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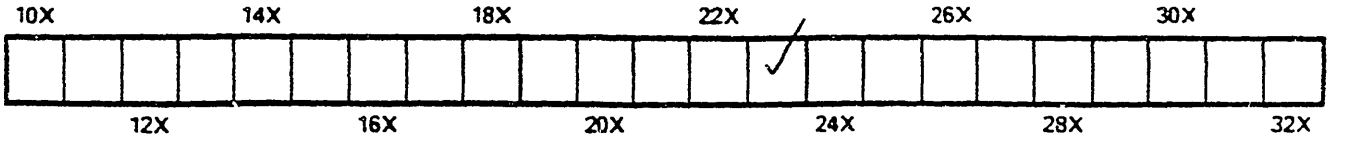

THE

CANADIAN NATURALIST

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THE LIGNITE FORMATIONS OF THE WEST.

By George M. Dawson,

Assoc. R. S. M., Geologist B. N. A. Boundary Commission.

The true Carboniferous formation and that with which the greater part of the valuable coals of the world are associated, and which is so largely developed in the eastern half of the American continent, from Nova Scotia southward, does not appear in the western prairie region. Its north-western border lies in the eastern part of the Territory of Nebraska and in Iowa, where the thickly wooded country of the east has already passed into the prairie land of the west. Here, however, this formation, depended on for fuel in so many parts of the world, to a great extent loses its coal-bearing character. In Nebraska it has now been pretty thoroughly explored, both by surface examination and by boring, and yet has only yielded coal in very sparing quantities. Coal seams of 18 inches and 2 feet are described, and one which has been pretty extensively worked in the vicinity of Nebraska city, is not more than 8 inches in thickness. Such coal beds as these would not be workable in England or on the continent of Europe, with all the cheap and skilled labour there at command, and in a new country like Nebraska are only rendered so by the extreme scarcity of wood for fuel, the coal, such as it is, being sold at prices ranging from about 40c. to 80c. per bushel.

Hayden and other United States geologists, who have examined this region, consider it to be upon the western lip or margin of the true coal formation. Even in the State of Iowa the coal beds are of comparatively small importance. The formation is

thin and irregular, and the coals themselves contain an excess of moisture and much ash and sulphur. In this western country the sandstones and mud rocks, usually associated with coal, are gradually replaced by limestones, indicating deeper water and conditions unfavourable to the formation of coal beds, as pointed out by Professor Hall.

Poor as these western coal-bearing rocks are, they labour under the additional disadvantage of being in great part covered by a newer formation, the Cretaceous; and where the Carboniferous formation again comes to the surface along the Rocky Mountain region of uplift, to the west of the great plains, it has not been found to contain so much as a single seam of coal, but is represented by massive limestones, shewing deposit in deep ocean water, and so far removed from land that it is rare to find in them even a fragment of any of the plants which were growing so luxuriantly in the swamps and deltas of the eastern half of the continent at the same time. Just where the coal of the recognized formation fails, the luxuriant growth of timber of the east also comes to an end, and the country assumes that prairie character which persists with scarcely a break to the foot of the Rocky Mountains. The bare rolling grassy hills and plains, though in many places eminently suited for agriculture, seldom yield wood for fuel or construction. Trees as a rule are only found fringing the deep river valleys, and in steep-edged gullies, where they are protected from the sweep of the prairie fires, and find a permanent supply of moisture.

In the western portion of the Dominion, in Manitoba and the Red River country, the Carboniferous formation is not found at all, but the Cretaceous rocks already alluded to, overlap the limestones of the older Silurian period. The true coal formation can only be supposed to exist there below a great thickness of Cretaceous rocks, and even if accessible the probability of coal of any value being found in it is, from analogy with the regions already mentioned, exceedingly small.

Neither do the Cretaceous rocks of the eastern portion of the plains yield, so far as known, any fuel of economic value in their great stretch from the borders of Mexico to the northern part of the British North-West. They consist almost entirely of clay rocks and sandstones, with one interesting zone of limestone and marl, which forms part of Hayden's group 3, or *Niobrara Division*, and which appears to be recognizable in Manitoba at Pembina mountain.

The lower part of this formation, however, in Nebraska, and on the Missouri river, seems to show an attempt at the production of beds of fuel. Beds of "impure lignite" of small thickness and of "carbonaceous clays" are met with there, especially in Hayden's lowest, or *Dakota Group*. Fossil leaves and stems are also found associated with these beds, and one lignite occurring in beds believed to be transitional between the *Dakota Group* and the *Fort Benton Group*, next above it, is even stated to have been worked to a small extent, and to have been "used by blacksmiths with some success."

There is therefore a possibility that the eastern edge of the Cretaceous in some regions may yet give a supply of fuel; and in Manitoba, the lower beds, and those in which the deposits above mentioned occur further south, probably lie east of the escarpment of Pembina mountain, and further east than the Cretaceous formation is made to extend in Hind's Geological Map, which has hitherto been the authority for the region. These lower beds, if they still exist beneath the alluvium of the Red River valley, are nowhere exposed, and cannot be explored except by boring operations. The possibility of the existence of fuel in the representative of the *Dakota Group* in Manitoba is much increased if the coal beds of the Upper Saskatchewan, examined last summer by Mr. Selwyn, are, as he supposes, of Lower Cretaceous age also, for in this case there would appear to be a tendency in the Lower Cretaceous formation east of the Rocky Mountains to become coal-bearing northwards.

Dr. Hector, many years ago, referred lignite beds observed by him in this region, to the same period. In view of these facts the position and character of the Cretaceous rocks occurring in Manitoba and the neighbouring country, becomes an interesting and important subject of inquiry.

Fortunately, however, the advance of settlement and civilization on the Western plains need not wait for the development of these possibilities, or for the tedious process of the planting and growth of trees suitable for fuel. A great deposit of fossil fuel, of still later age than the Cretaceous, has of late years been prominently brought to notice in the Western States, and the northern extension of this lignite formation of Tertiary age is largely developed in the Canadian Northwest. The existence of these fuels on the eastern side of the Rocky Mountains has long been known in a general way. Sir Alexander Mackenzie, the explorer

of the river of the same name, in his account of his voyages of discovery prosecuted during the years 1789 to 1793, says that along the eastern side of the mountains there exists "a narrow strip of very marshy, boggy, and uneven ground, the outer edge of which produces coal and bitumen; these I saw on the banks of the Mackenzie River, as far north as Lat. 66°. I also discovered them in my second journey at the commencement of the Rocky Mountains, in 56° N. Lat.; 120 W. Long.; and the same was observed by Mr. Fiddler, one of the servants of the H. B. Company, at the source of the South branch of the Saskatchewan, in about Lat. 52; Long. 112° 30'." He also describes near the Peace River, "several chasms in the earth which emitted heat and smoke which diffused a strong sulphurous stench,"—probably a case of the spontaneous combustion of a lignite bed comparable with those observed in other localities. Sir John Franklin in his second journey to the Polar Sea, noticed what he calls beds of lignite or tertiary pitch-coal at Garry's Island, off the mouth of the Mackenzie River, and also an extensive deposit near the Babbage River, on the coast of the Arctic Sea, opposite the termination of the Richardson chain of the Rocky Mountains. Sir J. Richardson, who accompanied Franklin in the expedition just referred to, was one of those engaged in the search for him in subsequent years, and mentions in his account of a boat voyage on the Mackenzie and in the vicinity of Great Bear River, a species of coal which when recently extracted is massive but shows woody structure, the beds appearing to be made up of pretty large trunks, the fibre of which is contorted. He says that when this coal is exposed a short time to air it splits into rhomboidal fragments, which again separate into thin layers, and much of it eventually falls into a coarse powder. When exposed to moist air, it takes fire and burns with a fetid smell, but with little smoke or flame. Some varieties resemble charcoal, and others are conchoidal like cannel coal. Amber is also noticed to occur, and the beds of coal are often destroyed as exposed by their spontaneous inflammability. This description and the account given of the associated clays and shales might almost as well apply to some localities in the southern part of British America or to the lignite tertiary formation of the Missouri River.

In the United States the first observers of this formation appear to have been Lewis and Clarke, who, in the narrative of

their expedition on the Missouri in 1804, mention somewhat fully the occurrence and distribution of the rocks of this formation. Many other explorers have since that time noticed the occurrence of this lignite formation even as far south as the Arkansas River, but till the inception of the trans-continental railway, it was thought of as lying too far west to be useful. The explorations connected with the railway and its construction, and the simultaneous growth of an important gold and silver mining region in Nevada and other western territories, with the explorations of Hayden and other geologists, have brought the great Lignite Tertiary Basin of these regions to notice in a manner commensurate with its importance. The lignite coals of this formation are now very extensively worked in several places near the line of the Union Pacific, and are found to subserve all the ordinary purposes of the more perfect coals of the true Carboniferous formation. They are used on the railways, and also for the metallurgical treatment of ores.

The region examined by me during the latter part of last summer, lies for the most part immediately north of the International Boundary, which crosses the continent from the Lake of the Woods to the Pacific Ocean, on the 49th parallel of latitude. Of the country through which the line passes, about 300 miles from East to West, have remained unknown even geographically until explored by the Boundary Survey during last summer, and the Lignite Tertiary formation described in this paper lies almost entirely in this hitherto unvisited region.

In proceeding westward from Red River, the Cretaceous beds already mentioned are met with in the region of the escarpment called Pembina Mountain, and in the streams which flow down over it, and occasional exposures of these rocks are found for a distance of about 45 miles. Beyond this, for about 150 miles, no rock exposures whatever are to be seen in the vicinity of the Line, the whole surface of the plains being composed of drift materials and marly sands and gravels. The river valleys are deep and broad, but the banks are grassed from top to bottom, and though very generally strewn with boulders belonging to the drift formation, do not show any sections of the underlying rocks.

At about 240 miles west of Red River, the boundary line strikes the Lignite Tertiary formation; the prairie level rises at the same place by a gentle step, which may be considered as

the first elevation towards the Coteau de Missouri, or region of high and broken ground which separates the waters draining by the Souris and Saskatchewan Rivers to Hudson's Bay, from those forming the northern tributaries of the Missouri River, and falling at last into the Gulf of Mexico. Here also the river valley of the Souris, which is the largest stream in proximity to the line, undergoes a remarkable change, its banks become scarped and bare, and are seen to be composed of stratified sands, clays and sandstones belonging to the Lignite formation. The beds here represented are probably among the lowest of the Lignite group, and near their base is a remarkable nodularly hardened sandstone, which has been formed by the action of the weather where it outcrops in the valley into a group of extremely picturesque and castellated rocks, known collectively by the half-breeds as the *Roche Percée*. The lower part of this sandstone is grey, and so soft that it may be cut and scraped away with a knife. The upper part is divided into thinner beds and is hardened by calcareous cement. Both layers show false bedded structure in great perfection, and the lower has been pierced by window-like openings, due to weathering along lines of jointage.

These rocks have been probably from time immemorial objects of superstition to the Indians inhabiting this region of the plains, and chiefly belonging to the Cree and Assineboin tribes. They have covered the lower soft part of the sandstone with rude carvings, some representing human figures on foot or on horseback, others various animals of the chase, and many merely resembling strings and necklaces of beads. These sandstones closely resemble those described in Wyoming and elsewhere to the south at the base of the Lignite tertiary, and which there weather into similar fantastic forms, to which names such as "Fairy's Caves," "Hermit's Caves," &c., have been applied.

For about 15 miles westward along the Souris Valley, many banks showing good exposures of the Lignite Tertiary rocks occur. The strata there represented probably overlie those of the Roche Percée, and contain many beds of lignite, which those seen immediately underlying the sandstone do not.

The beds in association with which the lignites occur are mostly arenaceous clays, sometimes changing into moderately coarse sands or soft sandstones, but generally more resembling a true clay of a hard character, and frequently passing into a species of clay-shale. The colours of the beds are very varied, much

more so than their texture, and a bank which from a distance frequently shows a perfectly banded appearance from top to bottom in shades of drab, yellowish, light brown and purple-grey, when approached more closely, loses all distinctness, and it is almost impossible to draw well defined lines between the layers in a measured section. The formation, though showing some slight undulations on a small scale, does not appear to have any definite direction of dip, and it is therefore difficult to correlate the beds seen in different places.

Many seams of lignite coal crop out in this part of the Souris Valley, the thickest observed was 7 feet 3 inches, and from this they show all intermediate degrees of thickness down to layers of a few inches only.

The following is one of many sections seen in this locality, and may be taken as an illustration of the manner of alternation of the deposits. The beds are arranged in descending order:

	Prairie Sod	– –
1.	Mixed Shale and Drift	7 to 8 feet.
2	Lignite	6 feet 6 in.
3.	Greyish Sandy Shale	4 " 0
4.	Lignite	1 " 6
5.	Fine sand and shaly clays, greyish and yellowish, well stratified	14 " 0
6.	Ironstone (nodular)	2 to 4 in.
7.	Greyish and whitish clay	2 feet 0 in.
8.	Carbonaceous shale	1 " 0
9.	Grey soft sandstone	1 " 8
10.	Lignite	1 " 0
11.	Laminated sandy clay, grey and yellowish	5 " 0
12.	Ironstone (nodular)	0 " 3
13.	Lignite	1 " 7
14.	Carbonaceous shale	1 " 6
15.	Lignite	2 " 2
16.	Grey sandy clay	2 " 0
17.	Lignite	1 " 5
18.	Sandy under clay, with large and small roots, poorly preserved	1 " 6
19.	Lignite	3 " 2
20.	Greyish soft sandy clay	– –
		About 58 0

The upper lignite lies so near the surface that it is penetrated by the roots of shrubs and small trees growing above, and where exposed is soft and rotten. The lower lignites though not of

great thickness are excellent in quality. Bed No. 18 is one of the very few instances where a well characterized underclay was found to lie below a bed of lignite.

Few recognizable remains of plants are found in this part of the region in connection with the lignites. Some beds, however, and often those in close association with the lignites, yield molluscan remains, representing two species of *Paludina* or *Vivipara* at least two of *Melania*, one *Corbula* and several *Unio*-like bivalves. All these resemble those described by Meek and Hayden, from the Lignite Tertiary further South, and the *Corbula* is probably identical with their *C. mactriformis*, and indicates that brackish as well as fresh waters took part in the deposition of the lower beds of this formation.

Another peculiar feature in connection with the lignite deposits is their tendency to burn away *in situ*, and below the surface of the ground. The beds become ignited by some prairie fire, or the camp-fire of some Indian or trader, or it may be spontaneously (though this seems improbable, as iron pyrites, the general agent of spontaneous combustion in coals, is absent in these lignites); and smoulder away for years, producing breaks in the edges of the bank by the caving in of superior beds, and giving rise to a material which is plentiful in many places, and resembles a scoriaceous lava, but is really a species of clinker produced by the fusion of the ashes of the lignite.

In continuing westward, and after having crossed the region of drift hills already mentioned as the Coteau de Missouri, the Lignite formation is again represented in all the valleys and gullies of the streams which now run southward, and form the upper parts of the North Western tributaries of the Missouri. Specially good exhibitions of the rocks are to be seen in the first of these large valleys, at a distance of 345 miles west of Red River, and also in another a few miles further west, which has been called Pyramid Creek, from a remarkable pyramidal hill formed by the wearing away of the softer beds of the formation from below a layer of harder sandstone, a block of which has formed the capping of the hill. The beds are everywhere nearly horizontal, showing merely local dips, and it does not appear that a great thickness is represented by the whole of the sections examined. One locality is remarkable as showing the greatest development of the lignite beds, and also for the abundance of remains of plants in moderately good preservation. This is nearly 400

miles west of Red River, and the chief exposure is something less than a mile south of the line, and in the Territory of Montana. A seam of lignite coal no less than 18 feet thick there crops out. The section, including this lignite, is as follows, in descending order:

1.	Surface soil	1 foot 0 in.
2.	Drift (quartzite pebbles)	1 " 6
3.	Yellowish and grey stratified sandy clays	9 " 0
4.	Lignite	0 " 9
5.	Brown, banded clays, with plants and some crystalline gypsum	5 " 0
6.	Lignite (weathering soft)	10 " 0
7.	Lignite (hard and compact)	8 " 0
8.	Soft grey sandstone	5 " 0
		40 3

The laminated clays of bed 5 when first exposed show plant remains in great perfection; even the delicate fronds of ferns, which are here unusually common, showing every detail of their form. On drying, however, the clay becomes cracked and fissured, and it is with difficulty that the impressions can be preserved. The association of selenite crystals, isolated or in groups, with the clays and arenaceous clays holding plant remains, is very constant.

The upper part of the lignite bed weathers soft and forms a steep slope. The lower part is hard, and being divided by vertical jointage planes, like many true coals, falls into the stream in great rectangular blocks, and presents a vertical face.

The plants associated with the lignite beds are very numerous in species, but have not yet been fully examined. Many *flag* and *sedge*-like leaves occur. At least two kinds of Ferns are represented—a *Sphenopteris* and an *Onoclea* apparently identical with *O. sensibilis*, a form still living. There are also twigs of several coniferous trees, including a cedar, *Thuja interrupta* of Newberry, and apparently species of *Sequoia* and *Taxus*; and from the microscopic structure of the lignites it would appear that most of them are made up of woods of this kind. Leaves of a great many species of *deciduous* trees also occur, and are generally full grown, and appear to have fallen in the order of nature, and at the change of the season, and floated quietly out into the great lakes, in the fine silty deposits of which they have been preserved. *Populus, Salix, Ulmus, Platanus,* and

probably *Rubus* and *Hedera* are among the genera represented; and it is not the least remarkable of the facts indicated by these deposits that they thus prove that in a comparatively modern period the region now so entirely destitute of trees was covered by a dense growth of forest.

Though it must not be supposed that the lignites of this region are comparable with true coal as fuel, they are still of considerable value, and will play a very important part in the settlement of a country so destitute of wood, not only as fuel for ordinary use, but in the manufacture of bricks for constructive purposes from the abundant clays. Most of the samples obtained were necessarily merely outcrop ones, and these fuels deteriorate rapidly under the action of the weather; still the average of fixed carbon in 13 samples from widely separated localities was over 40 per cent, and the ash in nearly every case very small in amount and light in colour, indicating the absence of iron pyrites.

As examples of the composition, two analyses of lignites from good compact seams, where the bank had recently fallen away and exposed a fresh surface, are here given. The first is from a bed 7 feet 3 inches thick on the Souris; the second from the lower part of the 18 foot bed included in the last section, and at a distance from the other of considerably over 100 miles.

Souris R. Valley, 7 ft. 3 in. seam.		*Porcupine Creek, 18 ft. seam.*	
Water	15.11	Water	12.05
Fixed Carbon	45.57	Carbon	46.18
Volatile matter	32 76	Volatile matter	35.12
Ash	4.56	Ash	6.65

These lignites, therefore, while superior to many which are used in other parts of the world, are somewhat inferior to the best class of lignite coals found on the line of the Union Pacific Railway, some of which contain from 45 to 53 per cent. of fixed carbon. These occur in detached basins of this formation, but probably in lower beds than those now described, and have also been improved by metamorphism connected with the elevation of the mountains with which they are in proximity, and with the contortion of the strata containing them, the lignites being in some cases actually on edge, and frequently inclined at high angles. Similar flexures will probably be found to affect the formation north of the 49th parallel, when traced towards the mountains, and the lignites may improve in quality in the same way. The deposits here described, however, gain much by their

horizontal attitude and easy accessibility, and could probably be mined by a system similar to that known as *long wall*, at the expense of a comparatively small amount of mine timber, which in these woodless regions would be a great advantage. The iron-stones, though occurring frequently in proximity to the coals, have not yet been observed in workable quantity, but it is highly probable that further explorations may bring such localities to light. The ores are among the best of their kind, both as to percentage of iron and freedom from sulphur and phosphorus. None of the lignites yet discovered yield however a coherent coke suitable for the smelting of iron in the blast furnace.*

The conditions implied by the nature of these deposits are marshes, lakes and estuaries, on a grand scale, and from which the sea was for the greater part of the time excluded. The previous deposits of Cretaceous age show that at that time the whole western part of the continent was covered by a sea of some depth, in which during a long time before the advent of the lignite period, fine silty and muddy sediments were laid slowly down, and included the remains of *Cephalopoda* and *Lamellibranchiata* peculiar to that age. Then came on a period of emergence, coarser sediments were carried by the waters, and at last the sea was entirely shut off from the area in question and replaced by great lakes of fresh water, with wide swampy margins, where the lignites were slowly formed by the growth of trees and peaty moss.

Much question has lately arisen with regard to the true age of the representatives of these deposits in the Western States. The plants as compared with those of European formations, have a comparatively modern aspect, and were originally referred on good authority to the Miocene. The molluscous fossils occurring in marine beds connected with the base of the formation on its western margin, show Cretaceous affinities. Cope maintains that the Cretaceous age of the greater part, if not the whole of the formation, is proved by the existence in it of a few relics of Dinosaurian reptiles. It would seem indeed that in the regular passage of beds of well marked Cretaceous age upwards into the Lignite Tertiary formation, we have a case of the blending of

* Mr. Miller, in some remarks made after the reading of this paper, mentioned the successful employment of charcoal made from similar lignites in Germany, in iron smelting.

two geological periods, but complicated by a simultaneous change over the area in question from marine to estuarine and fresh-water conditions. It seems certain that the formation of lignites began in the Rocky Mountain region before the salt waters had entirely left the area, and consequently while forms generally known as Cretaceous were still living there. The evidence does not appear to show that the Cretaceous species were of themselves becoming rapidly extinct, but that over the Western region, now forming part of this continent, the physical conditions changing drove the Cretaceous marine animals to other regions, and it is impossible at present to tell how long they may have endured in oceanic areas in other parts of the world. This being so, and in view of the evidence of the preponderant animal and vegetable forms, it seems reasonable to take the well marked base of the Lignite series as that of the lowest Tertiary, at least at present. The formation described belongs to this lowest Tertiary, being in fact an extension of Hayden's *Fort Union group*, and from analogy may be called *Eocene*. Judging from Hayden's descriptions this Northern extension would appear to be richer in lignite beds than that portion represented on the Missouri River, and therefore to show a tendency in the lignites to increase in importance northwards as they do southwards of that region.

NOTE ON THE OCCURRENCE OF FORAMINIFERA, COCCOLITHS, &c., IN THE CRETACEOUS ROCKS OF MANITOBA.

By G. M. Dawson, As. R. S. M., &c.

A great portion of the Cretaceous division in England and on the Continent of Europe, is composed of typical chalk, a substance which must have been formed in the tranquil depths of the ocean, far removed from land, as it contains but a very small proportion of any earthy impurity. It consists in great part of the calcareous shells of Foraminifera, and the still more minute calcareous bodies known as Coccoliths. The remains of the larger Molluscs and of Echinoderms occur but rarely. The American representative of this formation contains no beds of true chalk, but is made up for the most part of deposits of sand

and clay, indicating comparatively shallow-water conditions, and the proximity of land. The nearest approach to chalk is found in the interior continental basin, especially where the Cretaceous rocks are finely exposed along the Mssouri River, and where in Hayden's third group or Niobrara division a soft white shelly limestone occurs. It forms bold bluffs on some parts of the river, and the name "chalk" is popularly applied to it, and is justified by the fact that it contains large numbers of Foraminifera, some of which from the Cretaceous of the Missouri and Mississippi have been described by Ehrenberg.

In Manitoba, the rocks of the Cretaceous Series are much masked by drift material, and do not in any place I have seen yield fossils in any quantity Through the kindness of Mr. A. T. Russel, I have however received specimens from a locality about twenty miles north of the 49th parallel, on the escarpment called Pembina Mountain, which exactly resemble the so-called "chalk" of Nebraska, and contain interesting organic remains.

The greater part of this rock is composed of shells of Inoceramı and oysters, the latter probably identical with *Ostrea congesta*, characteristic of the Niobrara division further south. These shells are imbedded in a soft whitish earthy matrix, which on microscopic examination proved to be rich in Foraminifera, Coccoliths, and allied organisms.

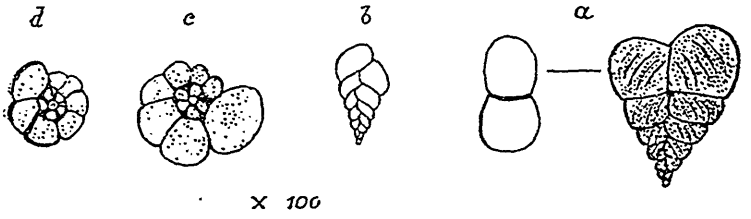

Fig. 1. Foraminifera from the Cretaceous of Manitoba.
(*a*) Textularia globulosa. (*b*) T. pygmæa. (*c*) Discorbina globularis.
(*d*) Planorbulina Ariminensis.

The commonest foraminifers belong to the genus *Textularia*, and represent two of its varieties. Of these the predominant is a stout form with globose chambers rapidly increasing in size at each addition, and sometimes even as broad as long. The primordial chamber, and those next it, are often bent away several degrees from the axis of symmetry of the larger part of the shell. The surfaces of the chambers are marked with extremely minute

diagonal interrupted ridges or wrinkles, which may also be seen in specimens from the English chalk. This form is doubtless identical with *T. globulosa* * of Ehrenberg, noted as being in cretaceous material from Dakota and Nebraska, and falls under D'Orbigny's species *T. gibbosa*.† *T. globulosa* was found by Ehrenberg in the Brighton and Gravesend chalk, and is one of the commonest forms in the latter. It also occurrs in the Meudon chalk of France, and is still living in the Mediterranean and elsewhere, in depths of from 50 to 100 fathoms.‡

The second Textularine form is usually smaller and more delicate than the last. It is longer in proportion, considerably flattened, and with more elongated chambers. It is comparatively rare. Not unfrequently the first two or three chambers are very small, and arranged almost in a linear series. This may be equivalent to *T. Missouriensis*, or one of the other forms recognized by Ehrenberg, but according to the revised nomenclature may be included under *T. agglutinans*, variety *pygmœa*, D'Orbigny. This form is closely allied to if not identical with one found in the English chalk, and is common at the present day in the North Atlantic and elsewhere, becoming, however, rare and small at great depths, and appears to be most at home in about 90 fathoms in the latitude of England.§

Both of these Textulariæ are small and frequently deformed, and there are forms more or less intermediate between the types here described. Both types appear prominently in the material I have studied from the Upper Missouri,|| and Ehrenberg's additional varieties, if his specimens were such as I have seen, were probably based on transitional or more or less abundant forms which might be included with advantage under these types. Both forms have a weak and depauperated appearance.

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* Smithsonian check list of Cretaceous Fossils.

† See Parker and Jones, Geol. Mag. Vol. viii. No. 11.

‡ The same species or a variety of it seems to be named *T. Americana* by Bailey, in Silliman's Journal, vol. 46. In any case, a comparison of specimens shows that the common species at Pembina Mountain is even varietally identical with one common in the English chalk.

§ Parker and Jones on North Atlantic and Arctic Foraminifera.

|| Specimens presented by the Smithsonian Institution to the Museum of McGill College, from "Eau qui Court," on the Niobrara River, about 500 miles South of Pembina Mountain, are very similar to those from the latter place, containing the same Foraminifera and abundant Coccoliths and Rhabdoliths, with *Ostrea congesta*.

The common spiral Foraminifer in the Pembina Mountain specimens, is *Discorbina* (*Rotalia*) *globularis*, D'Orb. sp., and is probably identical with *Rotalina* (*Rotalia*) *globularis*, characteristic and very common in the upper and lower chalk of England. This form is also common in the specimens from Nebraska, and must be the same as *Planorbulina globulosa*, recognized by Parker and Jones from Ehrenberg's figures as occurring in the Mississippi Cretaceous.* These authors there remark that *Planorbulina globulosa*, Ehr. sp. "must not be regarded as worth much, being a very minute Rotaline, and such a form as several species might present in their earliest stage of growth." It forms, however, a well marked type in the Manitoba and Nebraska deposits, and as no larger examples occur, must be regarded as an adult though depauperated variety. It is common everywhere at the present day. In the North Atlantic it is best developed from the shore down to 50 or 70 fathoms. It becomes flatter at greater depths. The specimens from Manitoba are considerably flattened.

A second Rotaline, smaller and flatter than the rest, and with more delicate chambers and more in a whorl, is referable to *Planorbulina* (*Planulina*) *ariminensis*, D'Orb. sp., included under *P. farcta* by Messrs. Parker and Jones, and belongs to the series of small quasi Rotalian and Nautiloid forms, more or less symmetrical, which they state † to be very common in some secondary deposits, and abundant in the present seas at from 100 to 1000 fathoms. *P. ariminensis* is common in the English chalk, in that of Möen, Denmark, and doubtless elsewhere. It is also found in Tertiary and recent deposits. *Globigerinæ*—referable to *G. cretacea*, also occur, and an examination of a larger quantity of material than that now at my disposal would no doubt bring to light many additional forms.

The general facies of the foraminiferal fauna of these Cretaceous rocks of Manitoba and Nebraska singularly resembles that of the ordinary English chalk. Both abound in Textularine and Rotaline forms of similar types, the most abundant in both being the form with globose chambers, and each having its rarer analogue with chambers flattened and more delicate.

To the bodies now included under the general name *Coccoliths*, attention has only been prominently drawn of late years. Ehren-

* Quart. Jour. Geol. Soc. 1872.

† Memoir on Atlantic and Arctic Forams.

berg long ago recognized them as forming an important constituent of the English chalk, and supposing them to result from a rearrangement and partial crystallization of the particles of carbonate of lime, called them "morpholites." The name by which they are now known was applied to them by Prof. Huxley, who found them to be characteristic of many deep sea sediments, where they appear in conjunction with the Amœba-like *Bathybius*. It is still a question in dispute, whether they form an integral part of that organism. *Rhabdoliths* were discovered by Dr. O. Schmidt in 1872* in the Adriatic Sea, in association with Coccoliths, with which they appear to be closely allied in structure and mode of increase. I do not know that they have heretofore been found in the fossil state.

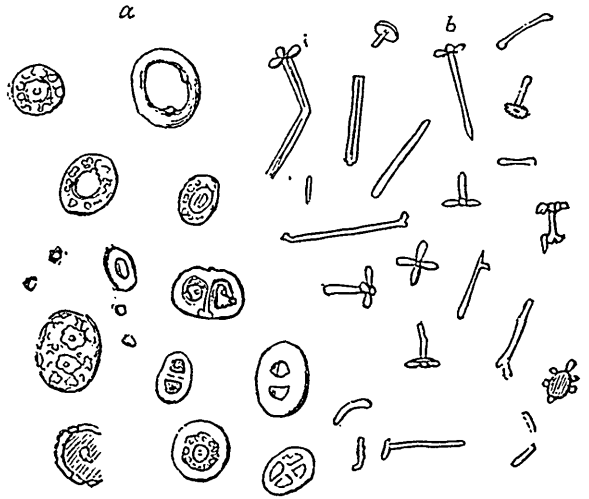

Fig 2. Various forms of Coccoliths (*a*) and Rhabdoliths (*b*) from the Cretaceous of Manitoba.

In the samples of Cretaceous limestone from Manitoba and Nebraska, both Coccoliths and Rhabdoliths are abundant, and constitute indeed a considerable proportion of the substance of the rock. The engraving represents a selection of the forms observed, magnified about 1250 diameters. The *Rhabdoliths* agree closely with those figured by Dr. Schmidt, † and pass

* Ann. and Mag. N. H. 1872. † Loc. Cit. Pl. xvii.

through nearly the same set of forms as those there represented. The Coccoliths agree with those figured in the same place exactly, and also with those found in the English chalk and recent seas. They are in a remarkably good state of preservation. The average diameter of the larger among them is about ·003 millimetres, which agrees very nearly with that of those found in other places. Dr. Gumbel has discovered Coccoliths in limestones of many ages, and they appear, though so minute even in comparison with the Foraminifera, to have played no unimportant part in the fixation of calcareous matter, and the building up of the crust of the earth.

ON RECENT DEEP-SEA DREDGING OPERATIONS IN THE GULF OF ST. LAWRENCE.*

By J. F. Whiteaves.

During the summer of 1873, the Hon. the Minister of Marine and Fisheries of the Dominion of Canada very kindly placed one of the government schooners at my disposal, for dredging purposes. These investigations, which were undertaken on behalf of the Natural History Society of Montreal, had, as their primary object, an examination into the present condition of the Marine Fisheries of the Gulf, and were supplementary to similar explorations carried out by myself in the summers of 1871 and 1872. In the present paper, a short descriptive account will be attempted of some of the most interesting zoölogical specimens collected in 1873. Nearly nine weeks were spent at sea (from July 18th to September 8th); and during this time, although the weather was often unfavorable, we nevertheless got about seventy successful hauls of the dredge. The cruises were essentially four in number, but on the whole the first yielded the greatest number of novelties.

Cruise 1.—The first two weeks were devoted to an examination of the deep water in the centre of the mouth of the river, between Anticosti and the Gaspé Peninsula. The most interesting specimens were obtained in from 200 to 220 fathoms, mud; and among them are the following:

* From the Am. Journal of Science and Arts for March, 1874.

FORAMINIFERA.—*Marginulina spinosa*, M. Sars; a large *Triloculina* allied to *T. tricarinata*, perhaps *T. cryptella* D'Orb.; curious arenaceous forms, new to me, some of which are simple and unbranched, others widely triradiate, while a third series is irregularly cruciform, and even five and six rayed. They are all, most likely, forms of one species; but whether they are the *Asterorhiza limicola* of Sandahl or not, I have at present no means of ascertaining.

SPONGES.—One specimen of *Trichostemma hemisphæricum* M. Sars; one of *Cladorhiza abyssicola* M. Sars; and about a dozen of the *Hyalonema longissimum*, of the same author, were taken in 220 fathoms. With these occurred another species, which is either a true *Tethea*, or belongs to a closely allied genus. In shape it is more or less pyriform, somewhat triangular in section, and with a flattened base. There are three orifices, corresponding to the three angles, of which two are basal. These are connected on two sides by a perforated canal or tube. The front basal orifice is partly closed by an outer fine open network and an inner and coarser one of siliceous spicules, the latter not very unlike those at the apex of *Euplectella;* and this opening seems to be the point of attachment to small stones, etc. The whole sponge is densely hispid with projecting spicules, which are sometimes of considerable length. These are mostly very attenuate; some of them are simple, and these are either straight or flexuous; others are simply ternate or biternate at one end; some again are anchorate at the extremity, with three or four slender flukes. In its canal connecting the three external and larger openings, and in its beautiful open network of spicules, it seems to differ generically from *Tethea*. In the shape of its spicules, but not in some other respects, it resembles the *Dorvillia agaricoformis* of Mr. W. S. Kent, and the *Tethea muricata* of Bowerbank. As the Canadian sponge may possibly be the same as Dr. Bowerbank's imperfectly characterized species, I refrain for the present from giving it a name. It is only fair to add that before I had dredged this species in a living state, my friend Mr. G. T. Kennedy, M.A., had found specimens in the Post-Pliocene clays of Montreal, which are undoubtedly conspecific with it.

ACTINOZOA.—A few individuals of *Pennatula aculeata* Dan., var., and of *Virgularia Ljungmanii* Köll., were taken in the deep-sea mud, together with large tubes apparently belonging to *Cerianthus borealis* Verrill, though the animal of this latter

species has not yet been taken in the Gulf. *Cornulariella modesta* Verrill, was collected (in 1871) at depths of 220 fathoms, between the east end of Anticosti and the Bird Rocks.

ECHINODERMATA.—*Schizaster fragilis* Dub. & Koren, and *Ctenodiscus crispatus*, are common in the deep-sea mud, as are also *Ophiacantha spinulosa* M. & T., and an *Amphiura* whose specific relations are still obscure. The Ophiuridæ collected during this cruise have yet to be studied. One living example of * *Ophioscolex glacialis* M. and T. was dredged in 210 fathoms, to the southwest by south of the Southwest Point of Anticosti.

POLYZOA.—A beautifully perfect specimen of *Flustra abyssicola* of G. O. Sars, showing the singular avicularia, so characteristic of the species, was dredged in the centre of the mouth of the river, at a depth of 220 fathoms. Two examples of *Hornera lichenoides* (Linn.) and one of a peculiar variety of *Bugula plumosa?* were dredged in the same place. *Escharella palmata* (M. Sars) was also sparingly taken in deep water.

MOLLUSCA.—The most abundant species collected at greater depths than 150 fathoms are *Pecten Grœnlandicus* Ch., and *Arca pectunculoides;* but *Portlandia lucida*, *P. frigida*, *Philine quadrata*, *Cylichna umbilicata* Mont., *Dentalium attenuatum** ? Say, and *Siphonodentalium vitreum* Sars, also occurred, though more sparingly. Two living speciment of *Cerithiopsis costulata* Möll. (the *Bittium arcticum* of Mörch) were dredged in the 220 fathom locality.

CRUSTACEA.—The deep-sea Crustacea are of unusual interest. Among them is a living specimen of *Calocaris MacAndreæ* Bell, the first, I believe, that has been observed on the American side of the Atlantic. In the same region, four specimens of a crustacean were collected, which belong, in my judgment, to a new

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NOTE.—I am indebted to Prof. Verrill for the identification of several critical species, to whose names an asterisk (*) is prefixed; and the difficult Crustacea, whose appellations are preceded by a dagger (†), were kindly determined for me by Mr. S. I. Smith.

* If the shell described by the late Dr. Gould as *Dentalium dentale* be really the *Dentalium attenuatum* of Say, the latter name is much prior to Stimpson's *D. occidentale*. Having received a number of Norwegian specimens of *D. abyssorum* Sars, through the kindness of Mr. Jeffreys, and compared them with the St. Lawrence longitudinally ribbed species, I cannot see any differences which in my judgment are sufficient to separate them. At the same time, *Dentalium striolatum* St. seems to me a perfectly distinct and good species.

genus.* In its characters, this genus (for which I venture to propose the name *Munidopsis*) approaches nearer to *Munida* than to *Galathea*. On some future occasion I hope to be able to give a detailed description, with figures, of this form; for the present a short diagnosis only of some of its salient points will be attempted. Of the limited genus *Munida*, only two or three species are known at present. *Munida rugosa* (Fab.) is the same as *Munida Rondeletii* of Bell, and *Astacus Bamffius* of Pennant. The other species are *M. tenuimana* of G. O. Sars, and *M. Darwinii* of Bell.

The following additional species of Crustacea were collected from the deep-sea mud: † *Hippolyte Fabricii* Kroyer; † *Diastylis*, sp.; † *Pseudomma roseum* G. O. Sars; † *Thysanopoda neglecta?* Kroyer, and another large species; *Stegocephalus ampulla* Phipps; † *Harpina*, sp.; † *Epimeria cornigera* Fab.; † *Halirages fulvocinctus* Boeck; † *Melphidippa*, sp.; *Phoxus Kroyeri* St.; *Munnopsis typica* M. Sars; *Anthura brachiata* St.; and † *Nebalia bipes* O. Fab.

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* *Munidopsis curvirostra*, nov. gen. et sp. External antennæ about equal in length to the carapace and its rostrum; internal ones very short, not reaching farther than about one-fourth the length of the beak. Eyes *rudimentary*, longitudinally oval, light yellowish in color; *cornea devoid of facets*. Carapace squarish, but longer than broad, with an outwardly directed straight spine on each of the front angles. Upper surface of the carapace granulate, hispid, transversely irregularly plicate. In the centre there are two dorsal spines, placed one above the other, but at some distance apart. These, as are two similar spines on the tail segments, are all exactly in a line with the rostrum, and the whole four point forward. Rostrum *simple* (without the spine on each side of the base so characteristic of *Munida*), *conspicuously curved upward*, stout at the base and gradually tapering to a fine point. A single spine in the centre of the first and second tail segments, the rest devoid of any. Anterior pair of legs about as long as, but not longer than, from the apex of the rostrum to the end of the tail, extending a little beyond the tips of the outer antennæ. The following are the measurements of an average and apparently adult female: length, from apex of rostrum to tip of tail, 1·38 inch; of carapace, including the rostrum, ·69 inch; of exterior antennæ, ·75 inch; of anterior legs, ·94. Inhabits the centre of the mouth of the St. Lawrence River, between Anticosti and the south shore, in from 180 to 220 fathoms, and probably burrows in the deep-sea mud. From *Munida* it may at once be distinguished by its curved and simple rostrum. In the rudimentary character of its eyes it closely resembles *Calocaris*, but not in many other respects.

Fishes—A fine living example of *Macrurus rupestris* (Fab.), the *M. Fabricii* of Sundevall, was brought up by "tangles" from a depth of about 200 fathoms.

During this cruise we were driven into Gaspé Bay for shelter from a heavy gale blowing outside, and were detained there about four days. At the entrance of the bay, some dredging was done in depths of from 30 to 50 fathoms. The most interesting forms obtained here were *Myriotrochus Rinckii* Steenstr.; *Priapulus caudatus;* both species of *Hyas;* an undetermined † *Eudorella;* *Acanthozone,* nov. sp., fide S. I. Smith; † *Syrrhoë crenulatus* Goes (several); † *Vertumnus serratus* Goes; † *Pontoporeia femorata* Kroyer; † *Haploops,* sp.; † *Melita dentata* Kroyer, and an allied species; as well as some interesting sponges. † *Gammarus ornatus* Edwards, was abundant at low-water in St. George's Cove; it appears to be a common littoral form throughout the Gulf.

Cruise 2.—We left Gaspé Basin on August 2d, intending first to examine the two largest of the inshore banks, the Orphan and the Bradelle. At the outset the weather was very stormy, so we got under the lee of Bonaventure Island, and dredged outside the northern entrance to the Bay des Chaleurs, from Cape Despair to a little below Grand Pabou. *Ophioglypha Sarsii,* of large size, was abundant here, and two specimens of *Myriotrochus Rinckii* were taken in the same place. The crustaceans from this region are unusually interesting: among them are † *Hippolyte macilenta* Kr.; *Thysanopoda neglecta?* Kr.; *Pseudomma* (nov. sp.); species of † *Mysidæ* "near to *Erythrops* and *Parerythrops* of G. O. Sars"; † *Eudorella,* sp.; † *Leucon nasicus* Kroyer; † *Acanthostephia Malmgreni* Boeck; *Œdiceros lynceus* M. Sars; † *Aceros phyllonyx* Boeck; † *Byblis Gaimardii* Kroyer; † *Pontoporeia femorata* Kroyer; a species of † *Melita.* Also a curious fish, at present undetermined.

The breeze moderating, we at once made for the Orphan Bank, and devoted three days to dredging on it, remaining on the ground during the night so as to lose no time. The Orphan Bank, which is situated nearly opposite the entrance to the Bay des Chaleurs, is a stony patch, as are most of the fishing banks, many of which are not mapped out in the charts.

The masses of rock are often of large size, and consist chiefly of a reddish sandstone (perforated by *Saxicava* and *Zirphæa crispata*) associated with a few scattered pieces of Laurentian

gneiss, &c. Soft-bodied organisms are peculiarly plentiful on this bank. The most characteristic of these are *Alcyonium rubiforme* Ehr., small varieties of *Urticina crassicornis; Ascidiopsis complanatus*, of unusual size and abundance; various other Tunicates; and quantities of common Ophiurids and Asterids. † *Metopa glacialis* Bœck, was occasionally met with between the inner and outer tunic of *Ascidiopsis*. The stones are often covered with encrusting sponges, of two or three species: *Grantia ciliata* was frequent, and with it there occurred another calcareous sponge which Prof. Verrill has identified as the *Ascortis fragilis* of Hæckel. Hydrozoa and Polyzoa are exceedingly abundant on this bank; the former seem to be mostly common northern forms. Among the latter, *Myriozoum subgracile* D'Orb.; *Cellepora scabra* Fab.; *Eschara cervicornis?* Pallas; *Caberea Ellisii;* and other species, were fine and frequent. Two fine specimens of *Porella lævis* (Fleming) were dredged at this locality. * *Boltenia ciliata* Möller; * *Molgula pannosa* V.; *Cynthia pyriformis* (Rathke); and *C. monoceros* Möll., occurred sparingly among the other Tunicates.

Among the Echinoderms are *Pteraster militaris, Asterias Grœnlandicus*, and *Psolus phantapus*. The rarest of the Orphan Bank Mollusca are *Amicula Emersonii* (Couth.), fine and frequent; *Mamma immaculata* (Totten); *Trophon craticulatus* (O. Fab.); *Buccinum tenue* Gray; *Neptunea Spitzbergensis* (Reeve); *Tritonofusus Kroyeri* Möll.; *Astyris Holbollii* Beck; and a few *Astarte lactea* of Brod., and Sowerby. Crustacea are peculiarly plentiful on this bank, particularly the two species of *Hyas; Eupagurus; Pandalus annulicornis; Crangon boreas*; *Nectocrangon lar* (fine); *Hippolyte spina;* † *H. Phippsii;* and † *H. pusiola.*

The Amphipods are represented by *Acanthozone cuspidata* (Lep.); *Tritropis aculeatus* (Lep.); and *Eusirus cuspidatus*. The Isopods by *Idotea marmorata* Packard, and by a *Bopyrus* which was found burrowing under the carapace of the common *Pandalus*. A small species of *Nymphon* was also dredged here.

At the end of the third day a stiff breeze from the southwest sprung up, accompanied with rain, and in consequence of this we made for Miscou Island for shelter. As soon as the gale moderated we proceeded to the Bradelle Bank, and on our way made one cast of the dredge between it and Miscou. In this haul, specimens of † *Hippolyte macilenta;* † *Pseudomma*, nov.

sp.; † *Byblis Gaimardii*; † *Ampelisca*, sp.; † *Ptilocheirus pinguis* St.; † *Melita dentata;* and † *Pontoporeia femorata*, as well as many Annelids, were collected.

The Bradelle Bank, which is situated almost due south of the one previously described, is also a stony patch, but the pieces of rock are usually small, and there is an admixture of gravel, coarse sand and mud. Its fauna is characterized by the abundance of its Mollusca, and by the apparent absence on it of many of the softer organisms so abundant on the Orphan Bank. The Hydrozoa and Polyzoa of the two banks are very similar, but on the Bradelle fine specimens of *Tubulipora lobulata*? Hassall, were collected. The most abundant shells on the Bradelle are *Astarte lactea* Brod. and Sow., *A. elliptica*, and *A. Banksii; Venus fluctuosa* Gould; *Cardium Grœnlandicum; Crenella nigra; C. lœvigata; C. glandula; Macoma calcarea; Panopœa Norvegica;* and *Cyrtodaria siliqua*. Its greatest rarities are a single living example each of *Tritonofusus latericeus* Möller, and *Volutopsis Norvegicus* Chemn. *Rhynchonella psittacea*, of large size, is common on both banks. *Astrophyton Agassizii; Ophioglypha Sarsii*, large; *O. nodosa;* and *Psolus phantapus* are frequent on the Bradelle, where also a fine living specimen of *Ophiocoma nigra* Müller, was obtained. The Crustacea of both banks are for the most part similar, but on the Bradelle a few additional species occurred. These are *Crangon vulgaris;* † *Diastylis*, sp.; † *Ampelisca*, two species; † *Haploops*, sp.; † *Byblis Gaimardii;* † *Ptilocheirus pinguis;* † *Harpina*, sp.; † *Paramphithoë pulchella* Bruz.; † *Œdiceros lynceus*; † *Vertumnus serratus;* and † *Nebalia bipes*.

These two banks seem to be outliers, so to speak, inhabited by a purely arctic fauna, and surrounded almost entirely by a more southern assemblage. The shores of the Magdalen Group, of Prince Edward and Cape Breton Islands, as well as the whole of Northumberland Straits as far north as the southern entrance to the Bay des Chaleurs, are tenanted by a somewhat meagre Acadian fauna. Owing to the shallowness of the water on these two banks, the temperature is probably higher by some four or five degrees than the average of that in the northern part of the gulf. In sailing from Point Miscou to the Bradelle Bank we found the temperature of the bottom (Miscou Point, bearing northwest half north, 22 miles distant) was 42° Fahr. After examining the Bradelle Banks, we made for Pictou, Nova Scotia, and arrived there on the afternoon of August 11th.

Cruise 3.—Leaving Pictou on the 13th of August, we dredged to the S.W. and S.S.W. of Pictou Island, then to the N.E. and N.N.E. of Cape George (N. S.), and from there to a little distance off Port Hood, C. B. We next stood over to the east point of Prince Edward Island, dredging at intervals on the way. After this we examined the Milne Bank, also various parts of the bottom from there to Cape Bear (Prince Edward I.), and to the north of Pictou Island, and got back to Pictou on the 16th of August.

From Pictou to Port Hood and along the west side of Cape Breton, the sea bottom consists of red clayey mud, in which annelids are remarkably numerous and often of large size. At almost every cast of the dredge, tangled masses of tubicolous annelids (inhabiting tubes of from the $\frac{1}{16}$th to a quarter of an inch or more in diameter, and from one or one and a half inches to nearly eight inches in length) come up in handfulls. These, together with large naked species, are so abundant as to form more than two-thirds of the whole number of specimens taken. One specimen of †*Diastylis quadrispinosus* G. O. Sars, was dredged off Pictou Island. Hydrozoa and Polyzoa are tolerably abundant, and sometimes very fine, in the red mud; these have not yet been examined, but among them are *Sertularia argentea* of unusually large size, and a bushy species of *Gemellaria*. *Alcyonium carneum* Ag., is one of the characteristic species of the eastern part of this area, as is also an apparently undescribed species of *Priapulus*, very distinct from *P. caudatus*. Tunicates are not unfrequent in the red mud; the commonest of which are *Pelonaia arenifera* and *Eugyra pilularis*, while **Glandula fibrosa* St., occurred more rarely. With these, about sixteen species of shells were collected; they are all characteristic Acadian species. The temperature of the mud seems to range from 40° to 42° Fahr. Off Port Hood, two large specimens of a Holothurian were taken, which exactly agree with the drawing and description of the *Cucumaria pentactes* of O. F. Müller, as given by E. Forbes in his British Starfishes.

Off the east point of Prince Edward Island the bottom is sandy, and as the depth where we dredged does not exceed fifteen or twenty fathoms, the summer temperature is high, being affected by surface conditions. Two small specimens of *Eupyrgus scaber* Lutken, and one of *Molpadia volitica* Pourtales, were collected here, as well as examples of **Molgula papillosa* V. and

**M. producta* St. On the Milne Bank we dredged quantities of the common *Echinarachnius;* an abundance of fine Hydroids and Polyzoa; a few shells; and some small algæ.

Between Cape Bear and Pictou Island the bottom is sandy, with shells and a few small stones. Three kinds of sponges were collected here, many hydroids, echinoderms (all common forms), annelids, crustacea, and tunicates. Among the latter are specimens of **Molgula littoralis* V. Shells were particularly abundant, among them are *Pecten tenuicostatus, Modiola modiolus, Crenella nigra, Astarte undata* Gould, *Cyprina Islandica, Callista convexa, Pandora trilineata, Crepidula fornicata, Lunatia triseriata, Mamma immaculata,* and several species of *Bela.*

The fauna of the region north of Pictou, between the west coast of Cape Breton and the east of Prince Edward Island, is essentially of an Acadian type. To the north, northwest, and west of Cape Breton, the deep water assemblage has probably an Arctic character.

In the marine slip at Pictou, I collected specimens of *Teredo navalis* burrowing into the black birch of which the roller frames of the cradle are composed. At Souris, (Prince Edward I.), the common periwinkle of England (*Littorina littorea*) was plentiful, and it was subsequently observed at Charlottetown. An *Argulus*, closely allied to *A. Alosæ* of Gould, if not identical with it, was taken off Pictou Island, in towing nets, attached to *Gasterosteus biaculeatus?* and other small fishes. *Klotea irrorata* Say, was common on the surface at the same place, and was subsequently obtained at Shediac Bay, and elsewhere. On the shores of the Magdalen Islands it is tolerably common.

Cruise 4.—In the last cruise we endeavored to explore both sides of Northumberland Straits, and dredged from Pictou as far to the northwest as Miramichi Bay. Leaving Pictou on the 19th of August, we first dredged a little to the N.N.W. of Pictou Island, and were then compelled by stormy weather to take shelter in Shediac Bay. Being detained at Point du Chêne for two days, we availed ourselves of the opportunity to examine the oyster beds of Shediac Bay. On these beds, from low water mark down to three fathoms, the following species were met with:

CRUSTACEA.

Cancer irroratus *Say.*	†Gammarus ornatus *Edw.*
Crangon vulgaris *Fab.*	Idotea irrorata *Say.*

MOLLUSCA.

Ostrea borealis *Lam.*
O. Virginiana *Lister.*
Mytilus edulis *Linn.*
Modiola modiolus *Linn.*
Mercenaria violacea *Schum.*
Gemma Tottenii *St.*
Callista convexa *Say.*
Petricola pholadiformis *Lam.*
and var. dactylus.
Mactra solidissima *Chemn.*
Mya arenaria.
" truncata.
Angulus tener *Say.*
Thracia Conradi (fine and
frequent).
Pandora trilineata *Say.*
Solen ensis, v. Americana.
Teredo, sp. (in a spruce log).
Haminea solitaria *Say.*
Cylichna pertenuis *Migh.*
Acmœa alveus *Conrad.*
Crepidula fornicata *Linn.*
" unguiformis *Lam.*
Paludinella minuta.
Odostomia trifida *Totten.*
Turbonilla interrupta *Totten.*
Lunatia heros *Say.*
Bittium nigrum *Totten.*
Nassa obsoleta *Say.*
" trivittata *Say.*
Astyris lunata *Say.*

ECHINODERMATA.

Asterias vulgaris *St.*
Cribella sanguinolenta.
Echinarachnius parma.
Echinus Drobachiensis.
Caudina arenata *(Gould).*

Leaving Shediac by daybreak on the 22d of August, we dredged from that place to the Egmont Bank, and stood back again to the south shore the same evening. The Egmont Bank is a small rocky patch, situated between Shediac Bay and Cape Egmont, Prince Edward Island. The depth on it is less than ten fathoms, and the bottom consists of coarse sand and stones, the latter covered with *Laminariæ* and smaller algæ, and perforated by *Petricola pholadiformis.* Annelids are numerous in the sand, from which also about twelve species of shells were collected. Early the next morning (August 23d), we stood over to the Prince Edward Island side, and dredged along the outside of Bedeque Bay, from off St. Jacques to a little to the south of Sea Cow Head. In the afternoon a falling barometer indicating the imminent approach of a storm, we made for Charlottetown, and reached there only just in time to weather out the memorable gale of the 24th of August. We subsequently managed to dredge in Hillsborough Bay; also, on the opposite shore, off Pugwash Harbor, N. S., and off Shediac, Buctouche and Richibucto, in New Brunswick, and on the 9th of September I left the schooner and proceeded home. On the Prince Edward Island side of Northumberland Straits proper, the bottom is usually a red (Triassic) clayey mud, while on the New Brunswick side it

is generally sandy. The fauna of the Straits is of a decidedly Acadian type. A few sponges, hydroids and crustaceans collected here have yet to be studied. The annelids are fine and frequent, but the echinoderms are all very common species. At depths of more than four fathoms, in Northumberland Straits, the following species were collected:

CRUSTACEA.

Homarus Americanus (fry.)
Crangon vulgaris.
†Hippolyte pusiola *Kr.*
†Diastylis lucifera.
† " sculpta? *G. O. Sars.*
†Pontoporeia femorata.
†Unciola irrorata *Say.*
†Amphithoe, *sp.*
†Ptilocheirus pinguis.
†Melphidippa, *sp.*
†Idotea phosphorea *Harger.*

TUNICATA.

*Eugyra pilularis *V.*
Pelonaia arenifera *St.*

MOLLUSCA.

Pecten tenuicostatus *Migh.*
Yoldia limatula *Say.*
" sapotilla *Gould.*
Nucula delphinodonta *Migh.*
Astarte undata *Gould.*
Cyprina Islandica *Linn.*
Cardium pinnulatum *Con.*
Callista convexa *Say.*
Petricola pholadiformis *Lam.*
Mactra lateralis *Say.*
Pandora trilineata *Say.*
Turbonilla interrupta *Totten.*
Lunatia triseriata *Say.*
Nassa trivittata *Say.*
Buccinum undatum *Linn.*
Sipho pygmæus *Gld.*
Bela cancellata *Migh.*

ON THE POST-PLIOCENE FORMATION NEAR BATHURST, NEW BRUNSWICK.

By Rev. C. H. Paisley, M.A.

In the Post-pliocene formation of the County Gloucester, quite widely distributed at the mouths of its rivers, and at many places on the sea coast, there is usually very little difficulty in observing the presence of the three members of the group, viz.:

Boulder Clay,
Leda Clay,
Saxicava Sand.

All three, so far as examination extends, are usually, if not invariably, present in well-defined superposition, and that part of the group which corresponds with the upper portion of the Leda clay and the lower portion of the Saxicava sand is generally fossiliferous. At two places in the neighbourhood of Bathurst, on the line of the Intercolonial Railway, there are good exposures of this formation. The one is about 2½ miles distant on the left bank of the Tattagouche River (*vid. Naturalist*, No. 1, Vol. vii. p. 41), and the other about ¾ of a mile distant from St. Peter's Village.

With regard to the general characteristics of the Post-pliocene in these localities, it may be said that they are similar in very many respects to those of the same formation on the St. Lawrence, as described by Dr. Dawson, and at St. John, as described by Mr. Matthew.

The boulder clay usually presents a banded appearance of red alternating with a bluish tint, and in some parts can be observed obscure traces of stratification. It is scantily fossiliferous, containing occasional valves of *Mya arenaria*, *Natica* &c., so much decomposed that they cannot be removed. The boulders are, in some places, numerous, not however so much so as to give a very marked character to the beds, which are of unequal thickness, but, in a general way, thin out towards the present sea shore. Some of the boulders must have been brought a considerable distance, although all but the softer variety are angular and wedge-shaped, not having undergone much wear in transportation. Most of them are very dissimilar

to the rocks of the neighbouring formations; but some have their representatives in Restigouche, near Dalhousie.

The surface of this formation, which seldom attains a greater elevation than about 150 feet, is marked by a good deal of inequality.

The Leda clay is generally, when wet, of a reddish hue, drying into a darker but less decided tint, and may possibly have been derived, in part, from the red Sub-carboniferous rocks in the neighbourhood. It varies a great deal in thickness, and through it there are distributed thin layers of sand that maintain a uniform thickness, shewing that they must have been deposited in a gently moving current, or in some quiet and protected place. Indeed all through the middle and lower part of this bed the fossils are so well preserved and so little mutilated, that they must have been deposited very gently. *Nucula*, which is quite abundant, is extremely well preserved with the valves united, epidermis fresh looking and perfect, and the teeth whole. *Mya* also is well preserved, retaining quite frequently the epidermis, and, in this respect, contrasts with specimens found in the fossiliferous bed constituting the lower part of the Saxicava sand and the upper part of the Leda clay. I have once or twice found what would seem to be cracks or holes 2—3 feet deep in this bed almost filled with *Nucula tenuis* and *N. expansa*, with an occasional *Cryptodon*, *Natica*, *Macoma*, and *Balanus*. So abundant were the *Nuculæ* that a pint might be readily washed out of a shovel full of the clay, which was much blackened by the decomposition of animal matter. What was the origin of these holes and why they should be filled so abundantly with *Nuculæ* to the almost entire exclusion of other shells, I cannot conjecture.

The Saxicava sand is also very irregular as to thickness, and terminates, in most places, abruptly on the uneven surface of the Leda clay. It would seem that before the deposition of the sand, currents or some other agents grooved and hollowed out the underlying clay, and that these irregularities were filled up by the sand, which seems to have been deposited by somewhat violent currents in unquiet waters. More rarely, however, instead of the one formation passing abruptly into the other, they gradually merge, so that it cannot be said where the one ends and the other begins. The surface of the Saxicava sand is even more irregular than that of the Leda clay, either from the in-

equalities of its deposition or from denuding agents at work afterwards, or from a combination of both. Viewing the Post-pliocene in this locality as a whole in its resemblance to that of the St. Lawrence on the one side and to that of St. John on the other, we may, perhaps, regard it, as suggested by Mr. Matthew, as a connecting link between the two. I may sum up the fossils thus far obtained in the following list:

RADIATA.

Echinoidea.—*Euryechinus Drobachiensis.*

MOLLUSCA.

Lamellibranchiata.—*Saxicava rugosa* (et var. *arctica*); *Mya truncata* (var. *Uddevallensis*); *M. arenaria* (et *juvenis*); *Macoma Grœnlandica; M. calcarea; Aphrodite Grœnlandica* (et *juvenis*); *Cryptodon Gouldii; Mytilus edulis; Nucula tenuis; N. expansa; Leda pernula; L. glacialis, L. minuta; L. limatula.**

Gasteropoda.—*Bela turricula* (Gould); *Trophon scalariforme; Natica clausa;*† *Buccinum undatum; B. cyaneum; B. Grœnlandicum; B. tenue; Fusus tornatus.*

ARTICULATA.

Annulata.—2 varieties of *Spirorbis.*

Besides these I have obtained the following plant remains: *Zostera marina*, rhizomata of *Equisetum*, and fragments of grasses.

Further examination, by more skilled observers, would doubtless be fruitful of greater results, but what has been done may serve to direct attention to a locality hitherto uninvestigated.

Before closing let me state that I am much indebted to Dr. Dawson and Mr. Matthew for assistance in the determination of the fossils.

* *Ostrea* was found by a workman on the railway, and afterwards shewn to me. He assured me that he himself picked it out about 16 ft. (I think) below the surface. Lest, however, there should be some doubt as to its not having fallen into the cut from the surface, I have not inserted it in the list, although I think it might be inserted with a question after it.

† *Natica heros.* I have seen a specimen of this shell said to have been obtained here, but I have not inserted it in the list, because I did not find it myself. It has been found in the next county.

TWO NEW FOSSIL COCKROACHES FROM THE CARBONIFEROUS OF CAPE BRETON.

By Samuel H. Scudder.

Through the kindness of Dr. J. W. Dawson, I have been enabled to study two fossil cockroaches, from the collections made by R. Brown, Esq., F.G.S., in the carboniferous deposits of the Sydney coal-field, Cape Breton, and placed in Dr. Dawson's hands for determination of the fossil plants. When more species and specimens of this ancient group shall have been discovered, I hope to undertake a revision of the whole, meanwhile describing new forms under the generic name *Blattina*, a somewhat heterogeneous group to which most fossil cockroaches have, for convenience' sake, been referred.

Three fossil cockroaches have already been described from the carboniferous formations of America: *Blattina venusta*, Lesq., from Arkansas, *Archimylacris acadicus*, Scudd., from Pictou, N.S., and *Mylacris anthracophilus*, Scudd., from Illinois. With the exception of the last, where the pronotum is also preserved, each of these fossils is represented by a single upper wing. The two additional species now described are also similarly represented; thus every specimen yet discovered in America is referable to a distinct species.

Fig. 1. *Blattina Bretonensis*, Scudd.

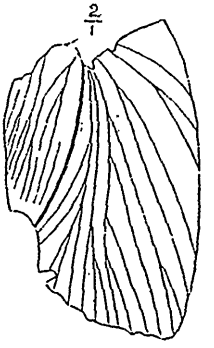

Fig. 2. *Blattina Heeri*, Scudd.

Blattina Bretonensis, nov. sp. This is a well preserved and very nearly complete upper wing of the right side, its length

16.35mm. and its extreme breadth 7.2mm. The form of the wing is an oblong, pretty regular oval, the apical portion a little produced. The anal nervure is deeply impressed, strongly curved, especially just before its middle, where the wing was somewhat convex, and terminates before the middle of the basal two-thirds of the posterior border. The other nervures and their branches are very delicate, and the branches equidistant and rather closely crowded; the spaces between them are wholly unbroken by any cross-nervules, and the surface of the wing appears to have been smooth in life. (Fig. 1.)

Blattina Heeri, nov. sp. This is also represented by a right upper wing, but it is not so perfect as the preceding; the whole of the apex, and the outer half of the posterior border is lost. The length of the fragment is 21mm.; probably the entire wing would have been two or three millimetres longer; the width of the wing, just before the middle, is 11.8 mm. The wing is proportionately broader than in the preceding species and less convex, and the apex is probably less extended, but otherwise it has much the same form. The anal nervure is deeply impressed only over its basal half, and is gently curved, terminating doubtless at about the middle of the posterior border; the other nervures and their branches are rather distinctly impressed, somewhat distant and regular; the spaces between are transversely and very faintly wrinkled, rather than provided with cross-nervules; the surface is nevertheless pretty smooth; the costal border is very delicately marginate. (Fig. 2.)

This species is named in honor of Professor Oswald Heer of Zurich, who has laid the foundation of our present knowledge of fossil insects.

Both of the above specimens are on dark gray shale, and are associated with leaves of *Sphenophyllum* and ferns.

Cambridge, April 24, 1874.

NATURAL HISTORY SOCIETY.

PROCEEDINGS FOR THE SESSION 1873–74.

MONTHLY MEETINGS.

1st Monthly Meeting, held Oct. 27th, 1873.

A paper on *Cornus Suecica* was read by Principal Dawson.

After some remarks on the distribution of this and the related species, in Canada, by Dr. John Bell and other members, Dr. P. P. Carpenter gave a verbal account of the life and labours of the late Mr. R. McAndrew, of London, as a conchologist.

Further observations on this topic were made by the President and Rec. Secretary, and Dr. Carpenter was requested to prepare an obituary notice for publication in this journal.*

2nd Monthly Meeting, held Nov. 24th, 1873.

R. C. Chisholm and Albert E. Linchant were elected members of the Society.

The Recording Secretary read a paper "On a collection of Himalayan birds recently presented to the Society by Major G. E. Bulger F.R.G.S., Z.S., L.S."

On motion of C. Robb, seconded by G. Barnston, it was unanimously resolved:

"That the special thanks of the Society be voted to Major Bulger for his liberal donation to its museum."

Principal Dawson read a letter from the Rev. Mr. Harvey (of St. John's, Newfoundland) giving an account of a gigantic cuttle-fish recently captured at Conception Bay.

3rd Monthly Meeting, held Jan 26th, 1874.

Resolutions of condolence with the family of the late Dr. C. Smallwood were submitted and adopted.

Messrs. Kenneth McLea, W. Barnston, W. Robertson and Dr. A. A. Browne were elected resident members.

Mr. A. R. C. Selwyn then read a paper entitled "Notes on a journey through the N. W. Territory, from Manitoba to Rocky Mountain House."†

* See Vol. vii. p. 227. † Ibid, p. 193.

A discussion ensued, in which Principal Dawson, G. M. Dawson, Prof. Bell, Prof. Darey and other members took part.

4th Monthly Meeting, held Feb. 23rd, 1874.

A paper on the Lignite Tertiaries of the West, was read by Mr. G. M. Dawson.*

Remarks on this subject were made by Principal, Dawson Mr. Selwyn, Mr. Miller, C. Robb, and other persons present.

5th Monthly Meeting, held March 30th, 1874.

Messrs. Arnold G. Fenwick, James Gardner, Charles Garth, W. F. Gatling, G. R. Grant, R. A. Lindsay, W. Rhind and James Williamson were elected members of the Society. Miss Cordner, Mrs. Mercer, Mrs. Molson, Miss Symmers, and Miss Smith were elected Associate Members.

A paper on the Geology of Arisaig N. S., by Mr. T. C. Weston, was read by the Recording Secretary.

Mr. Whiteaves made a communication on some results obtained during a recent deep sea dredging expedition round Prince Edward Island.

6th Monthly Meeting, held April 27th, 1874.

Messrs F. E. Grafton, S. P. Rowell, and J. J. Rowan Spong, were elected resident members.

Mrs. Lewis and Miss Julia Sanborn were also elected associate members.

Dr. B. J. Harrington then read a paper entitled "Notes on some of the Montreal Trap Dykes and the Minerals which they contain."

After some remarks on this topic by the President, the meeting was adjourned.

SOMERVILLE LECTURES.

The following is a list of the free lectures of this course, with the dates at which they were delivered.

1. Feb. 5th, 1874.—The Ancient Geography of North America, by Dr. T. Sterry Hunt, F.R.S.

2. Feb. 19th, 1874.—Geological Facts as to Primitive Man, by Principal Dawson, L.L.D., F.R.S.

3. Feb. 19th, 1874.—A Summer on the Plains, by Prof. R. Bell, F.G.S.

* See Vol. vii. p. 241.

4. Feb. 26th, 1874.—Oyster Culture, by Dr. P. P. Carpenter.

5. March 5th, 1874.—The Tooth of Time, by C. Robb.

6: March 12th, 1874.—Sponges, by G. T. Kennedy, M.A.

7. March 19th, 1874.—The Early Wanderings of the Anglo-Saxon Race, by Rev. Canon Baldwin, M.A.

8. March 26th, 1874.—Advanced Scientists, by Dr. Hingston.

DONATIONS TO THE MUSEUM.

From Major G. E. Bulger, F.R.G.S., L.S., Z.S.—60 fine specimens of the birds of the Himalayas.

Yale college New Haven, per. S. I. Smith.—45 named species of Marine Crustacea from the Northern United States.

Yale College, New Haven, per Prof. A. E. Verrill.—An extensive series of named Marine Invertebrates from the dredgings under the auspices of the U. S. Fish Commission.

Mons. A. Le Chevallier.—Skin of the Java Ant-Thrush.
" " " Brown Pelican, from Florida.
" " " Frigate " " "
" " " Painted Quail.
" " " Eggs of 73 species of N. American Birds.
" " " Asterid from Florida.

Prof. R. Bell.—Specimen of the American Badger, from the Plains of the Saskatchewan.

H. Vennor Esq.—Fine example of the American Wolf, from Levant Township, back of Hull, Ont.

G. Barnston, Esq. Fossil shells from Albany River, and seed-pod of a leguminous plant from Ceylon.

" " Specimen of the Magpie Robin (*Copsychus saularis*) and Bengal Ant-Thrush (*Pitta Bengalensis*), both from Ceylon.

C. Robb, Esq.—3 Specimens of marine sponges from Cape Breton.

F. B. Caulfield, Esq.—26 Named species of Canadian Coleoptera and one of Lepidoptera.

A. H. Foord Esq., F.G.S.—Two models of Greenland Harpoons.

A. R. C. Selwyn, Esq. F.R.S.—Specimens of *Tellina secta* Con., and *Coronula diadema*, from Vancouver Island.

Mr. W. H. Couper.—Pair of *Papilio brevicauda* Saunders (*P. Anticostiensis* Strecker.)
" " " *Pieris* (*Ganoris*) *borealis.*
" " " *Melitœa tharos.* (Northern variety)
" " " *Glaucopysyche Couperi* Grote.

S. J. Lyman, Esq.—An American Bittern.

Mr. S. W. Passmore.—An American Coot.

Mrs. Maitland.—Various objects found at Tadousac some 12 years ago, supposed to be relics of the old Jesuit mission at that place

The Smithsonian Institute, Washington.—14 Skins of N. American Rodents.

DONATIONS TO THE LIBRARY.

From the Trustees of the British Museum.—Catalogue of Hemiptera Heteroptera, Part 8.

" " " Hand list of Shield reptiles.

" " " Hand list of the Edentate, Thick-skinned, and Ruminant Mammals in the British Museum.

The Director of the Geological Survey of Canada.—Report of Progress for 1872–73.

From the U. S. Geological Survey of the Territories.—Contribution to the Extinct Vertebrate Fauna of the Western Territories By Joseph Leidy M.D. 4to with 37 plates.

Acrididæ of North America. By Cyrus Thomas, Ph. D. 4to., with one Plate.

From F. V. Hayden, U. S Geologist.—First, second and third reports of the U. S. Geological Survey of the Territories for the years 1867, 1868, and 1869. 8vo.

United States Geological Survey of Montana, Idaho, Wyoming, and Utah. Report for 1872. By F V. Hayden.

From the Author.—The Silurian Brachiopoda of the Pentland Hills. By Thomas Davidson. 4to., 3 plates.

Regents of the State of New York.—New York Meteorology. 1850–63. Second series by F. B. Hough.

Annals of the Dudley Observatory Vol. 2. Albany. 1871.

55th Annual Report of the Trustees of the New York State Library. Albany, 1873.

24th Report of the New York State Museum of Natural History. Albany, 1872.

Manual for the use of the Legislature of the State of New York Albany, 1871.

Department of Public Instruction, Quebec.—Report of the Minister of Public Instruction for the Province of Quebec for 1872 and part of 1873.

From the Author.—On the Classification of the Cambrian and Silurian Rocks. By Henry Hicks, F.G.S. 8vo Pamphlet.

From the Author.—*The Liberal Education of the Nineteenth* Century. By Prof. W. Atkinson. 8vo Pamphlet.

From the Author.—Notes of a tour from Bangalore to Calcutta, thence to Delhi and subsequently to British Sikkim, during the early part of 1867. By Major G. E. Bulger, F.L.S., F.R.G.S., C.M.Z.S.

ANNUAL MEETING,

Held May 18th, 1874.

The minutes of the last annual meeting having been read by the Recording Secretary, the following address was delivered by the President, Principal Dawson, LL.D., F.R.S.

ANNUAL ADDRESS.

The scientific work of this Society in the year which closes to-night, is not so remarkable for its variety as for the interest and importance of the subjects to which it relates. A list of the papers read is appended to this address;* but I shall confine myself principally to two subjects embraced in their scope. One is the bearing of the dredging operations of our colleague, Mr. Whiteaves, on the Post-pliocene Geology of Canada, in connection with other oceanic and geological researches. The second is the growth of our information as to the geological structure of those great plains of the West, whose profitable occupancy is now so important a problem for our statesmen.

Mr. Whiteaves in the past summer was chiefly occupied with the exploration of the great southern Bay of the Gulf of St. Lawrence, a basin of shallow water nearly semicircular in form, and in which is set the beautiful Island of Prince Edward. It is protected to some extent by the encompassing land, by its limited depth, and by the islands and shoals stretching across its mouth, from the influence of those cold northern currents which pervade all the middle and northern parts of the Gulf, and give to its fauna an almost Arctic character: it thus forms a peculiar and exceptional zoological province. The marine animals of Northumberland Strait were those with which I was myself most familiar in early youth, and I still possess many drawings of the more minute forms, made under the microscope for my amusement, before I had received any scientific training in natural history. In my cabinet there has been for the last thirty years a nearly complete representation of its mollusks, and I was even then aware from the observations of Gould and others in New England, of the specially southern character of this group of animals, though at that time I had no means of publishing my observations, and the importance of these peculiarities of distribution had scarcely dawned upon the minds of

* See preceding pages 273, 274.

geologists. In later years, however, Mr. Whiteaves and Prof. Verrill have, in connection with the dredging operations carried on in the interest of our fisheries, more fully worked up the relations of these faunæ, and we are now in a position to speak with some certainty of the facts, and to appreciate their significance.

If we draw a straight line from the northern end of Cape Breton through the Magdalen Islands to the mouth of the Bay des Chaleurs, we have to the southward an extensive semicircular Bay, 200 miles in diameter, which we may call the great *Acadian Bay*, and on the north the larger and deeper triangular area of the Gulf of St. Lawrence. This Acadian Bay is a sort of gigantic warm-water aquarium, sheltered, except in a few isolated banks which have been pointed out by Mr. Whiteaves, from the cold waters of the Gulf, and which the bather feels quite warm in comparison with the frigid and often not very limped liquid with which we are fain to be content in the Lower St. Lawrence. It also affords to the more delicate marine animals a more congenial habitat than they can find in the Bay of Fundy or even on the coast of Maine, unless in a few sheltered spots, some of which have been explored by Prof. Verrill. It is true that in winter the whole Acadian Bay is encumbered with floating ice, partly produced on its own shores and partly drifted from the north; but in summer the action of the sun upon its surface, the warm air flowing over it from the neighbouring land, and the ocean water brought in by the Strait of Canso, rapidly raise its temperature, and it retains this elevated temperature till late in autumn. Hence the character of its fauna, which is indicated by the fact that many species of mollusks whose headquarters are south of Cape Cod, flourish and abound in its waters. Among these are the common oyster, which is especially abundant on the coasts of Prince Edward Island and northern New Brunswick, the Quahog or Wampum shell, the *Petricola pholadiformis*, which along with *Zirfea crispata*, burrows everywhere in the soft sandstones and shales; the beautiful *Modiola plicatula* forming dense mussel-banks in the sheltered coves and estuaries; *Cytherea* (*Callista*) *convexa*; *Cochlodesma leana* and *Cummingia tellinoides*; *Crepidula fornicata*, the slipper-limpet, and its variety *unguiformis*, swarming especially in the oyster beds; *Nassa obsoleta* and *Buccinum cinereum*, with many others of similar southern distribution.

Nor is the fauna so very meagre as might be supposed. My own collections from Northumberland Strait include about 50 species of mollusks, and some not possessed by me have been found by Mr. Whiteaves. Some of these, it is true, are northern forms, but the majority are of New England species.

The causes of this exceptional condition of things in the Acadian Bay carry us far back in geological time. The area now constituting the Gulf of St. Lawrence seems to have been exempt from the great movements of plication and elevation which produced the hilly and metamorphic ridges of the east coast of America. These all die out and disappear as they approach its southern shore. The tranquil and gradual passage from the Lower to the Upper Silurian ascertained by Billings in the rocks of Anticosti, and unique in North America, furnishes an excellent illustration of this. In the Carboniferous period the Gulf of St. Lawrence was a sea area as now, but with wider limits, and at that time its southern part was much filled up with sandy and muddy detritus, and its margins were invaded by beds and dykes of trappean rocks. In the Triassic age the red sandstones of that period were extensively deposited in the Acadian Bay, and in part have been raised out of the water in Prince Edward Island, while the whole Bay was shallowed and in part cut off from the remainder of the Gulf by the elevation of ridges of Lower Carboniferous rocks across its mouth. In the Post-pliocene period, that which immediately precedes our own modern age, as I have elsewhere shown,* there was great subsidence of this region, accompanied by a cold climate, and boulders of Laurentian rocks were drifted from Labrador and deposited on Prince Edward Island and Nova Scotia, while the southern currents flowing up what is now the Bay of Fundy, drifted stones from the hills of New Brunswick to Prince Edward Island. At this time the Acadian Bay enjoyed no exemption from the general cold, for at Campbelltown, in Prince Edward Island, and at Bathurst in New Brunswick, we find in the clays and gravels the northern shells generally characteristic of the Post-pliocene; though perhaps the lists given by Mr. Matthew for St. John and by Mr. Paisley for the vicinity of Bathurst, may be held to shew some slight mitigation of the Arctic conditions as compared with the typical deposits in the St. Lawrence valley. Since

* Notes on Post-pliocene of Canada, *Canadian Naturalist*, 1872

that time the land has gradually been raised out of the waters, and with this elevation the southern or Acadian fauna has crept northward and established itself around Prince Edward Island, as the Acadian Bay attained its present form and conditions. But how is it that this fauna is now isolated, and that intervening colder waters separate it from that of southern New England. Verrill regards this colony of the Acadian Bay as indicating a warmer climate intervening between the cold Post-pliocene period and the present, and he seems to think that this may either have been coincident with a lower level of the land sufficient to establish a shallow water channel, connecting the Bay of Fundy with the Gulf, or with a higher level raising many of the banks on the coast of Nova Scotia out of water. Geological facts, which I have illustrated in my Acadian Geology, indicate the latter as the probable cause. We know that the eastern coast of America has in modern times been gradually subsiding. Further, the remarkable submarine forests in the Bay of Fundy show that *within a time not sufficient to produce the decay of pine wood*, this depression has taken place to the extent of at least 40 feet, and probably to 60 feet or more.* We have thus direct geological evidence of a former higher condition of the land, which may when at its maximum have greatly exceeded that above indicated, since we cannot trace the submarine forests as far below the sea level as they actually extend. The effect of such an elevation of the land would be not only a general shallowing of the water in the Bay of Fundy and the Acadian Bay, and an elevation of its temperature both by this and by the greater amount of neighbouring land, but as Prof. Verrill well states, *it would also raise the banks off the Nova Scotia coast*, and extending south from Newfoundland, so as to throw the Arctic current further from the shore and warm the water along the coasts of Nova Scotia and Northern New England. In these circumstances the marine animals of Southern New England might readily extend themselves all around the coasts of Nova Scotia and Cape Breton, and occupy the Acadian Bay. The modern subsidence of the land would produce a relapse toward the glacial age, the Arctic currents would be allowed to cleave more closely to the coast, and the inhabitants of the Acadian Bay would gradually become isolated, while the northern animals of Labrador would work their way southward.

* Acadian Geology, p. 29.

Various modern indications point to the same conclusions. Verrill has described little colonies of southern species still surviving on the coast of Maine. There are also dead shells of these species in mud banks, in places where they are now extinct. He also states that the remains in shell-heaps left by the Indians indicate that even within the period of their occupancy some of these species existed in places where they are not now found. Willis has catalogued some of these species from the deep bays and inlets on the Atlantic coast of Nova Scotia, and has shown that some of them still exist on the Sable Island banks.*

Whiteaves finds in the Bradelle and Orphan bank littoral species remote from the present shores, and indicating a time when these banks were islands, which have been submerged by subsidence, aided no doubt by the action of the waves.

It would thus appear that the colonisation of the Acadian Bay with southern forms belongs to the modern period, but that it has already passed its culmination, and the recent subsidence of the coast has no doubt limited the range of these animals, and is probably still favouring the gradual inroads of the Arctic fauna from the north, which, should this subsidence go on, will creep slowly back to reoccupy the ground which it once held in the Post-pliocene time.

Such peculiarities of distribution serve to show the effects of even comparatively small changes of level upon climate, and upon the distribution of life, and to confirm the same lesson of caution in our interpretation of local diversities of fossils, which geologists have been lately learning from the distribution of cold and warm currents in the Atlantic. Another lesson which they teach is the wonderful fixity of species. Continents rise and sink, climates change, islands are devoured by the sea or restored again from its depths; marine animals are locally exterminated and are enabled in the course of long ages to regain their lost abodes; yet they remain ever the same, and even in their varietal forms perfectly resemble those remote ancestors which are separated from them by a vast lapse of ages and by many physical revolutions. This truth which I have already deduced from the Post-pliocene fauna of the St. Lawrence Valley, is equally taught by the molluscs of the Acadian Bay, and by their Arctic relatives returning after long absence to claim their old homes.

* Acadian Geology, p. 37.

Still another lesson may be learned here. It appears that our present climate is separated from that of the glacial age by one somewhat warmer, which was coincident with an elevated condition of the land. Applied to Europe, as it might easily be, this fact shows the futility of attempting to establish a later glacial period between the Post-pliocene and the present, in the manner attempted, as I must think on the slenderest possible grounds, by Prof. Geikie in his late work "The Great Ice Age."

The grandeur of those physical changes which have occurred since the present marine animals came into being, is well illustrated by some other facts to which our attention has been directed. Recent excavations in the Montreal mountain have enabled Mr. Kennedy to observe deposits of Post-pliocene marine shells at a still higher level than that of the old beach above Cote des Neiges, which was so long ago described by Sir Wm. Logan and Sir Charles Lyell. The new positions are stated to be 534 feet above the sea. Let us place this fact along with that recorded by Prof. Bell in the Report of the Geological Survey for 1870-71, of the occurrence of these same shells on the high lands north of Lake Superior, at a height which, taking the average of his measurements, is 547 feet above the sea level. Let us further note the fact, that in the hills behind Murray Bay and at Les Eboulements I have recorded the occurrence of these remains at the height of at least 600 feet. We have then before us the evidence of the submergence of a portion of the North American continent at least 1000 miles in length and 400 miles in breadth to a depth of more than a hundred fathoms, and its re-elevation, without any appreciable change in molluscan life.

Another important and impressive fact in this connection has recently been brought out by Dr. Hunt in a paper on the Geology of the South-eastern Appalachians.* He there shows that in these mountains, which lie to the south of the region of the great Post-pliocene submergence, the gneissose rocks have been decomposed in place to enormous depths, without any of the material being removed—a most striking contrast to the generally bare and scraped condition of similar rocks in the north. I was struck very much with this fact several years ago, when, under the guidance of my friend Dr. Tyson, I had an opportu-

* Proceedings American Association, 1873.

nity of examining the crystalline rocks near Baltimore, and I have also in my notes on the Post-pliocene of Canada, pointed out that in some places, as at Les Eboulements and on the southern side of our own mountain, where the rocks have been sheltered from the northern currents, extensive evidence of old sub-aerial disintegration may be seen.

It is most instructive to compare in connection with this point the condition of the Silurian rocks on the north-east and south sides of the Montreal mountain. On the former they show no signs of sub-aerial waste, but are polished and striated in the most perfect manner. The striae are N.E. and S.W., or in the direction of the river valley, and that the force producing them acted from the N.E. is shewn by the manner in which projecting trap dykes are ground on the N. E. side and left rough on the opposite one. The striae vary in direction, having evidently been produced by many successive impacts of heavy bodies moving from the north-east but not always in precisely the same lines. It seems absolutely impossible that anything except floating ice running from the N. E. or against the present drainage of the country could have produced these striations.* On the limestone slopes which front the mountain, all is different. In the vicinity of the reservoirs, for example, the coarse earthy limestone, where it has been protected by hard trap dykes, is in many places decomposed to a great depth, and shows no signs of glacial action.

What does this teach us? The same truth which we learn from the wholesale transference of boulders, sand and clay to the south-west over our country, namely, that *the great agent in denuding it of all its decomposed and broken rock has been the Arctic current passing over it when submerged.* The boulders which have been swept away from our Laurentian hills are merely the harder and less decomposed parts of rocks which had been disintegrated long before the glacial period, but became the prey of water and ice when the land was submerged. Geologists will not learn to understand fully the Post-pliocene period,

* I saw last autumn on St. Helen's Island a very instructive instance of striation on Utica shale produced by the ice-shove of the previous spring. This was in the direction of the river valley, but the evidence of the force acting from the south-west was plain, while a miniature moraine of rock fragments in advance of the markings shewed the agent by which they had been effected.

until they are prepared to admit that the power of the heavy Arctic currents passing over the submerged land and carrying with them their burden of ice, is vastly greater as an agent of denudation than either the rivers or glaciers. Nor must we confine this to the Post-pliocene period. Prof. Hall has shewn that the whole of the vast thickness of the Palæozoic rocks of the Appalachians may be attributed to the carrying power of the same currents which are now piling up banks of Arctic sand and stones along the American coast. Nay more, the history of the land of the Northern Hemisphere throughout geological time has been that of a series of elevations and depressions or gigantic pulsations of the earth's crust, so regular that we cannot hesitate in referring them to some constantly operating law. Every elevation exposed the land to sub-aerial disintegration. Every subsidence scraped and peeled it by the action of the Arctic currents, and thus the carriage of material and the growth of the continents have ever been to the south-west. I cannot leave this subject without according to Dr. Carpenter much credit for contending as he has done for the reality, power, and true causes of these great sub-oceanic rivers, which have played and are playing so important parts as geological agents, that without them it is impossible to account either for the Palæozoic deposits or the Post-pliocene deposits of our North American continent.

But it is time to turn to the second topic which I have marked out for myself in this discourse. In the past summer three lines of geological reconnaissance have been pushed out from the Laurentian and Huronian country of Lake Superior over the plains of Manitoba. One of these, under Mr. Selwyn, followed the line of the North Saskatchewan. The second was that of Prof. Bell on the south branch of the same river and its tributaries. The third was that of Mr. G. M. Dawson on the 49th parallel. All of these have been brought under the notice of this Society in the course of the winter. This great western plain presents first a wide expanse of Cretaceous rocks, apparently not highly fossiliferous and not well exposed, but containing some limestone layers rich in Foraminifera and Coccoliths precisely similar to those of the English chalk. Some of these have been described by Mr. Dawson in our Journal. This is succeeded by vast estuarine and lacustrine deposits of clay and sand, holding brackish-water and fresh-water shells, and beds of lignite with abundant plant remains. The general geological

history of these great prairie lands is thus as plain and simple as their own superficial features. First, we have a great Cretaceous Mediterranean, extending from the Gulf of Mexico perhaps to the Arctic sea. Then we have this dried up into estuaries, lakes and marshes, and becoming clothed with a rich vegetation similar in general character to that of the west coast at present, and indicating a mild and genial climate. Then we have the great Post-pliocene subsidence, with its trains of gravel and ice-borne boulders; and lastly the re-elevation into the prairie lands of to-day, with perhaps an intervening age of modern forests. The final results are a vast expanse of fertile soil, and great stores of mineral fuel, which may one day make these now lone lands the seats of extensive manufacturing industries. Detailed reports of the explorations of the past year are in progress, and will greatly increase our precise and definite knowledge of regions which have hitherto been known to us principally through the vague impressions of unscientific travellers.

Simple though the structure of these Western regions is, it has already given rise to controversies, more especially with reference to the age of the plants and animals whose remains have been found in these formations south of the United States boundary. In looking over these controversies, I am inclined in the first place to believe that we have in the West a gradual passage from the Cretaceous to the Tertiary beds, and that these last may scarcely admit of a definite division into Eocene and Miocene. We may thus have in these regions the means of bridging over what has been one of the widest gaps in the earth's history and of repairing one of the greatest imperfections in the geological record.

Physically the change from the Cretaceous to the Tertiary was one of continental elevation—drying up the oceanic waters in which the marine animals of the Cretaceous lived, and affording constantly increasing scope for land animals and plants. Thus it must have happened that the marine Cretaceous animals disappeared first from the high lands and lingered longest in the valleys, while the life of the Tertiary came on first in the hills and was more tardily introduced on the plains. Hence it has arisen that many beds which Meek and Cope regard as Cretaceous on the evidence of animal fossils, Newberry and Lesquereux regard as Tertiary on the evidence of fossil plants. This depends

on the general law that in times of continental elevation newer productions of the land are mixed with more antique inhabitants of the sea; while on the contrary in times of subsidence older land creatures are liable to be mixed with newer products of the sea. Thus in Vancouver's Island plants which Heer at first regarded as Miocene have been washed down into waters in which Cretaceous shell-fishes still swarmed. Thus Cope maintains that the lignite-bearing or Fort Union group contains remains of cretaceous reptiles, while to the fossil botanist its plants appear to be unquestionably Tertiary. Hence also we are told that the skeleton of a Cretaceous Dinosaur has been found stuffed with leaves which Lesquereux regards as Eocene. At first these apparent anachronisms seem puzzling, and they interfere much with arbitrary classifications. Still they are perfectly natural, and to be expected where a true geological transition occurs. They afford, moreover, an opportunity of settling the question whether the introduction of living things is a slow and gradual evolution of new types by descent with modification, or whether, according to the law so ably illustrated by Barrande in the case of the Cephalopods and Trilobites, new forms are introduced abundantly and in perfection at once. The physical change was apparently of the most gradual character. Was it so with the organic change, That it was not is apparent from the fact that both Dr. Asa Gray and Mr. Cope, who try to press this transition into the service of evolution, are obliged in the last resort to admit that the new flora and fauna must have migrated into the region from some other place. Gray seems to think that the plants came from the north, Cope supposes the mammals came from the south; but whether they were landed from one of Sir William Thomson's meteors, or produced in some as yet unknown region of the earth, they cannot inform us. Neither seems to consider that if giant Sequoias and Dicotyledonous trees and large herbaceous mammalia arose in the Cretaceous or early Tertiary, and have continued substantially unimproved ever since, they must have existed somewhere for periods far greater than that which intervenes between the Cretaceous and the present time, in order to give them time to be evolved from inferior types; and that we thus only push back the difficulty of their origin, with the additional disadvantage of having to admit a most portentous and fatal imperfection in our geological record.

The actual facts are these. The flora of modern type comes into being in the Cretaceous of the West without any known ancestors, and it extends with so little change to our time that some of the Cretaceous species are probably only varietally distinct from those now living. On the other hand the previous Jurassic flora had died out apparently without successors. In like manner the Cretaceous Dinosaurs and Cephalopods disappear without progeny, though one knows no reason why they might not still live on the Pacific Coast. The Eocene mammals make their appearance in a like mysterious way. This is precisely what we should expect if groups of species are introduced at once by some creative process. It can be explained on the theory of evolution, only by taking for granted all that ought to be proved, and imagining series of causes and effects of which no trace remains in the record.

The problems for solution are, however, much more complicated than the derivationists seem to suppose. Let us illustrate this by the plants. The Cretaceous flora of North America is in its general type similar to that of the Western and Southern part of the continent at present. It is also so like that of the Miocene of Europe that they have been supposed to be identical. In Europe, however, the Cretaceous and Eocene floras, though with some American forms, have a different aspect, more akin to that of floras of the Southern Hemisphere. There have therefore been more fluctuations in Europe than in America, where an identical group of genera seems to have continued from the Cretaceous until now. Nay, there is reason to believe that some of the oldest of these species are not more than varietally distinct from their modern successors. Some that can be traced very far back are absolutely identical with modern forms. For example, I have seen specimens of a fern collected by Dr. Newberry from the Fort-Union group of the Western States, one of those groups disputed as of Cretaceous or Tertiary date, which is absolutely identical with a fern found by Mr. Dawson in the Lignite Tertiary of Manitoba, and also with specimens described by the Duke of Argyle from the Miocene plant beds of Mull. Further it is undoubtedly our common Canadian sensitive fern—*Onoclea sensibilis*. There is every reason to believe that this is merely one example out of many, of plants that were once spread over Europe and America and have come down to us unmodified throughout all the vicissitudes of the Tertiary ages. But while

this is the case, some species have disappeared without known successors, and others have come in without known predecessors. Nay whole floras have come in without known origin. Since the Miocene age the great Arctic flora has spread itself all around the globe, the distinctive flora of North-Eastern America and that of Europe have made their appearance, and the great Miocene flora once almost universal in the Northern Hemisphere has as a whole been restricted to a narrow area in Western and warm temperate North America. Even if with Gray, in his address of two years ago before the American Association, we are to take for granted that the giant Pines (Sequoias) of California are modified descendants of those which flourished all over America and Europe in the Miocene, Eocene and Cretaceous, we have in these merely an exceptional case to set against the broad general facts. Even this exception fails of evolutionary significance, when we consider that the two species of Sequoia, which have been taken as special examples, are at best merely survivors of many or several species known in the Cretaceous and Tertiary. The process of selection here has been merely the dropping out of some out of several species of unknown origin, and the survival in a very limited area of two, which are even now probably verging on extinction: in other words, the two extant species of Sequoia may have continued unchanged except varietally from Mesozoic times, and other species existed then and since which have disappeared; but as to how any of them began to exist we know nothing, except that, for some mysterious reason, there were more numerous and far more widely distributed species in the early days of the group than now. This is precisely Barrande's conclusion as to the Palæozoic Trilobites and Cephalopods, and my own conclusion as to the Devonian and Carboniferous plants. It is rapid culmination and then not evolution but elimination by the struggle for existence.

The argument deduced from these successive floras reminds one of certain attempts which have been made in England to invalidate Barrande's law in his own special field. With a notice of one of these, which emanates from a successful collector of Primordial fossils, I shall close. He says, after referring to the different species of Paradoxides and allied genera in the Cambrian:—

"Other species show various gradations in the eyes and in the pygidium until we attain to *P. Davidis*, which has small eyes, a small

pygidium, and the greatest number of thoracic segments. Indeed there are forms to represent almost every stage, and there can I think be no doubt that in the fauna of the Tremadoc group, which is separated from the earlier Cambrian by several thousand feet of deposits indicating a period of very shallow water in which large brachiopods and phyllopod crustaceans were the prevailing forms of life, we witness a return to very much the same conditions as existed in the earlier Cambrian periods, and with these conditions a fauna retaining a marked likeness to the earlier one, and in which the earlier types are almost reproduced, though of course greatly changed during their previous migrations. The *Niobe(?)* recently found in the Tremadoc rocks is truly a degraded *Paradoxides*, retaining the glabella and head spines, but with the rings of the thorax, excepting eight, consolidated together to form an enormous tail. Instead therefore of having here, as stated by M. Barrande, "a very important discord between Darwinism and facts," we find in these early faunas facts strongly favouring such a theory, and in support of evolution.

This is an exquisite piece of evolutionist reasoning, worthy of some of the greater masters of this peculiar logic. It is assumed that specific differences are "gradations" and the word "almost" covers the gaps between these. It is taken for granted that Paradoxides, which disappears with the Menevian age, has only gone upon its travels to parts unknown, and after the deposition of several thousand feet of beds, returns disguised as the Niobe of the Tremadoc,—and not only changed but "degraded",—a sorry result certainly of the struggle for existence in the interval, and holding out small prospect that the creature can be promoted in any subsequent age into a fish or even into a Decapod. If Barrande's reasoning can be met only in this way, he need not fear for the result. Seriously, one scarcely knows whether to be amused or grieved at the phases which the doctrine of derivation assumes in the writings of some modern naturalists. It is at least devoutly to be hoped, in order that science may not fall under the contempt of all thinking men, that the advocates of this hypothesis may become more careful in their treatment of facts, and more modest in their demands on our faith.

In the meantime the record of the rocks is decidedly against them in the particular point to which I have above adverted, namely, the abrupt appearance of new forms under several specific types and without apparent predecessors. They should direct their attention in this connection to the appearance of Foraminifera in the Laurentian, of Sponges, Brachiopods, Trilobites,

Phyllopods, Crinoids, and Cephalopods in the older Palæozoic; of Land Snails, Millipedes, Insects, Fishes, Labyrinthodonts, Acrogens and Gymnosperms in the middle and later Palæozoic: of Belemnites, Dinosaurs, Ornithosaurs and other Reptiles, and of Marsupial Mammals and Dicotyledonons trees in the Mesozoic; of Placental Mammals and Man in the Tertiary and modern. When they shall have shewn the gradations by which these, out of the many cases which may be cited, have been introduced, and this without assuming an imperfection in the record incredible in itself and destructive of its value as a history of the earth, they may be in a position to rebuke us for our unbelief.

But it may be asked:—Have we no positive doctrine as to the introduction of species? In answer I would say that it is conceivable that the origin of species may be one of those ultimate facts beyond which science by its own legitimate methods cannot pass, and that all we can hope for is to know something of the modes of action of the creative force and of the modifications of which species when introduced are susceptible. In any case it is by searching for these latter truths that we may hope successfully to approach the great mystery of the the origin of life. It is with reference to these truths also that the discussion of modern theories of derivation has been chiefly valuable, and in so far as established they will remain as substantial results after these theories have been exploded. Among such truths I may mention the following: We have learned that in geological time species tend to arise in groups of like forms, perhaps in many parts of the world at once; so that genera and families culminate rapidly, then become stationary or slowly descend, and become restricted in number of species and in range. We have learned that in like manner each specific type has capacities for the production of varietal and race forms which are usually exercised to the utmost in the early stages of its existence, and then remain fixed or disappear and re-appear as circumstances may arise, and finally the races fall off one by one as it approaches extinction. Many of these races and varieties constitute conventional species as distinguished from natural species, and in so far as they are concerned, descent with modification occurs, though under very complex laws, and admitting of retrogression just as much as of advance. We have also learned that in the progress of the earth's history embryonic, generalised and composite types take precedence in

time of more specialized types, and thus that higher forms of low types, precede higher types and are often replaced by them. We are further, as the relation of varieties and species is investigated and their extension in time traced, becoming more and more convinced of the marvellous permanence of specific types, and of their powers of almost indefinite propagation in time. Lastly, vast stores of facts are being accumulated as to the migration of species from one area to another and as to the connection of the great secular elevations and subsidences of continents with their introduction and extinction. All these are substantial gains to science, and the time is at hand when they will lead to more stable theories of the earth than those now current. If I am not greatly mistaken, these considerations or some of them will be found to cover the case recently so much insisted on of the Tertiary predecessors of the modern Horse; a case which includes a great number of complicated and curious successions and relations, which we may hope to consider at a future time, when the American facts relating to them have been more fully elaborated.

I have however digressed from my special subject, and in returning to it, and in closing this address, would express my thankfulness that here in America we have a field for work on so broad a scale that there is little temptation to abandon the ever fresh and exciting exploration of new regions and the discovery of new facts, and the working out of legitimate conclusions, for that process of evolving worlds out of our own consciousness which seems to be the resource of those who have access only to the often ransacked treasuries of nature in smaller and older countries. Placed on a continent which in its geological development is the grandest and noblest of all, and which may be made a type for all the rest, let us push forward the conquests of legitimate science, and bear in mind that our present aim should be above all things the diminution of that imperfection of the geological record of which so much complaint is made.

The Report of the Chairman of Council was read by Mr. G. L. Marler, as follows:

REPORT OF THE CHAIRMAN OF COUNCIL.

At the close of another Session, your Council beg to submit the following Report:—

During the past year eighteen new ordinary members have been elected, a number though small, slightly in advance of last year's accessions. The new collector not having furnished the necessary data, it is impossible to state with accuracy what losses have been sustained by death, removal, or other causes. A circular, inviting the co-operation of ladies in the work of the Society, has been issued and distributed at meetings of the Ladies' Educational Association, and on other suitable occasions. Seven ladies have become associate members, and the Council suggest to their successors to try and interest more ladies in the objects which the Society was formed to promote.

The number of visitors to the museum, during the past Session, is about one thousand.

After continual remonstrances with the corporation of Montreal, and petitions to that body, the cab-stand in front of the premises, which was so great a nuisance to the Society and so detrimental to its interests, has been in part removed.

Through the kindness and liberality of friends, and especially in consequence of the active exertions of Mr. Selwyn (to whom the Society's thanks are specially due in this matter), your Council are happy to be enabled to report that Messrs. Dawson Bros.' account, amounting at the last annual meeting to $653.92, has been entirely liquidated. The following is a list of the donors, to whom the cordial thanks of the Council are hereby tendered:

Sir W. E. Logan, LL.D., F.R.S.	$50	John H. Molson	10
James Ferrier, Jun.	50	John Molson	10
J. H. Joseph	50	D. J. Greenshields	10
W. F. Kay	50	John Kerry	10
Peter Redpath	50	Messrs. Morland, Watson & Co.	10
C. J. Brydges	50	G. L. Marler	10
His Excellency the Governor-General	20	N. Mercer	10
Principal Dawson	20	John Lovell	10
Sir Hugh Allan	20	Kenneth Campbell	10
Donald A. Smith	25	Messrs. Savage, Lyman & Co.	10
H. Archibald	20	Joseph B. Moore	10
E. Murphy	20	R. B. Angus	10
R. J. Reekie	20	D. Lorn MacDougall	10
G. B. Burland	20	H. Benjamin	10
Messrs. Walker and Miles	20	Rev. Dr. De Sola	10
Sir Francis Hincks	10	B. Gibb	10
Hon. Judge Torrance	10	W. Notman	10
		D. R. McCord	10

D. W. & Co	10	Charles H. Waters	5
Messrs. Prowse, Bros	5	H. Lyman	5
Jas. Sutherland	5	Henry Morgan & Co	5
Thomas Irving	5	A Friend	5
F. W. Henshaw	5	A Friend	5
Rev. Gavin Lang	5	Dr. Reddy	3
James Bissett	5	W. Grant	2
W. D. McLaren	5	F. C. & Co	2
E. J. Major	5	H. J. Shaw	2
H. Shackell	5	M. Cassidy	2
S. Waddell	5	F. H. Harrison	2
Scott Barlow	5	A. Freeman	1
John Date	5	W. Marler	1
D. Sinclair	5		
			$800

A case to hold alcoholic preparations has been made, the cost of which ($45) has been defrayed by the liberality of the following gentlemen :

M. H. Brissette	$35
G. Barnston	5
J. Ferrier, jun	5—$45

On the occasion of the Dominion Cabinet meeting at Montreal in June last, the Hon. the Minister of Marine and the other Ministers of the Privy Council, were invited to visit the museum, which, however, they were unable to do.

A memorial has been sent to the present Minister of Marine and Fisheries, asking for increased facilities for dredging operations in the Gulf, but the answer received has been unfavorable, and your Council regret that for the time at least these investigations will have to be discontinued.

A petition to the Legislature of the Province of Quebec for a special donation of $1,000 to liquidate the debt due on the Society's buildings has proved unsuccessful, although the usual Government grant of $750 has been duly received.

The basement has been thoroughly cleaned, and attempts have been made to remedy the defective ventilation of the ground flat. Some dissatisfaction having been evinced by members of the Council at the amounts of bills for repairs, &c., Messrs. J. H. Joseph and E. E. Shelton were appointed a committee to supervise and examine into necessary expenses of this kind, and the thanks of the Society are due to them for the trouble they have taken in the matter.

In consequence of Mr. Ferrier's time being so much preoccupied, Mr. E. E. Shelton has kindly acted as Assistant-Treasurer.

The Ladies' Educational Association have, as on two previous Sessions, used the rooms for their lectures, but do not intend to continue doing so: they complain of insufficient heating and defective ventilation.

The Somerville Course of Lectures has been duly delivered to good audiences; the titles of the lectures, with the names of their authors, will be found in the proceedings of the Society.

No conversazione or field day have been held during the past Session, but your Council is of opinion that it is desirable to hold one or two field meetings before the first of July.

The following report was then read by Mr. J. F. Whiteaves:

REPORT OF THE SCIENTIFIC CURATOR AND RECORDING SECRETARY.

The work done during the past session is very similar in character to that of the two previous years. Shortly after the last annual meeting, as soon as the necessary preparations were made, nine weeks were spent in active dredging operations in the Gulf of St. Lawrence. As the Schooner was employed exclusively for this particular service during that time, the number of specimens collected was far greater than on any previous occasion.

These, together with undetermined specimens remaining over from collections made in former years, have been as carefully studied as the time at my disposal would permit.

The Foraminifera have not been examined much in detail, as it has been found that on the whole they do not yield a return in the shape of new discoveries, at all commensurate with the time spent upon them. Only one form new to the St. Lawrence has been noticed so far.

Much more attention has been devoted to the Sponges. Of the 40 or 50 Canadian species represented in Montreal cabinets, the generic and specific names of about 15 have been ascertained with tolerable certainty. Although this number may seem small, it may be mentioned that many of those that are undetermined are probably new to Science, and in Principal Dawson's Handbook of Geology, published in 1869, only three are enumer-

ated, of which one is fossil, and of another the specific name is not given.

The Hydrozoa have been submitted to further microscopical examination. Eleven species have been added to our fauna, of which two are new to America. Some of the deep sea species are different from any of those described by English writers.

No special novelties occurred among the Alcyonaria and Zoantharia collected last summer, but the whole series has been carefully studied and all the species made out and labelled. The Echinodermata have given better results, eight species new to the St. Lawrence, of which three are new to America, have been collected and determined. Three of these are brittle stars and three sea cucumbers.

A further portion of the Marine Polyzoa has been carefully studied. The latest catalogue of these beautiful corallines, published as a report to the department of Marine and Fisheries last year, gave 39 species. Fifteen additional forms have been recognized, all of which are new to the Gulf of St. Lawrence. Most of them are very rare and striking kinds, and several of them are new to the American side of the Atlantic. Not one half of the material collected, however, has been examined, even in a somewhat cursory way.

The whole of the Tunicates of the St. Lawrence in the Society's collection, with the exception of a purple Botryllus, whose specific relations are still obscure, have been determined and labelled. There are some 17 species, and the Society is indebted to Prof. Verrill, who has made the study of these molluscoids a specialty, for the identification of several critical species, originally described by him.

The Shells proper, collected last summer, have all been examined and determined. In 1869 the catalogue of shells from the Northern part of the Gulf, which was complete up to date, gave 115 species. Including the discoveries of Mr. Willis on the Nova Scotian coast and additional species dredged by Principal Dawson, as well as novelties obtained in the government expeditions of 1871, 1872, and 1873, 214 species are now known from that region.

Of	these	91	are	bivalves
"	"	107	"	gasteropods.
"	"	3	"	pteropods.
"	"	3	"	cephalopods.

Through the kindness of Dr. W. C. McIntosh, of Perth, an eminent authority on this group, the marine worms of the St. Lawrence are in a fair way of being worked up. The whole of the specimens dredged during the last three summers, filling about 200 bottles, have been forwarded to him.

In the April No. of the Annals of Natural History, Dr. McIntosh has published the result of his studies on those Canadian specimens which belong to the first six families in the classification proposed by Malmgren. The general results are that 19 species have been determined, of which six are new to science. These latter have been described and figured in the Journal previously mentioned.

With the assistance of Mr. S. I. Smith, of Yale College, who has identified most of the Amphipods and the more critical among the Decapods, most of the crustaceans recently collected have been determined. 56 species have been added to our local lists, several of which are Norwegian forms, not hitherto met with on the American coast. One of these is a curious new generic type collected in the deep sea mud, and described in a recent number of the American Journal of Science and Arts. The few fishes collected at great depths, some of them of great interest, and including about 10 species, have been studied and labelled.

Extentive exchanges have been made with Professors Verrill and S. I. Smith, and in this way about 120 species collected in dredgings under the auspices of the U. S. Fish Commission, have been obtained. All of these are carefully named. The whole series has been put into a fresh set of bottles, and re-labelled.

The new case for alcoholic preparations mentioned by the Chairman of Council now contains 250 species of N. American marine invertebrates, each in a separate bottle labelled with the proper locality and name of the object it contains. In addition to this, there are about 150 bottles (or jars) full of various marine animals dredged in the Gulf, which have yet to be studied. Before leaving this topic, it may be as well to mention that an article giving a condensed account of the zoological results of last summers investigations has been published in Silliman's Journal for March last, and that a more detailed account of the observations made, has been submitted as a report to the Minister of Marine and Fisheries for the Dominion Government. This is now in type and will shortly be issued. The subject has

been also brought before the Society at one of its monthly meetings.

Some progress has been made in the re-arrangement of the Society's very interesting and valuable collection of fishes amphibia and reptiles, but the work in this direction has been stopped, on account of the want of proper bottles, and of alcohol. Many rare exotic snakes, lizards, fishes &c., presented to the Society some years ago by Dr. Gunther, have never been accessible to students, because we had no proper means of exhibiting them It is eminently desirable to have a much better series of the smaller fishes, newts, frogs &c. of Canada, for reference, than we can now boast. If a small expense were incurred to obtain alcohol, and suitable bottles, the specimens could soon be obtained. As it is, our small collection has been greatly augmented by a donation of a series of the snakes of Western Canada, presented by Mr. Passmore.

In the department of Canadian birds, the additions have been about equal to the average of former years. Some rare United States species have been presented by Mr. LeChevallier. Among these are the painted quail of Texas, and the Brown and Frigate Pelicans of Florida.

Major Bulger has most liberally presented us with a collection of 60 specimens, of the Birds of the Neilgherry Hills and from the Deccan. These have been duly labelled, and the attention of the Society has been called to them in a paper read at one of our monthly meetings.

By exchange with Mr. LeChevallier the Society has acquired the eggs of about 80 species of N. American birds, some of them of considerable rarity. They are all fine specimens, mostly blown in the most approved fashion, and have all been marked with names and localities.

The most important additions to the mammalia are an unusually fine specimen of the Canadian or American wolf, obtained through the kind instrumentality of Mr. Vennor and other gentlemen, mostly connected with the Geolgical Survey; a good specimen of the Badger, presented by Prof. Bell, and a Skunk, given by Mr. S. J. Lyman.

A small series of U. S. Rodents has recently been received from the Smithsonian Institute at Washington, but they are mostly in a bad state of preservation, and none of them have been mounted as yet.

The Society's permission having been duly obtained, at Mr. Selwyn's request some time has been spent in the examination of the Cretaceous fossils collected by Mr. Richardson at Vancouver and the adjacent islands, in 1873. The series, though small, is exceedingly interesting. Occupying a position apparently at or near the base of the Upper Cretaceous, perhaps synchronic with the Upper Greensand or Gault, these fossils, with one or two exceptions, belong to genera not yet recognized from corresponding formations in Europe. A supplementary report on these is in progress.

The correspondence involved in endeavoring to work out the material collected in the Gulf, has been considerable and the microscopic work heavy. The proceedings of the Society have been duly published in the Local Press, and it is hoped that the other Secretarial duties have been efficiently performed.

The Treasurer being unable to attend the meeting, the following statement of the financial position of the Society for the past session was submitted on his behalf, by the Chairman of Council:—

REPORT OF THE TREASURER.

Dr. THE NATURAL HISTORY SOCIETY OF MONTREAL IN ACCOUNT WITH JAMES FERRIER, JUN., TREASURER. **Cr.**

1872—'73.		1873, May 1.	
To Cash paid interest	$ 70.00	By Balance in Treasurer's hands	$ 0.60
" " Mr. Whiteaves	400.00	" Government Grant	750.00
" " Mr. Passmore	200.00	" General Contributions	738.00
" " Messrs. Pell and Foote	34.20	" Subscriptions to "Naturalist"	99 00
" " For Coal and Wood	250.00	" Members' Yearly Subscriptions	632.00
" " Gas	55.30	" Museum Entrance Fees	76.15
" " Water	38.50	" Rent of Rooms	221.00
" " City Taxes	56.00	" Freight Collected on Books	2.50
" " Insurance	44.00		
" " Repairs and Petty Expenses	201.40		
" " Books, Printing and Advertising	913.91		
Balance in Treasurer's hands	255.94		
	$2519.25		$2519.25

Errors and Omissions excepted.

Montreal, May 18th, 1874.

[Signed] JAMES FERRIER, JR.

It was moved by Dr. J. Baker Edwards, seconded by W. Muir and resolved:

"That the foregoing reports be adopted, printed, and distributed to the members."

On motion of Rev. Dr. De Sola the thanks of the meeting were unanimously voted to Principal Dawson for the preparation of the annual address.

Rev. Dr. De Sola moved, seconded by E. E. Shelton, that the bye-law relating to the balloting for officers be suspended and that A. R. C. Selwyn, F.R.S. be elected President. The motion was carried by acclamation.

Dr. J. B. Edwards moved, seconded by Rev. A. De Sola, that the Cor. Secretary and the Scientific Curator and Rec. Secretary be re-elected without the form of balloting. The motion was duly adopted.

Dr. B. J. Harrington and Prof. P. J. Darey having been nominated scrutineers, the following officers were elected by ballot in the usual way.

Vice-Presidents—Sir W. E. Logan, L.L.D., F.R.S.; Rev A. De Sola L.L.D.; G. Barnston; E. Billings F.G.S.; Principal Dawson L.L.D., F.R.S.; His Lordship the Metropolitan; C. Robb.

Treasurer—E. E. Shelton.

Council—Dr. B. J. Harrington, D. A. P. Watt, G. L. Marler, Prof. R. Bell, J. H. Joseph, Dr. J. B. Edwards, Rev. Canon Baldwin, D. R. McCord and Jas. Ferrier Jr.

It was moved by J. H. Joseph, seconded by Dr. J. B. Edwards and resolved:

"That the Library and Membership Committee do consist of the following gentlemen: N. Mercer, W. Muir, Dr. John Bell, G. R. Grant and J. B. Goode."

Mr. J. H. Joseph moved, seconded by C. Robb:

"That the special thanks of the Society be voted to Mr. J. Ferrier, jun. for his long continued and valuable services as Treasurer." The motion was adopted unanimously.

On motion of Mr. E. E. Shelton, seconded by W. Muir, it was resolved:

"That in future the number of Vice-Presidents be limited to seven."

ON SOME NEW GENERA AND SPECIES OF PALÆOZOIC MOLLUSCA.

By E. Billings.

Genus Ilionia (n. gen.)

The above generic name is proposed for such forms as *Tellina prisca* (Hisinger), *Anatina sinuata* (Hall), and the species herein described. All the specimens I have seen are internal casts, and the characters of the hinge-line, therefore, cannot be given. The form is irregularly ovate, compressed or sub-lenticular; one extremity larger than the other; beaks turned towards the larger end, which is therefore supposed to be anterior. In all the species a concave depression commences on the umbones and extends downwards to the posterior ventral margin. A large sub-ovate muscular impression in the upper half of the posterior extremity.

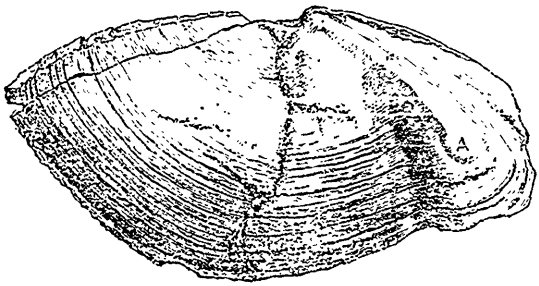

Fig. 1.—Left side of a cast of the interior of *I. Canadensis*.

Fig. 2.—Dorsal view of the same.

1.—*I. Canadensis* (n. sp.) Transversely irregularly ovate; compressed, sub-lenticular; length about twice the greatest height; umbones situated a little behind the mid-length; ventral margin with a concave notch at about the poster or fourth of the whole length. In front of this notch the margin is uni-

formly convex, gradually sloping upwards nearly (if not quite) to the hinge-line. The dorsal margin is not perfect in the specimen figured, but judging from the direction of the striæ on the surface of the cast, it is nearly straight, or at the most, only gently convex in front of the beaks, and nearly parallel with the length of the shell, sloping slightly downwards. Behind the beaks it is gently convex, nearly straight, and slopes downwards to the narrowly rounded posterior angle, the latter situated at about one-third the height of the shell. The margin behind the beaks is compressed. Close under the beaks, in front, there appears to have been a short escutcheon. From the umbones backwards for about six lines, a linear groove runs along close to the dorsal edge on each side. This may be related to the ligament.

The most projecting point of the anterior extremity appears to be situated considerably above the mid-height of the shell, near the hinge line. The posterior angle is below the mid-height.

Surface concentrically striated.

Length 3 inches; greatest height, a little in front of the mid-length 18 lines; greatest depth of both valves, just below the umbones 8 lines.

The specimen was collected by Sir W. E. Logan in the Upper Silurian rocks at Port Daniel on the Bay of Chaleurs.

Genus Pteronitella, (n. gen.)

Among the fossils collected at Arisaig, Nova Scotia, in the Upper Silurian, there are many casts of the interior, of several species congeneric with *Avicula retroflexa* (Hisinger). These show that in front of the beaks, there are several small cardinal teeth, and that close beneath the hinge line there are several more or less elongated posterior teeth. This arrangement is quite different from that of both *Avicula* and *Pterinea*, to which these shells are usually referred. There is a strong anterior muscular impression and the whole structure of the hinge resembles closely that of *Cyrtodonta*.

Prof. McCoy has noticed the teeth, in his description of *P. retroflexa* (Pal. Foss., p. 262) but does not seem to think their structure of generic importance. The above generic name is proposed, to include *P. retroflexa* and some others, soon to be described.

GEOLOGICAL SOCIETY OF LONDON.

March 25th, 1874.—John Evans, Esq., F.R.S., President, in the chair. The following communication was read:

1. "On the Upper Coal-Formation of Eastern Nova Scotia and Prince Edward Island, in its relation to the Permian." By Principal Dawson, LL.D., F.R.S., F.G.S.

The author described the Carboniferous district of Pictou county as showing the whole thickness of the Carboniferous system arranged in three synclinals, the easternmost consisting of the Lower series up to the Middle Coal formation, and including all the known workable Coal-measures in the district, the second towards the west of the middle and the lower part of the Upper Coal-formation, and the third showing in its centre the newest beds of the latter. On the north the bounding anticlinal of the first depression brings up the New-Glasgow Conglomerate, which contains boulders 3 feet in diameter, often belonging to Lower Carboniferous rocks, and represents the upper part of the Millstone-grit or the lower part of the Middle Coal-formation. The author regards this as representing an immense bar or beach, which protected the swamps in which the Pictou main coal was formed.

The succession of the deposits above the Conglomerate was described in some detail as seen in natural sections. The Upper Coal-formation, as shown in the section west of Caribou Harbour, consists of, 1. Red and grey shales, and grey, red and brown sandstones; and 2. Shales, generally of a deep red colour, alternating with grey, red and brown sandstones, the red beds becoming more prevalent in the upper part of the section. In Prince Edward Island beds apparently corresponding to these are found, and also gradually become more red in ascending. These are overlain, apparently conformably, by the Trias.

The author gave a tabular list of 47 species of plants found in the Upper Coal-formation of Nova Scotia and Prince Edward Island, and stated that all but about ten of these occur also in the Middle Coal-formation. The number of species decreases rapidly towards the upper part of the formation; and this is especially the case in Prince Edward Island, some of the beds in which are considered by the author to be newer than any of

those in Nova Scotia. The plants contained in the upper deposits were compared with those of the European Permian, and a correlation was shown to exist between them, so that it becomes a question whether this series was not synchronous with the lower part of the Permian of Europe, although in this district there is no stratigraphical break to establish a boundary between Carboniferous and Permian. The author therefore proposes to name these beds Permo-Carboniferous, and regards them as to some extent bridging over the gap which in Eastern America separates the Carboniferous from the Trias.

DANA'S MANUAL OF GEOLOGY.—The second edition of Prof. J. D. Dana's excellent Manual of Geology has just been published. The first edition made its appearance in 1862. During the twelve years that have elapsed, numerous and important discoveries in Geology and Palæontology have been made, especially on this Continent. The results of these are embodied in this new edition, which thus gives a full exposition of the science as it stands at the present day.

The Manual is an octavo volume of 828 pages, illustrated by 1122 excellent wood engravings of fossils, sections and geological phenomena, besides a physiographic chart of the world. It is divided into four parts, 1. Physiographic Geology; 2. Lithological Geology; 3. Historical Geology, and 4. Dynamical Geology. Each of these four subjects is thoroughly explained and illustrated. Of these the third part, the most important, occupies 456 pages, and is copiously illustrated by groups of the characteristic fossils of all the formations. Among these will be found a large number of the principal organic remains of our Canadian rocks. Such a book as this will be found exceedingly useful to those who do not intend to follow Geology as a profession, but still are desirous to acquire by private study such a general idea of the principles of the science as every well-informed man should be possessed of. It contains in a condensed form the substance of a whole geological library.

Its value to the college student is too widely known to need a notice here. One of the most interesting illustrations is the frontispiece, representing the fossil man of the early stone age, just as he lay during his long sleep for thousands of years in the Cave of Mentone. B

Published July 11th, 1874.