vides.*"

It would be unjust to conclude this historical sketch of the names Cambrian and Silurian in Geology, without a passing tribute to the venerable Sedgwick, who to-day, at the age of eighty-seven years, still retains unimpaired his great powers of mind, and his interest in the progress of geological science. The labors of his successors in the study of British geology, up to the present time, have only served to confirm the exactitude of his early stratigraphical determinations; and the last results of investigations on both continents unite in showing that in the Cambrian series, as defined by him more than a generation since, he laid, on a sure foundation, the bases of paleozoic geology.

SEXUAL SELECTION IN MAN.

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"Sexual selection" is the term employed by Darwin to denote a twofold winnowing, to which he believes that the individuals of many species of animals are subjected. On the one hand, certain males being stronger and more powerful than the others, succeed in leaving descendants behind them, whilst other weaker males do not get the opportunity of perpetuating their peculiarities, the female in this case remaining passive. On the other hand, it is believed that in some cases the females have the power of choosing their mates, and that they select such males as please them best, whether this be in consequence of some peculiarity of form, colour, or voice, or as a result of some undefinable attraction. In this process the selection lies with the female, and the male remains passive, in any other sense than that he does what he can to secure that the choice of the female shall fall upon him instead of upon any other of his rivals. In either case Mr. Darwin believes that great modifications have been produced in this way, and that many animals owe to this cause some of their most striking peculiarities. Mr. Darwin, in fact, has so far abandoned his former belief in the efficacy of "natural selection" as an agent in producing the differences which separate different species of animals, as to admit that some supplementary cause must, in some cases at any rate, be looked for; and this he thinks is to be found in the action, through long periods, of "sexual selection."

Without entering into the question of the extent to which Mr. Darwin's views may be depended on as regards animals, we purpose here very briefly to survey his application of the theory of sexual selection to the case of man. In so doing we shall glance at the leading propositions laid down in Chapters XIX and XX of the "Descent of Man," examining in greater detail those which appear to be of the highest importance. It may as well be premised, however, that there are two distinct aspects to the question of sexual selection, in the case of all animals alike, but especially in the case of man. It is one thing to admit the existence of what Mr. Darwin calls "sexual selection," as an actual fact; and in the case of man it is undeniable that such a kind of selection must have existed, whilst it is almost certain that it must have played some important part in the development of the species. It is one thing to admit this; but it is quite another thing to admit that any of the peculiarities which separate man from the brutes are due to this cause. Few will be disposed to deny the existence of selection, both natural and sexual, amongst mankind, but many will be disposed to doubt if any adequate ground has as yet been advanced for the belief that man's distinctive characters have been acquired in consequence of the action of either of these causes. In the case of sexual selection, with which alone we are dealing at present, Mr. Darwin himself admits the weakness of his case, as regards man; and does not hesitate to candidly confess that his views on this subject "want scientific precision." We shall endeavour to show, not only that this is the case, but that some important elements in settling this question have been altogether overlooked; whilst we must fully recognize the ability with which Mr. Darwin supports his views, and the vast research which characterises all his observations on this and kindred topics.

Mr. Darwin begins by pointing out the chief physical differences which distinguish the man from the woman; and he indicates that "as with animals of all classes, so with man, the distinctive characters of the male sex are not fully developed until he is nearly mature; and if emasculated they never appear." It follows from this—as, indeed every one will admit—that some of the characters of the male, as his possession of a beard and his bass voice, are characters clearly connected with his relations with the other sex; so that if these relations be disturbed or abolished, they do not appear. A still more striking fact, pointing in the same direction, and showing how certain apparently trivial characters are in both sexes connected with the function of reproduction, is the not uncommon growth of hair to a greater or less extent upon the face of women in whom the reproductive functions have naturally ceased to be active.

A curious consideration, however, arises here. If we take the case of a male who has been emasculated in early life, we find that, more or less perfectly, he retains throughout life some of the characters of his boyhood, which are also common to the female, such as smoothness of skin, a beardless face, and a treble voice. Are we, however, on this account to conclude that we are dealing with anything but a male? There are the strongest grounds for the belief that the characters which distinguish the two sexes lie far deeper than the mere physical structure. The difference between the male and female, in man at any rate, seems to be a fundamental one, in which the entire nature is involved; and the male, when artificially mutilated, no more ceases to be a male, than a man ceases to be a man when his leg has been amputated. It is true that the mutilation has rendered him imperfect in one very important aspect of his nature; but the difference is bodily, not mental, and he cannot do otherwise than remain a male as regards his essential nature. It is quite true, also, that as in the case of emasculated animals, the bodily incapacity is accompanied by a deficiency in certain mental attributes which minister to the corporeal function. Thus, the mutilated might very possibly be less courageous or pugnacious than the normal man. Still, we cannot believe that the deeper differences which fundamentally separate the man from the woman, are in any way affected by such a mutilation. We should, at any rate, require much more evidence than we hold at present before concluding that such mutilated males are not distinguished by just those mental characters (with the exception of the above) which are afterwards enumerated by Darwin as distinguishing the male from the female in the human species.

Having discussed the physical differences between the male and female, Mr. Darwin, under the head of "Law of Battle," next endeavours to show that man, in his earlier stages at any rate, must have had to fight for his wife, and that success in marriage must have been to the strongest, in most, if not in all cases. No doubt if this could be shown, there would be a reasonable probability that the race might have been much improved in this way, the strongest and most powerful males leaving the largest number of children, and these inheriting the physical characters to which the success of their fathers was due. We cannot think, however, that Mr. Darwin sufficiently recognizes to what an extent even the lowest savage is something more than a mere animal, and how largely the spiritual element enters into his composition. Taking the savage races known to us—and we have no right to speak dogmatically as to the supposed habits of a hypothetical and still more degraded race—Professor Huxley has recently admitted that the intellectual labour of a good hunter or warrior "considerably exceeds that of an ordinary English-man." A much smaller admission would answer our purpose, as all that is here contended for is that the struggle for any coveted object, amongst even the lowest savage races known to us, is in the main a spiritual contest and not a physical one. Even if we suppose the struggle to be decided by purely physical arguments, still success would by no means invariably attend the strongest, but would be more likely, in the long run, to fall to the cleverest. In the case of a contest between two male animals, such as two stags, we may believe that the strongest is sure to win; but this would by no means hold good amongst even the lowest savages. No races of men are known to us so degraded as to fight solely with the weapons nature has given. But the moment artificial weapons are employed, the contest becomes essentially one of skill and not of mere strength. In other words, the result of the contest would depend mainly upon the mental characters of the combatants, instead of on their relative physical strength. Take the only case Mr. Darwin adduces in support of his view, namely the case of the North American Indians, of whom Hearne says that the men wrestle for any woman to whom they are attached, and that "of course, the strongest party always carries off the prize." Any one, however, who has ever seen wrestling knows that this last statement does not express a fact. Success in wrestling depends only to a very limited extent upon actual strength or even weight, but almost entirely upon skill. Not only is this the case, but success in wrestling is largely influenced by the possession of certain mental peculiarities, wholly irrespective of mere mechanical adroitness.

Upon the whole, then, it is perhaps safe to conclude that even the actual physical contests between individual men or tribes of men, however savage, are ultimately decided by the mental characters of the competitors, as much as by anything else. We may, however, go further than this. Admitting that women are always likely amongst savage races to constitute a bone of contention for the men to fight over, still we need not admit that success in such a fight would always, or even generally, fall to the strongest. On the contrary, the man most skilful in the use of his weapon, most fertile in resource, with the most inventive genius, and with the most ready use of his tongue, would be at least as likely to win a wife as the biggest and strongest of his competitors. Mere brute strength is not always the *ultima ratio* even amongst the lowest savages. In some respects savages are often singularly like children, and one can imagine many cases in which a savage might carry of his wife from several competitors by his mental ascendency alone, without having recourse to the carnal weapon. Lastly, Mr. Darwin himself afterwards points out at length that there are many cases even amongst savages in which the woman has a free choice, and in which she does not play the merely passive part of espousing the strongest of her suitors. Whenever this is the case, and we have no right to assume that it was not the case in a hypothetical semi-human race, the strongest would, of course, by no means always be the most successful in his matrimonial affairs.

We cannot, then, agree with Mr. Darwin in thinking that man owes his greater size and strength as compared with woman, "together with his broader shoulders, more developed muscles, rugged outline of body, and greater courage and pugnacity," to the continued success of the strongest man of some primaeval race in a long series of combats for the possession of their wives. On the contrary, if any "selection" of this kind has ever taken place to an extent sufficient to produce any palpable and recognisable effect, we believe that it has been in favour of the most cunning, clever, inventive, and skilful men. We also cannot believe that man's superior strength, as compared with woman, has been kept up amongst the civilized races by the fact that "the men, as a general rule, have to work harder than the women for their mutual subsistence." Civilized man has as a rule to work harder than his wife, but his work in a very large proportion of cases is itself of a nature to diminish his physical strength, or it is attended with concomitant circumstances which do not favour his physical development. It is also worthy of notice here that the physical superiority of man as compared with women is even higher amongst civilized races than amongst savages, and this not only relatively but absolutely. Amongst savages, the women have generally to work at least as hard as the man, and thus the disproportion between the sexes is reduced. In a state of civilisation, on the other hand, whilst the women may have to work less and may thus be physically stunted of their full development, the man, contrary to what might have been expected—are on the whole physically superior to the savage races, in spite of the fact that their avocations are not such as always promote physical strength. Th t civilized man is a finer *animal* than savage man may be disputed, but little doubt can be entertained as to the general truth of the above assertion. There is, therefore, a greater disproportion in strength between the sexes among civilized than among savage races; though, on Mr. Darwin's views, the cause which has led to this disproportion must have ceased to operate for many successive generations of the former.

Passing on now to the differences in the mental powers of the two sexes, Mr. Darwin adopts the view which most impartial and unbiassed reasoners affect, namely, that man is decidedly the superior of the women in intellectual calibre. In spite of all that has been said of late about the equality between the sexes, Mr. Darwin concludes that "the chief distinction in the intellectual powers of the two sexes is shown by man attaining to a higher eminence, in whatever he takes up, than woman can attain—whether requiring deep thought, reason, or imagination, or merely the use of the senses and hands." Accepting this intellectual difference, there are also other differences sufficiently weighty to support the view that the two sexes differ fundamentally in their mental constitution. If this be admitted, we might go farther than Mr. Darwin, and we might defend the proposition that the difference between the sexes, in the case of man, is one essentially and primarily mental, and that the physical difference is a secondary and non-essential one, truly flowing from and depending on the former. Facts are by no means wanting which would support this view, but they are mostly unsuitable for introduction here.

We next have a remarkable section on the voice and musical powers of man and some of the lower animals, the leading feature in which is the proposition that "although the sounds emitted by animals of all kinds serve many purposes, a strong case can be made out that the vocal organs were primarily used and perfected in relation to the propagation of the species." This is no new theory, and we have not time to analyse here the grounds upon which it rests. We may observe, however, that this theory leads to what we cannot but regard as a very debasing view of what music is and what it can effect. We are called upon, in fact, to believe that the feelings called up by music, of which Herbert Spencer remarks that it "arouses dormant sentiments of which we had not conceived the possibility and do not know the meaning," are merely reminiscences of the passions felt by some "half-human progenitor of man" during the season of courtship, when his excitement led him to express himself in harmonious tones and cadences. On this view, "musical tones would be likely to excite in us, in a vague and indefinite manner, the strong emotions of a long past age." So that, the emotions which we feel on listening to one of the productions of a great composer stand on no higher level than the impulse felt by dogs which leads them to turn round and round on the carpet as if to trample down grass to form their bed; both alike being vague associations inherited from some aboriginal ancestor! Water, however, rises no higher than its source; and it would be difficult to show how the complicated and wholly inexpressible emotions evoked by music, from their vague and indefinite nature, could ever have been developed out of the emotions felt by one of our savage ancestors in the performance of what, on Darwinian principles, must have been a purely animal function. Natural selection, certainly, never could have led to such a development, for it would need very strong evidence to establish the view that the appreciation of music is in any way beneficial either to the individual or the species; and there are no grounds for believing that sexual selection could have brought about such a fundamental change.

An elaborate account is next given of the habits of savages, in order to prove that men in all states of civilization, but especially in the lowest, are more or less influenced in their marriages by the beauty of the women. No one, we take it, will hesitate to admit this to the fullest extent; so that it is hardly necessary to devote any time to the demonstration of the fact that beauty, in all times and amongst all peoples, is a mere matter of taste; features which are admired by one man being regarded as hideous by another. Admitting that men are in many cases influenced in their choice of a wife by mere external appearances, we have to enquire whether "the consequent selection during many generations of those women which appear to the man of each race the most attractive, has altered the character, either of the females alone or of both sexes." Mr. Darwin answers this enquiry in the affirmative, and though he adduces no very strong evidence in support of this view, we see no reason for doubting its general correctness. If, in fact, we admit that man is an animal at all, and no reasonable person would dispute this proposition, we must admit that he is amenable to the general laws which govern the improvement of the various breeds of domesticated animals. We cannot, therefore, doubt but that the tendency of each man to choose a good-looking wife, according to his standard of beauty, must in successive generations have had the effect of improving the personal appearance of the women, and, through them, of the race in general. This admission, however, in no way carries with it the acceptance of any belief that the fundamental characters which distinguish the sexes, or which separate man from the monkeys, have been produced by any conceivable action of "sexual selection" of this kind, acting through any conceivable period.

Mr. Darwin next passes on to notice the causes which he conceives to have interfered with or prevented the action of sexual selection amongst savages. The only cause adduced by him which demands our consideration, is what Sir John Lubbock has politely termed "communal marriages," *i. e.* the state of things in some savage tribes in which "all the men and women in the tribe are husbands and wives to each other." This state of things is, of course, a complete bar to the existence of "sexual selection," and we may at once dismiss it, so far as this aspect of the question is concerned. There is, however, another aspect of this subject upon which it may be well to make a few remarks. Upon strict Darwinian principles such a habit as that of "communal marriage" could never have been "the original and universal form throughout the world," unless it had been derived by modification from habits and feelings existing in some prehuman type of animal. But this is one of the numerous points in which—paradoxical as it may seem—man really proves his superiority over the brutes, by being *worse* than any beast. The disciples of Mr. Darwin's school do not recognize that man's sins and vices, indeed his very capacity for doing wrong, raise him immeasurably above the brutes that perish. *They* can do no wrong, for they cannot transgress the laws of their nature; but man can act in opposition to the dictates of his higher nature, when he becomes, not worse than himself merely, but worse than any animal. The capacity to fall, however, is truly but a measure of the capacity to rise; and man's evils distinguish him from the lower animals as much as his virtues. From this point of view, it is not difficult to shew that "communal marriage" is a strictly human institution, that it can never have existed amongst the quadrupeds, and that it cannot, therefore, have been produced amongst the early races of mankind by a modification or expansion of habits existing amongst the animals. Not only is communal marriage an infinitely worse institution than anything known to obtain amongst the mammals; but it would not be difficult to show that its very existence depends upon the fact that man, alone of all the mammals, is not limited to a particular period of the year in which he courts the female. But Darwinism fails to assign any adequate cause to explain how man should in the first instance have come to depart from the ordinary rule amongst animals in this very important respect. On the other hand, communal marriage is utterly opposed to all the feelings which are known to regulate the relations between the sexes amongst the higher mammals. "With the existing Quadrumana, so far as their habits are known, the males of some species are monogamous, but live during only a part of the year with the females, as seems to be the case with the Orang. Several kinds, as some of the Indian and American monkeys, are strictly monogamous, and associate all the year round with their wives. Others are polygamous, as the Gorilla and several American species, and each family lives separate. . . . . . Again, other species are polygamous, but several males, each with their own females, live associated in a body, as with several species of baboons." Upon the whole, therefore, Mr. Darwin concludes that "communal marriage" never prevailed amongst the mammals in a state of nature, or even amongst the primeval races of men, "if we look far enough back in the stream of time." It would appear, however, that such an admission strongly militates against the whole Darwinian hypothesis of the descent of man. If man be descended from "some ape-like creature," as Mr. Darwin asks us to believe, it ought to be shown that the habits of man, at any rate in his savage condition, are modifications of habits in pre-human ancestors; and as such ancestors are unknown to us, traces of such habits, to say the least of it, ought to be shown to exist in the monkeys, since these are assumed to be man's nearest living relatives. But communal marriage, like so many of man's vices and degraded habits, is strictly human, and no traces of such an institution can be shown to exist in any of the mammals. Nay more, such an institution is wholly foreign to all the instincts of the brutes, so far as these are known to us. We may readily suppose that each male quadruped (except amongst the monogamous species) would prefer having as many wives as he could get; and hence we have no difficulty in understanding how various species of mammals come to be polygamous. But polygamy stands on a totally different footing to communal marriage. The possession by each male of many wives would certainly be secured by communism; but this recommendation of the system would be far more than counterbalanced by the fact that each male has to undergo the trial of knowing other males, his rivals, to be just as well off in this respect, as he is himself. Judging from what we know of the habits and instincts of wild animals, no male mammal would or could endure this trial with patience; especially as the males are often armed "with special weapons for battling with their rivals," and as they are limited to a short breeding-season. Communal marriage implies that each male should acquiesce in the success of his rivals, in order that a similar license may be extended to himself, and he may be permitted to pursue his loves in peace. Each male, on the other hand, amongst the mammals, resists, so far as he is able, the successes of the other males; and we can not, therefore, suppose that communal marriage, in our sense of the term, ever occurs, or has occurred, amongst the quadrupeds. We are thus unable to trace in any mammal the commencement of those feelings which render communal marriages possible amongst men.

As regards the manner of action of sexual selection with mankind, there are only three points which may be noticed. In the first place, sexual selection is said by Mr. Darwin to have acted much more powerfully in very remote periods than at the present day. We cannot see that any adequate grounds exist for such an assertion. Sexual selection, so far as it acts at all, must be at least as powerful now as it ever was. Its action amongst the most civilized nations has doubtless become infinitely complex, but men select their wives, or wives select their husbands, just as much as they ever did, and if sexual selection has any action in modifying races, it cannot be less effective now than it used to be, simply because the grounds of the selection have been changed. In the second place, it is a fallacy, so far, at any rate, as civilized peoples are concerned, to suppose that the strongest men necessarily leave the largest number of children. On the contrary, the notorious fact is that it is amongst the weaker members of the community, and those both physically and morally below the standard, that the highest ratio of multiplication is found. Not only does a certain amount or kind of physical degeneracy predispose to rapid multiplication; but the same classes of society in which the best examples of this may be found are just those in which early marriage is the rule, instead of the exception. The strongest classes of the community, therefore, certainly have no assured advantage over the weaker and poorer classes, as regards the number of descendants likely to be left by each. In the third place, Mr. Darwin believes that the characters of male animals have in the main been acquired by "the law of battle," in consequence of their having been compelled to fight for their wives. If such had been the case with man, however, the characters gained in this way must have been chiefly, if not exclusively, *mental*. For, we have already seen that the struggle between man and man, even in the savage state, turns upon skill, ingenuity, cunning, and patience, far more than upon mere brute strength; whilst man, alone of all the higher animals, has been endowed by nature with no special weapons either of offence or defence. In fact, on Mr. Darwin's hypothesis, he is supposed to have early lost the few natural weapons with which he commenced the battle of life; a supposition very inconsistent with the theory of sexual selection.

Finally, it only remains to add that the chief character of the human race which Mr. Darwin proposes to account for by the action of sexual selection, is the general hairlessness of his body. It is admitted that natural selection, formerly so confidently appealed to, cannot have metamorphosed man from a hairy into a hairless animal; but it is now supposed that this change may have been brought about by the constant selection by the males of a hairy race of men of females in whom the hairy covering became "small by degrees and beautifully less." Mr. Darwin thinks that there is "nothing surprising in a partial loss of hair having been esteemed as ornamental by the ape-like progenitors of man." We can only say that we cannot agree with him in feeling no surprise on this head; whilst we do not think that the general evidence bears out his views as to the origin of man's hairless skin.

ADDITIONAL NOTES ON THE TACONIC CONTROVERSY.

By E. Billings, F.G.S.

In the last number of this journal I stated that the error in regard to the age of the Taconic rocks, was corrected by the investigations of the Geological Survey of Canada. I now propose to advance some further evidence in support of that averment. The question was decided chiefly by our discoveries at Point Levis, in May, 1860.

A trilobite that had been collected in the Georgia slates, was sent to me by Col. Jewett, in April, 1859. I considered that its occurrence in that group of rocks, was very much in favour of the views of Dr. Emmons. It is to this that he refers in his letter, published in my former note, where he says, "I had for years past looked upon the subject with a kind of indifference, until you had expressed to Col. Jewett opinions favourable to the existence of the lower rocks I had contended for."

I did not publish my opinion, but when afterwards Prof. Hall described and figured three trilobites from the same locality, I sent his pamphlet to Barrande, and called his attention to them as a group of primordial fossils, in a formation which was by the principal geologists of America, considered to be of the age of the Hudson River group. I saw that the facts could only be explained in one of two ways—either Dr. Emmons was right, or the trilobites constituted a sort of a colony of primordial fossils, in the Lower Silurian. The following are some extracts from Barrande's letter in reply:

"Paris, 28th May, 1860.

"My Dear Sir,

"A short time ago I received your letter of the 25th April, and at the same time the three Decades with two pamphlets, equally important for me. * * *

"You will see shortly, in the Bulletin my observations on the subject of *Paradoxides Harlani*, which I consider as identical with *Paradoxides spinosus* of Bohemia; that opinion dates back to 1851. Being then in London, at the British Museum, they presented to me for determination, a cast sent from the United States under the name of *P. Harlani*. After having examined it, I was convinced that this cast had been made from a Bohemian specimen, which had been sent to the other side of the Atlantic. I therefore thought myself right in effacing the American name, and in substituting that of *P. spinosus*. A short time afterwards I experienced the same illusion at the School of Mines in Paris. You may perceive by this how evident it is that these two forms are identical.

"After this fact, I think with you, that the opinions of our American confreres might well be modified. Besides you are aware that my doctrine, often expressed, is that the local deposits of countries, distant from each other, do not necessarily correspond exactly, one to one. * * *

"Nothing is more remarkable than the apparition of the three *Olenus* of Vermont, described by J. Hall in the pamphlet which I owe to your kindness. I demand of you, before all, if the figures are of the natural size, because there is nothing said about it in the text. The dimensions figured, greatly exceed those of the congeneric species of the ancient continent. You have good reason certainly to consider the apparition of these three species, in the Hudson River group, as a fact analogous to that of my colonies. * * *

"These three *Olenus* reproduce certainly the forms, which appear in Europe, only in the Primordial fauna. Consequently they would constitute by themselves, the phenomena, of the re-apparition of a genus heretofore considered as having become extinct with the primordial fauna. It would be a fact analogous to the Colonies, and I would be happy to be able to cite it in the work which I am preparing upon that subject, and which I hope to publish soon. But before placing that fact among those on which I found my doctrine, you will perceive that it is indispensable for me to obtain a perfect security of its reality. * * *

"You will render me a great service, if you can send me the facts which I have asked you for. If the three *Olenus* of Georgia represent really a re-apparition of an extinct type, or a sort of a colony, that fact would be very apropos for me, since it will show that on the new continent the succession of organic beings has been subjected to anomalies, similar to those which I have discovered in our old Europe. But if by chance, by some local accident, hitherto not perceived, there has been an illusion, very conceivable, as to the age of the Georgia slates holding the *Olenus*, it would simply be in America a repetition of that which has taken place in England, in Spain, and in Germany, as I have already related to you. * * *

J. BARRANDE."

The above is quite sufficient to prove, that I had recognized the trilobites to be primordial, before the pamphlet in which they were figured was sent to Barrande. Prof. Hall had referred them to *Olenus*, but I have been assured by several of the geologists who followed him, that he never intimated to them that the fossils indicated a horizon lower than that of the Hudson River group. I was the first to point this out. I considered that the evidence afforded by these trilobites was strongly in favour of Dr. Emmons' views, but did not amount to a perfect demonstration. They might constitute a colony, or something analogous thereto. Had no other evidence of the antiquity of the Georgia slates ever been discovered, it is possible that their age might still be disputed.

About the middle of May, 1860, before I had received Barrande's letter above quoted, and in fact before it was written, the trilobites and other fossils in the limestone of Point Lévis were collected. This discovery at once changed the whole aspect of the question. Up to this time the three trilobites of the Georgia slates stood alone, but now a crowd of similar forms came to their assistance. As these new fossils were partly primordial, and in part Lower Silurian types, I assigned to them a position about the horizon of the Calciferous and Chazy formations.* It was at first thought that those which occurred in a peculiar white limestone might constitute a group distinct from the others, and that they might represent some portion of a strictly primordial fauna. It was afterwards found that this group was connected with the others, and that the whole belonged to one series.

On the 12th of July, 1860, I wrote to Barrande, and gave him an account of our discovery. The following are some extracts from his answer:

"Paris, 19th August, 1860.

"My Dear Sir,

"Your letter of the 12th July last remained some days at Prague, where it awaited me. I have received it, and hasten to inform you, that I have read it with the most lively interest and the greatest satisfaction. The important discovery which you announce did not surprise me, upon the whole, since, as you have reminded me, I have always hoped for it. I recognize a coincidence, so to speak, providential, between that manifestation of the primordial fauna in the environs of Quebec and the moment when the question relative to the three *Olenus* of Vermont is about to arise.

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* When Sir W. E. Logan first examined these rocks he thought they were older than the Trenton. In his "Preliminary Report" dated 6th December, 1842, he states "of the relative age of the contorted rocks at Point Lévis opposite Quebec, I have not any good evidence, though I am inclined to the opinion that they come out from below the flat limestone of the St. Lawrence." We now know that his first view was the correct one.

" Without knowing in detail, the forms of the primordial fauna which you have collected, the only head of the *Conocephalites*, of which you have sent me the engraving, suffices to show me, that your appreciation of the ensemble of that fauna is exact. Besides I am convinced, by all that I know of your works up to this time, that your judgment is correct, and that you are not the man to permit yourself to be led away by preconceived ideas. Therefore the distinction which you have established between the three faunas; the black slates, the white and the grey limestones constitute for me facts which merit all my confidence.

" I think then as very rational all that you have said on the order of succession. If the locality at Quebec, does not admit of the determination, in an evident manner, of the relative age of the three faunas, by observation of their superposition, that which is the fundamental proof in palæontology as it is in stratigraphy, I think you will discover some other locality, in which may be more clearly decided that relative age.

" In the meantime we can only judge from the nature of the fossils. As to those of the white limestone, such as you have recognized them, they indicate clearly a stage of the primordial fauna. Whether that stage is above or below that of the Potsdam, or whether it represents the same horizon as the latter, is a question of secondary and local importance, which probably will be solved in time. There may be several stages distinct from each other in America as in Sweden, while I recognize only one in Bohemia. These are only such diversities as we may expect in countries distant from each other.

" The fauna of the black slates, as you have described it in your letter, consisting almost entirely of Graptolites with two *Lingulæ*, a *Discina* and a small trilobite, does not present a decisive character like that of the white limestone. We cannot then, on the first view, declare that it constitutes a stage of the primordial fauna. But if these black slates are the same as those which have furnished the three species of *Olenus* in Vermont, there can be no hesitation, and it will be necessary to recognize also that fauna, in that schistose mass. In that case, the occurrence of the graptolites, in such great numbers on that horizon, would be a very remarkable phenomenon, of which we have no example in other Silurian regions. It would be necessary to recognize, in that fact, a new proof, of the remarkable privilege of anteriority, which I have signalized for the zone of the North, of which your country forms a part. As to the small trilobite found in these slates, its dimensions calls forth the thought that you may discover the metamorphoses (of trilobites) in that formation.

" The fauna of the grey limestone is well characterized as appertaining to the second fauna, as you have observed, for it presents the ordinary genera of Trilobites, Cephalopods, Gasteropods, &c. The presence of one species of *Agnostus*, is also very natural, since that Genus is found in other Silurian countries, just up to the superior limit of the second fauna, for example, in Bohemia just in d 5.

"I think you are acting wisely in studying with time and all necessary care, all the elements of the question before asserting in a positive manner, the order of the succession of these three fauna. As there are many savants interested in the debate which will infallably arise, when you publish your discoveries, it is very desirable that your opinion may be so well founded that it may be inattackable.

"At all events, it is certain that the labours of the Geological Survey of Canada, will throw a great light on the Geology of the North of America, and in particular on the Silurian Epoch. Naturally, that light will reflect on the ancient continent, and we will be permitted to fix our ideas on bases more broad and solid, &c., &c.

J. BARRANDE."

This letter proves that the age of the Point Levis fossils was determined by me before I had written to Barrande about them. It now became almost certain, that the trilobites in the Georgia slates did not constitute a colony. This was confirmed by stratigraphical evidence, in 1861, by J. Richardson, who while making some examinations for our Survey at the straits of Belle Isle, found the fossils of the Georgia slates, in the undisturbed rocks lying directly on the Laurentian. He also discovered them in the same position, in Newfoundland, but in this instance with other rocks holding the fossils of the Potsdam and calciferous above them. The above appears to me to be quite sufficient to show, that the error relating to the Taconic rocks, was removed by the investigations and discoveries of the Geological Survey of Canada.

In December 1860, Mr. Marcou, who took a very active interest in the investigation, published Barrande's opinion on the age of the Georgia slates. This I have always considered to be equivalent to the publication of Barrande himself, as no doubt it was authorized by him. According to the laws of priority, therefore, Barrande was the first to determine the horizon of this formation on palæontological grounds, and I have on several occasions given him full credit for it. But by so doing, I am not precluded from showing what my own views were. I had previously recognized that the fossils were primordial forms, and that either they constituted a colony, or the rocks were older than the Hudson-River group.

American geology is indebted to Barrande for much greater services. It was he that discovered that, as a general rule, rocks holding trilobites of those types which we now call primordial, lie below the Lower Silurian. It was by the application of this rule, or law of nature as it may be called, that met only the age of the Taconic but also the age of the slates, at St. Johns New Brunswick, and of the great series of rocks investigated by Mr. Murray in Newfoundland were determined. The age of a number of other deposites in the Western States and in the Rocky Mountains has been decided by the same law.

ON SOME FOSSILS FROM THE PRIMORDIAL ROCKS OF NEWFOUNDLAND.

By E. Billings, F.G.S.

In Mr. Murray's "Report upon the Geological Survey of Newfoundland for the year 1870," the Primordial rocks of the southeasterly portion of the Island, are estimated to have a thickness of about 6000 feet. The upper 476 feet, constituting Bell Island, in Conception Bay, a short distance from the city of St. Johns, hold a peculiar group of fossils, the exact age of which has not yet been determined. The species thus far collected, consist entirely of *Lingulæ*, *Cruziana* and fucoids. Among the latter are fine specimens of several species of *Eophyton*, a genus first discovered on this continent by Mr. Murray. The *Lingulæ*, on a superficial examination, might be taken for those of the Upper Potsdam of Wisconsin. They are, however, specifically, and two of them are, perhaps, even generically, different. These two are distinguished by the remarkable convexity of the dorsal valve. They have their nearest representatives in some species from the "Budleigh Salterton Pebble-bed" of Devonshire, England. The pebbles of this latter formation, which hold the *Lingulæ*, are supposed to have been derived from the "Armorican sandstone" of Brittany, France, considered to be about the base of the Lower Silurian. In Newfoundland, up to the present time, true primordial trilobites have been collected, only in beds, the highest of which are full 2000 feet below the lowest strata of Bell Island.

I shall therefore describe the fossils of this Island as a distinct division.

FOSSILS FROM GREAT BELL ISLAND.

Genus Eophyton, *Torell.*

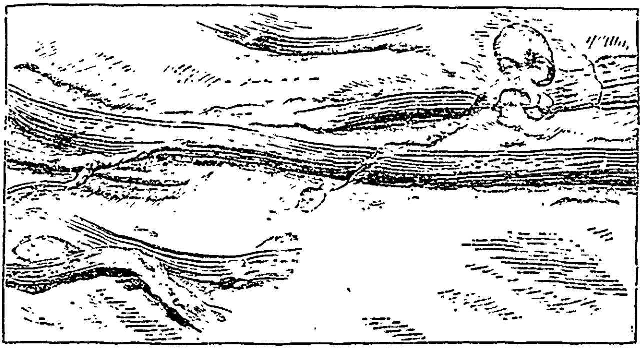

Fig. 1. *Eophyton Linnæanum?* Torell. Part of a slab of sandstone with several fragments supposed to be of this species.

The only specimen I have access to at present, is a slab of sandstone, about 15 inches in length and 12 inches wide, on the surface of which there are about thirty stems of the fossil. Most of these lie across the stone in a direction nearly parallel to each other. They appear to have been, when perfect, slender, cylindrical, straight, reed-like plants, about three lines in diameter, with the surface longitudinally striated; four striæ upon an average in the width of one line. Some of the stems, which have been partially flattened by pressure, are coarsely grooved or fluted; but when the surface of such is perfect, the fine striæ can always be seen on the large ridges and in the furrows between them. When pressed quite flat some of the stems only exhibit the fine striæ. I cannot see that any of the stems are branched. One of them, which is pressed flat, is bifurcated, but I think this due to the pressure, which has split the stem into two portions.

I refer this species as above, because it is impossible to distinguish it from some of the figures of the Swedish form. As it occurs above the *Paradoxides* beds, while the Swedish specimens, have as yet, only been found below, it is most probably a distinct species.

Eophyton Jukesi, spec. nov.

In this species the stems are nine lines in diameter, cylindrical, straight or slightly flexuous. They are longitudinally striated, but the surface of the specimens examined, are not sufficiently well preserved to exhibit the dimensions of the striæ. It is separated from the former principally on account of its much greater size.

ARTHRARIA ANTIQUATA, gen. and spec. nov.

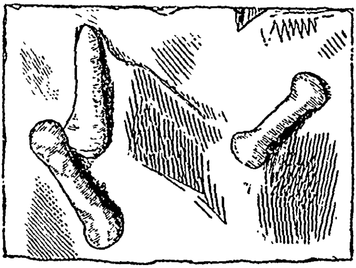

FIG. 2. Part of a slab of sandstone with *Arthraria antiquata.*

The fossils for which the above generic and specific names are proposed, are small cylindrical bodies, with usually an expansion at each end, giving the form of a dumb bell. Those that I have seen, are from six to nine lines in length, and from the manner in which they are grouped upon the surface of the stone, they appear to me to be segments of a jointed plant. Similar forms occur in the Clinton formation.

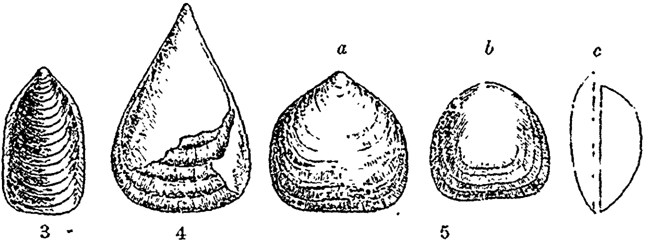

FIG. 3. *Lingula Murrayi.*
4. *Lingulella? affinis*, ventral valve.
5. " *spissa*, *a* ventral valve; *b.* dorsal valve; *c*, side view of both valves.

LINGULA MURRAYI, spec. nov.

Fig. 3.

Shell elongate, sub pentagonal; front margin straight or gently convex for a space equal to about two-thirds the width in the middle; anterior angles rounded; sides somewhat straight or very gently convex and parallel for two-thirds the length, then converging to the apex, where they meet at an angle of between seventy and eighty degrees. In one of the two specimens collected, there is a flat margin on each side one-sixth the whole width of the shell. Between these two flat margins the remainder of the shell is gently convex. In the other specimen this central space is slightly convex in the anterior part of the shell, but on approaching the beak it becomes an angular roof-shaped ridge. The shell is thin, black and shining with obscure fluctuating, concentric undulations of growth, and with very fine, obscurely indicated, longitudinal striæ.

Length nine lines; width five lines.

LINGULELLA? AFFINIS, spec. nov.

Fig. 4.

Ventral valve elongate, conical or acutely triangular. Apical angle about 45°. Front margin gently convex in the middle, rounded at the angles; sides nearly straight, uniformly converging from the anterior angles to the beak. Surface with very fine longitudinal striæ, about ten in the width of one line.

This species is founded upon the single specimen of a ventral valve above figured. The upper two-thirds is partly worn away in the middle, leaving only the outline in the stone. It appears to have been, when perfect, gently convex, the rostral portion near the beak semi-cylindrical. Length about thirteen lines, width nine lines.

The dorsal valve has not been identified.

LINGULELLA? SPISSA, spec. nov.

Fig. 5, a, b, c.

Shell sub-pentagonal, or sub-ovate, length and width about equal, sometimes strongly ventricose. Dorsal valve with the front margin straight or very gently convex for about two-thirds the width in the middle; anterior angles rounded; sides straight or slightly convex and sub-parallel until within one-third or one-fourth the length from the beak, then converging to the apex, where they form an obtuse angle which varies from 100 to about 110 degrees. This valve is generally very convex, sometimes almost hemispherical, the outline on a side view is rather abruptly elevated in the rostral third, depressed convex for a short space in the middle, and then more gently descending to the front margin. Most of the specimens of this valve are eight or nine lines in length, and about the same in width.

The shell which is supposed to be the ventral valve of this species, is gently convex, with usually a somewhat flat space extending from the front margin upwards towards the beak. The apical angle appears to be from 90 to 100 degrees. Shell very thick, of a lamellar structure, dark brown or nearly black, and, sometimes, where exfoliated, of an ashy grey colour. Surface with a number of obscure undulations of growth and with fine longitudinal striæ, about ten in the width of one line.

CRUZIANA SIMILIS, spec. nov.

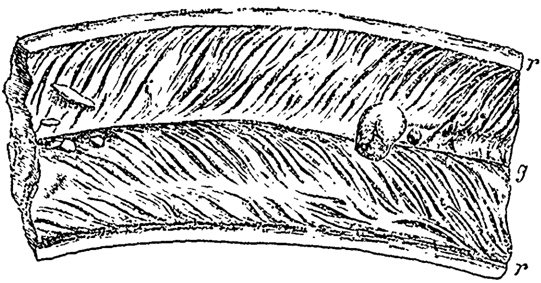

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FIG. 6. *Cruziana similis*; *g*, the median groove; *r*, *r*, the ridges at the sides.

The specimens are from twelve to fifteen lines wide, divided along the middle by an angular groove, and bordered on each side by a narrow ridge, about one line wide. The space on each side between the median groove and the marginal ridges, are moderately convex and crossed obliquely by numerous irregular raised lines, with furrows between them. These lines usually have the form of a gentle sigmoid curve, sometimes extending quite across, but are often crowded together in a somewhat confused manner, still preserving the general oblique direction. Upon an average there are about ten lines in the length of half an inch. The marginal ridges are sometimes longitudinally striated.

This species has been heretofore referred by me to *C. semiplicata*, Salter, but although closely allied, none of our specimens agree exactly with the figures of the British species.

Besides the above six species, many of the beds of sandstone of Great Bell Island, are covered with several species of *Palæo-*

phycus and other forms allied to *Eophyton* and *Cruziana*. To describe these would require further collections. In the upper strata there are yet two or three new species of *Lingula*, of which we have only fragments.

FOSSILS FROM THE MENEVIAN GROUP.

Below the strata of Bell Island, there are about 2000 feet consisting of sandstones and slates, in which no fossils have been found except a few fucoids. These with the Bell Island rocks may represent the Middle and Upper Lingula Flags. They are immediately underlaid by about 2000 feet of slates, sandstones and limestones, holding fossils which prove them to be of the age of the Lower Lingula Flags, or the Menevian group of Salter and Hicks. Fossils in some of the beds are abundant but very imperfect. The following are all that are sufficiently well preserved to admit of description.

OBOLELLA? MISER, spec. nov.

Shell small, transversely broad ovate, nearly circular, width slightly greater than the length. Ventral valve strongly convex, depressed conical, greatest elevation at about one-third or one-fourth the length from the hinge line. The latter appears to be straight and about one-fifth the width of the shell. In the apex, or the most elevated point of this shell, there is an irregularly circular aperture or depression. The dorsal valve is less convex than the ventral but more uniformly so, the greatest elevation near the centre; beak apparently curved down to the level of the hinge line.

Surface to the naked eye apparently smooth, but when magnified showing very fine concentric striæ. The width of the largest specimen of the dorsal valve seen, is about one line; length a little less. This species occurs at Chapel Arm, in Trinity Bay.

Mr. Davidson has figured and described* under the name of *O. saggitalis*, Salter, a species from the Menevian group, North Wales, which is closely allied to this, the only difference, (so far as can be made out without comparison of specimens) being, that the English species is about double the size of ours. As I un-

* On the earliest forms of Brachiopoda hitherto discovered in the British Palæozoic rocks; by, Thomas Davidson, Esq., F.R.S., Geological Magazine, Vol. 5, No. 7, July 1868.

derstand Mr. Davidson, what appears to be an aperture, in the apex of the ventral valve, is not truly such, but an impression made in the cast of the interior by a tubercle on the inside of the shell.

STRAPAROLLINA REMOTA, spec. nov.

a *b*

7

FIG. 7. *Straparollina remota*, *a*, view of the spire; oblique view of anterior side.

Shell small hemispherical, spire depressed and rounded in outline, height 2 to 3 lines, width 3 to 4 lines, whorls about three, suture deep. The whorls are nearly uniformly rounded, more narrowly so on the upper side close to the suture, and also on the basal side. On a side view the minute apical whorl is scarcely at all seen; the next below it is elevated about half its own diameter above the body whorl. In a specimen 4 lines wide, the width of the aperture is about 1½ lines, as nearly as can be determined from an individual partly buried in the matrix. Surface nearly smooth.

Occurs at Smith's Sound, Trinity Bay.

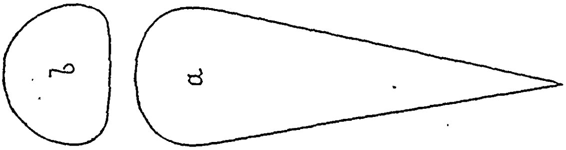

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FIG. 8. *Hyolithes excellens.* In these diagrams, *n*, represents the rate of tapering on the ventral side; *b*, the transverse section. The dorsal side of *b* is too broadly rounded.

HYOLITHES EXCELLENS, spec. nov.

Shell usually about two inches in length, tapering at the rate of between four and five lines to the inch. The ventral side is nearly flat or very gently convex; the lateral edges narrowly rounded, in some specimens rounded angular; the most projecting parts of the sides are at about one-third the height; above this the sides are gently convex, the dorsum more narrowly rounded. The shell is thin, nearly smooth with very fine obscure striæ, about ten in one line. The striæ curve forwards on the ventral side, forming an arc the height of which is equal to about one-third the width of the shell. On crossing the lateral edges the striæ curve backwards, until they reach the most projecting part of the sides, then cross up and over the dorsum at a right angle. On a side view the shell is gently curved upwards on approaching the apex.

A specimen 24 lines in length on the ventral side is $8\frac{1}{2}$ lines wide and 6 lines in depth at 20 lines from the apex.

Occurs in the red limestone at Smith's Sound, Trinity Bay.

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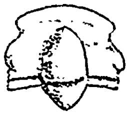

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Fig. 9. *Agraulos socialis*. The head without the moveable cheeks. The glabella is too distinctly defined in this figure.

Fig. 10. " *strenuus*.

Agraulos socialis, spec. nov. Fig. 9.

Head (without the moveable cheeks) semi-elliptical or conical, width at the base a little greater than the length, gently convex. Glabella conical and (including the triangular projection backwards from the neck-segment) about two-thirds the whole length of the head, neck-furrows all across but obscurely impressed; neck-segment with a triangular projection backwards, terminating in a short, sharp spine. Fixed cheeks gently convex; front margin sometimes with a portion in front of the glabella thickened. Eyes of moderate size and situated on a line drawn across the head at about the mid-length, distant from each other about the length of the head. Surface nearly smooth.

In small perfect specimens no trace of glabellar furrows can be seen, but in some of the large ones four or five obscure furrows are exhibited.

The largest specimen seen is six lines in length and seven in width. It occurs at Chapel Arm, Trinity Bay.

AGRAULOS STRENUUS, spec. nov. Fig. 10.

Head (without the moveable cheeks) irregularly quadrangular, broadly rounded in front. Glabella rather strongly convex, conical, variable in its proportional length and width, either smooth or with several obscure impressions on each side representing the glabellar furrows; neck segment with a strong triangular projection backwards; neck furrows all across but usually obscurely impressed. In some specimens the front of the head has a thick, convex marginal rim separated from the front of the glabella by a narrow groove. In others this rim is scarcely at all developed. The eyes, shown by the form of the lobe, appear to have been semi-annular and about one-third the length of the head. The surface appears to be smooth. The following are the dimensions of the best preserved specimen:

Length of the head including the large posterior projection, 6 lines; width of the convex marginal rim, 1 line; width of the groove between the rim and the front of the glabella, $\frac{1}{3}$ of a line; length of the glabella including the projection, $5\frac{3}{8}$ lines; width of the glabella at the posterior margin, 3 lines; width of the fixed cheek from the centre of the edge of the eye-lobe to the side of the glabella, 2 lines. A line drawn across the head at $2\frac{1}{4}$ lines from the front margin, would pass through the anterior angles of the eyes. The length of the eye appears to be nearly 2 lines.

As above remarked, this species varies somewhat in its proportional length and width, and hence the dimensions, above given, would not be found to be exactly parallelled in all the specimens.

Occurs in the grey limestone of Topsoil Head and also in the pinkish limestone of Brigus, Conception Bay.

AGRAULOS AFFINIS, spec. nov.

This species is closely allied to *A. socialis* and is of the same size but differs in the following respects. The glabella is broader and with the sides gently convex. The eyes are somewhat nearer the sides of the glabella. The whole of the anterior portion in front of the glabella is convex. The dorsal furrows are more distinctly impressed all around the glabella.

It occurs at Branch, St. Mary's Bay.

Genus CONOCEPALITES.

This genus has been used as a general receptacle for a number of groups which, according to several authors, constitute distinct genera. Although it has been found very convenient, there has lately sprung up a disposition to dispense with it altogether. I have no doubt but that this will be done, and I shall therefore dispose of our species as follows.

SOLENOPLEURA COMMUNIS, spec. nov.

Glabella conical, convex, abou' two-thirds the whole length of the head, about one-third wider at the neck-furrows than at the front; on a side view considerably elevated above the fixed cheeks; neck-furrow well defined all across; neck-segment thickened in the middle and bearing a small tubercle. The fixed cheeks are strongly convex but not so prominent as the glabella. The dorsal furrows are deeply defined all around the glabella. The front margin has a strong rounded rim, separated from the front part of the cheeks by a narrow, but distinct, groove; between the groove and the front of the glabella, there is a gentle depression, which separates the anterior angles of the fixed cheeks. The eyes are small, situated a little in advance of the mid-length of the head, distant from the side of the glabella a little less than half the length of the head, and are connected with the front of the glabella by an obscure ocular fillet. Surface with a few scattered tubercles, just visible to the naked eye, and between these numerous minute tubercles only seen when magnified.

The glabella exhibit traces of two or three obscure furrows on each side. Length of the largest head collected five lines.

Occurs at Chapel Arm, Trinity Bay.

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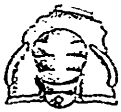

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Fig. 11. *Anapolenus venustus.* 12. *Paradoxides tenellus.*

ANAPOLENUS VENUSTUS, spec. nov.

Fig. 11.

Description.—Glabella convex, most elevated in front, obscurely angular along the median line widest at the anterior third of the length; sides gently concave in the posterior two-thirds, and slightly diverging from each other forwards; anterior third and front uniformly rounded. Neck segment with the margin convex and projecting backwards, an obscure tubercle, or rather an angular elevation in the middle, neck furrows all across. There are four glabellar furrows; of these, the posterior is strongly marked and extends in a nearly straight line all across; the next two are linear, slightly impressed, extend inwards about one-third the width of the glabella and are gently curved backwards, but still almost at right angles to the sides. The anterior furrow is short, extends inwards about one-fifth the width of the glabella, and curves backwards at an angle of about 45° to the sides. The dorsal furrow around the glabella is very shallow. The fixed cheeks are triangular, nearly flat, with a small elevation, close to the extremity of the posterior furrow. Front of the head with a moderately convex marginal rim, almost in contact with the glabella or separated therefrom by a narrow space. The eye-lobe starts from a point close to the side of the glabella and just opposite or a little behind the short frontal furrow, and runs with a gently sigmoid curve (at first convex outwardly, and then concave) backwards and outwards to the posterior marginal furrow, which it reaches at a distance from the sides of the glabella, about equal to the length of the neck segment. The facial suture leaves the side of the glabella a little in front of the anterior furrow, and runs outwards, nearly at a right angle, but with a gentle convex curve, to the margin.

The surface is covered with fine rippled striæ. These on the marginal rim are irregularly parallel with the margin; on the glabella they curve around the front, but further back, and on the neck segment they have a rudely longitudinal direction, curving outwards in crossing over the glabellar lobes.

Length of the head of the largest specimen examined, 6 lines; length of the glabella, including neck segment, 5 lines; width of glabella at the neck segment, 3 lines, at the front pair of furrows, 3½ lines; width of the posterior margin of the fixed cheek 3 lines; length of the eye lobe, 4 lines.

When compared with the species figured by Salter and Hicks the following differences become apparent:—*A. Henrici*, Salter, has the eye lobes with a gently uniform curve outwards. In *A. Salteri*, Hicks, the eye lobes are also convex and the glabella proportionally longer, while the neck furrow "is the only one continued across." (Hicks.) *A. impar*, Hicks, has the flexuous eye lobes of our species, but the marginal rim is more decidedly in contact with the front of the glabella, while the two median pairs of furrows extend further inwards.

Occurs at Chapel Arm, Trinity Bay.

PARADOXIDES TENELLUS, spec. nov.

Fig. 12.

Descrip'on.—Glabella clavate, convex, most elevated at the anterior third of the length, front and sides in the anterior half, rounded, becoming sub-parallel in the posterior half. Neck segment strongly elevated in the middle, where there is situated a small tubercle, neck furrow extending all across. There are four glabellar furrows, of which the posterior extends across but is very indistinctly impressed in the middle; the next two in advance extend inwards about one-third of the width of the glabella, while the small one in front is somewhat shorter. The furrows are all nearly at a right angle to the longitudinal axis, and about equidistant from each other. The anterior margin of the head, is bordered by a narrow convex rim, which is separated from the front of the glabella by a flat space, varying in width from once to thrice its (the rim's) width. The fixed cheeks are subtriangular and nearly flat. The anterior extremity of the eye lobe is situated at a point nearly opposite, but a little behind, the anterior furrows, and is close to, but not in contact with the side of the glabella. The lobe is slightly sigmoid, its posterior extremity opposite the last glabella furrow. The dorsal furrow is distinctly impressed along the posterior half of the glabella but obscurely marked in front.

The surface is minutely granular. In all of the three specimens collected there is a small straight rounded ridge, which runs from the front of the glabella to the margin. It is situated exactly on the median line.

Of this species we have three specimens of the glabella, two of which retain portion of the fixed cheeks and show the form of the eye. The largest is three lines in length, including neck segment and front margin.

Occurs at Chapel Arm, Trinity Bay.

PARADOXIDES DECORUS, spec. nov.

Description.—The form of the glabella of this species is nearly the same as that of *P. tenellus* but the glabellar furrows are somewhat different. The posterior pair seem to be entirely disconnected in the middle and the next two pairs are rather more curved. The marginal rim of the front of the head, seems to be close up to, and in contact with, the front of the glabella. The surface is ornamented with minutely corrugated, raised lines which, in some places, anastomose so as to present an irregularly reticulated appearance. This at once separates the species from *P. tenellus*, the surface of which is minutely granulated. The surface of *A. venustus* is somewhat like that of this species, but the raised lines are more distant, and besides the posterior glabellar furrow extends all across. The length of the most perfect glabella examined is about thirteen lines. Only three fragments, (all of the glabella) of this species occur in the collection. Form of the eyes and of all other parts unknown.

It occurs at Chapel Arm, Trinity Bay.

Genus Iphidea, gen. nov.

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Fig. 13. *Iphidea bella;* ventral? aspect.

Of this genus we have no specimens showing the internal structure, but the external characters seem sufficient to separate it from any described generic group. The ventral? valve of *I. bella*, is conical, strongly elevated at the beak, hinge-line nearly straight, posterior angles narrowly rounded, sides and front nearly uniformly rounded, forming rather more than a semi-circle. Posterior side with a large false area, and a convex pseudo-deltidium, the width of which at the hinge line is nearly one-third the whole width of the shell. The dorsal valve is semi-circular, moderately convex most elevated at the beak. The hinge-line appears to be straight. The form and structure of the posterior side, (such as the area, foramen, deltidium, &c.,) cannot be made out from the specimen, owing to its imperfection. The surface is covered with fine concentric striæ, which in the ventral? valve are continued around on the area. Of these striæ there appear to be from 15 to 20 in the width of one line, their size varying somewhat in different parts of the specimen. There are also a few obscure radiating striæ. Width of ventral valve, 7 lines; length, 5 lines; height, 2 lines.

In the specimen above figured there is an aperture in the beak, but in another there is no appearance whatever of a perforation. This genus resembles *Acrotreta*, but differs therefrom in having a large convex deltidium. It seems to be also closely allied to *Kutorgina*. The shell which I have described under the name of *Obolus Labradoricus* belongs to this genus.

I. bella was found by T. G. Weston, in a boulder of limestone associated with numerous fragmentary trilobites, of primordial age, near Trois Pistoles below Quebec. A closely allied species of the same genus occurs in the primordial limestone at Topsail Head, Conception Bay, Newfoundland.

FOSSILS IN THE HURONIAN ROCKS.

ASPIDELLA TERRANOVICA, nov. gen. and spec.

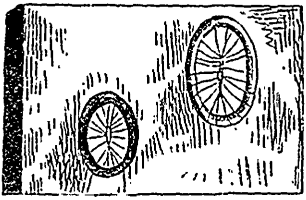

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FIG 14 *Aspidella terranovica*, two specimens on a small slab of stone, slightly restored.

These are small ovate fossils five or six lines in length and about one-fourth less in width. They have a narrow ring-like border, within which there is a concave space all round. In the middle there is a longitudinal roof-like ridge, from which radiate a number of grooves to the border. The general aspect is that of a small *Chiton* or *Patella*, flattered by pressure. It is not probable, however, that they are allied to either of these genera.

Associated with these are numerous specimens of what appear to be *Arenicolites spiralis*, a fossil that occurs in a formation lying below the primordial rocks in Sweden. These fossils were first discovered by A. Murray, Esq., F.G.S., in 1866. Other specimens were collected by Capt. Kerr, R.N., Mr. Howley and Mr. Robertson.

They occur near St. Johns, in the Huronian. A more detailed description will be given hereafter.

STENOTHECA PAUPER, spec. nov.

Description.—Shell small, conical, with the apex incurved, laterally compressed. Aperture ovate, elongated in the plane in which the curvature of the apex occurs. Surface with four or five small engirdling convex ridges. Length of aperture about 1½ lines; width about 1 line; height of shell about 1 line.

Occurs in the red limestone at Bridgus, Conception Bay.

In the Quar. Jour. Geol. Soc. of May last, Mr. Hicks has described and figured, under the name of *Stenotheca cornucopia*, a small shell which is evidently congeneric with this. To the same genus should perhaps be referred the shell known as *Metoptoma rugosa* of the Lower Potsdam? of New York.

SCENELLA RETICULATA, gen. and spec. nov.

Description.—Shell small, almost uniformly depressed, conical; apex central or nearly so; an obscure carina extending from the apex down one side to the margin. Aperture nearly circular, apex very slightly incurved towards the side opposite the carina. Surface reticulated with fine radiating and engirdling striæ, just visible to the naked eye. Diameter of the aperture of the largest specimen collected, 3 lines; height of the apex, 2 lines.

Occurs at Topsail Head, Conception Bay.

Species resembling this have been heretofore referred to *Capulus, Metoptoma*, &c., to which, however, they do not belong. For the present I propose to refer those with a strongly corrugated surface to *Stenotheca*, and the others with a smoother surface to *Scenella*.

(*To be Continued.*)

WHAT IS TRUE TACONIC?

BY PROF. JAMES D. DANA.

The true use of the term Taconic should be learned from Prof. Emmons's first application of it when he made his formal announcement of the "Taconic system." In his final New York Geological Report, 4to., 1842, the rocks so-called are those of the Taconic mountains, on the borders of Massachusetts and New York, together with the quartzite, limestone, and slates adjoining on the east,* and not the slates far west of these mountains; †

* Professor Emmons opens the subject of the "Taconic System" in his final Report (1842) by saying that it extends north through Vermont to Quebec, and south into Connecticut; but the only rocks he describes as the rocks of the system are those of Berkshire County,

moreover the slates, the rocks of the mountain, were the typical beds, and not the quartzite. Hence, if there are any Taconic schists or slates, those of the Taconic range are the rocks entitled to bear the name, being Taconic geographically, and Taconic by the earliest authoritative use, Prof. Emmons the authority.

Prof. Emmons, in his Agricultural Report, subsequently published (in 1843), announced the Primordial beds of Bald Mt. (near Canaan Four Corners, in Columbia Co. N. Y.), as *Taconic* also; but this did not make them so. He referred to the Taconic the Black slates of northern Vermont, since shown to contain primordial fossils; he searched the country north and south for other Taconic rocks, and found them as he thought; and he set others on the search, not only in this country, but over the world. But all this has not changed the fact that the true Taconic beds, if any are such, are those he first so announced; and that the rest, so far as they are of different age from these, younger or older, have been dragged into the association without reason. The Taconic rocks of Berkshire and of the counties of New York just west, always bore the most prominent part in his later descriptions of the Taconic system.

The error on the part of Prof. Emmons, in referring beds of other ages to the Taconic system, is not surprising, considering the difficulties in the case. But it was no less an error; and his name as a backer cannot make the wrong right.

Geologists now regard the slates of Taconic Mt. and the limestone, also, as of Lower Silurian age, but later than the Potsdam sandstone. Logan refers them to the Quebec group. Whatever the period of the slates, or slates and associated limestones, to that period properly pertains the term *Taconic*.—*Amer. Naturalist.*

Massachusetts, and their continuation westward into New York. These are the typical rocks on which the system was founded. On plate xi. four figures representing sections across this particular region are given. The only Vermont observations are contained in the only other section on the same plate representing a section from Lake Champlain to Richmond, Vt., through Charlotte. No description of the rocks of this section is to be found in the text of the volume.

† In figure 4 of plate xi. (referred to in the preceding note) representing a section through Graylock, the "Taconic slate" stops just west of Berlin, Rensselaer County, New York, the slates on the west being put down as "Hudson River shales," and in figs. 2 and 3, the boundary is near Petersburg, north of Berlin. The extension of the Taconic to the Hudson River appears first in Prof. Emmons' Agricultural Report, published in 1843.

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