MEMOIRS

READ BEFORE THE

BOSTON SOCIETY OF NATURAL HISTORY;

BEING A NEW SERIES

OF THE

BOSTON JOURNAL OF NATURAL HISTORY.

VOLUME I.

BOSTON:
PUBLISHED BY THE SOCIETY.
NEW YORK: WILLIAM WOOD & CO., 61 Walker St.; B. WESTERMANN & CO., 440 Broadway;
L. W. SCHMIDT, 24 Barclay St.
LONDON: TRÜBNER & CO., 60 Paternoster Row, E. C
1866—1869.

VIII. *Observations on the Glacial Phenomena of Labrador and Maine, with a View of the recent invertebrate Fauna of Labrador.* *By* A. S. PACKARD, JR., M. D.

Read October 4, 1865.

1. OBSERVATIONS ON THE GLACIAL PHENOMENA OF LABRADOR AND MAINE.

IN its general features the Peninsula of Labrador is an oblong mass of Laurentian rocks lying between the 50th and 60th parallels of latitude. It rises abruptly from the ocean as an elevated plateau, forming the termination of the Laurentian chain, which here spreads out into a vast waste of hills and low mountains. Thus, there is no well-marked, single chain of mountains rising above spurs of smaller elevations, but simply a height of land with isolated peaks, irregular in its course, from which streams take their rise and flow by various directions into the ocean.

This plateau of hills and low mountains rises abruptly on the coast from the ocean to a height of 500 to 800 feet, and inland continues to rise in peaks to a height of from 1500 to about 2500 feet until it reaches the water-shed at a distance of 100 to 200 miles from the coast. On the western slope this plateau falls gradually away by an easy descent towards the shores of Hudson's Bay.

On the south, the coast has a northeasterly trend, following the coast line of the southern Atlantic border of the continent. From Belle Isle, situated at the mouth of the Straits of Belle Isle, the eastern coast trends in a northwesterly direction to Cape Chudleigh, thus following the northwesterly trend of the northern Atlantic coast line of the continent from Cape Race in Newfoundland to the head of Baffin's Bay, near latitude 80°. It thus lies parallel to the western coast of Greenland. The northeasterly trend of the southern coast of Labrador is determined by the same course of the Laurentian range of syenites and gneiss rocks, which forms the northern shore of the St. Lawrence Gulf and River. Its northwesterly course beyond the Straits of Belle Isle is likewise determined by a range of syenites and trap rocks, upheaved in a general N. W. and S. E. direction. Thus the interior plateau of Laurentian gneiss seems surrounded by a framework of igneous rocks, which has apparently preserved to this day the original form and proportions of the Atlantic slope of the azoic nucleus of our continent.

Parallel to the Straits of Belle Isle and situated about 100 miles from the coast, is an important water-shed which terminates in a spur of high peaks, called the Mealy Mountains, which on the southern shore of Hamilton Inlet (Invuctoke Bay) rises 1500 feet, it is said, above the level of the sea. Numerous rivers descend the steep southern slope into the St. Lawrence. Of these the River Moisie and Esquimaux River are the largest. They arise from a chain of lakes on the summit of the water-shed, from 100 to 200 miles in the interior, which also give rise to a still larger river which flows into Hamilton Inlet and bears the same name. I have been informed by residents that the Indians can travel in their canoes from the mouth of the Esquimaux River across the country to the Hudson Bay Posts in Hamilton Inlet. Professor Hind,[1] and Mr. Cayley[2] likewise state that the head waters of the River Moisie lie contiguous to those of the two above named rivers — if the source of all the three rivers be not the same. The Moisie River forms part of the

[1] *Explorations in the Interior of the Labrador Peninsula,* 2 vols., 8vo., London, 1863.

[2] *Up the River Moisie.* By Edward Cayley. Trans. Lit. and Hist. Soc., Quebec, N. S., vol. i., p. 73.

St. Lawrence river system. It is 125 miles long, and flows south, emptying into that river near the Bay of Seven Islands, at a point west of Anticosti and opposite the northern shore of the Gaspé Peninsula. From this point the streams running into the Gulf assume, the farther we go east, a N. W. and S. E. direction. Such is that of the Meschikimau or Esquimaux River, which empties into the western mouth of the Straits of Belle Isle, at the lower Caribou Island.

This stream is about 250 miles long, as I learned from residents, and is only navigable for about twelve miles from its mouth by ordinary fishing-boats. There is no large river between this and Hamilton River which flows into the Atlantic in a direction a little north of east. This river seems to flow in a fissure that runs at right angles to the line of upheaval of the syenite and traps of the Atlantic coast; as upon the Gulf coast the rivers flow from the northwest along natural fissures in the earth's crust that run at right angles to the axis of elevation of the Laurentian chain on the north side of the St. Lawrence. In this connection it should be noticed that the fiords on the Atlantic coast of Labrador assume the same direction, and though they agree much in this respect with the direction of those farther south, there is yet a greater west and east course as we go northward towards Cape Chudleigh, until beyond lat. 58° the fiords run in a N. W. and S. E. direction, especially on the Hudson Bay slope. According to Davies [1] the Grand or Hamilton River is supposed to rise from a chain of lakes in the "rear of the Seven Islands, and flows for a considerable distance on the top of the ridge, if I may so express it, between the head waters of the rivers falling into the St. Lawrence and those falling into the Hudson's Bay and Straits, for they are said by the Indians to be quite close to the waters of the Grand River on either side." Our author also states, that "two hundred miles from its mouth it forces itself through a range of mountains that seem to border the table land of the interior, in a succession of tremendous falls and rapids for nearly twenty miles. Above these falls, the river flows with a very smooth and even current."

Two other important rivers empty into Invuctoke Bay: the Kenamou, which flows in from the south, and the Nascapee or Northwest River, which is a larger stream with a very circuitous southeasterly course.

The Atlantic system of streams to the north are small rivers flowing into the ocean in an easterly course.

Ungava Bay receives two important rivers which imperfectly drain the northwestern slope of western Labrador. The smaller of the two is the Kangutlualuksoak or George River, which empties into the bay in lat. 58° 57′, and is 140 miles long. Its water-shed is said by Kohlmeister and Knoch [2] to be a chain of high mountains which terminates in the lofty peaks of syenite at Aulezavic Island and Cape Chudleigh, which are the highest mountains in Labrador, and rise probably over 3000 feet in height, as the smallest of them, Mount Bache, was measured in 1860 by the Eclipse Expedition of the U. S. Coast Survey, and found to be 2150 feet high. This mountain is a gneiss elevation, and a sketch on the geological chart by Mr. Lieber, the geologist of the expedition, shows it to be rounded by glacial action, while lofty, "wild, volcanic-looking mountains" form a water-shed in the interior, whose craggy peaks have evidently never been ground down by land-ice into

[1] *Trans. Lit. and Phil. Soc.*, Quebec, vol. iv. p. 70, 1843.

[2] *Journal of a Voyage from Okkak, on the Coast of Labrador, to Ungava Bay, westward of Cape Chudleigh, undertaken to explore the Coast, and visit the Esquimaux in that unknown region.* By Benj. Kohlmeister and George Knoch, Missionaries of the Church of the Unitas Fratrum. London, 1814.

domes and rounded tops. The two Moravian missionaries, mentioned above, state in addition, that "this chain of mountains may be seen from the Kangutlualuksoak River, in Ungava Bay, which is a collateral proof that the neck of land terminated to the north by Cape Chudleigh is of no great width. Both the Nain and Okkak Esquimaux frequently penetrate far enough inland to find the rivers taking a westerly course, consequently towards the Ungava country. They even now and then have reached the woods skirting the estuaries of George and South rivers." These missionaries describe the Koksoak or South River as flowing smoothly through a low, rocky (probably Silurian) district, and emptying into Ungava Bay in lat. 58° 36′. It is said to resemble at its mouth the Thames, and affords anchorage for vessels twenty-four miles from its mouth. This stream probably arises near the source of the Grand or Hamilton River, and flows in a N. N. W. direction, probably along a natural fissure formed by the juncture of the Silurian rocks and Laurentian system.

At the western political boundary line between Labrador and Prince Rupert's Land, according to recent maps, we find apparently another water-shed, which on the eastern slope sends a few streams into the Koksoak River, while on its western slope descend several streams which flow in a westerly course into Hudson's and James Bay.

Thus it will be seen that these four river systems take their rise from a great water-shed which curves in a southwesterly direction from Labrador along the northern shores of the St. Lawrence River and the Great Lakes.

Labrador is essentially a *lake* district. Its numerous rivers afford a very imperfect system of drainage to a country densely covered with lakes, ponds and pools, and morasses innumerable. It resembles in this respect the probable aspect of the Lake or Terrace period in New England and Canada after the Glacial period, when the present broad rivers were only chains of lakes, and may thus be said to be in an embryonic stage, as its river-beds have never been remodelled and scooped out into gentle declivities and broad valleys, nor immense depths of sand and clay deposited to smooth over the inequalities of the rocky surface of the country, such as in the temperate zone render a continent inhabitable throughout its breadth; while in Labrador man can only inhabit the coast, and gain a livelihood from the sea.

We must distinguish two classes in the lakes of Labrador, viz.: the deep mountain *tarns*, lying in the interior, directly upon the summits of the water-sheds; and the far more numerous broad, shallow lakes and pools spread profusely over the surface below the height of land. These last occupy shallow depressions and hollows, most probably excavated by glaciers, in valleys which have been simply remodelled by glacial action. The deep tarns, on the contrary, evidently fill original depressions, sinking between lofty ranges of hills. Davies says that in the region about the source of the Hamilton River the lakes are very deep, and lie directly on the height of land, while the ponds on the lowlands are shallow; and on the other hand, those which directly communicate with the ocean or with the fiords are in general distinguished for their depth. "This almost universal shallowness of the lakes is a singular feature, when the nature of their borders is taken into consideration, as they are generally surrounded by hills, which would lead one to look for a corresponding depth in the lake; but, instead of this, some are so shallow, that for miles there is hardly water enough to float a half-loaded canoe. I am informed by my friend John McLean, Esq., that this is likewise the case with the lakes lying on the water-shed of Ungava Bay. The lakes, lying *on* the table-land are said to be deep."[1] He also states that

[1] *Loc. cit.* p. 76.

the large lakes in the interior are well stocked with fish, while the shallow lakes, and, in fact, the deep ones communicating with the ocean, are in general very destitute of them.

We must believe that the same causes that produced the deep fiords likewise account for these deep fissures and depressions in the summit of the water-sheds. It is evident that any amount of glacial action, however long sustained and vast in its operation, can never account for these rude, irregular, often "geoclinal" troughs which follow lines of fracture and faults, lying along the axis of elevation of mountain chains, or at nearly right angles to them.

The fiords on the Labrador coast are of great extent and depth. They are either original lines of fracture and faults, or what Professor Dana terms *geoclinal* troughs, occurring at the line of juncture of two rock formations. Thus Chateau Bay is a fissure at least 1200 feet in depth. The western shore rises 600 feet above the sea level, and the waters of the bay at their deepest are 600 feet in depth. This fault must have been produced at the time of the upheaval of the syenites of the coast.

All the broad, deep bays and fiords on the Atlantic Ocean occur at the juncture of the syenites and gneiss rocks, or juncture of quartzites and their trap overflows. There are deep bays between Cape St. Lewis and Cape St. Michael's, where syenites rise through the gneiss, producing faults and lines of dislocation. The large bay just north of Cape St. Michael's occurs at the junction of gneiss and "hyperite" rocks. Sandwich Bay and Hamilton Inlet were formed by the denudation of the Domino Quartzites. Despari Harbor is a deep fiord occurring at the juncture of the "Aulezavic Gneiss" of Lieber, with syenitic rocks forming the coast line between this point and Hopedale. The irregular overflows of trap and syenitic rocks which enclose the gneiss rocks, produce an immense number of cross fiords and channels, from the presence of innumerable islands which line the coast, and are composed of these eruptive rocks.

These original fissures and depressions have been modified by glaciers, by frosts and shore-ice and icebergs, and the waves of the sea.

The shallow lakes, formed most probably by glaciers, lie in shallow troughs, upon a thin bed of gravel and boulders. We only learn in some regions, especially in Southern Labrador, that the country has been covered with boulders, by their presence on the banks and in the centre of these pools. Clear examples of lakes partially surrounded by walls of rock, with the banks at one end completed by a barrier of sand and gravel, are frequent. Such barriers of drift have lost entirely their resemblance to glacial moraines, to which they undoubtedly owe their origin, since the drift deposits have been remodelled into sea beaches composed of very coarse gravel and boulders, while the finer materials have been swept away by the powerful "Labrador Current" with its burden of icebergs and floe-ice that has so effectually removed traces of the former presence of what we must believe to have been extensive glaciers.

Azoic Rocks of the Labrador Coast.

Laurentian Gneiss and Syenite. Between Little Mecatina Island and Henley Harbor, there is a great uniformity in the rocks, which are either wholly gneiss, or more commonly a syenitic gneiss, forming bold headlands. At Bradore are two lofty hills of gneiss, estimated by Bayfield to be 1200 feet high. Between Belles Amours and Anse au Sablon, on the northern side of the Straits of Belle Isle, occur the lower Silurian or Taconic rocks which have been already fully described in the "Geology of Canada," published by the Canadian

Geological Survey. In coasting within a mile or two of this interesting region we see the red sandstones running out as a low point of land resting on the lofty, precipitous Laurentian rocks. Between Bradore Bay and Anse au Loup these sandstones and grits rise up to a height of 500 to 600 feet, forming the coast line; and looking up through the bays and harbors we can see the low conical hills of Laurentian gneiss in the interior. At the eastern termination of this formation, the Laurentian rocks rise into high, rugged and broken syenitic hummocks, in marked contrast with the regular terraces and smooth slopes of the fossiliferous sandstones and limestones. Approaching Henley Harbor, there is a visible change in the scenic features of the coast; the hills grow more regular in outline, and slope gradually to the water, giving us the peculiar physiognomy of the Laurentian gneiss.

Upon entering Henley Harbor the dark gneiss is seen resting upon syenite, and at the point of contact interpenetrated by irregular intrusive masses of the latter rock. On Henley Island, where these rocks crop out under the trap capping this island, there appears a true syenitic gneiss, very hard, distinctly stratified, and of the usual flesh color of the syenite.

At this point I broke off some pieces of nearly unstratified syenite which showed very distinctly the sedimentary origin of the rock, for the crystals were often partly rounded and contained rolled quartz pebbles, one being ovate and nearly two inches long. This syenitic gneiss was evidently an altered conglomerate.

The syenite is the same as occurs on the coast of the St. Lawrence River, and while of the same color as that of the Maine and Nahant syenite, differs in its greater hardness and in the absence of black hornblende. It is composed of a flesh-red labradorite or soda feldspar and a smoky and glassy quartz with minute particles of hypersthene disseminated sparsely through the mass. It is exceedingly tough and durable, as evidenced by the lofty capes and islands standing far up above the gneiss rocks spreading around the base of the overflows.

At the northern end of the island the syenitic gneiss dips under the trap in a southeasterly direction at an angle of 50°. On an island a few rods farther to the north, the gneiss assumes its usual character, being banded with light and dark strata, and has the general N. N. E. strike and dip indicated above.

At Square Island, which lies at the mouth of a deep bay just north of Cape St. Michael's, occurs in large, conical hills the great *anorthosite formation* of Logan and Hunt, composed of large, crystalline masses of labradorite, with a little vitreous quartz, and coarse, crystalline masses of hypersthene. The labradorite is of a smoky color, very lustrous, translucent and opalescent, with cleavage surfaces often two inches in diameter, and on some of the faces presents a greenish reflection. This is but a slight approach to the rich blue reflections of the precious labradorite which I have seen only at Hopedale, where we obtained specimens brought from the interior by the Esquimaux. It compared favorably with specimens from the Ural Mountains.

As the rock weathers, the hypersthene crystals project in masses sometimes two inches in diameter. This rock easily weathers, and large masses are detached by frosts and readily crumble to pieces. The gneiss rests on the south side of the hill. From the top of the hills here can be seen huge gneiss mountains at least 2000 feet high, rising in vast swells at a distance of fifteen to twenty miles in the interior, while the bay is filled with innumerable *skiers* and islets of gneiss.

At Cape Webuc or Harrison, the gneiss again appears upon the coast as a lofty headland

faced with steep precipices of syenite. From off this cape are seen in the interior lofty mountains, of which the central and highest peak is called Mount Misery, which in this clear climate can be plainly seen in pleasant weather by fishermen at a distance of seventy-five miles in an air line. At Strawberry Harbor on the south side of Thomas Bay are lofty syenite hills. This point is fifty-five miles north of Cape Webuc. It is a small deep hole in the coast, like a "purgatory," and an amphitheatre of rock rises around it in huge steps, affording a striking illustration of the power of the frost and waves on this exposed coast. The rock is a hard tough flesh-colored syenite, with deep vertical and horizontal fissures resulting from the decomposition of thin trap dykes, thus causing huge blocks of syenite to be detached and fall down. In sailing twenty-five miles up this bay, the gneiss rises on each side from the ocean into hills 800 to 1000 feet in height. About Hopedale, which is in latitude 55° 30′, the rocks are gneiss. Behind the Mission House the strata are much disturbed locally; at one locality the gneiss with veins of quartz and syenite trends northwesterly and dips 60° west. Trap dykes, prismatic in places, cross the island in a northeasterly direction.

Northward of Hopedale the "Aulezavic gneiss" of Lieber, forms the coast range of mountains, which, according to Lieut. Curtis (Trans. Geol. Soc. London, Vol. ii. 1773), rise to a height of 2733 feet at Mount Thoresby, on an island south of Kiglapyd. This observer states that Kiglapyd is evidently higher, but inferior to Kaumagok, which "has been seen thirty leagues from land," and is lower than Nachvoak which must be 3000 feet high.

At Aulezavik Island near Cape Chudleigh, according to Mr. Lieber,[1] "syenitic gneiss is the true rock of the region, the normal one, although so many modifications occur that entirely new rocks are produced; having no direct connection with the basic syenitic gneiss. In consequence of this we have beds in which quartz alone occurs, or beds entirely occupied by the red feldspar of the region, as is seen with very beautiful distinctness in some of the dangerous Pikkintit Islands. Again, some beds are composed of white quartz and tourmaline as in Norway, others contain scarcely anything but black hornblende, or tourmaline and garnets. Some are composed of green hornblende, approximating to actinolith. From this there seems to be a passage into a coarse diorite rather porphyroid in its character, but occurring in regular intercalated beds, not in dykes, and evincing no sign of an eruptive origin. Again, some beds are composed of quartz and garnet, while others are studded with a beautiful golden-colored mica. A rock which appears identical with aphanite, although not at all igneous, I also found, yet, with all this apparent variety, the transitions are too gradual to permit the differences to leave any effect on the landscape."

For some notes on the geology of Hamilton Inlet we are indebted to Mr. Davies — "In some places mica slate was found — it is said that the Mealy mountains are composed of this rock. I had no opportunity of verifying this fact, as I did not visit them. Granite was only seen in one place, viz., on Lake Keith, an expansion of the Grand River, about one hundred and thirty miles from its mouth. Specimens of Chlorite schist were also procured on this lake, as was also a specimen of sandstone, with disseminated grains of iron pyrites. At some distance below the lake, Primary Marble, of a beautiful whiteness, was seen cropping out at the edge of the water; it was found in contact with a quartz rock passing into mica slate, having crystals of common garnet imbedded in it; this was the only place where limestone of any sort was seen.

[1] *Loc. cit.*, p. 405.

The shores of the bay where they are not of rock are generally composed of rolled fragments of syenite, mica-slate, quartz, hornblende, sometimes in large masses, feldspar, &c. Magnetic iron in the form of sand was also met with in some of the small coves.[1]

Laurentian Trap Rocks. At Henley Harbor is a system of trap rocks which have been upheaved in a N. N. E. and S. S. W. direction, in a course much more northerly than the direction which the Straits of Belle Isle assume. These rocks consist of three masses of columnar basalt, capping the syenitic gneiss. It is a hard fine compact diorite, breaking with a conchoidal fracture and metallic ring, and contains much iron. The mass is 255 feet high on Henley and Castle Islands, and consists of two layers of vertical columns. West of these basaltic rocks, on the opposite side of the harbor, is a large trap overflow forming a hill over 300 feet high, and apparently of the same age. It should be remarked that the two layers of basalt representing successive overflows, incline at a very slight angle towards the S. W. The third mass of basalt is seen rising out of the ocean a few miles northerly, nearly in a line with the basalt of Henley Harbor.

Dykes of this age are likewise seen at Strawberry Harbor, Cape Webuc, and at Hopedale, intersecting the Laurentian gneiss and syenite. Its age is plainly anterior to the deposition of the undisturbed Taconic, "primordial" strata at Anse au Loup, and on the Newfoundland coast opposite.

Huronian Group. A system of quartzite and trap rocks which lie in a depression of the Laurentian rocks, about one hundred and twenty-five miles long, and probably twenty-five miles broad, stretching along the coast between Domino Harbor and Cape Webuc, I refer, with some hesitancy, to the Huronian series of Sir W. Logan, and consider as probably equivalent to the "Quartzose Division of the Primitive Slate formation" of Naumann and Keilhau.[2] It agrees in part with the "Domino Gneiss" of Mr. Lieber.

At Domino Harbor in lat. 33° 30″, the quartzose rocks attain their greatest development, occurring as a slightly schistose light colored quartzite, the base of which is a white granular vitreous quartz, with speckles of black hornblende, and more rarely still, minute particles of hypersthene, with a few particles of a lilac colored mica. There are also minute rude crystals of yellow garnet, or cinnamon stone, disseminated through the mass. No feldspar was detected in this rock. In some places the rock was exceedingly fine, in others, it assumed almost a conglomeritic aspect, from the presence of small pebbles of quartz. The quartz is often colored green. This rock weathers easily, leaving masses of quartz projecting on the surface; it is comparatively soft, and has been greatly denuded. It thus forms at this locality a broad low flat plain about ten miles broad and fifteen to twenty miles long, through which rise bosses of diorite. Its surface is but a few feet above the level of the sea, and to one just coming from the high coast to the southward, this broad naked flat, almost wholly destitute of vegetation, with no valleys to shelter even a growth of spruce trees, and but slightly furrowed by glacial action, with patches of white rock glistening in the sun from between the dull green morasses and ponds that are everywhere scattered over its surface, — presents a strange and foreign feature of the coast scenery, startling from its very tameness. When in contact with the trap hills the rock is much harder, rising into higher elevations.

Nowhere was I able to see the juncture of this rock with the Laurentian gneiss, which rises from the edge of this formation into high hills and mountains. So smooth had this

[1] *Loc. cit.*, p. 81.

[2] See T. Macfarlane, on the *Primitive Formations in Norway and in Canada.* Canadian Nat. and Geol., vol. vii. 1862.

plain been levelled and worn by glacial and aqueous agents, that it was difficult to observe the dip and strike of the beds, which, when undisturbed by eruptive rocks, I am inclined to believe, dip easterly at a slight angle. At Dumplin Harbor, which is a bight in an island lying just S. E. of Huntington Island, the quartzite, when lying next to trap, approximates to gneiss in its character, under which it dips at an angle of 35° S. E., the strike of the beds being northeasterly. At Tub Harbor these rocks come in contact with the Laurentian syenite. Between the quartzites were beds of a dark fine-grained hornblendic quartzose gneiss, capped by the syenite. At Indian Harbor, about thirty miles north of Tub Harbor, and on the opposite side of Hamilton Inlet, these same rocks appear. These rocks occur also at Sloop Harbor, rising two hundred feet high, and are capped by syenite, which is very pale in color, with particles of black hornblende. Here, as at Tub Harbor, the quartzite at the point of contact with the syenite becomes a dark gneiss. The Esquimaux Islands which lie off this coast, are composed of the light colored quartzite which here seems to assume the character of a true gneiss. At no point was I enabled to observe whether these quartzites rest unconformably upon the older Laurentian gneiss, though strongly inclined to think so.[1]

Invariably accompanying these rocks is a dioritic trap of a peculiar mineralogical character, occurring in overflows of a peculiar physiognomy, and upheaved in a direction at nearly right angles to that of the Laurentian dykes, thus following the general northwesterly trend of the Atlantic coast of the Peninsula.

This rock differs from the hard fine-grained trap at Henley Harbor, in being coarsely porphyritic. It is composed of large crystalline masses of hypersthene and labradorite, this last being of a dark smoky color, and precisely such as described as occurring in the hyperite of Square Island. It seems to follow that this porphyritic trap is the result of the refusion of the anorthosite rock, which must consequently underlie this Domino quartzite. This is an argument for the unconformable bedding of this quartzite upon the lower Laurentian gneiss, while this trap rock is evidently of the age of the former quartzose rock, which it has somewhat disturbed. The Isle of Ponds is largely composed of these trap hills. Huntington Island is a large mass of trap. Tub Island, as its name betokens, is a peculiar, truncated cone of trap, resembling an inverted tub. These trap overflows extend northward to Cape North, which is a lofty headland of trap capping the gneiss, and thus adding very materially to the elevation of this, as of all the other numerous gneiss promontories which run out from the main land. Occasionally an island is seen half black and half white, one side being composed of the dark trap rock, and the other of the light colored quartzite. Such is "Black and White," a very prominent island near "Indian Tickle," a harbor at the northern side of Hamilton Inlet. Here are some remarkable dykes which ascend the gneiss hills in huge irregular zigzag crests, often crossing each other at right angles.

Beyond this point the Laurentian gneiss again appears, and forms the high bold shores extending to Hopedale, rising in the interior into lofty imposing mountains on whose tops lie patches of snow.

Among the erratic rocks at Domino Harbor were some which show that in the interior are beds of jasper and chert. There occurred several small boulders of jasper and gneiss. The jasper was pale green, banded and striped by darker shades of green, while the

[1] The Canadian Geologists likewise state that the strata of the Huronian system have not been observed resting *directly* on tilted Laurentian rocks; it is as yet a matter of hypothesis.

irregularly alternating bands of syenitic gneiss appeared to be an altered quartzite, as it was found under a glass to be largely composed of a fine granular quartz rock, with a little flesh colored and white feldspar, and minute particles of hypersthene.

Several boulders of chert occurred at Tub Island. This was a very tough compact silicious rock, lineated by fine veins of quartz. It weathers to a dull chalky white.

It is most probable that these rolled stones were borne down from the interior by glaciers, but the chert pebbles may have been borne on floating ice from Frobisher's Bay, as Mr. Hall notices such rocks as being abundant there. At Tub Island I was shown specimens of magnetic iron ore, which were brought from "Cartwright's Tickle," a few miles toward the main land. It occurred in veins half an inch wide.

Should further search prove the existence, in connection with this quartzite, of beds of a true conglomerate, which we should look for in the interior, and of the presence of copper ore in connection with the quartz veins near the trap rock, the identity of this formation with the Huronian rocks of Canada and similar rocks in Sweden would seem satisfactory; and if proven, will be interesting not only to the geologist, but be of practical value in the search for ores on this coast.

Quaternary Formation.

In studying the drift phenomena of Labrador as compared with those of the temperate zone, we shall at the outset find ourselves disappointed in our anticipations as to their relative development. In a region which has evidently been exposed to the most intense action of glaciers, prolonged over a period vastly longer than in Canada or New England, we have surviving this period of denudation and wasting away of the surface, but few drift scratches remaining on any exposed surfaces below a height of 500 feet above the sea; and superficial deposits which are reduced almost to a minimum as compared with those of the temperate zone.

In this absence of drift and more recent deposits, the Labrador plateau agrees exactly with all mountainous districts, above the level of most deciduous trees. We are to look to the lowlands about their base for the debris and drift borne down by streams or glaciers from the mountain centres. The Labrador plateau has been greatly denuded. Its highest mountains have been truncated, and their peaks sliced off by the denuding agent as if by a knife. The quartzites of Domino have lost at least 300 to 400 feet of their comparatively soft strata, as evidenced by the lofty trap hills which now rise above the strata of altered sandstones. The trap is as firm and hard at the top of the overflows as at the base. The loose material resulting from this long continued denudation is not now found in the interior or on the coast of Labrador, except in very small quantities. It was evidently conveyed southwards by icebergs and floe or shore-ice, and forms the bottom of the St. Lawrence Gulf, and the banks and shoals southward. In most subarctic and all arctic lands the soil is but a few inches deep.

In all temperate regions the superficial deposits have been characterized by Prof. Desor[1] to be "a succession of rocky hills and drift plateaus or valleys, which can be traced to the highest elevation of the country, near the dividing ridge, each following plateau or valley being commonly at a higher level than the preceding." This state of things obtains in Labrador, but there is an immense disproportion between the rocky hills and the drift deposits. We find no sandy plains or level tracts of glacial drift, or marine clays, distributed

[1] Foster and Whitney's *Report on the Geology of Lake Superior.*

at intervals from the coast to the interior. They take the form of occasional, isolated sand-banks and cliffs of clay, of slight extent, overhanging rivers, and which by their secluded and retired positions have escaped the general denudation by the Labrador current which must have passed over the lower levels of the Peninsula subsequent to the glacial epoch. In travelling in the interior we find ourselves walking, when it is possible to walk or climb at all, over the rocky floor of this inhospitable region, smoothed in spots, though rarely striated by glaciers, but on the coast more generally mangled and torn by the action of shore-ice and frosts, which have here shown a vast power.

The Leda clays are mostly confined to the head of retired bays, or if in more exposed situations, lie between bold headlands. Those vast sand barrens of Canada and New England spreading into broad plains, are here represented by precipitous masses of sand hanging upon the steep mountain slopes. The traveller stumbles upon them in ascending the swift impetuous streams.

The most abundant superficial deposits in Labrador are the ancient sea-beaches, which are found, according to Prof. H. Y. Hind, at all levels to a height of 1200 feet above the sea, at a distance in the interior of one hundred and twenty-five miles from the coast. They are evidently altered glacial moraines.

Glacial Epoch. Drift Striæ and rounded Rocks. The whole Labrador Plateau has been moulded by ice to a height at least of 2500 feet above the level of the sea. The gneiss mountains are moulded into large flat cones, often with a nipple-shaped summit; the syenites are either moulded into domes or into high conical sugar-loaves; the anorthosite syenite at Square Island occurs in high rude cones; and the trap overflows accompanying the Domino quartzites form rough irregular bosses. Only at one point near the northern termination of the Peninsula at Cape Chudleigh, have the mountains by their altitude escaped the rounding and remodelling action of glaciers. These scraggy peaks, covered with loose square blocks detached by frosts from their slopes, remind us of the summits of Mount Washington in New Hampshire, and Mount Katahdin in Maine. In a sketch of the former mountains by Mr. Lieber, as given in the "Report of the Coast Survey," the transition from the remodelled low mountains of the coast, to the "wild volcanic looking mountains" of the interior height of land, is very marked. Mount Bache, which was determined by the expedition to be 2150 feet high, was "one of the smallest mountains." The larger ones are inaccessible. Those who have been upon the summits of Mount Washington or Katahdin will recognize how well Mr. Lieber's description of the summit of Mount Bache agrees with the physiognomy of the New England alpine summits:—

"A second cause of the irregularity of surface here is to be found in the tremendous power of the frost of a Labrador winter, the influence of the heavy covering of snow, and very probably also the former existence of glaciers, all of which we shall presently take occasion to discuss.

"The effects of frost are manifested in a singularly forcible manner. The entire surface, where it is not too steep to enable debris to collect, is covered with broken masses of rock, cubes of ten feet and less scattered in wildest profusion. Sometimes a patch of moss, the grass and heather of this country, fills up the crevices, but generally we may look down into them far and deep without ever detecting the base upon which the rocks rest, hurled aloft, as they appear, by the hands of Titans. In scaling, in company with Mr. Venable, the summit of Mount Bache, on an occasion intended mainly for taking its altitude barometrically, we enjoyed the finest opportunities for studying this phenomenon. The

summit and sides of the mountain present few steep precipices. I speak comparatively only, and in reference exclusively to Northern Labrador. Yet, scattered helter-skelter over all, and piled up in endless number, the whole surface is covered with such loose rocks. The difficulties of locomotion may readily be conceived. In scarcely a single instance did we see the gneiss beds still *in situ*, and in only one or two exceptions some giant wedge seemed to have driven them asunder. Yet none of the blocks were rounded. Attrition of no kind had influenced them to any perceptible extent, neither had atmospheric influences altered the color, hardness and composition of their exteriors; it was simply a wilderness of unchanged blocks of the gray gneiss.

"There was a puzzle. Whence came these broken rocks? There was no higher spot whence they might have fallen. The slight protrusion of the uptilted beds of gneiss *in situ*, to which I have referred, alone seems to have been permitted to remain for the purpose of instructing us. Clearly, that force which had riven its beds asunder, no other than the *frost*, had broken the rest from their foothold and prepared them for removal by another coming into play at a later season; the thawing down-gliding *snow*. Many of the blocks were probably but slightly removed from their original position, perhaps barely turned over or merely forced a little out of place. Yet the effect to the eye of the beholder would be as great as if they had been transported hundreds of miles.

"When we descended from the mountain we crossed over a broad patch of snow, deeply packed, (twenty feet deep,) which clearly taught us how the blocks were moved. In truth, this was a miniature glacier, and a regular moraine was piled up along its edges. It is impossible for us to form any estimate of the amount of snow which may fall per square foot in a winter, but from the fact that such quantities were still remaining late in July, and certainly they never altogether thaw away, we may reasonably infer that during its downward progress, either as snow or water, a tremendous force must be exerted, a force quite sufficient to account for the characteristic surface phenomenon just described." [1]

Contrary to the statement of Sir John Richardson in his "Polar Regions," both the accounts of Parry and the earlier arctic voyagers, and especially C. F. Hall in his "Arctic Researches," prove that on the northern edge of the American continent, and as low down as lat. 62°, and upon land rising between 1000 and 2000 feet above the level of the sea, there is a *mer de glace* of vast extent, discharging glaciers into the sea which present ice-fronts 100 feet high.

Parry, in his second voyage, (p. 12), states that on the north side of Hudson's Straits, after passing by Resolution Island, there "is a smooth part of the land rather higher than that in its neighborhood, and for an extent of one or two miles, completely covered with snow. The snow remains upon it, as Mr. Davidson informed us, the whole summer, as they find the land presenting the same appearance on their return through the Strait in the summer. This circumstance, which has obtained for it the name of 'Terra Nivea' upon the charts, I do not know how to account for, as the height of the land above the level of the sea cannot certainly exceed a thousand feet."

Mr. C. F. Hall, during his residence in Frobisher's Bay, had excellent opportunities of observing during all seasons of the year both ends of the Kingaite range of mountains on 'Meta Incognita' which support this *mer de glace*, which he named the Grinnell Glacier, and which on the coast annually discharges icebergs from its streams. He describes it as being two miles long, starting from a sea of ice which extended many miles N. W. and

[1] *Loc. cit.*, p. 406.

S. E., reaching across the peninsula of Meta Incognita, nearly to the straits which divide Frobisher's Bay from Hudson's Straits. Mr. Hall states that "from the information I had previously gained, and the data furnished me by my Innuit companion, I estimated the Grinnell Glacier to be fully one hundred miles long. At various points on the north side of Frobisher Bay between Bear Sound and the Countess of Warwick's Sound, I made observations by sextant by which I determined that over fifty miles of the glacier was in view from, and southeast of, the President's Seat. A few miles above that point the glacier recedes from the coast and is lost to view by the Everett chain of mountains; and as Sharkey [an Esquimau] said, the *ou-u-e-too* (ice that never melts), extends on *wes-se-too-ad-loo* (far, very far off). He added that there were places along the coast below what I called the President's Seat, where this great glacier discharges itself into the sea, some of it in large icebergs.

"From the sea of ice down to the point where the abutting glacier was quite uniform in its rounding up, it presented the appearance, though in a frozen state, of a mighty rushing torrent. The height of the discharging face of the glacier was 100 feet above the sea."[1]

Given, as stated below, the rise of the Labrador peninsula only 500 feet above its present level, and we must have had during the glacial period most extensive glaciers fed by broad seas of ice resting on the table-lands, reaching above the line of perpetual snow; as only 120 miles northward of Cape Chudleigh we find the snow-line reaching as far down as 1000 feet, or thereabouts, above the sea level. We are inclined to doubt the accuracy of Parry's estimate of the height of these table-lands, as the height of Mount Bache is over 2000 feet, and it just reaches the lowest limit of the snow-line, which in Greenland is 2000 feet above the sea.

Owing to the extensive weathering of the rock, glacial grooves and scratches occur very rarely. I doubt not they will be found abundantly after ascending 500 to 800 feet from the sea level, for below this point the action of the waves and shore-ice has obliterated both striæ and loose drift. We have good evidence that an enormous glacier once filled the great fiord, Hamilton Inlet, which at its mouth is forty miles broad. Peculiar *lunoid furrows* were observed on the northern and southern shores about forty miles apart, which would seem to justify the conclusion, that the glacier was of that breadth where it descended into the sea. The best examples of these lunoid furrows occurred at Indian Harbor on the northern shore of Hamilton Inlet, near the fishing establishment of Mr. Norman. This harbor is a narrow "tickle" or passage, where the Domino quartzites, very smoothly worn and polished, are capped by trap overflows, and run under the water to the depth of thirty feet, forming a polished and smooth bottom to the harbor. The marks occur about twenty-five feet above the water's edge, and below the line of lichens which are kept at a distance by the sea spray.

These crescent shaped depressions which run transversely to the course of the bay, were

[1] J. F. Campbell, who visited this coast in 1864, states in his work entitled "Frost and Fire," that at Indian Island, lat. 53° 30′ "the striæ pointed into Davis' Straits at a height of 400 feet above the sea; at Red Bay, in the Straits of Belle Isle, they aimed N. 45° E. at the sea level."

At Newfoundland, about St. John's, "the striæ which were found were near the coast, and seem to indicate large land-glaciers moving seawards. At St. John's the marks run over the Signal Hill, 540 feet high, from W. and N. 85° W. eastwards; at Harbor Grace, from S. 75° W. down the bay northeastwards; at the head of Conception Bay they fill a large hollow, overrun hills, and point from S. 15° W. northwards. Vast terraces of drift stretch along the base of rounded hills at the head of Conception Bay, at Harbor Grace, and at Old Purlican, near the end of the bay, sixty miles off. At the head of the bay most of this drift seems to have come from the hills. Opposite to granite hills are numerous blocks of granite; opposite to sandstone and slate hills, sandstone and slate boulders abound." — *Frost and Fire*, ii. 1865, p. 240.

from five to fourteen inches broad by three to nine inches long, and about an inch deep vertically in the rock. Their inner, or concave edge, pointed southwest, the bay running in a general S. W. and N. E. direction. They were scattered irregularly over a surface twenty feet square. When several followed in a line, two large ones were often succeeded by a couple one quarter as large, or *vice versa*. Also at Tub Harbor on the southern coast of this bay, similar markings, but less distinct, occurred about the same distance above the sea, and on a similar polished quartzite. These agree precisely with the "lunoid furrows" of Mr. DeLaski, as observed by him in great abundance on Isle au Haut, in Penobscot Bay, — specimens of which he has deposited in the Museum of the Portland Society of Natural History.

These were the only glacial markings I observed. It should be noted that Mr. Jukes, in his "Geology of Newfoundland," states that he never observed any glacial striæ during his explorations on that island. They were observed in abundance by Professor Hind about fifty miles from the mouth of the river Moisie, where occurred "gneiss terraces five in number, the highest being about 1000 feet above the sea, and backed by a stunted birch and spruce-clad mountain, some 800 feet higher still. The sloping sides of these abrupt steps are rounded, polished, and furrowed by glacial action. Cuts half an inch deep, and an inch or more broad, go down slope and over level continuously. Rounded and water-worn boulders are perched here and there on the edge of the uppermost terrace. These strange memorials of the drift begin to be more common."— p. 133.

Fine examples of rounded and embossed rocks occurred at a bay situated a few miles to the westward of Little Mecatina Island. Here the numerous islets of syenites assume a low dome-like shape, whose shores descend to the water's edge by a gentle slope, and are so smooth and polished that one can with difficulty descend them when wet, without slipping.

On the southern coast the eminences all present their longer slopes to the northward, and their lee sides descend seaward and southward in sudden falls and slopes. On the contrary, on the eastern and Atlantic shores the *stoss* or struck sides look westward, and the lee side is on the eastern side of the hills, thus showing that the denuding and abrading agent moved downwards from the top of the water-shed, — that is always nearly parallel to the coast.

About Cape Chudleigh the hills and rocks are shown by Mr. Lieber's drawings to have been rounded and moulded by ice to a height corresponding to that of Mount Bache, as noticed above.

Distribution of Boulders. The whole surface of the country is strewn thickly with boulders. After ascending five or six hundred feet above the level of the sea, and penetrating into the interior, their presence is especially marked. Near the shore they are rarely seen, being covered by vegetation. We must look for them about the edges of ponds and along the banks of the rivers, and especially in raised beaches. I am also inclined to think that their abundance near the coast is greatly lessened by their having been carried off by shore ice into the sea, and there rearranged into submarine beaches.

No loose, single boulders scattered over the surface of the country were seen on the coast from Mecatina to Square Island. They only occurred as stated above, along the courses of rivers, by ponds, and rearranged into beaches. But we first saw them on a hill, estimated roughly to be 1000 feet high, a few miles north of Cape St. Michaels, at Square Island, where they lend a new feature to the landscape. At this level they were strewn sparsely

upon the tops of the surrounding hills. One was about fifteen by forty feet in size. A large proportion were well rounded, while others were angular. The greater proportion were of syenite, a few small ones were of greenstone.

Northward of this locality I did not have an opportunity of ascending the mountains above the level of the ancient coast line.

Professor Hind likewise found very few boulders at a distance from the bed of the Moisie, for a distance of fifty miles from its mouth. But on ascending the water-shed, and penetrating farther inland they everywhere grew more numerous. A few miles beyond "Burnt Portage" on this river, "huge blocks of gneiss, twenty feet in diameter, lay in the channel or on the rocks which here and there pierced the sandy tract through which the river flowed; while on the summits of mountains and along the crests of hill ranges they seemed as if they had been dropped like hail. It was not difficult to see that many of these rock fragments were of local origin, but others had travelled far. From an eminence I could discover that they were piled to a great height between hills 300 and 400 feet high, and from the comparatively sharp edges of many, the parent rock could not have been far distant."[1]

Also at Caribou Lake, an expansion of the same river, he states, "the long line of enormous erratics skirting the river looked like Druids' monumental stones; for in many instances they were disposed in such a manner as would almost lead one to suppose they had been placed there by artificial means."— p. 229.

Of this same expedition Mr. Cayley has published an account in the "Quebec Transactions," where we have the statement of this observer that boulders are very thickly strewn over the surface and on the summits of mountains 2214 feet high, and situated one hundred and ten miles from the coast, being near the head waters of the Moisie. "Immense numbers of boulders had for the last few miles strewn the sides of the mountains, in some cases almost seeming to make up the very mountains themselves; there being this difference, that whereas the rock itself *in situ* is granitic, the boulders in every case are of gneiss."[2]

Nowhere did I see on the coast of Labrador any deposits of the original glacial clay, or "unmodified drift." Upon the sea-shore it has been remodelled into a stratified clay, and the boulders it once contained now form terraced beaches. Professor Hind, however, notices the occurrence of "drift clay, capped by sand" in precipitous banks rising seventy feet above the level of the Moisie River, twenty miles from its mouth.

Before giving an account of the marine clays and their fossils, which should naturally come in at this place, I would draw attention to the numerous raised beaches that line this coast.

Raised Beaches. Some of the finest examples of raised beaches and rock-shelves representing ancient coast lines, about 400 feet above the present coast line, are seen in the lowest Silurian rocks on both sides of the Straits of Belle Isle. The following notes and sketches were made while coasting along the northern shore, which rises in high sandstone and gritty bluffs, contrasting in their regular water-worn outlines most strongly with the peculiar swelling curves of the Laurentian gneiss which rise near Bradore, according to Bayfield's measurements, 1200 feet above the sea, — or the jagged, rough and hummocky outlines of the rude syenitic hills, which rise 400 feet above the sea. At Anse au Loup, as

[1] *Loc. cit.*, p. 227. Also, *Quart. Journ. Geol. Soc.*, Jan. 20, 1864, p. 122, On supposed Glacial Drift in the Labrador Peninsula, &c.

[2] Up the River Moisie, *loc. cit.*, N. S., vol. i. p. 88.

seen from one half to one mile from the shore, the land rises on the west side of the bay in three very regular terraces (Fig. 1, A), the lower of which is covered with debris. On the

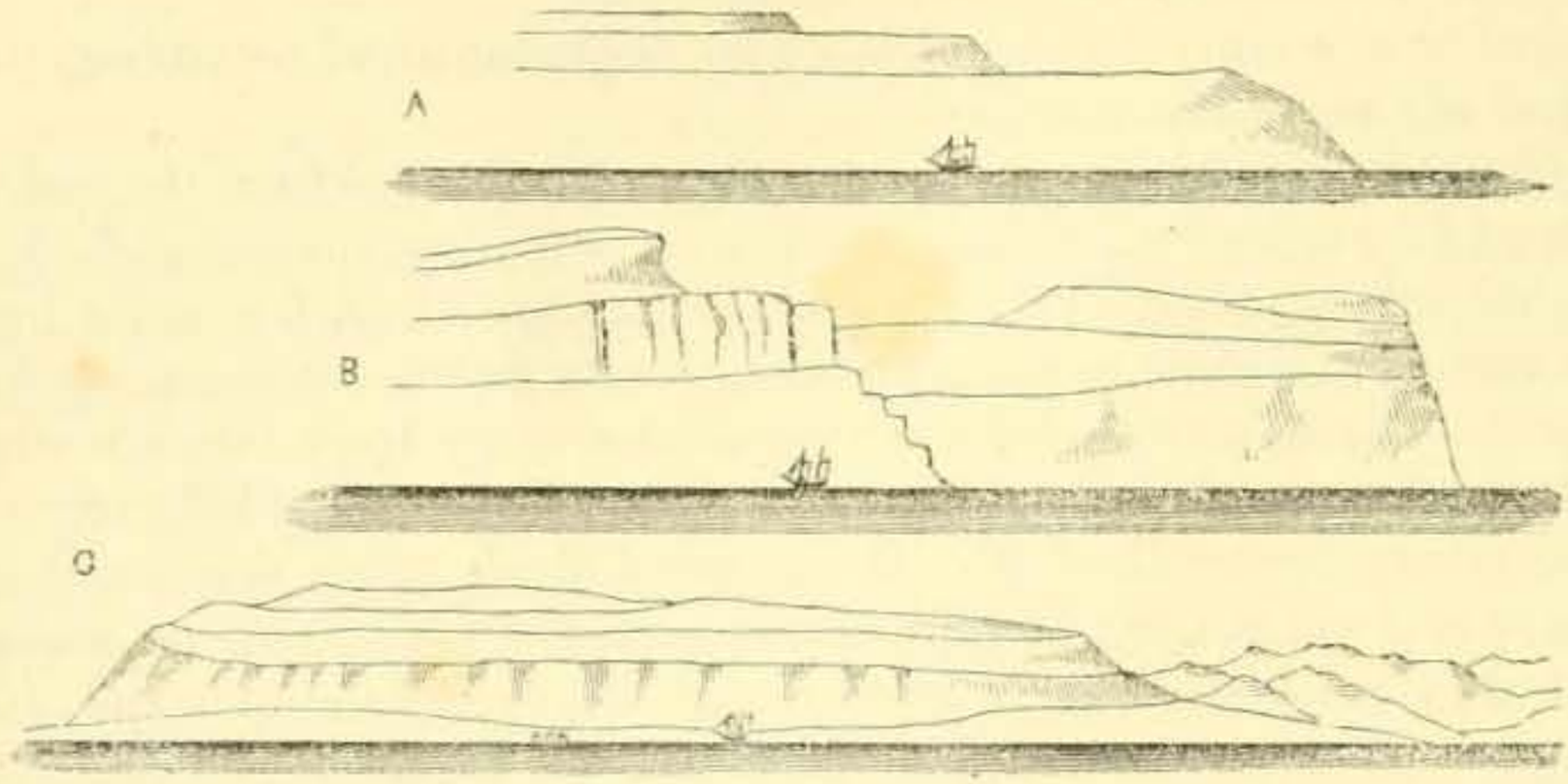


FIGURE 1.
Terraces at Anse au Loup, (A) (B) and (C) looking eastward at the N. E. end of the Lower Silurian formation.

east side the land is much more irregular, descending in buttressed steeps like the Palisades on the Hudson, though far exceeding them in height. On the east point are five terraces on the N. W. side with heavy buttresses, and beyond four terraces come in sight (Fig. 1, B). The strata here are nearly horizontal, dipping under the Straits at a very slight angle. At the eastward termination of the formation are again seen five very regular terraces (Fig. 1, C) running out in a long low point, beyond which rise the syenite hills. At Blanc Sablon five terraces are very distinctly marked, the second of which is the highest; and there is a beach of huge boulders very regularly packed by the action of the waves, as observed by Admiral Bayfield.

In Chateau Bay and Henley Harbor are some fine examples of ancient sea margins. They occur in recesses in the shore which have been sheltered from the denuding agency of the waves and strong arctic currents, which have swept around this bend in the coast with great power. The most plainly marked example forms the eastern shore of Henley Harbor, being the western shore of Henley Island. This beach, which is 180 feet high above the water level, is composed of three well-marked terraces, which become steeper as we go from the bottom to the top. The upper terrace begins at the base of the basaltic columns capping this island, and is covered at its upper edge with the debris from this mass of trap. The two lower terraces at the northern end of the island present a delta-like expansion facing the northwest. On these terraces, which are destitute of the usual covering of moss and Empetrum, can be most distinctly seen the windrows of pebbles and gravel thrown up by the retreating waves. A continuation of this beach is seen on Castle Island just south.

On the eastern side of the same island is a beach of the same height, but much steeper, as it directly faces the ocean, and more irregular than the one just described, as its surface is broken by jagged masses of syenitic rock which protrude through it, and by large masses of trap which have fallen from the cliffs above.

North of Henley Island is a broad flat beach consisting of two low terraces, on the uppermost of which, and commanding the harbor, are the ruins of an old fort built during the last century. Also on the mainland near the head of the bay are situated in bights in the

shore, three low beaches, each composed of two terraces, overgrown with vegetation. They are all apparently of the same height, and correspond in height with that of the second beach or terrace on Henley Island. On the east side of Pitts Arm is another similar beach, and still another at the head of the bay on the west side of the stream emptying into this bay. Upon this latter beach are large boulders often two feet in diameter. Across the bay from Henley Island is a lofty steep beach sloping towards the east, and of the same height.

It is an important fact that the present contour of the coast from the sea level to a height of about 500 feet, also extends to at least fifty fathoms, or 300 feet below the surface of the water. Such we found to be the fact in dredging for a distance of nearly 600 miles along the coast. The jagged nature of the rocky terraces at Strawberry Harbor, so interesting a feature in the coast scenery, extends at least to a depth of 240 feet, a few rods from the shore, as in anchoring with the kedge anchor, it would drop on to a rocky shelf, and then drag and fall twenty fathoms lower on to another syenitic shelf; such a succession of rocky terraces we have no doubt extended much farther below the point sounded by our ship's lead.

Again, dredging was carried on off Henley Harbor on a pebbly bottom 300 feet below the surface which formed the continuation of the same beaches which rose some 200 feet above the sea-level. It follows from this that as both the jagged rocks and submerged beach must have formerly formed a coast line, the land once stood at least 300 feet higher than at present, and it is more than probable, much higher. Such an elevation would have produced the most important modifications of climate, lowering it greatly, bringing the snow line further down towards the coast, and must have led to a great accumulation of the snow and land ice.

At the settlement in Chateau Bay is a remarkably steep beach, which ascends half way up the side of the hill, which is about 500 feet high. It is composed of large boulders very closely packed in layers, without any gravel to fill up the interstices, and slopes to the level of the water at an angle of at least 40°, being the steepest beach I saw on the coast. It consisted of two terraces, the lowest almost precipitous in its descent. This beach, when below the level of the sea, was evidently exposed to the action of the powerful Labrador current which piled these huge water-worn rocks into a compact mass which served to resist the waves, while the coarse gravel and sand were borne rapidly away farther out to sea on to lower levels. It is a general rule that all beaches on this coast with a northerly and easterly exposure to the open sea, are much steeper, and composed of much coarser materials than those in more sheltered situations.

At Domino Harbor are beaches more than 100 feet high, and in sailing up the Sound which lies between the mainland and the numerous islands that line this coast, twelve beaches were seen rising 40 to 150 feet above the level of the sea, and composed of two or three terraces.

In Sloop Harbor, twenty-five miles south of Cape Harrison, is a noble shingly beach nearly 200 feet high on the south side of the harbor, consequently facing the north.

Thomas Bay, which lies about thirty miles south of Hopedale, afforded, along both of its shores for thirty miles from the sea, fine examples of raised beaches, composed for the most part of three terraces. High beaches also occurred at Hopedale. The Mission House and buildings belonging to this Moravian settlement, also rest upon raised gravelly beaches, which afford soil deep enough for gardens and cemeteries.

It is to be regretted that from want of time and proper instruments we were unable to measure the heights of these beaches and their respective terraces. Those given are simply approximative, with the exception of the one noticed as occurring upon Henley Island. The mass of basalt was rudely measured by Lieut. Baddeley, and estimated to be 255 feet high. The terraces rise to the base of the pillars, which he estimated to be 180 feet above the sea.

I believe it will ultimately be found that all these beaches rise above the present level of the sea at uniform heights, and will be found generally to agree in this respect with similar beaches in the St. Lawrence River and the coast of the British Colonies and New England, after making due allowances for local oscillations of the land. At Chateau Bay it could easily be seen that all the terraces composing the different beaches were of the same height; and, so far as memory would show, in the absence of actual measurement, all those beaches observed farther northward presented terraces which very generally corresponded in height with those of Chateau Bay.

I am informed by Captain Ichabod Handy of New Bedford, Mass., who has spent several years in Hudson's Bay engaged in the whale fishery, who is a close observer, and has coasted in a whale-boat the whole shore from Nain to Resolution Island in lat. 62°, that there are several very high raised beaches near Hebron, and also near Nain, one of which he roughly estimated to be 300 feet high. He observed that the beaches north of Nain increased in height. There were also beaches on Button Island. He noticed one on Resolution Island, about 200 feet high, which was composed of three terraces. On the Lower or East Savage Island he described to me a plain of soft clay elevated fifty feet above the sea, into which "he sank knee-deep," and perceived in it numerous "clams and mussels," and also the skeleton of a whale, the "boar-head" whale, (*Balaena boöps*) stranded upon the surface. This ancient sea bottom was flanked by a raised beach from thirty to forty feet in height.

At Sir Thomas Roe's Welcome, he describes the beaches as being higher than any observed southwards, and he also noticed clay-banks, containing shells, raised above the present level of the sea.

Prof. Hind has noticed some remarkable beaches far in the interior of the southern part of the Peninsula, and at a great height above the present level of the sea. Though this author does not refer to their rearrangement by the currents and waves of the sea, his description of the immense deposits of rounded and water-worn boulders, agrees precisely with similar raised beaches both upon, and a mile back from, the coast, observed by myself, where they are covered by moss and Empetrum, or stunted spruces. At "Burnt Portage," upon the river Moisie, one hundred miles from its mouth, and 1857 feet above the level of the sea, this author describes a "hill of boulders or erratics, all water-worn and smooth, without moss or lichen upon them, and piled two or three deep, and, for aught you know, twenty deep." . . . "The well-worn masses of all sizes, from one foot to twenty feet in diameter, and from one ton to 10,000 tons in weight, are washed clean." . . . "I could without difficulty see three tiers of these 'travelled rocks,' and in the crevices the charred roots of trees which had grown in the mosses and lichens which formerly clothed them."

Another feature of great interest in this connection are the rocky terraces or steps which have been hewn out of the solid rocks along the coast for a height of 500 feet above the present level of the sea, and mark the oscillations of the old coast line; and, as there occur in the interior of the country 1000 feet above the present coast line, similar lines of erosion,

they present the best evidence we have, to determine how far above its present level the glacial sea stood. These rock terraces could only have been formed so fully as seen here during a vast period, and the ice-foot of Dr. Kane, to which their formation is probably due, must have remained on the shore during the entire year. Fine examples of similar terraces are described and figured in Kane's "Explorations," Vol. ii. p. 81. At various points along the coast the joint action of frost, the waves, and floating ice, can even now be seen building up these steps in the slopes of trap and syenitic rocks, by taking advantage of the jointure and cleavage planes which cross at nearly right angles. At Strawberry Harbor the syenitic rocks have broken off into huge cubical blocks of many tons' weight. The rock abounds in cracks and fissures, into which the ice has entered wedge-like, and burst them asunder, while the fragments have been borne away by shore-ice. Thus for a height of 500 feet the shore consists of a series of steps ten to thirty feet high, forming broad shelves on which the sea-birds build, and where a little vegetation lodges. Where the shore consists of trap rocks, as at Domino Harbor and Tub Island, the steps are much smaller and more numerous. At Domino there are regular steps in the quartzites, which lend a very peculiar feature to the shores of the harbor, as at a little distance the rocky slopes descending by hundreds of steps to the water, appear like a lofty beach of boulders. At Sloop Harbor these rocky steps are of vast extent, their tops shelving inland, and in profile the rocky promontory presents a strange serrated outline when viewed from the sea. The lofty sugar-loaf syenitic island a few miles south

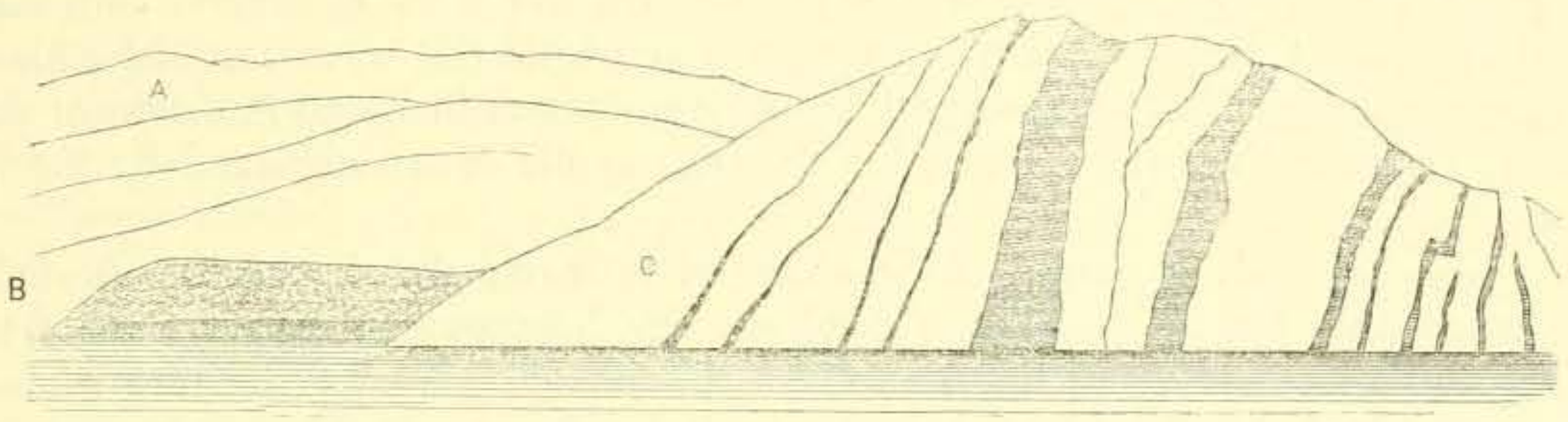


FIGURE 3.
View just north of Sloop Harbor, Kyueartarbuck Bay; (A) gneiss terraces, 500 to 800 feet high; (B) raised beach at the head of a small bay; (C) a headland of Domino quartzite (?) intersected by trap dykes.

of Hopedale, noticed previously, and which is 700 feet high, has its surface divided into four terraces of rock, which reach two-thirds of the distance up its sides from the water,

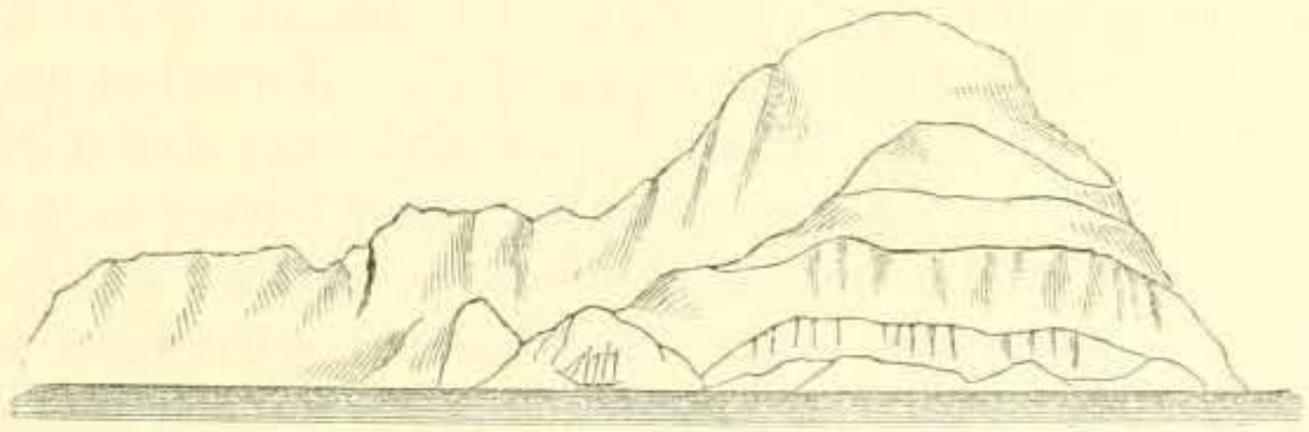


FIGURE 2.
Rock terraces on a conical promontory near Hopedale, Labrador.

thus affording a means of estimating the different heights at which the land paused in its oscillations upwards. We must again refer to Mr. Hind's work for an account of similar

rocky terraces in the interior of the Peninsula. Near the "Lake where the land lies," he describes the gneiss hills as rising in "gigantic terraces." He likewise speaks of "gneiss terraces five in number, the highest being about 1000 feet above the sea," and he states that the sloping sides of these abrupt steps are rounded, polished, and furrowed by glacial action.[1]

Mr. Cayley has described them also quite fully: "We now made the fifth portage, [fifty miles from the mouth of the river, and 370 feet above the level of the sea,] where we first met with some curious natural steps or terraces, which were continually repeated on our march. They were usually five or six in number, averaging three or four feet in height; the distances between each rather irregular, just affording room enough to take two or three paces, and their surfaces presenting the appearance of having been artificially constructed. They were of the common dark hornblendic gneiss, and ran in a general northeast and southwest direction."[2]

No glacial striæ upon these terraces were observed near the shore. It is evident that this process of terracing the crystalline rocks by frosts and shore-ice began during the glacial epoch. At present we must assume that the striæ found by Professor Hind upon these rocky steps far inland were graven by angular stones frozen into the bottoms of glaciers, for we find no such marks at present upon those now upon the coast, which shows how insufficient is the action of floating shore, or floe-ice, or grounded bergs even, in striating so regularly these hard crystalline rocks.

We saw a good example of rocks polished by the ice and waves at Gore Island Harbor, a point westward of Little Mecatina Island. On the faces of several cliffs forming perpendicular walls facing a narrow passage into which the waves rushed with great force in the calmest days, the sea-wall was smoothly polished and water-worn for ten feet above its shore-line, while above, the face of the cliff was roughened by the action of frost.

Upon this coast, which during the summer of 1864 was lined with a belt of floe-ice and bergs probably two hundred miles broad, and which extended from the Gulf of the St. Lawrence at Belles Amours to the Arctic seas, this immense body of floating ice seemed *directly* to produce but little alteration in its physical features. If we were to ascribe the grooving and polishing of rocks to the action of floating ice-floes and bergs, how is it that the present shores far above (500 feet), and at least 250 feet below the water-line, are often jagged and angular, though constantly stopping the course of masses of ice impelled four to six miles an hour by the joint action of tides, currents and winds? No boulders, or gravel, or mud were seen upon any of the bergs or masses of shore-ice. They had dropped all burdens of this nature nearer their points of detachment in the high Arctic regions. The bergs all bore evidence of having been repeatedly overturned as they were borne along in the current. The floe-ice was hummocky, which is a strong proof of its having come from open straits in the polar regions, the masses looking as if having been frozen and refrozen, jammed together, and then piled atop of each other by currents and winds long before appearing upon this coast; while the bergs exhibited old water-lines presenting different angles to the present water-level. The only discoloration noticed was probably caused by seals resting upon and soiling the surface. One boulder was noticed by a member of the party resting upon an iceberg off Cape Harrison in August.

This huge area of floating ice, embracing so many thousands of square miles, was of

[1] *Loc. cit.*, p. 133.

[2] Up the River Moisie, *loc. cit.*, p. 82.

greater extent, and remained longer upon the coast, in 1864, than for forty years previous. It was not only pressed upon the coast by the normal action of the Labrador and Greenland currents which, in consequence of the rotatory motion of the earth, tended to force the ice in a southwesterly direction, but the presence of the ice caused the constant passage of cooler currents of air from the sea over the ice upon the heated land, giving rise during the present season to a constant succession of northeasterly winds from March until early in August, which farther served to crowd the ice into every harbor and recess upon the coast. It was the universal complaint of the inhabitants that the easterly winds were more prevalent, and the ice "held" later in the harbors this year than for many seasons previous. Thus the fisheries were nearly a failure, and vegetation greatly retarded in its development. But so far as polishing and striating the rocks, depositing drift material and thus modifying the contour of the surface of the present coast, this modern mass of bergs and floating ice effected comparatively little. Single icebergs, when small enough, entered the harbors, and there stranding, soon pounded to pieces upon the rocks, melted, and disappeared. From Cape Harrison in lat. 55° to Caribou Island was an interrupted line of bergs stranded in eighty to one hundred or more fathoms, often miles apart, while others passed to the seaward down by the eastern coast of Newfoundland, or through the Straits of Belle Isle.

Secular Rise of the Land. From all the indications noticed casually by us, such as the position of beaches apparently very recently raised above the sea-level, so as to be just beyond the reach of the waves, the land is slowly gaining on the sea. The Rev. C. C. Carpenter, missionary at Caribou Island, in the Straits of Belle Isle, also informs me that this is his impression gained both from his observations and information given by the settlers. To this last source Mr. J. F. Campbell is indebted for the statement in his "Frost and Fire," that the coast of Labrador is slowly rising.

River Terrace Period. Owing to the great denudation of all drift material, and the hilly character of the country, we find no broad terraced river valleys, such as characterize more temperate regions. On the contrary, the rivers are a succession of ponds, connected by rapids, where the stream plunges from one rocky terrace to the next one below, taking the direction of natural ravines. Though the volume of these rivers during the Terrace epoch, or period of great rivers, may have been greater than now, as evidenced by a few small terraces upon their banks, we have no evidence that they ran in much wider channels than at present, owing to the great height of their banks.

Leda Clays.

Their occurrence in Labrador. — At the mouth of Salmon River, a small stream flowing into the Straits of Belle Isle three miles east of the mouth of the Esquimaux River, occurred a clay-bank about ten feet high, and situated just above high-water mark, which was dark blue and free from boulders. It contained in abundance *Aporrhais occidentalis, Serripes grönlandicam, and Cardium Hayesii.*

This deposit of clay is of more recent age than the deposits noticed below, as it was a few feet higher, and situated more inland. It undoubtedly rests upon the lower fossiliferous gravel beds, though I did not see the point of contact.

The most important deposits occurred at Caribou Island at the mouth of the Straits of Belle Isle, at Pitts Arm in Chateau Bay, and at Hopedale. They consisted of sandy clays and a coarse gravel found between tide marks, and extending beneath the water. Should

the present banks now lying off the coast be raised and exposed to view, we would have an identical deposit. All the stones and pebbles of this ancient sea-bottom, finely exposed at Hopedale, are covered with nullipores and polyzoa; the Mya truncata still remains perpendicular in its holes, and the most delicate shells with their epidermis still on, are unbroken, and their valves often united by the ligament. The delicate Myriozoum has preserved its fine markings nearly as perfectly as in specimens dredged at the present day, and the cases of the delicate Spiochætopterus are still preserved. It is evident that this deposit has slowly and almost imperceptibly risen some 400 or 500 feet without any paroxysmal movement of the continent over an extent of coast some 600 miles in length.

This rise of the Labrador peninsula must have accompanied the rise of the Polar Regions, including Arctic America and Greenland, and in fact all the land lying in the northern hemisphere. Many facts in the distribution of fossils in these glacial beds, and the present relations of these beds to deposits above and beneath them, tend to prove that the glacial epoch occurred simultaneously over all the Arctic Regions and the northern temperate zone, and that the submergence and subsequent rise of the continental masses and outlying islands, were synchronous in both hemispheres. Professor Haughton has summed up the evidence of such a rise from raised beaches and ancient sea-bottoms, in the American Arctic Archipelago.[1] The researches of Dr. Kane in the extreme north of Greenland enabled him "to assert positively the interesting fact of a secular elevation [480 feet] of the crust commencing at some as yet undetermined point north of 76°, and continuing to the Great Glacier and the high northern latitudes of Grinnell Land." Vol. ii. p. 81.

We need not here allude to the similar oscillations in Northern and Central Europe to still greater heights above the present level of the ocean.

At various points along the coast from Caribou Island, where they were abundant, to Hopedale, occurred in the drift gravel beds associated with the fossils, numerous pebbles and small boulders of a light silicious bedded limestone, which contained numerous Silurian fossils. Lieber mentions finding pieces of limestone on the shore of Aulezavik Island. There can be little doubt that these boulders were transported on ice from the Silurian basins in the Arctic regions on the west side of Baffin's Bay. Perhaps their origin may by future observers be traced to the Silurian limestones found at the head of Frobisher's Bay, by Hall. Such fragments are not now to be seen on the floe-ice coming down from the north.

A large proportion of the species mentioned in the following lists occurred in great abundance, and in a good state of preservation, so that they could be compared very satisfactorily with recent specimens dredged upon the coast. Most of the species, after careful and repeated comparisons with the recent examples, did not present any appreciable differences. In a few instances there were characters found by which the fossils could be distinguished from the recent shells of the same species, and those I have carefully enumerated.

1 "McClure found shells of the *Cyprina islandica*, at the summit of the Coxcomb Range, in Baring Island, at an elevation of 500 feet above the sea level; Captain Parry, also, has recorded the occurrence of *Venus* (probably *Cyprina islandica*) on Byam Martin's Island; and in the recent voyage of the "Fox," Dr. Walker, the surgeon of the expedition, found the following sub-fossil shells at Port Kennedy, at elevations of from 100 to 500 feet: *Saxicava rugosa*, *Tellina proxima*, *Astarte arctica* (borealis), *Mya uddevallensis*, *Mya truncata*, *Cardium sp.*, *Buccinum undatum*, *Acmea testudinalis*, *Balanus uddevallensis*." —*Appendix to McClintock's Narrative.* Amer. edit. p. 370.

Nullipora polymorpha Linn. This plant occurred abundantly at Caribou Island. At Hopedale it was profusely abundant, growing in large free masses or encrusting shells and stones.

Euryechinus dröbachiensis Verrill. (*Toxopneustes dröbachiensis* A. Agassiz. *Echinus granularis* Say.) Fragments of the shells and numerous spines occurred abundantly at Caribou Island and Hopedale.

Lepralia Belli Dawson. Encrusting pebbles at Hopedale. One colony also on a shell. The young cells were large, with crowded and sometimes perforate, granulated conical ovicells. The avicularia are situated either in front of the opening, or crowded to one side, and are two in number. Both old and young correspond precisely with a specimen received from Dr. Dawson.

Lepralia pertusa Thompson. This species occurred on the shells of *Buccinum cretaceum*. It agrees well with the large, oblong and coarsely punctate recent specimens. It is well figured by Dawson in the *Canadian Naturalist and Geologist*, Feb. 1859, p. 15, fig. 16.

Lepralia ciliata Johnst. This form also occurred frequently with the preceding. The cells are convex, the avicularia are present, projecting over the aperture. The surface is punctate.

Celleporaria surcularis Packard, Can. Nat. Dec. 1863, p. 410. Occurred frequently on Lamellibranch shells in large and thick masses at Caribou Island and Hopedale.

Myriozoum subgracile D'Orbigny. (*Millepora truncata* Fabr., Faun. Grœnl.) Fragments of the stems of this graceful species occurred abundantly at both localities.

Hypothyris psittacea King. Perfect valves were found at Caribou Island, and others were given me which were reported to have been found three miles from the mouth of the Esquimaux River. Other shells, such as a *Cardium* and *Cardita borealis*, also came from the same place, showing that they had been washed out of a drift deposit on the river. This species was abundant at Hopedale, where the valves adhered by their ligament.

Pecten islandicus Linn. This was not common. Several ponderous valves, larger than I have seen elsewhere had the ribs united into groups of two or three, separated by sulci of equal width; but in young and fragile subjects the ribs were equally distributed, and differed in no respect from the living young, or from those of the same age from the drift clays of Maine and New Brunswick.

Yoldia myalis Stimps. A specimen of *Yoldia arctica*, received from Dr. Lütken, approaches *Y. myalis* more than *Y. sapotilla*. It is, however, longer, and the lunule is not so short and deep as in *Y. myalis*. One valve. Hopedale.

Leda minuta Möll. (*Arca minuta* Fabr., Faun. Grœnl.) Caribou Island, rare. Common at Hopedale.

Modiolaria discrepans Möll. One broken valve. Hopedale.

Mytilus edulis Linn. Fragments of large valves were abundant, but young shells were uncommon.

Cardium Hayesii Stimps. Proc. Acad. Nat. Sc. Philad. p. 581, 1862. This species occurred both at Hopedale and Caribou Island.

Serripes grönlandicus (Chemn.) Beck. Caribou Island, frequent. Chateau Bay.

Astarte Banksii Leach, Zoöl. Beechy's Voyage (*A. Warhami* Hancock, Ann. Mag. Nat. Hist., vol. xviii., 1846, p. 336, pl. v., figs. 15, 16. *A. Richardsoni* Reeve, Last of the Arctic Voyagers, ii. App. *A. fabula* Reeve. l. c.; *A. Laurentiana* Lyell; *A. compressa* Daws., — not of European

authors.) A fine series of specimens, recent and fossil, from Labrador, and fossil from Maine and the river St. Lawrence, has convinced me that the numerous variations of form which this species assumes, are of local origin arising from differences in habitat or age. Among a number of *A. Laurentiana* Lyell, received from Montreal through the kindness of Dr. Dawson, are some thinner and more finely striated than usual, but I have recent specimens and also fossils from Labrador agreeing with them. The species varies in the length of the shell, and the form of the posterior end, but the shape of the anterior end, the sulci and the hinge characters, are in all the varieties very constant.

Very elongated forms are like *A. Warhami* Hancock, which we would consider as a synonym of this species. The varieties *A. Richardsoni* and *A. fabula* have occurred in the same locality, at Dumplin Harbor at the mouth of Sandwich Bay, Labrador, where I have dredged them alive.

Astarte striata Gray. One specimen from Hopedale. It did not differ from drift shells found at Brunswick, Maine. This shell, as it occurs fossil, is thicker, more ponderous, more equilaterally triangular; the beaks are directed more anteriorly, the teeth are much larger, and the lunule broader and shorter, than in *A. Banksii.*

Astarte compressa Linn. (*A. elliptica* Brown.) Common in all the beds, but not so abundant as *A. Banksii.*

Cardita borealis Conr. Very abundant with the preceding.

Macoma sabulosa Mörch. (*Tellina proxima* Brown.) Of frequent occurrence.

Cyrtodaria siliqua Daudin. Several valves at Caribou Island.

Panopœa norvegica Sprengel. A perfect valve of this shell occurred at Caribou Island.

Mya truncata Linn. Both the short and common elongated varieties of this species occurred especially at Hopedale in great profusion.

Saxicava arctica Desh. Large valves occurred in great profusion in all these beds.

Chiton marmoreus O. Fabr. Several valves were found at Hopedale.

Tectura testudinalis Gray. One specimen occurred, encrusted with Nullipora.

Lepeca cæca Möll. (*P. candida* Couth.; *P. cerea* Möller, Reeve); frequent.

Cemoria noachina Leach. (*Diadora noachina* Gray.) Frequent.

Margarita cinerea Couth. One specimen. Hopedale.

Margarita varicosa Mighl. et Adams. Frequent at Hopedale and Caribou Island.

Turritella erosa Couth. As numerous in proportion to the succeeding species as at present on the coast.

Turritella reticulata Mighl. et Adams. (*T. lactea* Möll.) Profusely abundant in both places.

urritella acicula Stimps. One specimen. Caribou Island.

Aporrhais occidentalis Beck. Several. Caribou Island.

Lunatia grönlandica Möll. Frequent.

Natica clausa Sowb. Frequent.

Admete viridula Stimps. At Caribou Island.

Bela robusta n. sp. [Plate vii., fig. 12.] No specimens of this species occurred at Caribou Island associated with the other species; it seems quite rare, and has not occurred in a living state. Though very distinct from any of the other species, it might be mistaken for a very much shortened and thickened *B. americana.* It is much shorter and broader than *B. americana;* the whorls are five in number, angulated, giving the shell a well-marked turretted form; the fourth whorl is one half to two thirds as long as the first, which is unusually large in proportion to the rest of the shell. The aperture is broad, regularly

ovate; canal, long, narrow, oblique, and not gradually widening towards the aperture. It has much fewer ribs than *B. americana*, there being thirteen on the lower whorl, where in *B. americana* are eighteen. Length .18; breadth .11 inch.

Bela americana Packard. (*Fusus turriculus* Gould, Invert. Mass. *Bela scalaris* Packard, Can. Nat. and Geol. 1863,— not of Möll., Index Mollusc. Grönl.) *Variety*. [Plate vii., fig. 11.] One specimen occurred fossil at Caribou Island which differed in no respect from a recent specimen dredged in 15–30 fathoms at Square Island, which will be further noticed below.

Bela exarata Möll. (*Defrancia exarata* Möll., Index Mollusc. Grönl.; *Pleurotoma rugulatus* "Möll." Reeve, Icon. Conch. f. 345.) Caribou Island. Common.

Bela Woodiana Möll. (*Pleurotoma harpularia* Couth., Bost. Journ. ii., p. 183. *Pleurotoma leucostoma* Reeve, Icon. Conch. f. 278.) Caribou Island. The most common species of the genus in these deposits, though very rarely found living by us; it is of large size and much eroded.

Bela decussata (Couth.) It occurred very rarely at Caribou Island.

Bela pyramidalis (Ström.) (*Pleurotoma rufa* Couth.) Not common; at Hopedale and Caribou Island.

Bela violacea Mighl. et Adams. (*Defrancia cylindracea* Möll. Ind. Moll. Grönl.; *Pleurotoma grönlandica* Reeve, l. c. fig. 343.) Of common occurrence at Caribou Island.

Buccinum glaciale Linn. Caribou Island, an imperfect specimen.

Buccinum grönlandicum Hancock. Annals and Mag. Nat. Hist. xviii., p. 329, pl. v., figs. 8, 9, 1846. [Plate vii., fig. 5 *b*.] Pitt's Arm, head of Chateau Bay; one specimen, with the outer coating of shell worn off.

Buccinum tenue Gray. (*Buccinum scalariforme* Beck, Stimps., Can. Nat., Oct. 1865, p. 14.) One specimen occurred at Caribou Island, wanting the lip and spire, but showing well the abbreviated longitudinal waves characteristic of the species.

Buccinum undulatum Möll. (*B. undatum* Greene, Gould, Dawson; *B. labradorense* Reeve, Packard, Can. Nat. viii. p. 416, 1863.)

Buccinum cretaceum Reeve, Icon. Conch, Packard, Can. Nat. viii., p. 417, pl. ii., fig. 6, 1863. [Plate vii., fig. 7.] This interesting species, now found not uncommonly on the coast of Labrador, also occurs fossil not unfrequently at Caribou Island. It differs in no respect from living forms.

Fusus (*Neptunea*) *tornatus* Gould. Rarely found fossil at Caribou Island, and in the blue clay at the mouth of Salmon River.

Fusus (*Neptunea*) *labradorensis* n. sp. [Plate vii., fig. 8.] Shell fusiform; whorls moderately convex, sutures deeply impressed, the upper ones somewhat flattened, spire elongated, acute, lower whorl ventricose, covered with rather coarse revolving striæ. On the lower whorl are twenty nearly straight, coarse, flattened folds, which on the succeeding whorls run the entire length of each whorl. Aperture ovate, columella concave, smooth; canal moderately long, oblique, slightly tortuous, spire a little longer than the shell. Length, one inch; breadth .48 inch. One specimen at Caribou Island. It differs from *Fusus pullus* Reeve (fig. 89.) in being apparently a much thicker shell, in the longer canal, and in the more ventricose body of the shell, with the coarser revolving lines.

Fusus tortuosus Reeve, Belcher's last of the Arctic Voyagers, ii., p. 394, pl. 32, fig. 5. Our specimens differ from the description, in the absence of the long tortuous canal which gives the species its name. The fossils have the same convexity of the whorls, which are cov-

ered by similar revolving striæ; but the first whorl is less contracted at the origin of the canal, and the canal itself is from half to two thirds the length of the first whorl, while in *F. tortuosus* the canal nearly equals the length of the whorl. In this respect it approaches *Fusus pygmæus* Gould, from which it is distinguished by its size, the greater convexity of its whorls, and the deeply impressed revolving lines.

In several specimens of *Fusus islandicus* from Eastport, Me., I find that the length and tortuosity of the canal is subject to considerable variation. Of two specimens collected together at low-water mark, one had a short and nearly straight canal, while in the other it was much elongated and twisted. Hence before separating our fossil species from *F. tortuosus* Reeve, more of the recent shells are desirable.

This was a frequent shell in the gravel deposit on Caribou Island, and large specimens measured nearly three inches in length.

Trichotropis borealis Sowb. et Brod. Not uncommon at Hopedale and Caribou Island.

Spirorbis glomerata Müll. Occurred as usual on shells at Caribou Island.

S. vitrea Stimps. Only young and flattened specimens occurred.

Spiochætopterus typus Sars, Fauna littoralis, ii. Fragments of tubes belonging apparently to this worm were found fossil at Caribou Island.

Balanus porcatus Da Costa. Numerous fragments occurred at Caribou Island and Hopedale.

In the above list occur several forms of great interest which have not been found fossil elsewhere, or in no such profusion, and seem to be perhaps characteristic of this fauna and to have had their metropolis either in this area or in Arctic America, in contradistinction from Arctic Europe. Such are

Cardita borealis,	*Aporrhais occidentalis,*	*Bela americana,*
Astarte Banksii,	*Admete viridula,*	*Fusus tortuosus,*
Margarita varicosa,	*Bela exarata,*	*Fusus labradorensis,*
Turritella reticulata,	*Bela Woodiana,*	*Buccinum undulatum,*
Turritella erosa,	*Bela robusta,*	*Buccinum cretaceum.*

From this list the polyzoa are excluded, since no species are recorded from Greenland, except by Otho Fabricius in the Fauna Grönlandica.

Upon comparing this list with that of the species comprised in the present fauna, as published in the latter part of this paper, we can observe how similar are the two faunæ, and how persistently the characters of the earlier of the two have survived the important changes this region has undergone since the glacial epoch. We have here the present Syrtensian fauna in its purity, without the intermixture of the few southern forms, that have subsequently encroached upon its limits. We shall below show where it shaded almost imperceptibly into the Acadian fauna, its nearest southern neighbor; but now we have to determine its most northern limits.

Fortunately Möller, in his "Index Molluscorum Grönlandiæ," and Rink,[1] have noticed the few fossils which have occurred in the Quaternary clays of Southern Greenland, a list of which is here given.

[1] Udsigt over Nordgrönlands Geognosi af H. Rink. *Viden. Selsk. Skrifter, Kjöbenhavn*, 1853, p. 96. The species were identified by Dr. O. A. L. Mörch.

Pecten islandicus,
Leda minuta,
Mytilus edulis,
Modiolaria discors,
Astarte semisulcata Leach,
Astarte corrugata Brown,
Cardium (Aphrodite) grönlandicum,
Cardium islandicum,
Cryptodon flexuosus,
Cyrtodaria siliqua,
Mya truncata,
Mya arenaria,
Panopœa norvegica,
Saxicava arctica,
Tellina calcarea,
Tellina fragilis (grönlandica),
Natica clausa B. & S.,
Littorina grönlandica,
Fusus despectus Linn,
Margarita glauca,
Fusus gracilis Da Costa.

The Leda Clays of Anticosti. In their expedition to this island, referred to in the "Canadian Naturalist," Messrs. Hyatt, Verrill, and Shaler found at the southwest point of Anticosti a deposit of blue drift clay containing *Saxicava arctica*. The shells occurred at ten feet above high-water mark, while fragments were found fifteen feet higher. This was the only fossil noticed.

The Leda Clays of New Brunswick. An interesting collection of invertebrates, received from Messrs. G. F. Mathew and C. F. Hartt of St. John, N. B., enables us to add to our lists several new forms of very considerable importance. They mostly occurred in red clay resulting from the denudation of the Devonian and Triassic deposits about the Bay of Fundy.

Ophiura Sarsii Lütken. St. John. This species has been determined by Dr. Stimpson.
Euryechinus dröbachiensis Verrill. Lawlor's Lake.
Lepralia hyalina Johnst. " "
Membranipora pilosa Johnst. " "
Cellepora pumicosa Ellis. " "
Pecten islandicus Linn. Lawlor's Lake. St. John, R. R. Depot.
P. tenuistriatus Mighl. (*P. magellanicus* Lamk.) St. John.
Leda buccata Steentp. (*L. Jacksoni* Gould.) Lawlor's Lake. Duck Cove.
Leda truncata Brown. (*Leda portlandica.*) Abundant. Lawlor's Lake. Duck Cove.
Nucula antiqua Mighl. Negrotown Point.
Mytilus edulis Linn. Lawlor's Lake. St. John.
Cardium islandicum Chemn. " "
C. pinnulatum Conr. Abundant. Lawlor's Lake. St. John.
Serripes grönlandica Beck. St. John. I have not seen the specimens of this species.
Astarte Banksii Leach. Black Point.
Macoma sabulosa Sprengel. St. John. Manarragonis.
M. grönlandica Stimps. Lawlor's Lake. St. John.
Mya arenaria Linn. " " " "
M. truncata Linn. Manarragonis. My specimens are too fragmentary to decide to which variety they belong.
Saxicava rugosa Linn. Lawlor's Lake. St. Andrews. Manarragonis.
Natica clausa Sowb. " " St. John.
Lacuna neritoïdes. Lancaster.
Balanus hameri Ascanius. Lawlor's Lake. Bathurst.
B. porcatus Da Costa. " " St. John.
Cancer sp.

There were besides well-preserved fragments of a fucus and a brown alga with a broad thin frond.

The Leda Clays of New England. General Features of drift action in Maine. Before describing the beds in which fossils are found in Maine, let us take a glance at the topographical features of this district and the relative distribution of the different members of the materials composing the superficial deposits of the State. This we are enabled to do from personal observation made in several excursions along the sea-board and into the interior through the wild lands, and from data given by C. H. Hitchcock in the "Reports of the Geological Survey of Maine," 1862–3.

The coast of Maine, while running in a general N. N. E. direction, thus corresponding to the general trend of the continent consequent on the upheaval of the Appalachian Mountain chain, forms part of a great indentation in the Eastern Atlantic coast, lying between Cape Cod and Cape Sable, Nova Scotia. This direction of the coast line, there is every reason to think, was determined long before the glacial period. Into this broad bay the river systems empty their waters, flowing, from Cape Ann to Casco Bay, in a general N. W. and S. E. direction. The Merrimac, after leaving the limits of the State of New Hampshire, flows in a northeast direction to the sea, but its general course seaward is southeasterly. Going farther north, the Saco flows in a very direct southeast course. This is the general course of the Androscoggin River. At this point the direction of the rivers changes. The Kennebec flows due south from its head-waters, Moosehead Lake. The Penobscot takes its rise in the highlands isolated from the Alleghany range, and flows in a direction slightly west of south. The S. E. direction is again resumed when we come to the St. Croix and St. John rivers, for their course lies nearly parallel to that of the Androscoggin. While assuming this general direction west of north, the *mouths* of the rivers of Maine within a few miles of the sea change their course almost at right angles, and assume the N. N. E. and S. S. W. course of the fiords. This is quite an important point in the consideration of the N. E. and N. W. course of the drift striæ, and explains, it would seem quite satisfactorily, the remarkable differences in the course of the striæ along the coast as distinguished from those in the interior.

In this connection let us advert briefly to the distribution of the lakes in Maine. They are by no means scattered irregularly over the surface of the State. The general direction of their longer axes is N. W. and S. E.; thus they run nearly at right angles to the course of the fiords or deep bays. We can also perceive an arrangement into two series: one, the inner, higher above the sea than the other, and resting on the great water-shed of the State, from which flow streams running north and south. If we draw a line through Lakes Umbagog, Moosehead, Chesuncook and the numerous lakes (Chamberlain, Webster, Telos, and Churchill) which form the head-waters of the Alleguash on the one hand, and the Penobscot on the other, and also the Schoodic Lakes and the broad, lake-like expansions of St. John River, we shall describe a great curve assumed by this water-shed, and which lies parallel to the sea-coast. A lower tier of lakes, inferior in size, as they are of less importance in the system of drainage, is also parallel to the coast, and situated just above the first or upper falls of our great rivers, or at the head of tidal waters; — these are Lake Sebago, the large lakes lying just above Augusta and Bangor, and the Grand Lakes on the eastern border of the State. At the time of the deposition of the upland clays, and during the later period of submergence when the *osars* and sea-beaches were laid down in the interior of

the State, and deep bays and fiords occupied the beds of the present lakes, we see that the course of those fiords were at nearly right angles to the direction assumed by those of the present coast line. This applies to each of the two interior coast lines. It is also evident that the middle coast line is more complete, the descent more abrupt at a given point, and consequently it is probable that the sea stood for a great length of time at this level. It is doubtful whether the inner series of lakes lying on the water-shed were ever deep fiords, as we have no evidence from fossils that the sea rose over 500 feet above its present level.

There is a special connection between the distribution of the three varieties of clays in the State, which present such different lithological and palæontological, or in the case of one, want of palæontological characters.

As we shall see below, the lowest horizon of life occurs in beds exposed only near high-tide mark on the coast, and consisting of an unusually tough clay filled with boulders overlaid by a great thickness of clay, which gradually becomes lighter in its character as we ascend to the upper layers. This is the earlier boulder clay. Next we have lighter brick-yard clays with their peculiar horizon of life, which are spread over the lowlands between a line about 25 feet above the high-tide mark, and the middle coast line from twenty to seventy-five miles in the interior and rising 200 feet above high-tide mark. Again, between this middle coast line and the top of the water-shed or interior line of coast and the bases of the mountains, occur the moraine clays or unmodified drift, though all these three varieties of clays evidently graduate into each other. In this inland area there is a greater proportion of rock surface exposed, and a far greater abundance of boulders, arranged in clearly marked trains, than upon the coast. In this highland region occur the marks of ancient glaciers, left in these trains of boulders, which were undoubtedly lateral moraines, and in the terminal moraines in the form of tumuli and especially rounded hillocks of peculiar shape, consisting wholly of gravel, which have been rounded by the subsequent action of the sea, and farther modified by the action of the broad rivers of the Terrace Epoch.

While the general direction of the drift or glacial striæ in the State is northwesterly, there are two other courses, a general north and south one, and more rarely a northeasterly course. In analyzing the directions of these striæ, as given by Mr. C. H. Hitchcock in the first "Report on the Geology of Maine," 1862, for seventy-seven localities, to which we would add three localities, Brunswick, Falmouth, and Lewiston, making eighty in all, we find that one of the number alone runs north and south, while sixty-two of the number run west of north; and seventeen, or less than one-fourth, run east of north. Of the sixty-two N. W. striæ, those occurring in localities in the northern part of the State have a greater *westing*, (from 40°–50°), than those nearer the coast. On the other hand, of the seventeen N. E. striæ, the greatest amount of *easting* occurs near the coast, being from 10°–20°. In the interior the great majority, nearly three-fourths of all the N. E. striæ, only vary 5°–10° from a north and south line. One mark on Lake Telos is put down by Mr. Hitchcock as 80° east, but in a region where the glaciation proceeded almost from the due west; this we must think is probably an observation which needs to be confirmed, as the majority of striæ run from 30°–50° W. of N.

Thus the northwesterly course of the glacial grooves and striæ is especially marked in the interior of the State, on the highlands and low mountains, whose stoss and lee sides uniformly agree with this course. But as we approach the coast, the glaciers, whose marks we see, moved down the river valleys and thus assumed a more north and south course and at times, owing to local bends in the depressions, were even deflexed so as to flow from

a direction a few degrees east of north. It must be remembered, as Professor Dana has noticed in his remarks on the Mohawk River glacier, that the glacial striæ, when following river courses, were made by local glaciers at the close of the period of great continental[1] glaciers, when the snow line was rapidly ascending, and the *mer de glace* stood much farther in the interior.

Such an arrangement of *estuary deposits*, as noticed below, at the mouth of the Androscoggin River, occurs also at the mouth of the Saco River, and of the Merrimac, and in fact of all the rivers of New England. In tracing the Androscoggin and Saco rivers from their mouths back to their head-waters, we shall find repeated at intervals along their course, wherever a village rests upon the bank, river terraces, resting on ancient marine beaches altered from ancient glacial moraines, flanking a former sea-bottom, consisting of marine clays. In tracing up the Androscoggin, these are finely shown at New Gloucester, Lewiston, Paris, and Bethel, in Maine. At Bryant's Pond is a fine example of a glacial moraine lake. Its northwestern end lies at the foot of hills rising abruptly around and partly enclosing it, while its southeast shore is composed of a semicircular altered moraine rising as a barrier between the pond and the river which flows by it a few rods to the eastward. On the sides of all the valleys lying at the foot of the White Mountains are distinctly seen moraine hills, which, lower down, are rewashed and modified into lake terraces, which were but dilatations of the large rivers, now represented by small mountain torrents and streams.[2]

In passing from Gorham, N. H., to the Glen House we see on each side of the road, fine examples of true glacial moraines which apparently have never been modified by the sea. These moraines, presenting vertical cliffs from fifty to one hundred feet high, of clay and mud and gravel, are mixed in confusion, though near the top of the deposit there is a rude stratification probably similar to what has been noticed in the ancient moraines in the Alps. There is a marked difference between the soft, oozy, treacherous, glacial mud which sticks to the enclosed rounded, worn, and polished boulders, and into which one may sink almost knee-deep, and the tough, tenacious, marine clays of the coast.

This moraine matter I observed, in ascending the sides of Mount Washington, to become gradually freer from the glacial mud, and the soil through which the boulders are scattered becomes more loamy and gravelly. Also, as we ascend the mountain, the boulders become more angular. Half way up the mountain, at a point beyond the limits of growth of the deciduous trees, where the spruces grew from 30 to 40 feet high, the drift was almost wholly composed of boulders, one half of which were angular, while the other half were rounded. As we ascend higher the rocks continue to grow more angular, until just beyond the limit of trees, at a height of 4150 feet, both the boulders and gravel are *all* angular. At this height no foreign boulders of rock differing from the peculiar slate which forms the summit of the mountain, and which, as Prof. Leslie oberves,[3] is not found at the base, were observed. The sides of the mountain, and the summits of Mounts Jefferson, Adams, Clay, and Madison, are strewn thickly with angular masses of granite and mica slate containing staurotide in great abundance. The "Ledge" is an embossed and rounded rock 3840 feet

1 By *continental glaciers* we would not convey the idea of a *single*, broad, unbroken ice-dome extending from one ocean to the other, but rather of a *system* of vast seas of ice capping the principal water-sheds of *Eastern* North America, and sending branches down the principal valleys. This may be *assumed*, though many years of observation, in British North America especially, are needed to *prove* the existence of such seas of ice capping broad areas of thousands of square miles.

2 See "Hitchcock's Surface Geology," Smithsonian Contributions. We would, however, rather consider the "moraine terraces" of that learned investigator, as remodelled glacial moraines, which at a later period formed ancient beaches.

3 *Proc. Amer. Phil. Soc.*

above the sea. Above this point no grooved or striated boulders were perceived. Indeed, there are no indications of the action of the sea in any deposits noticed beyond a height of five hundred feet above its present level, so far as I could discover anywhere in this group of mountains. The same may be said of Mount Katahdin, in Maine. The upper 1000 feet of its height is free from rounded transported boulders. The summit is strewn thickly with huge angular blocks broken off by frosts from the subjacent strata. At the height of about 4000 feet above the sea, at the "Slide" on the south side of Mount Katahdin, is a large mass of glacial moraine matter which has escaped denudation, and this encloses frequent rounded and polished boulders of fossils of the same species of Silurian shells and of the same silicious slates as are found *in situ* a few miles northwest, on Lakes Webster and Telos. The original fine glacial mud adheres firmly to these pebbles. They were evidently rounded by glacial streams and the pressure of the ice itself, and not by the action of sea waves, for writers have noticed a large percentage of such rounded pebbles in the moraines in the Alps. Parallel cases of a transfer of glacial matter from lower to higher levels have been noticed by geologists both in this country and in Northern Europe. Apparently the boulder containing the Silurian Brachiopods came from the horizon now developed on Webster and Telos Lakes, as the species I collected from both localities is the same in the beds at Webster Lake as that found on the mountain. The theory that the boulders were carried up by icebergs seems untenable, since the parent beds are but about twelve miles distant.

Above this point on the mountain there were no loose, rolled boulders, but the peak was covered by loose blocks detached by the powerful disrupting agency of the frost from the underlying rock, as in the five higher peaks of the White Mountains, and the higher of the mountains of Labrador above the rounded hills, 1000–2000 feet high, at their base. It should be noticed that the summit of Mount Katahdin is a true "needle" or sharp peak, being a short ridge on which two men cannot walk abreast with safety, and along which in wet or windy weather it is perilous to walk from danger either of slipping down or being blown over the precipice which on each side descends thousands of feet. Thus it seems reasonable to infer that the sea has not risen more than perhaps five or six hundred feet above its present level either in the mountainous portions of New England or over 1200 feet in any portion of the Labrador Peninsula. On the other hand, the White Mountains and the higher mountains of Maine all seem to differ from the high mountains in the northern termination of Labrador, in presenting one grand stoss and lee side. The long slopes toward the northwest, and the mural southeast faces are as well marked as the embossed rocks rising out of the lowlands at their base. The highest five hundred feet of Mount Washington, and probably the summits of the surrounding peaks, and the top of Mount Katahdin, probably, as stated by Professor Agassiz, rose to break the otherwise icy expanse, as at the present day granitic peaks rise out of the *mer de glace* in the Alps, Greenland, Spitzbergen, and Norway. This difference between the N. W. and S. E. sides is especially seen after riding through the "Notch" from Conway, and then taking the new Cherry Mountain road from the "Notch" around by way of the town of Jefferson to Gorham. All the narrow valleys, deep precipices, the more rapid torrents, and the loveliest as well as grandest scenery, is found on the southerly aspect of the mountains. On emerging from the "Notch," we soon come out into the broad intervals and tracts, many square miles in extent, bordering the banks of the Ammonoosuc River; and there is a gradual, steady ascent from the plain up

to the summit of the mountain, in striking opposition to the sudden ascent from the opposite side.

The deposits of gravel uniformly spread over the temperate zone, capping the clays and lying unconformably upon them, are, I conceive, derived from the upper part of the original moraine matter, and it is not necessary to explain its presence by introducing a new and more recent glacial period. Thus a continuity can be traced between the gravel deposits as they occur unconformably to the clays beneath, and as they occur in the White Mountains in an unwashed, undisturbed state, where they form a part of the original glacial moraine matter, differing only in having less mud in its mass and more gravel, and in lying at the top of the mass. This is the natural arrangement of moraine matter as described by writers on glaciers, who state that the mud is formed at the bottom of glaciers, while the gravel, transported blocks, and detrital matter are hurled down by avalanches upon the back or upper surface of the glacier. The sea, as it gradually encroaches upon the terminal moraine of the retreating glacier, would naturally seize and throw down on its bottom the finer mud of the lower part of the moraine mass, and the heavier gravel and trains of boulders would retain their position throughout the entire process of denudation. It is thus that the gravels, sands, and trains of boulders are always uppermost in the series.

The great point of interest in connection with a glacial theory, is to learn whether the White Mountains, and larger mountains of Maine, were centres of glacial action like the mountains of Switzerland, Scandinavia, Greenland, and the Himalaya Mountains, in the present day, and the Highlands of the British Isles, of New Zealand, and the Rocky Mountains, formerly. It would naturally be supposed that at the close of the glacial period, there would be left about this group of Alpine heights small glaciers descending the valleys.

Since this paper was presented for publication, additional observations made in the White Mountain Valleys, watered by the Androscoggin and the tributaries of the Saco, afford proofs that local glaciers radiated from the central peaks as in the Alps and mountains of Norway. At Jackson, N. H., on Thorn Mountain, which lies just south of Tin Mountain, there are some well-marked glacial scratches running N. 25° W., and which point directly towards Mount Washington, which stands at the head of the valley of the Ellis River. On the same mountain and hills lying below, are boulders of mica slate conaining numerous crystals of staurotide, beds of which occur only near the summit of Mount Washington, from which they must have been transported.

The summit of Mount Kearsarge, 3400 feet high, is rounded by ice. Dr. C. T. Jackson, in his "Report on the Geology of New Hampshire," states that half way up the mountain the drift scratches run N. 30° W., being about the same course as on Thorn Mountain. He also states that on Mount Chicorua the striæ run N. 35° W. (S. 35° E.), which is the general course of the Ossipee Valley southeast of this peak.

On a hill just east of Goodrich's Falls, on the Ellis River, are very distinct ice-marks on polished surfaces, with striæ running N. 30° W., and lunoid furrows with the opening of the crescent pointing up the valley in the same general direction as the grooves.

Crossing over the mountains into Chatham, N. H. and Stowe, Maine, into the valley of the Cold River, another tributary of the Saco, we find another set of striæ running in quite a different direction. On Speckled Mountain, which lies just east of Mount Royce, the grooves and lunoid furrows point N. 15° E., following the course of the valley at this place, and aiming, so to speak, at a higher peak to the North and East.

On Mount Baldface, 3600 feet high, three or four miles southwest of Speckled Mountain,

the glacial grooves are very clearly indicated both below and directly upon the summit. Here they run N. 10° W.; and it might be mentioned that the Cold River Valley turns more to the southeast at this point. On a shoulder of the mountain, three hundred feet perhaps below the summit, the lunoid furrows are very abundant. On the summit of this mountain, which is made up of a light-colored fine syenite, were a few boulders of a peculiar porphyritic syenite, with oblong crystals of albite. Following the N. 10° W. course, less than a quarter of a mile, we traced this train of boulders to the parent rock on Peaked Mountain, of which this mountain is composed. This elevation is perhaps one hundred feet lower than that of Mount Baldface.

Again, crossing the high range of mountains over into Gilead, in the Androscoggin Valley, glacial marks occurred on a high ledge near the river, indicating that the ice moved from the northwest, pursuing the general course of the valley at this point.[1]

Here, then, are good proofs of distinct systems of glaciers radiating from a central *mer de glace* which probably capped the White Mountains. This dome of ice must, so far as our slight observations show, have been soon subdivided into local glaciers, which pursued their route down the different valleys to the sea. Thus following down the Androscoggin River, at Lewiston, as I am informed by Mr. George J. Varney, the ice-marks run nearly north and south, corresponding with the course of the valley at that place. At Brunswick, on the sea-shore, there are deep furrows running in a northwest direction, following the ancient course of the river where it undoubtedly entered the sea up to a late period of the Terrace Epoch.

There is the clearest evidence in the remains of terraced beaches that, so far as we can judge by the slightly stratified state of the drift material, all the present valleys of the White Mountain streams, viz.: the Peabody River, the Ellis River, the Saco, Ammonoosuc and Moose rivers, which radiate from the base of Mount Washington, were formerly occupied and filled to the depth of many hundred feet by large bodies of water. Thus in the Glen the Peabody River is on its northwest bank lined by a series of terraces which rise four in number up to at least 1000 feet above the level of its junction with the Androscoggin at Gorham, though the terraces are best marked six miles from its mouth. The higher of the terraces are broken into hills, the "moraine terraces" of Professor E. Hitchcock; and in their characters can be noticed all the modifications so fully described in general terms as well as in a more detailed form, in Dr. Hitchcock's "Illustrations of Surface Geology." Similar moraine terraces with the lower lying, and consequently more recent terraces, are seen bordering the other streams just named. The moraine terraces ascend the sides of the mountain at least 2000 feet above the level of the sea, and the masses of slightly stratified drift material, found 4000 feet above the sea, are perhaps a continuation of the same moraine terrace, being drift material partially arranged by water, probably very fresh,

[1] Since this paper was placed in the printer's hands, Mr. G. L. Vose thus writes me — proving the existence of a Peabody River glacier, which moved down from the northeast side of Mount Washington, and also confirming our theory of an Androscoggin River glacier. "I noticed last summer, furrows on top of Mount Hayes running about S. 40° E. (N. 40° W.) magnetic; while about a mile up the Mount Washington carriage-road are furrows running S. 30° W. (N. 30° E.), and about two miles up, S. 25° W. (N. 25° E.), magnetic. The variation of the needle thereabouts is about 14° W., so that the reduced courses of the furrows would be: on Mount Hayes, S. 54° E. (N. 54° W.), and on Mount Washington, S. 16° W. (N. 16° E.)" These last furrows point down the Peabody Valley. Near the Alpine House at Gorham, on each side of the valley of the Peabody River, are high, steep cliffs of unmodified glacial drift, which must be the remnants of a terminal moraine thrown across the valley, while the more superficial and middle portions of the moraine have been remodelled into the river terraces, of which there are two sets, beautifully marked; especially the delta terraces of the mouth of the Peabody River, in front of the Alpine House. Mr. Vose also suggests that the "old Peabody River glacier, if I may venture on the expression, may have dammed up the Androscoggin at Gorham."

and running *down stream*. The slight sections seen in the lower levels of the moraine terraces presented, by the arrangement of the boulders and shingle in reference to the whole mass, quite a striking resemblance to the present position of the boulders in the mountain streams. All the stones were so arranged as to present a stoss side toward the mass of waters pouring over them — the longer slopes of the stones always facing up stream, the steep sides down stream. The stream had arranged the stones large and small with reference to gliding over its stony bed with as little hindrance and friction as possible.[1]

It is thus evident that during the Lake Period, or Epoch of Great Rivers, these White Mountain glens were filled with glacial lakes, restrained by barriers thrown up by terminal moraines, which the supposed previous presence of the sea was not sufficient to remove, but which yielded to the power of large masses of water running down stream through the mountain gorges. Slight remnants of these huge glacial deposits still exist as terraced fresh-water beaches on each side of the deep mountain valleys.

Localities of Fossils in New England. Starting from the border of New Brunswick we will proceed to describe in detail the characters of the drift beds and their fossils, going south and eastwards.

Calais. Seven miles below Calais, on the banks of the St. Croix River, is a deposit described to me by Mr. C. B. Fuller of Portland, which agrees, as stated by him, with the clays of Eastport and Campo Bello Island. Mr. Fuller found here *Leda truncata* in abundance, forty-five feet above the level of the river.

I am also indebted to Mr. Fuller for the following list of shells found by Mr. De Laski two hundred and seventeen feet above the sea, three miles above the Fox Island Thoroughfare at North Haven, in a bed of marine clay overlaid by a layer of "blue sand" eighteen inches in thickness: —

Pecten islandicus, Mytilus edulis, Astarte semisulcata, Serripes grönlandicus, Saxicava distorta, Mya arenaria, Mya truncata, Buccinum undulatum, Buccinum tenue Gray, *Natica pusilla* (*grönlandica*), *Balanus balanoides.*

Eastport. Professor A. E. Verrill has found at Prince's Point, Eastport, Maine, *Nucula antiqua* (*N. expansa*), *Macoma sabulosa, M. fusca, Cardium islandicum, Saxicava rugosa,* and *Pholas crispata* Linn. These specimens I have seen, and also have collected with Mr. C. B. Fuller, upon the island of Campo Bello, at the shore opposite Lubec, *Leda truncata* (*portlandica*), *Macoma sabulosa, Mya arenaria* and *Buccinum undulatum.* These occurred just above high water-mark, in a blue clay bank twenty feet thick, resting on the rocks underlying the island.

Waterville. I am indebted to Professor Hamlin of Waterville College, for a list of fossils from the Waterville clays, which are in the college cabinet and were labelled by Professor Loomis several years since. Among them were *Purpura lapillus,* and a *Natica.* There were several specimens of *Buccinum grönlandicum.* The list also contained "*Mya arenaria, Nucula antiqua, N. tenuis? Mytilus edulis, Fusus tornatus, Balanus,* and remains of a Crustacean, together with a crab's claw."

Beds at Bangor, like those at Gardiner, contain *Astarte Banksii* Leach, *Astarte compressa* Linn, (*elliptica*) and *Mya arenaria.*

[1] My attention having been called to this method of arrangement of stones forming the bed of a stream by a paragraph, and wood-cut illustration, in Sir Charles Lyell's *Antiquity of Man,* I was incited on the spot to extend the comparison to the material composing the moraine terrace.

Augusta.

The following species were collected by my friend Mr. C. G. Atkins, from the river bank just above the dam.

Pecten islandicus Linn. Abundant as usual.

Leda portlandica Hitchc. Abundant.

Mytilus edulis Linn. Abundant.

Ostræa canadensis. This species is inserted on the authority of Professor Desor, as specimens collected by him are in the Museum of this Society.

Astarte compressa Linn. (*A. elliptica* Brown.) Common.

Astarte semisulcata Leach. Frequent.

Astarte striata Leach. Rare.

Cardium pinnulatum Conr. Not common; also in a collection made by Professor Desor, in the Museum of this Society.

Serripes grönlandicus Beck. Frequent.

Macoma grönlandica Stimps. Common; showing that the deposit was near the upper level of the Laminarian zone, as also does the presence of large *Myæ* and *Mytili.*

Macoma sabulosa Sprengel. Common and large.

Mya truncata Linn., var. *uddevallensis.* Common.

Mya arenaria Linn. Abundant and large.

Saxicava arctica Desh. (*S. rugosa* Linn.) Common.

Natica clausa Sowb.

Natica grönlandica (Beck.) Both species were not uncommon.

Buccinum grönlandicum Hancock. Of the usual frequency.

Buccinum tenue Gray. (*Buccinum scalariforme* Beck.) One imperfect specimen.

Buccinum glaciale Linn. One specimen occurred.

Buccinum undulatum Möller. A specimen collected by Desor is in the collection of this Society.

Balanus Hameri Ascan., collected by Mr. C. G. Atkins, occurred at Vassalboro.

Gardiner.

The deposits of Gardiner possess great interest owing to their unusual thickness, and the rich assemblage of marine invertebrates which occur from the lowest to the higher strata, and from the occurrence of the teeth of the bison, and of the walrus, which were dug out of the beds at a distance of fifteen feet from the top of the clay, during Sir Charles Lyell's second visit to this country. He states that the teeth of the bison were forwarded to London, where they were identified by Professor R. Owen. The intermingling of the bones of the walrus and bison in the same beds, shows the great range both of Arctic and Temperate forms during this period. It is parallelized by the similar intermixture of *Leda truncata*, now peculiar to the seas of Spitzbergen, with shells, for example, *Cardium pinnulatum*, more characteristic of the present fauna of Maine. This clay formation rises in conical hills of over one hundred feet elevation above the level of the river, rising from the railroad, which is eighteen feet above high water, and twenty feet above the sea level, while their summits are capped by thick beds of coarse marine gravels often thirty feet thick. The marine gravel which overlies them has been greatly denuded by the action of the river which has formed out of this material the series of river terraces which rise about half way up to the summit of the hills. This clay formation extends continuously down the river to the coast, constantly spreading out into a broader area and rising into low hills and broad undulating fields as it approaches the coast, there presenting beds of similar lithological characters, and with much the same zoölogical assemblages, as at Brunswick and Saco.

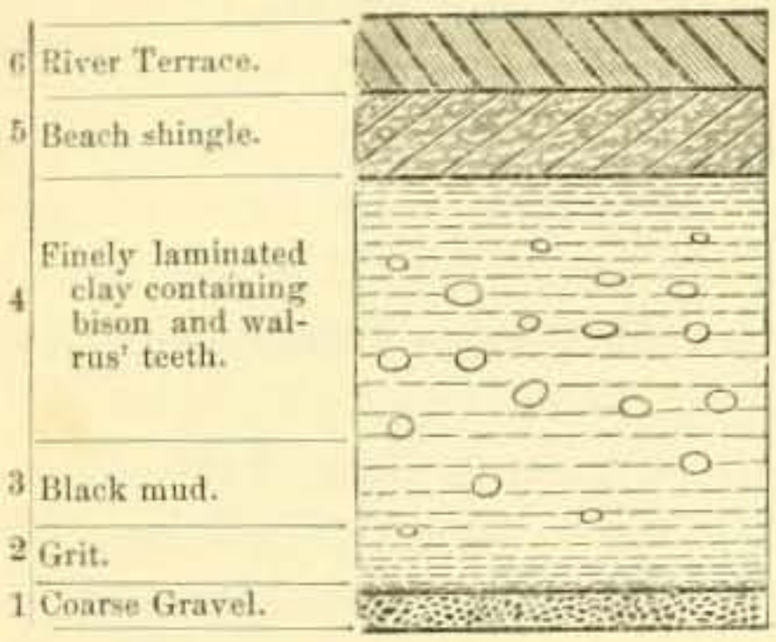


FIGURE 3.
Ideal Section of Quaternary formation at Gardiner, Maine.

A section given in the ascending order, shows the following succession of beds and their characteristic fossils: —

1. A few feet of unfossiliferous gravel resting directly upon the gneiss rock.

2. A few inches of a sandy grit, which weathers into an exceedingly hard sandstone, rich in life, containing *Membranipora americana*, *Lepralia variolosa*, *Pecten islandicus*, *Pandorina arenosa*, *Astarte Banksii*, *A. elliptica*, *Serripes grönlandicus*, *Natica clausa*, *Fusus tornatus*, *Buccinum grönlandicum*. Similar gritty sands are found in patches in the clays above.

3. A soft black clay with a strong odor of marsh mud, containing shells and the remains of Algæ.

4. These beds gradually pass into what the brick-makers call "bar clay." It is about seventy-five feet thick and is very finely laminated, very evenly bedded, consisting of layers an inch thick, separated by thin laminæ of a pure silicious sand. It also contains a few polished and scratched gneiss and greenstone boulders scattered through its mass. Here nearly all the fossils mentioned in the accompanying list occur.

The lowest bed of gravel I did not myself see, but it was described to me by the former proprietor of a pottery manufactory, as resting directly upon the solid rock, as it is often penetrated in boring for wells, and is thus found to be absent in many places about the town, as very frequently the rock is reached directly after digging through the black mud or clay. Most of the wells, after being sunk twenty-five feet, terminate in this soft clay, and the water is unfit for use; while very deep wells, sometimes sunk seventy-five to one hundred feet down into the stratum of clean pure gravel, afford the purest water.

The gritty beds near the bottom of the series of clay strata contain deeper sea forms than those above, and the paleontological evidence leads to the conclusion that they formed a sandy, shelly bottom like our submarine banks, swept by comparatively swift ocean currents; that at a later period the currents were not so strong; that the sea bottom changed into the floor of a deep bay or estuary, in which river silt accumulated, where the most delicate shells lived, and the *Natica* deposited its eggs in broad, thin, platter-like masses, and littoral shells, such as *Mya* and *Mytilus*, abounded. Again, the waters growing fresher, more river sand took the place of mud, the shells disappeared from the loamy strata, and then came an era of denudation, and the deposit of the sea shingle and beach sand, which filled up the hollows and inequalities of the boulder clay.

Returning again to the fossiliferous clays, they were found sparingly stocked with boulders of gneiss and argillaceous slate, often highly polished, with shells firmly adhering to them, as if pressed upon them, since they were flattened out, broken and cracked. All these clays, like those everywhere observed in Maine, where weathered, present a rude and unstratified steep cliff with a slight talus of stones at the bottom. The shells most characteristic of this deposit were *Nucula antiqua* and the two species of *Astarte*, *Mya arenaria*, and *Mytilus edulis*. Owing to the pressure of the superincumbent strata, many of the shells, especially the *Nucula*, were greatly flattened, and distorted into a variety of forms very different from the natural shape, reminding us of the distorted shells of the palæozoic rocks. Several forms, if presented to one unacquainted with this fact of distortion, would be readily mistaken for distinct species, as they are often elongated without being flattened, or cracked

and broken in the least. In the Saco beds, and in other beds generally, some forms of *Serripes grönlandicus* are much flattened and slightly elongated, differing in this respect greatly from the recent specimens, but all the changes of form evidently took place after the death of the animal. The mammalian remains occurred in the upper part of this series of beds. The bison teeth were taken out by Sir Charles Lyell about fifteen feet from the surface. Throughout the beds occurred in abundance concretions of clay, easily crumbling, which assumed cylindrical or spherical forms upon being hardened by exposure to the air. These have already been noticed by authors. They are evidently concretions around the fronds of Algæ and animal remains. They are very plentiful, and have been observed in abundance only in beds of this horizon.

These beds of clay become more sandy as they reach the top of the deposit, until the beds graduate into a loamy, sandy clay, affording our best arable soil. All these beds, with the exception of the lowest gravelly strata graduate into each other.

5. Resting unconformably upon them is a thick bed of marine coarse gravel or shingle, which evidently once formed a continuous sheet of sand, — an ancient sea-beach, and is now mostly rearranged (6) into river terraces.

Total thickness of the entire formation, about one hundred and thirty feet.

The clay beds containing the fossils enumerated below are gently inclined toward the east, dipping at an angle of about 10° toward the present bed of the river.

Lepralia hyalina Linn. On *Serripes grönlandicus.*

Lepralia variolosa Johnst. Several patches in shells of Buccinum.

Membranipora americana D'Orb. Occurred on *Pholas crispata.*

Pecten islandicus Linn. Large and coarsely ribbed; not very abundant.

Leda buccata Steenstp. (*L. Jacksoni* Gould.) Of the typical form.

Nucula antiqua Mighl. Very abundant, and finely preserved, the greenish brown epidermis preserving its original hue and lustre. Some very large and flattened forms occurred with those much elongated and much shorter from beak to lower border than in the typical, ventricose form.

Mytilus edulis Linn. The common form, young and old, were very abundant, and also the variety *pellucidus.*

Mytilus discrepans. (*Modiolaria nigra* Gray.) A few valves.

Astarte compressa Linn. (*A. elliptica* Gould.) Abundant, but not so common as the forms of *A. Banksii.*

Astarte Banksii Leach. (*A. Richardsoni* Reeve.) Common. The fossil forms agree precisely with those living, which I have dredged abundantly in Labrador.

Serripes grönlandicus Beck. Common.

Cardium pinnulatum Conr. Frequent.

Pandorina arenosa Sacchi. A few valves.

Mya arenaria Linn. Very abundant.

Pholas crispata Linn. One valve larger than common in recent forms.

Natica clausa Brod. et Sowb. Some specimens were greatly flattened, the spire appearing as if driven in to the body of the shell.

Buccinum grönlandicum Hancock. This species occurred in a broken and generally imperfect state. Some were large and the waves very much developed. Others occurred smaller, with the outer layer of shell off, corresponding with forms from Portland and Augusta, and agreeing well with the characteristic drawing in Lyell's paper on the fossil discovered at Quebec by Capt. Bayfield (Trans. Geol. Society, vol. vi. 1842, p. 135).

Fusus (*Sipho*) *tornatus* Gould. Frequent and of large size.

Spirorbis sp.

Balanus crenatus Brug. Frequent.

Balanus Hameri. Frequent.

Hyas aranea (Linn.) The claws quite large, showing that they belonged to individuals of maximum size, occurred rarely.

Mallotus villosus Cuvier. This was first detected by Mrs. F. Allen of Gardiner, and identified by Sir Charles Lyell. It is rarely found. Sir C. Lyell, in a letter to Mrs. Allen, observed its occurrence at Saco, having been found by a person in that town.

Rosmarus obesus Illiger. In the cabinet of the late Mrs. F. Allen is a walrus' tusk which, I am informed, was taken to London by Sir C. Lyell and identified by Professor Owen.

Bos americanus Gmel. [Plate viii., fig. 18, a, b,] A third upper molar and first premolar tooth are in the collection of Miss Allen of Gardiner, to whose kindness in loaning these unique specimens I am greatly indebted. A second upper molar belongs to the museum of this Society. They agree in all respects with those in a skeleton in the museum of this Society.

Lewiston. From a deposit of arenaceous clay finely laminated, has been taken, at a height of one hundred and ten feet above the sea, a finely preserved specimen of *Asterias vulgaris* Stimps., which is in the museum of this Society. Near this locality *Mya arenaria* and *Leda truncata* have been forwarded me by my friend Mr. George J. Varney of that city.

Brunswick. The drift deposits at Brunswick contrast most widely with the equivalent beds which we have described as occurring in Southern Labrador. All the three divisions of the drift here develop their characteristic features. Resting upon the grooved and striated (N. W. and S. E.) gneiss rocks which underlie the town, we have a thick bed of blue tenacious fossiliferous clay which inclines gently toward the south. Upon this lies the brick-yard clay, or modified drift into which the lowest beds graduate, which is always well marked, and forms a large proportion of the arable land of the town. It is exposed for miles along the shores of Casco Bay, on the river, and artificially. It is from this bed that most of the boulders are derived. Again, resting upon the boulder clay, and filling up its irregularities, is a broad sheet of stratified sand which forms the arid plain upon which the town is situated. It is four miles long and five wide, and slopes gently toward the sea at the rate of about fifty feet in three miles. This sandy plain must formerly have been the bottom of a shallow estuary into which the Androscoggin emptied its waters before the Terrace Epoch, while the immense bodies of water were draining off, during the elevation of the coast. For it was after the deposition of this immense body of sand, evidently the terminal moraine of a local glacier, which scooped out the river bed of the Androscoggin, that the river was turned eastward in its course, and emptied its waters into the Kennebec, after which these sands were reassorted into terraces.

These terraces are six in number upon the south side of the river, while upon the opposite, or Topsham side, there are but two straight parallel ones which run nearly east and west, following the course of the river at this point. Upon the south, or Brunswick side, of the river, the highest and earliest formed terrace is indistinctly marked, and turns southward from the river at nearly right angles to its present bed. The remaining ones are longer, more perfectly formed, and assume successively a direction more parallel with that of the river, until the two lower and most recently formed terraces lie almost exactly parallel to the two opposite ones upon the northern side of the river.

The locality of fossils situated farthest inland is at the "Railroad Cut," two miles and a half westward from the depot, eighty feet above the level of the sea, and about three miles distant from it. Upon the western slope of the gneiss hill through which the road has been blasted, lies the fossiliferous blue clay. At this point *Nucula antiqua*, *Leda truncata* (*portlandica*), *Mytilus edulis*, *Cryptodon Gouldii*, *Mya arenaria*, *Saxicava arctica*, and *Pandorina arenosa* occurred.

By digging for the construction of wells, anywhere through the sandy strata of the town, the blue clay is found at the depth of ten to thirty feet. Besides the shells of *Mya arenaria* and *Mytilus edulis* in all stages of growth, we find in their usual relative abundance, *Nucula antiqua*, *Leda truncata* (*portlandica*), and occasionally *Pandorina arenosa*.

These beds correspond perfectly with the higher beds of the Leda clay on the Kennebec and Penobscot rivers, and at Portland.

The lower horizon of fossiliferous clays is developed in several localities on the shores of Casco Bay, one of the most interesting of which is found at high-tide mark on the western shore of Mere Point. The shores of the Bay, in the more retired arms and reaches, are largely composed of cliffs of the boulder clay, which though always stratified, consisting of a tough blue clay at the bottom of the beds, graduates at the top into a lighter, more loamy clay, and abounds in sea-worn erratics. Where this boulder clay has been denuded on its surface, the land is invariably found thickly strewn with boulders, more so than in the more recent brick-clays farther inland. Besides the remains of sea-weeds were stems of a sedge-like plant and smaller portions of land plants too indistinct for identification. In the upper part of the beds, near the surface, concretions of clay formed about the stems of vegetables, occurred in great abundance.

Lepralia nitida (Fabr.) Rare. The living form has not yet been detected on our coast south of Greenland.

Lepralia annulata (Fabr.)

Hypothyris psittacea King. One valve occurred.

Nucula antiqua Mighl. (*N. expansa* Reeve.) Abundant.

Leda buccata Steenstr. (*N. Jacksoni* Gould.) Numerous.

Leda truncata Brown. (*N. portlandica* Hitchc.) Numerous.

Pecten islandicus Linn. Very abundant and large.

Serripes grönlandicus Beck. Common.

Macoma sabulosa Stimps. Frequent.

Astarte compressa Linn. (*A. elliptica* Brown.) Very abundant.

Astarte Banksii Leach. Rare.

Astarte striata Leach. Rare; fine large valves. [Plate vii., fig. 1.]

Mya truncata Linn. The short form frequently occurred.

Saxicava arctica Desh. Numerous.

Fusus (*Neptunea*) *tornatus* Gould. Abundant and very large, some specimens nearly four inches in length.

Buccinum undulatum Möller. Large. Specimens occurred of both the short common form, and the long variety which we have only seen growing in Labrador.

Balanus porcatus Da Costa. (*B. crenatus* Brug.) Abundant.

Portland.

The drift beds at Portland resting upon Bramhall Hill, a rounded gneiss hill 175.5 feet above the mean sea level, dip at rather an unusual angle, 15°–25°,

S. E. and N. W. on each side of the hill, following the natural declivity of the rock. They agree closely with those described at Gardiner and Augusta, with slight local variations; consisting, in the upper beds, on S. E. side of the hill on Canal Street, of more frequent alternations of arenaceous beds. First, in ascending order, is a bed of hard blue clay containing the numerous deep-sea forms enumerated below, which have been found at this locality by Mr. C. B. Fuller, without whose kind assistance this list could not have been prepared. These beds of pure clay pass into beds containing patches of sand and grit, until at a level varying from twenty-five to forty feet above the sea, following the slope of the surface, the beds are composed of sand, with an almost entire absence of boulders, but containing a few angular pebbles of quartz. These sandy beds alternate with thin beds of fine sandy mud, in which abound very perfect casts of *Euryechinus dröbachiensis*, numerous valves of *Serripes*, united valves of *Mytilus edulis*, and very perfect casts of the holes of *Mya arenaria* (see figure 4, near the top), showing that the animal after death had been replaced by mud, which had been washed into the empty shell, thus proving the tranquillity of the waters of that period.

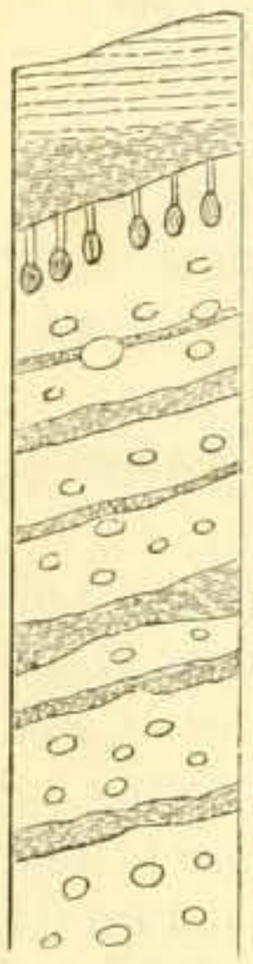


FIGURE 4.
Section of beds at Portland, Me.

We have never found living specimens of *Mya arenaria* of such great size and abundance growing with *Serripes grönlandicus*, and in almost equal abundance, as the latter is usually, in Labrador, only found in from ten to twenty fathoms. The presence of *Euryechinus* in abundance also shows that the sea could only have been four or five fathoms deep, while the beds of clay lower down in these series must have been deposited in a sea ten to twenty-five fathoms deep.

This deposit is unconformably capped by very thick beds of coarse sand and shingly gravel, precisely as at Gardiner, and about Boston. The lowest beds of tough blue clay are of the same origin as at Mere Point, Brunswick, while the brickyard clays inland are on the same horizon with the higher and more sandy beds. This point was more exposed to oceanic currents and tidal action, as evidenced by the frequent alternations of sands and sandy beds of clay, while the brickyard clays were deposited in estuaries and quiet protected bays. In these frequent alternations of beds of sand, which by their evenly bedded strata indicate a period of great tranquillity of the sea, we see evidence of a continued, slow, and almost imperceptible depression of the land during all this period.

Euryechinus dröbachiensis (Möll.) Found by Mr. E. S. Morse and myself very abundantly and well preserved in nearly entire casts on Canal Street.

Eschara elegantula D'Orb. Canal Street.

Stomatopora expansa Pack. On *Buccinum undulatum.*

Lepralia sp.

Membranipora americana D'Orb. This well-known form is not uncommon on shells.

Pecten grönlandicus Sowerby. Specimens from Mr. C. B. Fuller were thus identified by Dr. Stimpson. (*P. similis* Laskey? Fuller in the Report of the Maine Scientific Survey, 1861.)

Pecten islandicus Linn. In the usual abundance. From Mr. E. S. Morse.

Nucula antiqua Mighls. Bost. Journ. Nat. Hist., iv. 1844. (*N. inflata* Hancock. Ann. and Mag. Nat. Hist., 1836.) Common.

Leda buccata Steenstr. Frequent. From Mr. Fuller.

Leda tenuisulcata Couth. This I have received from Mr. Fuller. It is a well-marked specimen, agreeing precisely with the living forms, and is readily separated from any varie-

ties of *L. buccata.* Its occurrence here and at Saco is interesting, as showing that this locality was at the northern limits of the Acadian fauna of the Quaternary period.

Yoldia pygmæa Münster. (*Nucula lenticula* Möll.) I have compared the fossils with the recent shell from Greenland labelled "*lenticula* Möller," received through the kindness of Dr. C. Lütken of Copenhagen, and find no differences between them. It is not uncommon both here and at Saco. From Mr. C. B. Fuller.

Mytilus edulis Linn. Very abundant in the higher levels of the clays associated with *Euryechinus dröbachiensis* and *Serripes grönlandicus.* In a higher bed in another part of the city occurs a beach deposit formed largely, according to Mr. Fuller, of the comminuted angular fragments of this species, and among them occurred a valve of *Pholas crispata* Linn., now in the collection of Mr. C. B. Fuller of Portland, who has discovered most of the forms here enumerated.

Astarte compressa Linn. (Not *A. compressa* Montagu, Forbes, and Hanley; *A. elliptica* Brown.) Common. Morse, Fuller.

Astarte Banksii Leach. Abundant. Forms closely resembling, if not identical with, specimens of *A. Lawrentiana* received from Dr. Dawson show that the latter is but a variety.

Astarte striata Leach. Not infrequent; associated as usual with the preceding species.

Astarte lactea Brod. et Sowb., Gould! Rare. (Fuller.)

Cardium Hayesii Stimps. Rare. Fuller.

Serripes grönlandicus Beck. Abundant in what must have been the bottom of a much shallower estuary than the species is now known to inhabit. On the coast of Labrador it abounds in muddy bays, ten fathoms deep.

Mactra polynema Stimps., Smith. Misc. Coll., no description. (*M. ovalis* Gould.) Not uncommon at Zeb's Cove, Cape Elizabeth.[1]

Macoma sabulosa Spgl. In the usual abundance, though not so much so as in the Labrador deposits.

Solen ensis Linn. Collection of Mr. Fuller.

Mya arenaria Linn. Abundant.

Mya truncata Linn. Common.

Saxicava arctica Desh. Common.

Pholas crispata Linn. Rare.

Margarita cinerea Gould. Rarely found.

Natica affinis Gmel. (*N. clausa* Brod. et Sowb.) Frequent.

Natica (*Lunatia*) *grönlandica* Beck. Frequent.

Natica (*Amauropsis*) *islandica* Gmel. (*N. helicoides* Johnst.) Coll. Portland Nat. Hist. Soc.

Buccinum undulatum Möller. (*B. labradorense* Reeve.)

Buccinum plectrum var. *Packardi* Stimps. Can. Nat., Oct. 1865.

Dr. Stimpson quotes his typical recent specimens from near Behring's Straits, where they "were dredged alive in twenty to thirty fathoms, in the Arctic Ocean north of Behring's Straits, by Capt. John Rodgers, U. S. N."

Buccinum Totteni Stimps., Can. Nat., 1865. Frequent.

Buccinum grönlandicum Hancock. Frequent. Specimens in the Collection of Mr. Fuller agree well with Lyell's figure of "*B. angulosum*," a synonym of this species.

Buccinum cretaceum Reeve. Pack., Can. Nat. and Geol., Dec. 1863, pl. ii., fig. 6.

[1] See also a list of fossils found at this locality by Dr. Wm. Wood. *Proc. Portland Soc. Nat. Hist.*, i. 1862.

Fusus (*Neptunea*) 10-*costatus* Say. A specimen has been received from Mr. Fuller.

Fusus (*Neptunea*) *tornatus* Gould. Frequent.

Spirorbis nautiloides Lamk.

Balanus porcatus Da Costa. (*B. geniculatus* Gould.) Frequent.

Eupagurus Bernhardus Stimps. Specimens of claws were received from Mr. Fuller.

Hyas aranea Leach. Fine large specimens have been received from Mr. Fuller and Rev. E. C. Bolles.

Cancer borealis Stimps. Numerous specimens from Westbrook, with the preceding, from Mr. Fuller.

Saco. The beds at Saco are brickyard clays on the bank of the Saco River, about ten miles from its mouth, and agree very closely with the same beds at Gardiner, and are doubtless on the same horizon as the beds at Westbrook, occurring about the same distance above the sea. Mr. Fuller has very thoroughly explored these beds, and the numerous specimens of fossils received from him agree precisely with those from Gardiner. The *Nucula antiqua* and *Naticæ* have been flattened out by pressure as in the Gardiner specimens.

Idmonea atlantica (*I. pruinosa* Stimps.) Rare.

Modiolaria discrepans Möll. Frequent and very large.

Nucula antiqua Mighl. Abundant.

Yoldia myalis Couth.

Yoldia pygmæa Münster. (*Y. lenticula* Möll.)

Leda tenuisulcata Couth. Not common.

Leda (*Yoldia*) *arctica* (Gray.) Parry, Voyage, 1824, p. 241. (*Leda truncata* Brown; *L. portlandica* Hitchc. Sars, Fossile Dyreleveninger fra Quartaerperioden, 1865. *Nucula siliqua* and *sulcifera* Reeve. Belcher's "Last of the Arctic Voyagers," vol. ii., pl. 33, figs. 1, 2, 3, p. 186.) Very abundant. Found, according to Torell, at Spitzbergen, in from five to thirty fathoms.

Astarte Banksii Leach.

Thracia Conradi Couth. Broken and flattened specimens are not uncommonly found.

Thracia truncata Mighels et Adams. Usually the specimens are somewhat broken and distorted.

Pandora trilineata Say. Very common.

Pandorina arenosa Möll. Not frequent.

Bulla occulta Mighels. (*B. scalpta* Reeve. Belcher's "Last of the Arctic Voyagers," ii. app. p. 392, xxxii. 3, a, b, c.) Also occurred at Scarboro and Westbrook frequently.

Menestho albula Möll. Fine large specimens.

Natica affinis Gould. (*N. clausa* Sowb.) Of large size, as at Gardiner.

There are similar beds at Kennebunk, and also at South Berwick, where the bones of a seal have been found, as mentioned by Dr. C. T. Jackson in his Geology of New Hampshire.

In similar beds at the slide of the Presumpscot in Westbrook and also in Scarboro, a Macoma [Plate vii., figs. 2, 2a.] which is closely allied to, if not identical with, *Macoma fusca*, occurred quite frequently; it was collected by Messrs. Fuller and Morse. It is more ventricose, but otherwise of the same proportions. From *M. grönlandica* it is readily distinguished by being larger, much more ventricose, much more produced anteriorly, while the posterior end is more rounded and produced, wanting the truncate appearance of M. *grönlandica*. The ligamental notch is less distinctly marked.

Length, 1.08; breadth, .32; height, .70 inch.

The occurrence of this species is of great interest, as showing that at this point on the coast there was a decided increase in the temperature of the post-pliocene sea, owing probably to the influence of some branch thrown off from the Gulf Stream. Two other shells, members especially characteristic of the Acadian fauna, such as *Pandora trilineata*, and *Leda tenuisulcata*, find here their most northern limit. The occurrence of *Astarte castanea* at South Berwick, mentioned by Dr. C. T. Jackson in his Report on the Geology of New Hampshire, is a further proof of the boreal character of these beds, in distinction from the subarctic or Syrtensian beds of eastern Maine and the St. Lawrence River.

The beds at Portsmouth, N. H., as noticed by Dr. C. T. Jackson in his Geological Survey of New Hampshire, are identical with those of Saco and Westbrook. He states therein that Mr. John L. Hayes found *Leda* (*Nucula*) *portlandica* associated with "*Sanguinolaria*," at a level thirty feet above high tide, in blue plastic clay. This is the most southward limit yet known of *Leda portlandica*.

Point Shirley.

At Point Shirley, as has been shown by Stimpson, the beds dip into the sea over a rocky promontory at an angle of 18°. The forms therein contained are almost exclusively members of the Virginian fauna, being found abundantly in the waters south of Cape Cod, and agreeing precisely with the fossils discovered by Desor in Nantucket, and by Redfield in Brooklyn, New York. At this point the Acadian fauna seems to have merged into a more southern assemblage of animals.

At Point Shirley Dr. Stimpson records[1] the occurrence of the following species, which "occur in the upper part of the stratum of blue clay and pebbles which crops out from under the coarse drift": —

Balanus rugosus,	*Astarte sulcata,*	*Mytilus modiolus,*
Mya arenaria,	*Astarte castanea,*	*Ostræa borealis,*
Solen ensis,	*Cardita borealis,*	*Fusus decemcostatus,*
Mactra solidissima,	*Mytilus edulis,*	*Buccinum plicosum,*
Venus mercenaria,		*Buccinum trivittatum.*

The specimens which I collected were mostly much worn, as are many of those from New York and Nantucket in the Museum of this Society, collected by Messrs. Desor and Cabot.

The following species occur in the neighborhood of New York city: —

New York City.

Venus mercenaria Lamk.

Nassa (*Ilyanassa*) *obsoleta* Say. Specimens of both species are in the Museum of this Society, and agree precisely with those from Point Shirley.

Our knowledge of the drift beds southward of Point Shirley is comparatively scanty, owing to the few fossils that have been found in these beds, and preserved for future reference. But the interest of the subject is greatly enhanced by the fact, that these strata rest directly upon the middle tertiary beds at Nantucket and Martha's Vineyard, and in the vicinity of New York City, as it would seem from Mather's statements in the Report of the Geological Survey of New York. In addition to this, the fact that the contained fossils are forms now living in the adjacent seas heated by the warm currents thrown off from the Gulf Stream, and thus have almost wholly lost their character as an arctic glacial assemblage, shows that the transition from the cooled areas of the Gulf of St. Lawrence

[1] *Proceedings Bost. Soc. Nat. Hist.* vol. 3, p. 9, 1848.

and northeastern Maine was sudden, and no more distinctly marked than at the present day; — any light thrown upon the characters and distribution of this formation south of Cape Cod possesses the liveliest interest.

We have been led to believe that in the drift period, the present course of both the arctic current and the Gulf Stream existed at a very early period of that epoch from Labrador to Florida, and the abundant palæontological evidence now before us proves this to have been the case. It is most probable that during the period of glaciers in the northern parts of the continent, the growth of the coral reefs of Florida and the West Indies was not interrupted; and that a sub-tropical fauna existed in South Carolina, contemporaneously with the sub-arctic fauna peopling the seas of the southwestern coast of Maine, and the more purely arctic, glacial fauna, inhabiting the waters of Labrador and the Gulf of St. Lawrence.

Messrs. Desor and Cabot [1] have happily filled up the gap in our knowledge of the beds on the coast of New England lying just south of Cape Cod, in a paper which we were not aware had been published until most of this article had been prepared for the press, and subsequent to the publication of an abstract of the present article in the American Journal of Science and Arts, New Haven, January, 1866.

The authors give a section of the drift beds, seventy-two feet in thickness, at Sancati Head, forming the eastern extremity of the island of Nantucket, resting upon twenty feet of a brown clay which is referred to the Miocene Tertiary, which is considered as probably contemporaneous with a similar clay underlying the drift at Truro, Cape Cod, and also with the brown sandy clay at Martha's Vineyard, proved by Sir Charles Lyell to be miocene. Resting unconformably upon the brown clay are beds presenting the following section in the ascending order. (1.) a bed of gravel, — two feet; (2.) homogeneous white sand, — four feet; (3.) tough clay, very similar in its aspect to the plastic clay near Paris, except that it contains a great many nodules of ferruginous sand, — one foot; (4.) "an oyster bank one foot thick, intermixed and covered by (5.) large masses of *Serpula;* which are like the oysters, in their natural position," with many other shells, — four feet; (6.) a stratum of worn shells which "bear evident traces of exposure, the valves of the bivalves being generally isolated, and the *Balanus* disintegrated and more or less worn, — two feet." "Above this stratum of loose shells there is found a series of layers of sand and gravel, with a thickness of nearly fifty feet, in which every variety of materials may be seen, from the finest sand to the coarsest gravel." These beds dipped westward from five to fifteen degrees, the beds becoming less inclined from below upward.

We quote at length the conclusions of the authors, as the paper is not generally accessible to American students: —

"Concerning the drift overlying the tertiary clay at Sancati, it is obvious from the regularity of the strata, and from the very perfect state of preservation of the shells imbedded in it, that it has not undergone any violent disturbance since their deposition. The species collected by us in the above-mentioned oyster bank are the following: —

Venus mercenaria, plenty.
Mya arenaria, plenty.
Ostrea borealis, a bed several feet thick.
Arca transversa, very abundant.
Solen ensis, abundant, but very brittle.
Astarte cartanea, rather rare.
Cardita borealis, rare.
Cumingia tellinoides, rather rare.

[1] "On the Tertiary and more recent Deposits in the Island of Nantucket." By E. Desor and E. C. Cabot. *Quart. Journ. Geol. Soc. London*, V. p. 340, Feb. 1849.

Crepidula fornicata, abundant.
Buccinum undatum, rather rare.
——— *plicosum*, abundant.
Nassa obsoleta, abundant.
—— *trivittata*, abundant.
Scalaria grönlandica, rare.
Balanus rugosus, very abundant.
Serpula, forming a layer several feet thick.
Pagurus pallicaris (claws).

"Now these are, without any exception, the same species that are found living on the shore of Nantucket and Cape Cod; and as they are all in their natural position, the bivalves having almost always the two valves united, and the Venus being commonly half open, just as they are found on the beaches when the muscles have relaxed after death, we may fairly infer that in this part of the continent at least, the climate has not undergone any considerable change since the deposition of these fossils.

"The presence of a stratum of disintegrated shells of the same species, resting upon the undisturbed oyster-bank, may easily be accounted for by a somewhat more violent action of the tides, which deposited in this irregular manner a part of the shells which were washed off from the oyster bank itself, in the same way as is the case now among the Nantucket shoals.

"Until last year it was assumed by the geologists of this country that there were no fossils to be found in the drift, south of Lake Champlain and the State of Maine, when one of us had the good fortune to discover several species in the drift of Brooklyn, near New York.[1] Similar fragments, especially of *Venus mercenaria*, have since been found in the cliffs of Point Shirley, in Boston Harbor. Now, as the fossil shells in both places are of the same species as those of Sancati cliff, there is every reason to consider them as belonging to the same period, their more or less perfect state of preservation depending merely upon local influences. It ought further to be stated, that wherever the shells are worn or broken, and the strata which contain them coarse and irregular, it is either in such places where the tidal currents must have been violent, so as to carry and deposit promiscuously heavy pebbles and minute shells, as in the cliffs of Point Shirley; or in such places where we must suppose that floating ice was at work, carrying indiscriminately heavy materials, pebbles and boulders, together with oysters and other shells detached from the neighboring flats, and heaping them up in the corners of bays and sounds. This seems to have been the case with the coarse deposits of Brooklyn, where oysters and Venus are generally found imbedded in a reddish loam intermixed with pebbles and boulders, many of which are distinctly scratched, thus reminding us of similar actions which you have described in Fundy Bay and in the St. Lawrence; whilst in other places like Nantucket and the bays and fiords of Maine, a more quiet action prevailed, so as to allow the shells to be preserved in their natural place and position after death.

"Finally, the fossils of the drift of Nantucket bear such a striking similarity to those of the newer pliocene of the Southern States, that they become a natural link between the northern and southern deposits. Instead of considering these as so many distinct formations, we should therefore henceforth look at them as mere modifications of the same deposit, being the result of the same agencies, viz.: oceanic tide-currents along the whole coast of the United States, combined with gradual and secular oscillations of the whole continent, the local strength of the tidal currents affording a sufficient explanation for local diversity in the arrangement and size of the materials in each locality."

[1] E. Desor's Letter to M. de Verneuil, in the *Bulletin de la Société Géologique de France*, 1847. A most interesting collection of the drift fossils of Brooklyn has since been made by Mr. Redfield.

By the foregoing lists it will be seen that during the Quaternary of the French and Scandinavian geologists, or post-pliocene period of Lyell, the distribution of marine animals was governed by the same laws as at the present day. In going southward from Labrador to New York the seas became warmer the more they came in contact with the heated waters of the Gulf Stream, whose influence was evidently exerted on the coast of New England during the glacial period. The climate of New England was not purely arctic, but rather sub-arctic, where now it is "boreal." While this period was characterized by the wide distribution of what are now purely arctic or circumpolar species, there were also intermingled boreal or Acadian forms. Thus the arctic *Leda arctica, Pecten grönlandicus, Serripes grönlandicus, Pandorina arenosa,* and *Fusus tornatus,* were then wide spread and most characteristic shells from Greenland to Portland, Maine. The Leda especially, abounding in every clay deposit, has now become wholly extinct south of Spitzbergen and the 70th parallel of latitude.

An exceedingly small percentage, if any, of the species has become *wholly* extinct, the only instances occurring to us being the *Beluga vermontana,* about which there must be great doubt, owing to the difficulty of distinguishing the fossil species of whales, and the new species of *Fusus* (*F. labradorensis*), and, possibly, *Bela robusta,* described above.

A considerable number have become extinct in the north temperate seas, owing to the great changes in the climatic conditions. A parallel case is shown in the southward migration and subsequent extinction in Europe of the musk-ox, polar bear, lemming, and other quadrupeds now confined mostly within the limits of the arctic circle.

During the glacial period, or that of the deposition of the glacial beds, (Leda clay of Dawson,) which are unmistakably rewashed terminal moraines left during the incoming or coldest period of the Quaternary, (when, we have every reason to believe, true glaciers of great extent eroded the present river systems as far south as New York,) there was a greater uniformity than now of the climate; but yet, as shown by the distribution of animal life, there was a decided change from a purely arctic to a sub-arctic climate, from Greenland southward.

At present, the arctic or circumpolar fauna is restricted to a district north of the yearly isothermal line of 32°, which thus includes the arctic-american Archipelago, Northern Greenland, Spitzbergen, Nova Zembla, and the coast of Siberia. This is a true *circumpolar* fauna, and can scarcely be said to be Asiatic, European, or American, though members of the group extend in diminished numbers and size down on the Asiatic coast, to Japan, as we are informed by Dr. W. Stimpson and by P. P. Carpenter in the Report of the British Association for 1856; on the European coast as far as the Mediterranean Sea, and on the Eastern American coast as far as New Jersey, where the polar currents give, at great depths, the necessary amount of cold for their existence. South of this circumpolar belt is a sub-arctic zone of life corresponding to the yearly isothermal of 40°. This line starts from near Cape Breton in North America, and includes Iceland, the Hebrides, the Faroe Islands, Finmark, and Northern Norway. On the American coast this fauna is characterized by a small number of species not yet recorded as found in the circumpolar district, which only occur southward in the Acadian district in diminished numbers and impoverished in size. This Syrtensian fauna bears the same relations to that of the Acadian district as that of Finmark, (judging from the data furnished us in the papers of Professor Sars,) does to that of the Baltic, North Sea and Scottish seas, the boreal or Celtic fauna of Forbes, and which is the European representative of the Acadian fauna. We have shown[1] that

[1] *Canadian Naturalist and Geologist*, Dec., 1863. See also the *Proc. Bost. Soc. Nat. Hist.*, Jan. 1866, p. 276.

this fauna is limited to Hudson's Bay, the coast of Labrador, and the northern coast of Newfoundland. Southward it follows the line of floating ice, which partially excludes Anticosti, but includes both the Grand Banks, and those shoals lying to the southwestward along the track of the polar current, which on the coast of New England flows between the coast and the inner edge of the Gulf Stream; along this line lie the Banks, off Nova Scotia, and Maine, and Massachusetts, together with the St. George's Banks and the Nantucket Shoals. Its influence is likewise felt as far south as the shoals lying off the coast of New Jersey. This current would even seem to impinge slightly upon the north side of Cape Hatteras, where Redfield supposes its final influence to have been felt. Returning again to the shores of the British Colonies, we find this *Shoal* or Syrtensian fauna most curiously interwedged with the Acadian or New England fauna. This is owing, without doubt, to the overlapping of the Gulf Stream upon the great polar current. Thus, while the mouth of the Bay of Fundy is properly a Syrtensian outlier, the head of the bay, the coast of New Brunswick, the western side of the Gulf of St. Lawrence, the mouth of the river St. Lawrence on its southern side, and a small isolated area on the southern coast of Newfoundland, sheltered from the polar current sweeping by Cape Race, and on which a small branch of the Gulf Stream may possibly impinge, are outlying areas inhabited by species most characteristic of the coast of New England north of Cape Cod, constituting a fauna termed by Professor Dana the Nova Scotian Fauna, and by Lütken, the Acadian Fauna. Thus between Greenland and Cape Cod there are two distinct faunæ: the Acadian, with outliers situated north of its normal limits, due to the influence of the Gulf Stream, or, perhaps, to the absence of the polar current; and the Syrtensian or Labrador fauna, peopling the coast of Labrador and Newfoundland, sending outliers far southwards, due to the influence of the polar current. Any attempts to split up this area into smaller subordinate districts or faunæ than these must prove unsuccessful, as such distinctions would be highly artificial.

Having shown how these three faunæ are limited at the present day, it remains to notice how this distribution differed in Quaternary times. The arctic or polar current must have sent a branch through the present course of the St. Lawrence River into Lake Champlain, in a general southwestern direction. This current was evidently a continuation of the present Belle Isle current, which even now pushes the cold waters of the Straits far up beyond the island of Anticosti beneath the fresh waters of the St. Lawrence River. It has been noticed by Dr. Dawson,[1] who has satisfactorily shown the effects of this powerful St. Lawrence current, that the post-tertiary fauna of the St. Lawrence, as it has been studied by him at Montreal, Rivière du Loup, and Quebec, was in all its features purely Syrtensian, and identical with that of the colder portions of the Gulf of St. Lawrence, and especially the coast of Labrador.

The clay beds of Canada synchronize and agree in their general features very nearly with those of Maine, as has been already observed by Dr. Dawson. All the beds to the eastward of the Saco River afford a Labrador fauna. About Portland and on the Saco River we are, however, on the limits of the post-tertiary Acadian fauna. Certain common Syrtensian and purely arctic forms there dwindle in size and diminish very sensibly in numbers, and a few arctic species are replaced by Acadian forms.

[1] Address of Principal Dawson before the Natural History Society of Montreal, May, 1864, published in the *Canadian Naturalist*, where he shows that the general southwest striation of the valley was "from the ocean toward the interior against the slope of the St. Lawrence valley." p. 9.

At Point Shirley we have good evidence of the beginning of the Virginian fauna, where *Venus mercenaria* and *Buccinum plicosum* abound. This must have been the northern limits of the fauna so well developed, as noticed by Desor, in the beds of Nantucket, where the temperature of the sea could have scarcely differed from that of the present period. The same may be said of the post-tertiary fauna of South Carolina, and, from what little we know, of that of Florida, where the heated Gulf Stream evidently preserved the same conditions as now, only more checked in its northern limits than at present by impinging more directly on a coast lined with floating ice, as that of Maine must have been in post-tertiary times.

At such a time the increased degree of moisture must have produced a much greater rain fall, the fogs must have been of greater extent, and the snow line must have approached much nearer the sea, than at present, on the eastern coast of America, south of lat. 60°, and glaciers of great extent must have surrounded the mountains of New England. The land fauna and flora must have been that of Labrador. The bison, the *Phoca* (*Pagophilus*) *grœnlandica*, the *Beluga vermontana*, and among plants, the *Potentilla tridentata* and *Arenaria grœnlandica*, (both of which are now found in the colder parts of the coast of Maine,) must have been the characteristic species. Remnants of such a flora and fauna we now behold on our alpine summits. On the top of Mount Washington, the last 500 feet exhibit a purely sub-arctic or Labrador vegetation. We can scarcely call it arctic, for the dwarf spruces and firs are of the same size as in the more unprotected places in Labrador. The same species of weasel which abounds in Labrador, we have seen on the summit of Mount Washington. The insect fauna we must believe is an outlier of the Labrador sub-arctic assemblage of insects, though with certain features of its own. While some Diptera, Coleoptera, and Lepidoptera are identical, certain species, such as *Chionobas semidea*, *Argynnis Montinus* Scudder, differ slightly from any yet found in Labrador, though they may yet be found further north, or may prove to be local species, remnants of a sub-arctic fauna which peopled the surface of New England, living between the coast and the snow line in the interior. As the line of perpetual snow retreated up the mountain sides, the more hardy species followed, while many others doubtless died in the great changes of climate and topography which ushered in the historic period. As there are aërial or alpine outliers, relics of this ancient sub-arctic fauna and flora, so we must consider the present abyssal forms, and outliers of the Labrador marine fauna, — such as inhabited the Banks of Nova Scotia and Northern New England, and the cold waters of the mouth of the Bay of Fundy, — as the remnants of the Syrtensian fauna, which during the glacial period must have been spread very uniformly over this area.

The arctic sea-birds even now breed upon the islands in the mouth of the Bay of Fundy, as they do on the coast of Labrador. I am told by fishermen that the Puffin, *Mormon arctica*, used to breed on Mount Desert. The *Alca impennis* was probably a common bird, as it was once on the shores of Scandinavia and Scotland; there are rumors extant among our oldest fishermen of its having been seen years ago, but within the recollection of men now living, as I am informed by Professor A. E. Verrill; and its bones have occurred in the kitchen-middings of the coast of Nova Scotia. It is known by Rev. Mr. Wilson, a missionary in Newfoundland, to have been common less than forty years ago about the Fogo Islands, on the northeastern shore of Newfoundland, as I have been informed by Mr. G. A. Boardman of Calais, Maine. These birds represent the sub-arctic avi-fauna of New England during the later period of the drift, and owe their extinction possibly to the slow changes

of the climate, which must have been gradually ameliorating for two centuries past in the north temperate zone, but more especially to their destruction by man.

All the facts cited above must at least tend to disprove any theory of a former tertiary or post-tertiary continental connection between Europe and America. The fauna and flora of Labrador during the glacial period were too distinct, the oceanic currents could not have allowed any interchange of forms, and the great depth of the sea in Baffin's Bay would have prevented such migrations as Forbes supposed to have taken place from Europe.

The geological history of the American continent, as laid down so clearly by Professor Dana in the Proceedings of the American Association for the Advancement of Science for 1856, proves that the different formations were, during paleozoic, mesozoic, and tertiary times, built around the granitic laurentian nucleus of British America, and gradually proceeded southward. All the tertiary rocks form narrow strips of land along the coast. No well-informed geologist can believe that the tertiary strata formed continuous sea bottoms, — that, for instance, the miocene beds of Spitzbergen were continuous with those of Disco Island in Greenland, or that the Greenland beds are a part of the miocene strata of the southern States. Equally unfounded on general geological principles seems the theory of a tertiary Atlantis, advanced at the present time, especially by Heer and others, though first proposed by Forbes, to account for the distribution of life in the Azores, and the islands lying off the mouth of the Mediterranean Sea. In fact, the fauna as we go southward from the arctic zone, becomes more and more distinct, and it is probable that such distinctions obtained from the earliest palæozoic times. The Silurian fauna of Europe is nearly as distinct from that of North America as the tertiary fauna of England and France is from that of Virginia, as in the latter case insisted on by Sir Charles Lyell in the Quarterly Journal of the Geological Society for 1845.

During glacial times, while the cave-bear, lion, hyena, and aurochs were associated in Europe with the musk-ox, reindeer, and polar bear, in America the bison characterized a far different American sub-arctic fauna. It cannot be said that the glacial fauna of America was derived by immigration from Europe, for not a single feature, peculiarly European in its type, is found in our post-tertiary beds. On the other hand, the glacial fauna of Northern Europe was essentially arctic-european or "palæarctic." Because the musk-ox is found fossil in the turbaries of France and gravels of Germany, it need not be inferred that the European fauna of that period borrowed an American feature. We would rather suppose that the former range of the musk-ox, a circumpolar species, was arctic-european as well as American. In considering the origin of the flora of Labrador, though not possessing a special knowledge of the botany, we would on general principles venture to dissent from the view of Dr. Hooker, that the flora of northeastern Arctic America is essentially Scandinavian in its origin.

The flora of Labrador, so far as we were enabled to observe, follows closely the laws of distribution of the land and sea animals; and any theory that separates the origin of the two assemblages cannot be in accordance with the general laws of the distribution of life, be it plant or animal, over the surface of the globe. The fauna of Australasia is no less peculiar than its flora; the flora of Brazil is characterized by its peculiar tropical American forms, just as the fauna is circumscribed by peculiar features. So we must believe that the origin of the arctic-european and arctic-american and arctic-asiatic floras and faunas was distinct from the outset, and that they have never borrowed, by extensive inter-continental migrations, each other's peculiar characteristics. As we have observed in regard to the ani-

mals, there are a very large proportion of arctic plants spread over the whole arctic zone, which cannot be said to be American any more than European or Asiatic, but simply circumpolar. On the other hand, there is a small percentage of which the reverse is true, and this is paralleled among the animals.

Dr. J. D. Hooker, in his elaborate essay on the Distribution of Arctic Plants in the Linnean Transactions for 1861, accounts for the greater richness of the flora of Lapland over that of other arctic regions by the blending of warm and cold currents of air and water, and its great diversity of mountains and low lands; while on the broad plains of Siberia and the level plateau of Labrador there is the greatest uniformity of climate, and hence a corresponding paucity of plants.

The same climatic conditions determine the distribution of marine life. As we go from Norway to Greenland the number of species lessens greatly. Dr. Lütken, in his admirable View of the Echinoderms of Greenland, shows that the fauna is essentially arctic-american rather than European. It is so with the other radiates, and the articulate and molluscan fauna, and the fish fauna would seem to follow the same law. All the facts known to us tend to prove a separation of the two continents even from the palæozoic period.

Dr. Hooker cites fifty-seven species of plants which do not cross from Greenland to America. This is paralleled by the apparent restriction of a few species of marine invertebrates to the high polar seas, such as the *Leda truncata* and *Pecten grœnlandicus*, though in glacial times they abounded in northeastern America.

Among the most purely arctic-american plants are the *Potentilla tridentata*, which is abundant in Greenland and which we have collected in profusion in Labrador, Maine, and on the White Mountains; also the *Arenaria grœnlandica*, which is more thoroughly arctic, preferring the coldest spots on the outer islands of the coast of Labrador, and the alpine summit of Mount Washington, and which has even been detected on Cape Elizabeth, Me., by Dr. G. L. Goodale, of Portland.

These two plants — which Dr. Hooker acknowledges have never occurred elsewhere on the globe within the historic period — he supposes were originally from Scandinavia, though they have never been found in Europe. By this mode of reasoning we might just as well imagine the clam, *Mya arenaria*, to have been derived originally from Europe, or the bison to have been derived from the aurochs of Europe. The presence of such characteristic arctic-american forms in Greenland must destroy our confidence in the supposed identity of the Greenland flora with that of Lapland, for there are strong grounds for regarding the flora of Greenland as arctic and circumpolar simply, rather than European arctic, and that on either side the flora becomes more strongly either American or European, as we go westward or eastward of Greenland.

When, following the line of the yearly isothermal of 32°, we go to the southward on either side of the Atlantic, we find warm and cold currents of air and water intermingling, and thus producing much greater diversity of climate than in Greenland. While the Gulf Stream abuts directly upon Scandinavia, some of its effects are felt in Newfoundland and Labrador. Both lands are continental, and shade into temperate regions. There is a very perfect correspondence in the geology and distribution of the formations, and hence, as Hooker observes, there are a large number (230) of plants, common to Labrador and Scandinavia, which do not occur in Greenland. This is paralleled very exactly in the distribution of animal life. In the seas of Labrador and Newfoundland are found forms derived from the more temperate seas of New England, as on the coast of Norway many forms occur

which are derived from the British seas, and are even found as far south as the Mediterranean. These serve greatly to swell the lists. In fact the facies of the flora of Labrador is *sub-arctic* and by no means purely arctic, as is that of Greenland. Explained in this way the flora of Greenland seems to us no more anomalous than its colder climate and remoteness from sub-arctic lands do, isolated as it ever has been by deep seas and powerful oceanic currents of different temperatures, which, we must believe, served from the earliest times as barriers against the commingling of more temperate forms of life with purely circumpolar species.

There is, in our view, no reason to believe that the glacial period, as some writers think, has shifted from the eastern to the western hemisphere, or *vice versâ;* for the same causes which brought on the cold period were evidently common to the arctic and sub-arctic regions throughout their whole extent, though governed greatly by the present distribution of the isothermal lines. That the drift deposits were laid down contemporaneously on both sides of the Atlantic, seems proved by such facts as this: that *Leda arctica* (*L. portlandica*), more than any other shell characteristic of the drift deposits of the northern portions of America and Europe, has become alike extinct both in Scandinavia and its equivalent, Labrador, Canada, and New England.

The break in the glacial beds — which by Sars[1] (in which he closely follows D'Archiac) are divided into an earlier Quaternary or "*glacial*" formation, from which few fossils have been taken, and those purely arctic in character, and the more recent beds, "post-glacial," resting upon them, containing a great influx of *boreal* or sub-arctic and some Lusitanico-Mediterranean species — does not seem so distinctly marked in northeastern America as in Europe. In southern England the able researches of Mr. Searles V. Wood, jun., enable this writer to "arrive at the conclusion that the wide spread boulder clay of England is wholly distinct from the older, but partially developed drift of the Cromer coast. That conclusion was arrived at by the minute examination of more than 8000 square miles of the eastern portion of England, and the grounds for it were submitted to geologists in a detailed map of the drift beds over the whole of that area, with copious sections. It was thus that I acquired the opinion which induces me to deny, as I do, 'that we have yet any evidence of any general submergence at the incoming of the glacial period, far less of repeated oscillations of submergence and emergence.' . . . . . Now although I have endeavored to show that on the east coast of England four oscillations of climate have occurred since the incidence of the glacial period, viz.: first, the extreme cold of the Cromer drift when the country except a part of Norfolk was land; second, the ameliorated climate of the sand and gravel series, which overlies that drift unconformably, and partially underlies the boulder clay; third, the return of cold with the extensive submergence which introduced the wide spread formation of boulder clay; and fourth, the return to sand and gravel conditions, with the elevation and denudation of that clay and the introduction of the post-glacial series — yet the oscillations of climate during the tertiary period begin as well as end with these." — *The Reader*, London, 1865, p. 466.

Having the grand outlines of this formation thus mapped out for us, it remains for geologists in this country to see how far the parallel can be carried out in America. There is as yet everything to be learned of the lowest and oldest boulder clay of the coast of Maine; to ascertain how far it is conformable with the brickyard clays of the uplands,

[1] Om de i Norge forekommende fossile Dyrelevninger fra Quartærperioden, etc.; af M. Sars, Christiania, 1865.

and whether there is an overlying bed of sand such as the sheets of sand resting everywhere on the upper boulder clay. At present there have been revealed no signs of this lower bed of sand clay, and the lowest clay beds we are acquainted with seem to graduate into the rewashed, more inland, and more recent boulder or brickyard clays.

In adopting the term *Quaternary Period*, we would use it in the amended sense proposed by D'Archiac in 1848, in his "Histoire des Progrès de la Géologie." From his able review of all the prime characteristics so trenchantly dividing this Period from the Pliocene Tertiary, we are led with that author to consider this Period as rather equivalent to the Tertiary as a whole, than to either of its three subdivisions; and rather as the beginning of a new Epoch or Period, than the close of the Tertiary. The distinctions, as shown by D'Archiac, obtain no less in the tropics than in the high latitudes. In tropical America the period is marked off from the Tertiary by the appearance of the great mammals, the Herbivores characterizing the formation in America, and the great Carnivores the deposit of the Eastern hemisphere. About the Mediterranean the Tertiary Period closed with the upheaval of the Sub-Apennines of Italy, or Alps of Valais.

Professor Dana, in his "Manual of Geology," states further important distinctions, such as the rise of land in the high latitudes which had not before taken place since Palæozoic times, ushering in the Period of great glaciers, and thus serving, over one half of the surface of the globe, to further separate this epoch from the Tertiary.

Another feature of this Period is the great uniformity of climate over broad, continental areas, and the wide distribution in space of certain species most characteristic of the Quaternary Formation. Such are the occurrence, on both hemispheres, of the musk-ox, the Siberian mammoth (*E. primigenius*), and among marine mollusca of *Leda arctica* Gray, Sars (*portlandica*), which is now restricted to the circumpolar seas.[1]

General Conclusions.

To account for all the facts which have been developed above, we must assume, —

I. That the northern portion of North America, that is, the boreal and arctic regions, stood at a much higher level above the sea than now. We have given good evidence that it stood at least 360 feet above that level in Labrador. It would be safe to assume that the coast line stood at an elevation not falling short of 600 feet. While this increase in the

[1] D'Archiac in the *Résumé Général* of the first part of his volume on the Quaternary Period, divides the epoch into five periods — for an enumeration of which we would refer the reader to his volume. But the differences upon which that learned and philosophic author bases his Periods 3 and 4, seem to us not well founded. They both together correspond to our *Leda clay* of the northeast coast of North America. "Période (4), de calme peu prolongée," he characterizes by the "Till and deposits of Arctic shells;" while Période (3), a later one, is characterized by the "Pampæan deposits, the development of the fauna of Great Mammals and marine, fluviatile shells, *identical with the species which still live under the same latitudes.*"

On the contrary, we find in Maine, in the upper part of the Leda clay, the remains of the bison associated with *Leda arctica*, a shell now purely circumpolar, while the bison inhabits the temperate zone. The Period 4, then, graduates into Period 3 of D'Archiac. His "Période (2), de transport cataclystique générale et de courte durée," seems to be equivalent to the *Saxicava sands* of American authors.

The lacustrine or Terrace Period of American geologists he also includes in this 3d Période, which is as distinct from the Saxicava Sands as the latter is from the Leda Clays — the three being unconformable and accompanied by distinct oscillations of land.

His 1st and most recent period of existing glaciers in the Alps, and "probably other chains of mountains," accompanied by "polished, striated, and rounded (moutonnées) rocks; gravel, sand, unstratified pebbles, and erratic blocks of the Alps," being of local origin, seems an artificial subdivision when applied to the Quaternary period generally.

The term *Leda Clay*, first proposed by Dr. Dawson, and adopted by the Canadian geologists, characterizes much better this formation in northeastern America than the term *Champlain Epoch*, taken from a shallow inland sea of slight extent, where the strata are but partially developed, and some of the most characteristic fossils entirely wanting.

height of the land would not materially change the physiognomy of the continent north of the St. Lawrence River and Gulf, where the table land rises abruptly from the ocean as in the arctic regions; it would effect a great alteration in the distribution of dry land south of the parallel of 50° N. Should all the present sea-bottom lying within the limits of the depth of one hundred fathoms be thus raised, the Gulf of St. Lawrence would be represented by a river delta, one mouth in the Straits of Belle Isle, the other flowing out between Cape Breton and Cape Ray. All the submarine plateaux, such as the Grand Bank of Newfoundland, and the banks lying off the coast of Nova Scotia, Maine, and Cape Cod, would be elevated above the sea, and probably form broad plains. Thus the effects on the distribution of life would essentially differ from those of the region north of 50° N. Such a rise and enlarged area of land would, as has been stated by physicists, produce an extension southward of an extreme arctic temperature. While the climate would be greatly lowered, we still have added the proximity of the Gulf Stream, as evidenced by the temperate rather than arctic fauna of the glacial beds of New York and Nantucket, and the more tropical assemblage of South Carolina. Such a blending of hot and cold currents of air and water must have produced even more fogs and a much greater rainfall than now, to feed the enormous glaciers which moved into the sea from off the principal water-sheds.

Thus the snow line descended near the sea level, the shore presented a nearly solid front of glacial ice at least rivalling in height and breadth the enormous glaciers 1000 feet thick and 540 miles long, discovered by Sir James Ross in the antarctic lands. As the ice receded, it left all the marks of intense glaciation, in the appearance of rounded rocks, glacial grooves and moraines, both terminal and lateral.

II. *Leda Clay.* There was a gradual change of level in the sea. At the close of the glacial period the snow line gradually receded from the coast, and the glaciers retreated to the mountains. During the slow and gentle submergence of the land ushering in this epoch, the crude moraine matter was sorted into beds of regularly stratified clays 100 to 300 feet in thickness. The lowest beds consequently are the most ancient, as is also evidenced by the greater prevalence of arctic forms. During this time the sea was filled with floating ice, as at present on the Labrador coast, and the great polar or Labrador current exerted its full power. The temperature being so even throughout the northern hemispheres of the globe, there was a great uniformity in the distribution of life, and certain species enjoyed a wide distribution where now they are restricted to comparatively narrow areas. Toward the close of this period the bison, the Greenland seal, the walrus, and the Vermont whale (*Beluga Vermontana*), flourished. The Age of great Mammals dated from this early period. An arctic fauna and flora inhabited the coast between the sea and the low snow line, and the flora and fauna which are now found only on our alpine heights, or in cold, isolated spots on the coast of Maine and the northern lakes, then peopled the surface of New England and Canada. All the biological features of this epoch partook of an intermixture of the boreal and arctic faunas and floras that are now more distinctly circumscribed into narrower areas.

We have no evidence of an intercontinental communication with Europe during this period. The remains of the bison, the purely American forms of the lower animals found in the Leda clay, all tend to show that no migrations took place either from Europe or Asia into northeastern America. Then, as now, there was a local facies imprinted on those animals whose remains have survived, exhibiting the same faunal distinctions, and even more strongly marked than now.

The close of this period was signalized by a great amelioration of climate, by broad areas of marine clays finely laminated, and having more sand and loam intermixed than in the lowest and oldest beds. This was the transition from a period of broad estuaries, and, at a late stage, of shallow seas, to the next epoch of a secular emergence. It ushered in the —

III. *Period of raised Beaches* (Saxicava Sands). This necessarily implies a great denudation of the glacial clays. The rolled, sea-worn boulders, shingle and sand, composing the mass of the ancient osars and beach deposits, now found at all heights from the present sea-level to 500 or 600 feet, are derived from the resorting of the moraines. We thus find that the highest beaches are the oldest, and the most recent, those just above the ocean level. The temperature of the sea did not differ greatly from that of the present day. During this epoch the present distribution of the faunæ now inhabiting the temperate and arctic zones was established, and since then but little change has taken place. The fresh-water shells found about the Niagara River and other deposits in Canada, were, so far as we know, introduced at this time. Those shells found in beach deposits on the St. Lawrence River, 4–500 feet above the present level of the river, show that but little change has taken place in the climatic relations of the land or in the distribution of the animals depending on such relations. It is evident that the Acadian fauna, once restricted to the regions south of the Saco River, during this epoch crept up the coast of Maine, extended itself along the western shores of the Gulf of St. Lawrence and prevailed in the St. Lawrence River, and the broad estuary now represented by Lake Champlain.

The close of this period witnessed the surface of New England covered by broad lakes and ponds, with vast rivers and extensive estuaries, with deep fiords cutting up the coast-line. Its scenic features must have resembled those of Labrador at the present day.

IV. *The Terrace Epoch.* The estuaries and deep bays left beach deposits of sand and shingle, resulting from the drainage of the slowly rising continent. All the terraces are unconformable to the marine sands underlying them, though the highest terraces farthest from the coast may have been forming while the more recent sea-beaches were being deposited by the action of the waves and tide. Thus the early part of the Lake period is synchronous with the latter part of the Beach period. So also the lower strata of the Leda clays were laid down during the deposition of the oldest beaches, causing a constant inosculation of these unconformable deposits, and thus the beginning of one epoch overlaps the close of the previous one.

II. View of the recent Invertebrate Fauna of Labrador.

The additional observations here recorded were taken from dredging notes made during the summer of 1864, while coasting from the Little Mecatina Island in the Gulf of St. Lawrence, to Hopedale, the lowest Moravian settlement. Many of the localities are known only locally to the fishermen, but their positions relative to points more generally known have been explained in the foregoing part of the article, and are indicated on the geological map.

Note. — I am indebted to Dr. A. A. Gould, Dr. William Stimpson, and Mr. E. S. Morse, for valuable aid in identifying the species mentioned below. The reader will find numerous corrections of typographical errors occurring in an article on the marine invertebrates found at Caribou Island, Straits of Belle Isle, published in the "Canadian Naturalist and Geologist" for December, 1863, and embodied in the present article.

This list is necessarily very imperfect, giving but a slight notion of the riches which must ultimately reward careful exploration in so interesting a field.

Many of the species have been compared with specimens from Greenland received through the kindness of Dr. C. Lütken, Assistant in the Zoölogical Museum of the Royal University of Copenhagen.

Valuable information regarding the identification of several species of Amphipoda has been kindly communicated through Dr. Lütken by Mr. A. Boeck, and similar notes regarding the Polyzoa by Mr. F. A. Smitt, who has detected an alternation of generations among the Polyzoa, some of the asexual forms of which are indicated below.

Polypi.

Metridium marginatum Verrill.

Actinia marginata Say.

This species occurred quite frequently as far north as Square Island in fifteen to thirty fathoms, and Indian Harbor, and in its size and general appearance agreed with specimens dredged at different points on the coast of Maine. The forms when expanded to their fullest extent closely resembled figures of *A. dianthus*, as the disk was subdivided into lobules of a high pinkish color, while in younger specimens the disk was entire, and the polyp was of the usual amber hue. One young specimen when expanded was so transparent that the partitions could all be clearly distinguished, as also the ovaries attached to certain of them. Its disk was elevated above the eight rows of tentacles, each of which had a hyaline, smoky spot at its base.

Rhodactinea (Tealia) Davisii Agass. Verrill. Mem. Bost. Soc. Nat. Hist. I: 18; 1864.

Probably *Tealia crassicornis* Gosse.

Large specimens dredged at Caribou Island in eight fathoms, gravelly bottom, and at Square Island in from fifteen to thirty fathoms on a shelly bottom, had three rows of thick, short, blunt tentacles, each with three red circular bands, the outside of the polyp being entirely smooth with slashes of deep red on a carneous ground. Small specimens were wholly red.

Edwardsia sipunculoides Stimps.

Actinia sipunculoides Stimps. Marine Invertebrates of Grand Menan, p. 7, Pl. I., fig. 2.

A specimen, too imperfect for description, about .75 inch long and .10 inch in diameter, is, according to Professor A. E. Verrill, allied to, or identical with, this species. The tentacles are apparently twenty-four in number. Epidermis destroyed. Four fathoms, Henley Harbor, Chateau Bay.

Hydractinia polyclina Agass.

Hydractinia echinata Stimps. Syn. Inv. Grand Menan.

Found on an ascidian, and also on *Aporrhais*, in fifteen fathoms, Salmon Bay. It occurs along the whole coast.

Coryne mirabilis AGASS.

Sarsia mirabilis Agass.[1] *Oceania tubulosa* Gould, Invertebrates of Massachusetts.

This species, just in the act of throwing off the Medusæ, was dredged in great abundance on June 24th, in eight fathoms at Belles Amours, Straits of Belle Isle, where the hydraria were found attached to *Ptilota elegans*, growing on a clean gravelly bottom.

Clava multicornis PALLAS.

Clava multicornis Stimps., Leidy. *Clava leptostyla* Agass., Contr. Nat. Hist. U. S.

Occurs on shells in ten to twenty fathoms, Salmon Bay.

Thuiaria thuja FLEMING.

Collected by Messrs. Hyatt, Shaler, and Verrill in the Cambridge Expedition to Anticosti in 1861, at the Mingan Islands, Labrador.

Halecium halecinum JOHNST.

Caribou Island in eight fathoms, gravelly bottom, where its branches supported the nests of *Cerapus rubricornis* Stimps. Frequent in thirty fathoms; Chateau Bay, on a sandy bottom.

The vesicles are not so urceolate in form, the margin of the mouth being less contracted than Johnston's figures would indicate.

Halecium muricatum JOHNST.

Frequent on a fishing-bank off Caribou Island in the Straits of Belle Isle, in from thirty to fifty fathoms. Also common at Square Island a few miles northward of Cape St. Michael, in thirty fathoms.

Cotulina polyzonias AGASS. Contr. Nat. Hist. U. S. Vol. IV.

Sertularia polyzonias Linn.

Common between tide-marks at Caribou Island, and in deeper water, where it grows very stout and large.

Cotulina tricuspidata A. AGASS. Catalogue of N. Amer. Acalephæ, Mus. Comp. Zoöl. 1865.

Sertularia tricuspidata Alder.

Abundant in the Straits of Belle Isle in forty fathoms upon *Diphasia rosacea.*

Amphitrocha rugosa AGASS. Contr. Nat. Hist. U. S.

Sertularia rugosa Linn.

Rarely met with in thirty fathoms at Square Island.

Sertularia filicula ELL. and SOL.

The vesicles are minute, smooth, ovate, pyriform, often subglobose; aperture circular, not produced beyond the body of the cell; seen laterally, it is bidentate.

[1] The synonymy of the Acalephs noticed here is fully given in the Illustrated Catalogue of North American Acalephs in the Museum of Comparative Zoology, Cambridge, Mass. By Alex. Agassiz.

Sertularia falcata Linn.

Mingan Island, Gulf of St. Lawrence. Brought home by the Anticosti Expedition.

Sertularia argentea Ell. and Sol.

Caribou Island; not common; found in eight fathoms.

Sertularia cupressina Linn.

The cells in our specimens are large, thick-set; ovicapsules ovate, with fine prominent ribs, while the mouth is round, and much contracted. Henley Harbor, in seven fathoms.

Sertularia abietina Linn.

Mingan Island, Gulf of St. Lawrence, and Labrador. Anticosti Expedition.

Diphasia rosacea Agass.

Sertularia rosacea Linn.

Very abundant in fifty fathoms, gravelly bottom, in the Straits of Belle Isle.

Dynamena pumila Lamx.

Found in abundance in the Straits of Belle Isle between tide-marks.

Lafœa dumosa Sars.

Campanularia dumosa Johnst., 1838.

Cateau Harbor, Long Island; fifteen fathoms; not common.

Cosmetira *sp.*

A beautiful species of this genus, about three inches in diameter, with large tentacles about two inches long and half an inch apart, was found by Mr. Verrill in great abundance, June 25th, at Entry Island, one of the Magdalen Group. Anticosti Expedition.

Laomedea amphora Agass. Contr. Nat. Hist. U. S.

Found on *Bugula murrayana* in fifteen to thirty fathoms; Square Island.

Clytia volubilis A. Agass.

Campanularia volubilis Alder (non Auct.)

Mingan Islands; Anticosti Expedition. Henley Harbor, in deep water, twenty to thirty fathoms.

Oceania languida A Agass.

Campanularia syringa Stimps., Syn. Mar. Invert., Grand Menan.

Caribou Island; dredged at a depth of eight fathoms.

Campanularia verticillata Johnst.

Taken at Henley Harbor, in twenty fathoms of water, upon a pebbly bottom.

Halyclystus auricula Clark.

Very abundant on *Chorda filum*, at low water, August 14th, Anticosti, S. W. Point. Anticosti Expedition.

Lucernaria quadricornis Müll.

Caribou Island, ten fathoms, sand. These two species of Eleutherocarpidæ have been submitted to Professor H. J. Clark for identification.

Manania auricula Clark.

Lucernaria auricula Fabr. (*non* Müll.)

Not common; did not differ from specimens received from the Scandinavian Naturalists.

Trachynema digitale A. Agass.

Medusa digitalis Fabr. Faun. Grönl.

Specimens, agreeing well with Mr. A. Agassiz's figures and description, and of a beautiful sherry tint, were dredged in fifteen fathoms, rocky bottom, near "Strawberry Harbor," and at another point on the coast, southward.

Cyanea arctica Pér. et Lesson.

This species is most commonly observed in the Straits of Belle Isle.

Aurelia flavidula Pér. et Lesson.

Found abundantly in the Straits of Belle Isle, and in retired bays.

Idyia roseola Agass. Contr. Nat. Hist. U. S. 1860.

A very abundant form, and occurring along the coast from Cape Webuc (Harrison) to Salmon Bay in the Straits of Belle Isle, and not differing apparently from specimens observed on the coast of Maine. At Indian Tickle a specimen six inches long was observed. Another specimen was found swimming with its body contracted into the form of a very flattened, oblate sphere, and hence was scarcely recognizable at first sight. The first week in August great numbers of fragments of these animals were observed floating near the surface together with still more abundant wrecks of *Mertensia*, adding greatly to the phosphorescence of the sea, as specimens obtained in the night testified.

Anticosti, Anticosti Expedition.

Pleurobrachia rhododactyla Agass. Mem. Amer. Acad. IV.

Beroe pileus Fabr. Faun. Grönl.

Observed but rarely at Little Mecatina Island, Gulf of St. Lawrence. Anticosti, Anticosti Expedition.

Mertensia ovum Mörch. Bid. til en Besk. af Grönland, 1857.

Beroe ovum Fabr. Faun. Grönl. 1780. *Mertensia cucullus* Agass. Contr. Nat. Hist. U. S. 1860.

This superb species, as fragile as it is beautiful, is of a delicate pink color, with irides-

cent hues; the bright red spermaries and ovaries, the deep purple, red tentacles being in striking contrast with the delicate tints of the spherosome. As noticed by Mr. A. Agassiz, they are very difficult to keep for more than an hour or so in confinement. This species was extremely abundant from the Straits of Belle Isle, where there was floating ice in the last of June, to as far north as Hopedale in lat. 55° 30′. It was not commonly met with in waters from which the ice had disappeared. It was not noticed by us during our residence in the summer of 1860 at Salmon Bay.

In harbors free from ice the *Mertensia* would keep out of view near the bottom; but as soon as the ice drifted in and choked up the harbor, myriads could be seen near the surface, rising and falling between the ice-cakes, gracefully throwing out their tentacles, which were nearly two feet in length, and suddenly withdrawing them when disturbed.

Bolina alata Agass. Mem. Amer. Acad. 1849.

Anticosti; Anticosti Expedition. Not observed any farther northward.

Echinodermata.

Astrophyton eucnemis Müller and Troschel.

Straits of Belle Isle, in eighty fathoms. They are common in eighteen fathoms on a bank off Caribou Island.

Ophiacantha spinulosa Müll. and Trosch.

Straits of Belle Isle, forty fathoms, upon a hard, rocky, shelly bottom.

Amphiura Holbölli Lütken.

Found in fifteen fathoms at Cateau Bay, Long Island, on a sandy bottom.

Ophiopholis aculeata Müller.

Taken along the whole coast at a depth varying from two to fifty fathoms.

Ophioglypha Sarsii Lyman, Cat. Mus. Comp. Zoöl.

Ophiura Sarsii Lütken.

Cateau Bay, Long Island. Of large size, in fifteen fathoms, on a sandy bottom.

Ophioglypha nodosa Lyman.

Ophiura nodosa Lütken.

The most abundant and characteristic species. At Salmon Bay it occurred in the sand at low-water mark, and also in fifty fathoms in patches of sand on a rocky, shelly bottom in the Straits of Belle Isle. In fifteen to thirty fathoms at Square Island; in fifteen fathoms at Cateau Harbor, and thirty fathoms at Chateau Bay.

Crossaster papposa (Linn) Agass.

Salmon Bay, just below low water; not uncommon at Square Island, in fifteen to thirty fathoms.

Solaster endeca (Linn.) Forbes.

Taken with the preceding species at Long Island, Cateau Bay, in fifteen fathoms. Rare.

Cribella oculata Forbes.

Salmon Bay, Straits of Belle Isle, in fifteen fathoms, on a sandy bottom; not common.

Asterias grœnlandicus Steenstr.

Not uncommon at Caribou Island and Square Island in fifteen fathoms.

Asterias vulgaris Stimps. MSS., Verrill, Proc. Bost. Soc. Nat. Hist., 1866, p. 347.

Asteracanthion rubens Müll. and Trosch.

Common just below low-water mark. The largest specimens from eight to ten inches across.

Asterias (Asteracanthion) polaris Müll et Trosch.

Occurring with, and as common as, the preceding, if not more so. Often taken at Caribou Island, especially the young, in from ten to fifteen fathoms; Square Island and Hopedale.

Asterias n. sp. ?

Large specimens, measuring 20 inches across, frequently occurred in pools at low-water mark. The color in life was a light greenish hue, mottled with reddish brown.

Euryechinus dröbachiensis Verrill, Proc. Bost. Soc. 1866, p. 340.

Toxopneustes dröbachiensis Agass. *E. granulatus* Say.

Specimens measuring four inches across were often taken at low-water mark. It extends to fifty fathoms, at which depth it was frequently dredged on the Bank in the Straits of Belle Isle, where the specimens were uniformly small: but after a careful study I cannot see any permanent specific differences. I cannot see that it differs at all from individuals collected during the past summer at Eastport.

Echinarachnius parma Gray.

E. atlanticus Gray.

Abundant and large on sandy bottoms in from two to fifteen fathoms; Straits of Belle Isle.

Lophothuria Fabricii Verrill, l. c., p. 354.

Psolus Fabricii Lütken.

Two were taken in fifteen fathoms on pebbles in Esquimaux Bay.

Pentacta calcigera Stimps.

Cucumaria Koreni Lütken.

One was taken in fifteen fathoms, sand, in Salmon Bay; common at Belles Amours in eight fathoms, mud; Cateau Harbor, fifteen fathoms, sand.

Pentacta frondosa Jaeger.

One specimen was thrown upon the beach.

Chirodota læve GRUBE.

Very fine specimens, eight inches long, were abundant in ten fathoms, sand, in Salmon Bay; abundant on the whole coast.

Eupyrgus scaber LÜTKEN.

Several were taken in ten fathoms, sand, in Salmon Bay. It has not occurred so low down the coast before. Also at Long Island in fifteen fathoms.

Myriotrochus Rinkii STEENSTR. LÜTKEN, Oversigt Grönl. Echinodermer.

This beautiful species first occurred in abundance in patches of sand on a stony bottom in seven fathoms at the anchorage in Domino Harbor. It was afterward found commonly in fifteen to thirty fathoms at Square Island; also at Thomas Bay, fifteen fathoms, sand; Long Island, Sandwich Bay, fifteen fathoms, sand.

POLYZOA.

Tubulipora serpens JOHNSTON.

Occurred in long, twisted masses on *Bugula Murrayana* at Square Island in thirty fathoms; Henley Harbor, common. I have compared this with specimens from Denmark, from which it scarcely differs.

Tubulipora patina JOHNST.

Common. Domino Harbor, seven fathoms.

Tubulipora divisa STIMPS. Mar. Invert. Gr. Menan, p. 18.

Not common, Henley Harbor, four fathoms. Mr. Smitt states that this form is "a stage of development of *Pencilletla penicillata* (Gray)."

Tubulipora hispida JOHNST.

Frequent on sertularians in fifty fathoms.

Tubulipora palmata WOOD. (*fide* SMITT.[1])

T. flabellaris Johnst.

On stones in the Straits of Belle Isle, fifty fathoms.

Diastopora verrucaria M. EDW.

Millepora verrucaria O. Fabr.

Frequent in fifty fathoms. I have specimens from Greenland, and also from the Bay of Fundy, from which it does not differ.

Stomapora expansa PACKARD, Can. Nat., p. 406, 1863.

Creeping, flat, expanding; the branches widening at the origin of new ones, rugose. Cells in the young long, slender, erect, slightly recurved; arising singly, or in groups of two or three at irregular intervals along the branch. Old specimens broader, cells horizontal, apertures hardly raised above the surface, emarginated.

[1] Mr. Smitt's identifications are based on specimens from Labrador sent by us to the Zoölogical Museum at Copenhagen.

A small, slender, white species, the erect tubes in the young longer than the width of the branch. It differs from the European *S.* (*Alecto*) *major* in being broader and more expanded.

Idmonea atlantica JOHNST. (*fide* SMITT.)

Idmonea pruinosa Stimps.

Frequent on the bank, in the Straits of Belle Isle. Square Island, at a depth of thirty fathoms.

Hippothoa catenularia JAMESON (*fide* SMITT.)

Hippothoa rugosa Stimps.

This species was found in abundance.

Hippothoa borealis D'ORB.

H. divaricata Lamx?

Found in abundance in the Straits of Belle Isle and Cateau Harbor.

Hippothoa expansa DAWSON.

Frequent in the Straits of Belle Isle. I have also dredged it at Mount Desert, Maine, in fifteen fathoms.

Lepralia annulata O. FABR.

A group of three cells, with two spines on each side of the distal margin, occurred in the Straits of Belle Isle; also in Cateau Harbor, Long Island, in fifteen fathoms.

Lepralia ciliata JOHNST.

L. crassispina Stimps.

This was one of the most abundant species, and occurs on the whole coast in deep water.

Lepralia n. sp.

Allied to *L. trispinosa* Johnst.; very abundant. It is also abundant in Maine, as far south as Portland. According to Mr. Smitt, this is not the European species, with which it has been confounded in our list in the Canadian Naturalist.

Lepralia pertusa THOMPS.

I cannot distinguish my specimens by any permanent characters from the British species. It is oval or broad oval, somewhat flattened or convex, punctured somewhat coarsely, with ridges separating the cells, which are arranged in no special order. Aperture round, truncate behind, or with a broad shallow sinus. The ovi-capsules globose, sub-rugose, subpunctate, much as in the British specimens. Found growing in purple patches. Length $\frac{1}{30}$ of an inch, half as broad as long.

What I take to be a second and larger form of this species has the cells large, oblong, oval, convex, being closely connected with the ones before and behind in radiating lines. The surface has coarse emarginated punctures. In old specimens the punctures are so large that the surface is often but a net-work enclosing them. Apertures round, slightly raised, with a deep narrow sinus, at the entrance of which are two denticles, one on each side, which often become obsolete. In some cells the surface is perfectly smooth, and only the marginal punctures are present. It is much larger than the preceding form, being $\frac{1}{40}$ of an inch long, and arranged in more regular rows, and preserves better its oblong, oval, convex form. The ovi-capsules are emarginato-punctate, and proportionally smaller and

smoother than in the preceding form. Specimens from Greenland do not differ. Long Island, Cateau Harbor, fifteen fathoms. Are the two forms an instance of Dimorphism ?

I have also specimens on *Pecten islandicus* from the Newfoundland Bank.

Mr. Smitt supposes this to be the "Lepralia" stage of *Eschara saccata?*

L. producta Pack. Can. Nat. p. 407, Pl. I., fig. 1.

Cells oval, convex, coarsely punctate; in the young the punctures are emarginate, the base of the cell is produced and wedged in between adjacent ones. Aperture broad, round, with a moderately large and deep sinus in the young; in older cells, small, round, truncate behind, horse-shoe shaped; margin full, broad, unarmed, and when the cells are crowded, the margin in front expanding upon the base of the cell in front. Cells arranged in lines, soon becoming very irregular, and partially radiating; forming white, but more generally purple, patches. Length $\frac{1}{30}$ of an inch. Old specimens are flattened, granulated, with marginal punctures; very rarely the aperture has a small sinus. It is the largest species observed. Frequent.

As in the preceding species, there are two forms which might easily be mistaken for as many species. The young cells are rounded, ovate, depressed, and with emarginate punctures, while the apertures are sinuate. With the other form the species becomes the largest of the genus yet observed on this coast. The cells are much thickened, convex, in outline often pyriform, owing to the elongation of the base of the cell; and the aperture is small and truncate behind.

In both forms the surface is more than usually rugose.

Lepralia trispinosa Johnst. (*fide* Smitt.)

See the remarks under *Eschara lobata* Lamx ?

Lepralia Belli Dawson.

Taken frequently on the Bank in the Straits of Belle Isle.

Lepralia labiata Stimps.

Only one group of this singular species occurred.

Lepralia lineata Hassell.

This species was met with but rarely.

Lepralia globifera Pack. Can. Nat. p. 408.

Cells large, flat, white, the surface somewhat raised around the small round aperture, which has a slight sinus. Behind the sinus is a minute perforated conical avicularium. Ovi-cell large, globose, with a few emarginated coarse punctures. Cells in radiating lines, with ridges running between them. The ovi-capsules are more crowded in the centre of the patch, not being present in the inner cells. Frequent, forming frosty white patches. It often encrusts Celleporæ, where the ovi-cells are much crowded, and the ridges between the radiating rows of cells obsolete. I have dredged it in the Bay of Fundy.

Stimpson's *L. candida*, very common in the Bay of Fundy, did not occur in my collection.

Membranipora pilosa JOHNST.

Especially abundant encircling fronds of Desmarestia just below low-water mark.

Membranipora lineata BUSK.

Frequent in from ten to fifty fathoms, Straits of Belle Isle.

Membranipora (Reptoflustrella) americana D'ORB. (*fide* SMITT.)

M. Lacroixii Busk ? Packard, Can. Nat. p. 408.

I cannot distinguish these two species from Greenland specimens.

Membranipora solida PACK. l. c. p. 408. Pl. I., fig. 2.

Cells large, flat, solid, oval, angulated, often presenting a six-sided figure as is common in the genus. Margin raised, simple, very broad and without spines. Aperture occupying one half of the upper surface, transversely broad, oval, with a broad deep sinus; the posterior half of the upper valve is thin, convex, subrugose, with a small, triangularly perforate, conical avicularium, situated at the posterior end of the upper surface. Cells arranged in lines, or in quincunces, or more often irregularly. The cells are not so crowded as in the other species. To the naked eye it looks like bleached patches of old worn Lepraliæ.

Beania admiranda PACK. l. c. p. 408.

Cells very large, erect, oval, smooth, base produced, sessile. Growing in tufts, the cells arranged in contiguous series, the new cells arising on each side of the aperture of the parent cell. Aperture raised, circular, surmounted by two long, stout, truncate spines, which are succeeded on the opposite side by two rows of long obtuse spines nearly meeting across the hollow formed by the two ridges on the back of the cell. Compared with *B. mirabilis* of the British coast, this is a much stouter species, growing in low spreading, but not creeping, tufts. There are from six to eight pairs of large obtuse spines which meet across the cell; being fewer in number, and longer and stouter than in *B. mirabilis*. More important differences exist in the diameter of the cell which is greatest at the distal or anterior third of the cell, where in the British species it is thickest posteriorly; and in our species the aperture opens near the end of the cell. It occurred rarely on Pecten in fifty fathoms, Straits of Belle Isle.

Crisia eburnea (LINN.)

Crisia luxata Fleming.

Our specimens agree perfectly with Smitt's excellent drawings of the cœnœcium and ovi-cells. Hopedale, ten fathoms, rocky bottom; Henley Harbor, four fathoms.

Cellularia Peachii JOHNST ?

Found with the preceding. A rare species.

Menipea ternata Busk ?

Rare. Straits of Belle Isle, fifty fathoms. Caribou Island, eight fathoms.

Menipea fruticosa Pack. l. c. p. 409, Pl. I., fig. 3.

This fine species grows an inch in height, with large wide branches, dividing dichotomously. The cells are large and long, being attenuated downwards. Above they are truncated, with four spines, two upon each side, and invariably with an outer projecting spine, when the others are absent. The upper valve is long, oval, and sunken; aperture transversely linear, closed by a square incomplete lid. Cells contiguous, arranged in two alternating rows, with two or three median ones before the origin of the branches. The avicularia have long beaks, and are arranged sparsely at the base of the median cells. Long vibracula arise near the front of a few lower valves. The ovi-capsules are globose and smooth. It is more nearly allied to *M. cirrata* of Europe than to any other species, though very distinct. It is a common species, and occurs in Greenland, from whence I have a specimen.

Scrupocellaria americana Pack. l. c. p. 409.

This species is closely allied to *S. scruposa*, with specimens of which, collected by Dr. Stimpson on the English coast, I have compared it. With much the same habit, our species is twice as large and much more solid. There are the same relative proportions in the form and size of the cells, but in our species the avicularia are smaller in proportion to the cell, and there is but a single spine surmounting this appendage, the lip of the orifice being unarmed, while in *S. scruposa* two spines are very constantly present on the inner side of the cell. The lids or upper valves, which in my specimens are raised from the cœnœcium by the relaxation of the muscles, are convex, and somewhat rugose, owing to several slight transverse lines. The ovi-cells are smooth and globose. It is not infrequent on the Bank in the Straits of Belle Isle. Belles Amours, eight fathoms; Square Island, ten to thirty fathoms. Common.

Acamarchis plumosa Busk.

A. fastigiata (Fabr.) Faun. Grönl.

Thomas Bay, at a depth of fifteen fathoms, in sand and mud. Rare.

Caberea Hookeri Busk.

Our specimens present some differences from the British specimens in my possession, collected by Dr. Stimpson; and also from Mr. Busk's figures. It is abundant in Labrador, and on the coast of Maine as far as Casco Bay. Mr. Smitt pronounces our form identical with the European.

Halophila borealis Pack. l. c. p. 409, Pl. I., fig. 4.

This species agrees well in its generic character with *H. Johnstoniæ* Gray, from New Zealand, though differing specifically, among other respects, in being multiserial. The cœnœcium forms soft and flexible, horn-colored tufts, an inch in height. The cells in mature specimens are arranged in several contiguous series, and are very long, sub-clavate, truncate, widening a little above, with sometimes a slight spine on the outer angle. The aperture is transversely linear and closed by a slightly sinuate lid. The ovi-capsules are

globular and nearly smooth. The upper valves are so thin that in dried specimens they readily contract, and the lid and linear aperture are effaced, and the cell then appears as if it possessed a large, broad, oval aperture, covered by a thin lid. A single branch consisted in one example of eight rows of cells. A single isolated cell closely resembles a cell of *Flustra truncata*, showing the near relationship of this genus to the Flustradæ. But one tuft of this interesting species occurred in fifty fathoms, associated with *Beania admiranda*, on a fragment of *Pecten islandicus*, Straits of Belle Isle.

Flustra truncata Linn.

This species was taken frequently.

F. membranacea Linn.

This species was found in abundance.

Flustra digitata n. sp. [Plate VII., fig. 16.]

Cœnœcium broad, rather thick, flexible, membranaceous, dividing into digitate portions, much as in *Bugula Murrayana*. Cells long and narrow, unarmed, well rounded in front. Lid covering a curvilinear aperture opening very near the front edge.

Its unarmed cells, well rounded in front, with the curvilinear aperture, will serve to distinguish it.

Chateau Bay, thirty fathoms. Not uncommon.

Bugula Murrayana Busk.

Abundant on the whole coast. Caribou Island, ten to fifty fathoms; Belles Amours, eight fathoms; Strawberry Harbor, fourteen fathoms; Square Island, ten to thirty fathoms; Domino Harbor, seven fathoms; Hopedale, ten fathoms.

Cellepora pumicosa Ellis.

Found frequently on sertularians.

Celleporaria surcularis Pack. l. c. p. 410.

Grows two or three inches high, branching dichotomously, the ends of the branches somewhat truncated. Cylindrical, base two or three lines in thickness, surface rough. Cells crowded, of unequal size, erect, conical. Aperture small with a slight sinus. In the young conical communities, the cells stand out more from the axis; apertures large, round, with a slight, often obsolete, sinus. Surface of the cells coarse, irregular, and deeply punctured, often arranged in irregular series running down the sides from the aperture. The terminal cell large and conical. In old species the sinus is sometimes enlarged with two denticles at its entrance. In section, the cells are irregularly oval, scattered thickly over the axis and periphery. Abundant on stems and shells in company with Escharæ.

Dr. Stimpson has placed in my hand specimens belonging to this species, collected by Dr. Hayes in Northern Greenland, and by McAndrew in Manseroe Sound, Finmark. European authors have confounded this arctic species with *C. cervicornis* of the Mediterranean Sea, from whence it was originally described by Pallas.

Eschara lobata LAMX ?

Lamouroux describes *Eschara lobata* as growing in radiating patches, always adhering to the surface of objects, and as having been collected near the Banks of Newfoundland.

The cells are oblong, oval, convex; each end is connected with the cell in front and behind, with a few larger emarginate punctures. Aperture round, with a shallow broad sinus. Just behind the aperture a small perforated conical eminence, which in old specimens bears a large avicularium, with long, sharp-pointed beaks gaping widely; or when absent the cone is large, covering the upper surface of the cell, and furrowed with descending ridges. In communities with ovi-capsules, the surface of the cell itself cannot be seen; the capsules are globular, sublunate in form, with emarginated punctures; the aperture large, often truncate behind. Cells arranged in linear series with intervening ridges.

Occurs spreading over dead Cardium and Serripes in ten to twenty fathoms, Salmon Bay, or in fifty fathoms on the Banks; Hopedale, ten fathoms, rocky. I have taken it in the Bay of Fundy and at Eastport from low-water mark to twenty fathoms. Mr. Smitt considers this as being the Lepralia stage, *L. trispinosa*, of an unknown species of Eschara.

It is very different from a thin, flat, membranaceous, inverted, cup-shaped species that inhabits Massachusetts Bay.

E. elegantula D'ORB.

The cœnœcium of this fine species grows several inches high in erect branching masses, the branches expanding flat and spreading at the ends. Cells broad, oval, flattened, somewhat produced at the base; surface smooth, sub-granulated. Aperture round, with a broad shallow sinus. Young cells often margined with a row of large punctures. In old communities the ovi-cells are narrow-oblong, very convex, semi-cylindrical, the cylinder-like avicularia projecting over the aperture, and perforated with a large operculated aperture. Toward the end of the branches, the cells are somewhat cylindrical, bearing narrow globular ovi-capsules, which are emarginate-punctured. This is near Busk's *E. saccata*, which came either from Norway or Finmark. It differs, however, from his figure; and his rather unsatisfactory description does not aid me in determining the species.

Common on the Bank in the Straits of Belle Isle, in company with Cellepora. I have specimens also from the Newfoundland Banks. Dr. Stimpson has also specimens collected in Northern Greenland by Dr. Hayes in his last expedition.

Eschara papposa n. sp. [Plate VII., fig. 17.]

Cœnœcium thick and solid, spreading out in broad, lobulate expansions. Cells numerous, rather small; their surface mostly concealed by the large cylindrical tubes which are unusually erect, giving a papillose appearance to the surface of the cœnœcium; the tube is perforated by a large operculated aperture, which is bilobate orbicular, divided by a mesial obtuse tooth in the hinder edge. The aperture of the cell seen from above is partially concealed by the tube, giving it a lunate form. The ovi-cell is of medium size, globular, thin, smooth and hyaline. The youngest cells at the outer edge of the cœnœcium consist of the very free erect tube, without any ovi-sacs, and with the small aperture protected by a thin lid. The avicularia are remarkably large and thorn-like, being acutely conical, compressed laterally; the smaller lid is often narrow and hooked like a hawk's

bill. They occur on the oldest cells. Chateau Bay, not unfrequently found with *Flustra digitata*.

Myriozoum subgracile D'ORB.

Millepora truncata **Linn. Fabr., Faun Grönl.**

Frequent with the other species.

Fabricius's description applies well to this species. It grows two or three inches high, branching dichotomously; branches cylindrical, smooth, while at irregular distances slightly contracting, — *passim annulis angustioribus* — cells immersed; apertures round with a very narrow, deep sinus, those at the end of the truncate branches have the *figuram calcei equini*, of Fabricius's description. The surface between the cells is deeply and irregularly punctured. A transverse section of a branch shows about twelve oval cells separated by thin walls, arranged around the solid axis of the stem.

This species approaches somewhat Busk's *Eschara teres*, (Ann. Nat. Hist., 1856,) but it seems to have a more regular form; the oval cells shown in a transverse section are not so much produced toward the central axis of the stem; while it differs wholly from *E. teres* in the punctures dotting thickly the whole surface between the cells, instead of there being a single row surrounding the aperture, as usual in the genus. *Millepora truncata* is a Mediterranean species, and, as represented by Lamouroux, is a much larger and very different form from the two species above mentioned. On the Bank in fifty fathoms, with the preceding species; also from the Banks of Newfoundland, and the Bay of Fundy.

TUNICATA.

Leptoclinum sp.

A species of compound ascidian was abundant in somewhat pellucid masses surrounding branches of nullipores in fifteen feet.

Didemnium roseum SARS, Reise i Lofoten og Finmarken, p. 33, 1850.

Colony forming a calcareous, thin, encrusting mass, coriaceous, much expanded, surface finely granulated, being covered densely with round, mammillated bodies. Branchial orifices rudely arranged in quincunces, slightly raised above the surface, formed of six triangular lobes, with the alternating lobes a little unequal in size, composed of three or four granules a little larger than those on the surface generally.

It bears a close resemblance to *Didemnium exaratum* Grube, (Ausflug nach Trieste. Taf. II., fig. 2, 2^a,) but the branchial openings are thicker and the mass thinner and more calcareous in our species. It agrees exactly with Sars's description of *D. roseum*, though it is whitish in alcoholic specimens.

Found frequently encrusting fucoids in masses an inch in diameter, in ten fathoms, Hopedale; and on the whole coast. I have also dredged it at Eastport in twenty fathoms.

Ascidia callosa STIMPS. Proc. Bost. Soc. Nat. Hist.

Abundant at the Straits of Belle Isle in forty to fifty fathoms, occurring as on the coast of Maine, but growing to a larger size in masses affording shelter to various worms, Gephyrea and Modiolariæ, and serving as a base of attachment to numerous Hydroids.

Glandula glutinans MÖLLER, Index Mollusc. Grönlandiæ.

Does not differ from specimens thus labelled, from Europe. Henley Harbor, six fathoms, sand.

Cynthia pyriformis RATHKE.

This species was not uncommon in the Straits of Belle Isle.

Cynthia condylomata n. sp.

Test spherico-conical, surmounted by a spinulated apex; it is a little higher than broad, with transverse rows of lighter-colored, unequal, wart-like tubercles, which often terminate in minute, blunt spinules, the larger ones stout and curved, with black tips. Apex of the test high, rising up between the two orifices, into a square, truncate, corneous projection, and terminating in five or six large spines. Incurrent and excurrent orifices, consisting of four triangular depressed valves, being surrounded by a raised broad rim of crowded tubercles, surmounted by spinules. Length, .50 inch. A still larger specimen, over an inch in length, from the Banks of Newfoundland, is in the Museum of the Essex Institute.

This species may be easily recognized by its conical form, with circles of large wart-like tubercles, and the steeple-like corneous apex, truncated at tip, and armed with acute, short thick spinules.

Caribou Island, eight fathoms, on Nullipores.

Cynthia echinata (LINN.)

Dredged at a depth of fifty fathoms in Chateau Bay.

Cynthia placenta n. sp.

Test broad, expanded, much flattened, very emarginate, about five times as broad as high, with the thin edge uneven, revolute; surface granulated, though the scales are flattened. Anal and branchial orifices much alike, of equal height, and as distant from each other as the thickness of the test, which is half an inch in diameter.

One specimen covered with sand was larger and more roughened about the orifices than the other specimen, which was smooth and naked.

Dredged in the Straits of Belle Isle, forty fathoms, hard bottom; Henley Harbor, ten to twenty fathoms, sandy; Cateau Harbor, Long Island, fifteen fathoms, sandy. It is also common in the Bay of Fundy.

Pelonaia arenifera STIMPS.

This occurred in fifteen fathoms, sand, at Salmon Bay, in the Straits of Belle Isle.

Boltenia Bolteni LINN.

Boltenia oviformis Sav. Pack. Can. Nat. 1863.

Comparison with specimens from Greenland shows that this common species is found along our northeastern coast from the Bay of Fundy to Greenland.

BRANCHIOPODA.

Hypothyris psittacea KING.

Frequent on hard and sandy bottoms along the whole coast in from eight to fifty fathoms.

LAMELLIBRANCHIATA.

Anomia ephippium LINN.

Abundant, though small, at Caribou Island, eight fathoms, on Nullipores. Square Island, thirty fathoms.

Anomia aculeata GMELIN.

Dredged at depths varying from ten to fifty fathoms, Straits of Belle Isle.

Astarte Banksii LEACH.

Astarte Laurentiana Lyell, Travels in North America. *Astarte Warhami* Hancock, Ann. Nat. Hist. 1846. *Astarte compressa* Dawson, Can. Nat. *passim*.

There are the same variations noticeable in the fossil specimens from Portland, — which I have received in large numbers from Messrs. E. S. Morse and C. B. Fuller, — as in the recent specimens dredged on the coast of Labrador. Some old specimens resemble the variety *A. Richardsoni* and *A. fabula* of Reeve; others the *A. Warhami* of Hancock; while still older individuals are much eroded at the beaks, as in the recent ones, and much thickened at the hinge. Younger, thinner shells represent *A. Laurentiana* of the St. Lawrence Leda Clays, and agree very closely with specimens thus labelled and kindly sent me by Dr. J. W. Dawson. Recent specimens, given me by Dr. Stimpson from off Halifax, agree very closely with *A. Laurentiana.*

Astarte compressa (LINN.)

Astarte semisulcata Leach. *A. elliptica* Brown, Gould.

Abundant on the whole coast in from ten to fifty fathoms. It is more abundant in the bays than *A. Banksii*, which is a deep-sea shell, and is found on the more exposed deep-sea bottoms.

Astarte striata LEACH.

This species was taken at Hopedale in ten fathoms. It is not common.

Cardium islandicum CHEMN.

Of large size. In thirty fathoms at Square Island; at Salmon Bay in ten fathoms, mud.

Cardium Hayesii STIMPS. Proc. Acad. Nat. Sc. Phil., p. 58, 1862, [Pl. VII., fig. 14.]

This species is found on the whole coast, and is more abundant than the preceding species. Square Island, fifteen to thirty fathoms. Hopedale, ten fathoms. The figure is from

a photograph taken by Professor A. E. Verrill, and reduced in size from a specimen nearly three inches long.

Pecten tenuicostatus MIGHL.

P. magellanicus **Lamk.**

Is most abundant on a sandy bottom at a fathom's depth. The young were only dredged in fifteen fathoms. The inhabitants call them "pussels," and often eat them. We can bear testimony to the delicacy and rich flavor of this shell-fish.

A species of boring sponge, *Clionea?* which grows two inches or more in height, its roots boring worm-like galleries in the shell, hastens the decomposition of dead shells very greatly.

Pecten islandicus MÜLL.

Common in ten to fifty fathoms on a sandy or rocky hard bottom. Valves are occasionally thrown up on beaches.

Limatula sulculus LEACH.

Several were dredged in fifteen to fifty fathoms upon a sandy and gravelly bottom.

Nucula tenuis TURTON.

Common on the whole coast on a muddy bottom.

Nucula expansa REEVE.

This species occurred abundantly with the preceding. Dr. Stimpson has identified our specimens as being this before doubtful species. Chateau Bay, fifty fathoms, where it occurred of large size.

Yoldia sapotilla STIMPS.

A few of these occurred at a depth of ten to fifteen fathoms.

Leda buccata STIMPS.

Abundant. Does not differ from Greenland specimens. Long Island, fifteen fathoms; Henley Harbor, twenty fathoms.

Leda minuta (FABR.)

Long Island, fifteen fathoms; Henley Harbor, twenty fathoms; Chateau Bay, fifty fathoms; Square Island, thirty fathoms.

Crenella glandula TURTON.

Abundant. Caribou Island in five fathoms, sandy bottom. Square Island, thirty fathoms.

Modiolaria corrugata STIMPS.

This species was found at a depth of fifty fathoms.

Modiolaria lævigata GRAY.

This species was taken with the preceding.

Modiolaria faba FABR.

Henley Harbor, four fathoms.

Modiolaria discrepans MULL.

A valve two inches long was taken from the stomach of a cod caught on the Bank, in the Straits of Belle Isle. Thirty fathoms, Square Island.

Mytilus modiolus LINN.

This species was not common.

Mytilus edulis LINN.

This species was found in great abundance.

Alasmodonta arcuata BARNES?

I was told that a fresh-water mussel was common in Salmon River. This must be the same shell that Professor P. A. Chadbourne informs me is very abundant in the streams of Newfoundland.

Pisidium Steenbuchii (MÖLL.)

Abundant in fresh-water streams and swampy land at Square Island and Strawberry Harbor.

Cryptodon Gouldii PHIL.

Very large and abundant; a few in fifty fathoms, Straits of Belle Isle. Long Island, fifteen fathoms. Chateau Bay, fifty fathoms.

Cardita borealis CONR.

On a bank in fifty fathoms, Straits of Belle Isle. Long Island, fifteen fathoms. Chateau Bay, fifty fathoms.

Cardium pinnulatum CONR.

Very common, and as large as usual southward. It did not occur north of the Straits of Belle Isle.

Serripes grœnlandicus BECK.

This is a very abundant species, and is a very constant companion of *Cardium islandicum*, occurring in a mixed sand and mud bottom in ten to twenty fathoms, where it grows to an enormous size.

It varies considerably when old, some specimens being triangular and flattened, with the beaks placed far anteriorly, while other shells are ventricose, oval, with the beaks very central. The young all agree in being short and high, very thick, and in having the large, swollen beaks placed nearly in the middle of the shells. Some specimens from Greenland

differ very much from the Labrador shells in being very triangular, not much longer than high, and having the beaks small and flattened, and placed far anteriorly. Were there not others approaching very closely to some Labrador forms, these characters would easily separate the *grœnlandicus* into two representative species. Whole coast; Square Island, ten to fifty fathoms; Long Island, thirty fathoms.

Gemma Totteni Stimps.

Venus gemma Totten.

Taken in Indian Harbor, low water.

Tapes fluctuosa Sowb.

One valve from the Bank. Henley Harbor, twenty fathoms; Square Island, thirty fathoms. Not uncommon.

Mactra solidissima Chemn.

One valve was given me, which was taken three miles inland from the mouth of Esquimaux River on a sand beach.

Mactra polynema Stimps.

Mactra ovalis Gould.

This species was found rarely having been thrown up on beaches.

Mesodesma Jauresii Joannis.

It is of a very large size, and thrown up very abundantly on beaches.

Macoma fusca Stimps.

It is quite common, generally occurring between tide marks.

Macoma sabulosa Stimps.

T. proxima.

A very large and abundant species, taken in fifteen fathoms, at Salmon Bay; Long Island.

Solenensis Linn.

Rarely taken. Some young specimens were dredged at a depth of fifteen fathoms.

Thracia Conradi Couth.

We succeeded in dredging only one small specimen of this shell.

Thracia myopsis Beck.

A fine large specimen was dredged in ten fathoms mud, at Salmon Bay; at Long Island, in fifteen fathoms, sand.

Anatina papyracea Say.

In fifteen fathoms, sandy bottom, at Chateau Bay. It was identified by Dr. A. A. Gould.

Pandora trilineata SAY.

A few specimens occurred in fifteen fathoms, sand. Henley Harbor, twenty fathoms; Square Island, thirty fathoms.

Pandorina arenosa MÖLL.

One valve was taken with the preceding among nullipores in stony sand, fifteen fathoms. Long Island, fifteen fathoms, sand.

Cyrtodaria siliqua DAUDIN.

At a depth varying from fifteen to fifty fathoms. Mostly on hard, stony bottoms.

Mya truncata LINN.

The short, obliquely truncated variety *uddevallensis*, occurred on the Bank, and abundantly in thirty fathoms at Square Island.

Mya arenaria LINN.

This species occurred in great abundance.

Saxicava rugosa LINN.

Common in ten to fifty fathoms. Limestone pebbles are often fished up from the Gulf, which are bored into in every direction by these shells, which are then short and much thickened.

GASTEROPODA.

Clione limacina PHIPPS.

Clio borealis Brug.

This species was frequently seen floating near the surface of the water in calm weather.

Limacina helicina PHIPPS.

This species was taken very abundantly off Cape Harrison.

Proctoporia? sp.

A species with an expanded foot was taken in fifty fathoms on the Bank. It was not discovered until immersed in alcohol, and is undistinguishable, though it differs from any form known to us to occur in New England, approaching rather Fabricius's figure of *P. fusca*. No other species of Nudibranchs were found, though the ova frequently occurred in round masses on sea-weeds in the *Laminarian* zone.

Eolis sp.

A fine specimen one and a quarter inches long occurred at Henley Harbor, in four fathoms. It is rather broad, slightly flattened, with a broad space between the papillæ. The tentacles are nearly equal in length, the anterior pair remote, the lateral pair recurved, while the

posterior pair are of the same length but slenderer, and approximate on each side of the median line of the body. The dorsal papillæ are massed continuously on the sides of the body, four deep in the middle, slightly roseate, with the central biliary (?) tube deep red; tip white; tentacles and body white, with a very faint roseate hue.

Dendronotus arborescens FABR.

Several at a depth of four fathoms in Henley Harbor.

Cylichna alba LOVÉN.

Several large specimens with a thin brown epidermis, and differing in no respect from one from Greenland, occurred in ten to fifteen fathoms, mud and sand; Caribou Island, Chateau Bay fifty fathoms. Sloop Harbor, seven fathoms, sand.

Bulla pertenius MIGH.

This species was taken in the vicinity of Belles Amours, in eight fathoms, muddy bottom.

Bulla occulta MIGH.

Bulla scalpta Reeve, non Belcher.

Chiton marmoreus FABR.

Found all the way from low water to a depth of fifty fathoms.

Chiton albus LINN.

Several specimens of this shell were dredged in fifty fathoms of water.

Tectura testudinalis MÜLL.

This occurs largest and most abundant at low-water mark. The young were dredged in fifteen fathoms.

Pilidium rubellum (FABR.)

Square Island, in thirty fathoms on a hard bottom; near Strawberry Harbor, in twenty fathoms.

Diadora noachina GRAY.

Several specimens taken at the Straits of Belle Isle in ten to fifty fathoms; at Square Island in thirty fathoms.

Scissurella crispata FLEM.

Dr. Dawson has detected this species in sands examined for Foraminifera, as also the following species.

Adeorbis costulata STIMPS.

Both this and the preceding species occurred at Caribou Island.

Margarita cinerea GOULD.

Grows largest on sandy bottom in fifty fathoms. Caribou Island, seven fathoms, hard bottom. Long Island, fifteen fathoms. Square Island, thirty fathoms.

Margarita undulata Sowb. and Brod.

Of common occurrence at a depth of fifteen to twenty fathoms; sandy bottom.

Margarita varicosa Mighels.

Found abundantly along the whole coast. At Square Island in ten to thirty fathoms. Straits of Belle Isle, fifty fathoms.

Margarita helicina Möll.

This species was very plentifully found at a depth varying from two to fifteen fathoms.

Margarita campanulata Morse nov. sp. [Pl. VII. fig. 15, 15a.]

Shell umbilicated, depressed, thin, translucent, smooth and shining; composed of four volutions, last whorl rapidly expanding. Aperture large, outer lip flaring. Plane of aperture nearly at a right angle with the axis of the shell; breadth one-sixth of an inch; height one-twelfth of an inch. This species has always been confounded with *Margarita helicina*, which it somewhat resembles. The differences are seen in its smaller size, in its greater depression, and the rapidly expanding outer whorl and flaring aperture. We have examined hundreds of specimens from Portland Harbor and various points on the coast of Maine, and have seen specimens from Labrador, and the characters hold good in every specimen. The color of the extended animal is different from that of *Margarita helicina*. — Morse.

Rissoa minuta Stimps.

One dead specimen occurred; it was found above high-water mark.

Rissoa castanea Möll.

Rissoa exarata Stimps.

Dredged at a depth of fifteen fathoms on a sandy bottom.

Velutina haliotoides Müll.

Found not uncommonly in deep water on the whole coast.

Lacuna vincta Turt.

The plain and banded varieties were common. Taken at Square Island in thirty fathoms.

Littorina vestita Gould.

T. vestitus Say; *L. rudis* Gould.

Not uncommon along the whole coast.

Littorina palliata Gould.

Littorina littoralsi, Forbes and Hanl.

Both of these species occurred abundantly and with variations, as in Maine.

Scalaria grœnlandica Perry.

Of this species we were able to obtain only a fragment of a specimen.

Turritella erosa COUTH.

Abundant along the whole coast, at Chateau Bay, Long Island, in fifteen fathoms, sand.

Turritella reticulata MIGHL.

Very abundant, occurring with the preceding in ten to fifty fathoms, but most abundant in fifteen fathoms, mud, Salmon Bay. Chateau Bay, fifteen fathoms. Square Island, thirty fathoms. Hopedale, ten fathoms.

Turritella acicula STIMPS.

One individual of this species was dredged at a depth of fifty fathoms, on a hard bottom.

Aporrhais occidentalis BECK.

Very abundant on the whole coast from Salmon Bay to Hopedale, and is one of the most characteristic shells of the coast, occurring in from six to fifty fathoms, mostly in muddy quiet bays.

Menestho albula MÖLL.

Young specimens occurred very frequently in from two to fifteen fathoms, sand.

Lamellaria perspicua LOVÉN.

Dredged at a depth of fifteen fathoms, on a sandy and muddy bottom.

Natica heros SAY.

Two young dead shells were found at high-water mark, in Salmon Bay, Straits of Belle Isle.

Natica clausa SOWB.

Found to occur quite frequently at a depth of fifteen fathoms.

Natica (Lunatia) grœnlandica BECK.

Taken at Chateau Bay, Long Island, in fifteen fathoms, on a sandy bottom.

Bela americana.

Defrancia scalaris Möll., Ind. Moll. Grönl. *Fusus turricula* Gould.

The European *B. turricula*, as observed by Mörch, is very different from the American representative. On a comparison of our shell with several specimens of the *turricula*, we find that the shoulder on each whorl which gives the shell its turreted appearance, is situated more in the middle in *B. scalaris*. The *turricula* has twelve longitudinal ridges on each whorl, being fewer and proportionately larger than in our species, which has seventeen. Our species seems also to be a larger shell. It agrees well with Möller's *D. scalaris*, to which he refers *turricula* Gould.

In a long variety figured on Pl. vii. fig. 11, the shell is slender, much elongated, regularly fusiform, whorls flattened more than usual, being but slightly flattened, with the shoulder of

each whorl removed much nearer the middle than is usual; spine acute, longer than the body of the shell, suture not deeply impressed; aperture long ovate; columella smooth, a little flattened, regularly concave, not plicated; canal very short, oblique; the body of the shell covered with revolving lines and slightly waved longitudinal plications, which are especially marked on the spine. Length, .48; breadth, .20; length of aperture, .22 inch. One specimen was dredged in fifteen to thirty fathoms at Square Island. Found fossil at Caribou Island; rare. The typical forms are found on the whole coast.

Bela nobilis (Möller).

This species differs from *B. americana and B. turricula* (of which we would scarcely consider it a variety), in its fewer and larger rugæ, with less distinct revolving lines.

Bela scalaris.

Defrancia scalaris Möll., Index Moll. Grönl.

This shell we would consider as also distinct from *B. americana*, and like that species it has both a short and elongated form. The canal is longer and the spine is more acute. The fossil specimens scarcely differ. Specimens from Dr. Lovén, thus labelled, were kindly loaned me by Dr. A. A. Gould for comparison. Square Island, thirty fathoms, shelly bottom; and also at Dumplin Harbor, Sandwich Bay, in four fathoms.

Bela woodiana Möll.

Fusus harpularius Gould.

It is a shorter and thicker shell than the preceding, in which the first whorl is as long as the remaining ones together. Not common, though a very abundant fossil.

Bela exarata.

Defrancia exarata Möller. *Pleurotoma rugulatus* "Möll." Reeve, Icon. Conch. fig. 345.

In this species the first whorl is longer than the rest; the canal is shorter and the aperture rounder. The longitudinal ridges are the same in number as in *B. woodiana*, but are less prominent, while the revolving lines are much coarser, giving the surface a reticulated appearance. Common on the whole coast.

Bela decussata Stimps.

Common in Salmon Bay in ten to fifteen fathom, smud, where it occurred more abundantly than elsewhere on the coast. Square Island in thirty fathoms, shelly bottom.

Bela pleurotomaria Stimps.

Fusus pleurotomarius Couth. *Defrancia Vahlii* Beck.

Dredged at a depth of thirty fathoms Square Island; of four fathoms at Sandwich Bay.

Bela pyrimidalis Stimps.

Fusus rufus Gould.

This species is found along the whole coast. Taken in thirty fathoms, at Square Island.

Bela cancellata Mighl.

Not uncommon at Square Island in thirty fathoms.

We should scarcely unite *B. Pingelii* (Beck) from Greenland, with this form. It differs in the long and slender, scarcely turreted, less convex whorls; the costæ and revolving lines are fainter, and the last are more numerous; the canal is slenderer and more pointed. Reeve's *Fusus rugulatus* Icon. Conch. is perhaps a synonym of *B. Pingelii*, though stated by Mörch to be identical with *B. exarata.*

Bela violacea Stimps.

Common along the whole coast. Dredged at Square Island, in thirty fathoms, on a shelly bottom.

Bela borealis.

Pleurotoma borealis Reeve, l. c. f. 277. *Defrancia livida* Möll. (non Linn.)

This species occurred but rarely. It was found at Square Island in thirty fathoms; at Sandwich Bay in four fathoms.

Buccinum Grœnlandicum Hancock. [Plate VII., fig. 5.]

Buccinum grœnlandicum Hancock, Annals and Mag. Nat. Hist. [1.] xviii., 329; pl. v., figs. 8, 9, 1846. Reeve, Conch. Icon., iii. Bucc. xiv., 118, 1847. *Buccinum Anglicanum* Lyell, Trans. Geol. Soc. *Nitorium Hancockii* Mörch. in Rink's Greenland Taellaeg. Aftr., 84, 1857.

A fine specimen of this species, but belonging to a rather more elongated type than usual, comes from the Banks of Newfoundland, and is in the collection of Mr. C. B. Fuller of Portland, who kindly loaned us two specimens for illustration.

It did not occur to us in a living state on the coast of Labrador, though it will doubtless be found there on more careful search.

A fossil specimen occurred at Pitts Arm, Chateau Bay, with nearly all the outer coating of shell off. It is thick and stout. (Pl. vii. fig. 5 a.) The large single spiral rib is very prominent, while midway between it and the suture are two ribs of half the size.

I have also received a much thinner shell from the Leda clays of Montreal, kindly sent by Dr. J. W. Dawson, associated with *Trichotropis borealis ;* also from Negrotown Point, at Carleton, opposite St. John, N. B., collected by Messrs. Mathews and Hartt.

From Canal Street, Portland, specimens collected by Mr. C. B. Fuller are unusually ventricose, more heavily plicated with large costæ, increasing in size nearer the suture than usual, and with a large raised revolving line.

This very rugose form [Pl. vii. fig. 5] also occurred fossil at Caribou Island. Young specimens collected at Portland by Mr. Fuller, however, conform more to the slender type, and agree in all respects with Lyell's figure in the Transactions of the Geological Society.

Buccinum undulatum Möller. [Pl. VII., fig. 3, young; 4, adult.]

Buccinum Labradorense Reeve, Icon. Conch., pl. i. fig. 5.

Most abundant just below low-water mark. Fine specimens three and a half inches long were frequent; their egg capsules laid in large bunches were often deposited at low-water mark. This species represents the European *B. undatum.*

We figure a young specimen dredged in deep water, with a prominent central carina on the lower whorl.

Buccinum tenue Gray. [Pl. VII., fig. 6, fossil.]

B. scalariforme Müll.

One specimen was taken on the Bank, Straits of Belle Isle.

Buccinum cretaceum Reeve, Icon. Conch., Monogr. Bucc., Pl. XIV., fig. 112.

At Long Island, found in fifteen fathoms. Shell fusiform, slender, nearly three times as long as broad. Aperture oval, ending in a rather long, broad, oblique canal. Inner lip regularly curved; the columella projecting into the aperture at the base of the canal; from this projection a slight ridge runs back to the other end of the aperture, following the curve of the inner lip. Whorls nine, convex, especially on the upper two thirds. Spire much prolonged, acute. Twenty-one longitudinal ridges, smooth and rounded. On the first whorl the ridges disappear on the lower two thirds, where the minute revolving lines are more minute than elsewhere. Aperture within light chocolate, darker in the young, in which the revolving lines are more distinct. Length, $\frac{21}{20}$ in., breadth, $\frac{8}{10}$ in.

The slender and fusiform shape, and greater length of the spire than is found in other northern species, will distinguish it. The young and old were dredged alive in ten fathoms, mud and sand, Salmon Bay. Dr. Stimpson informs me that he has seen specimens from the Newfoundland Banks. It seems to be identical with Reeve's species, of which he gives no locality. This fine species is not uncommon, occurring at Caribou Island, seven fathoms young and old, mostly on a rocky bottom. Square Island, fifteen to thirty fathoms, on a shelly bottom.

Fusus (Neptunea) islandicus Gould.

According to Dr. Stimpson our American form differs specifically from the European form. A specimen from the Banks is remarkably short and thick, the spire being no longer than the aperture, while the whorls are flattened, being but slightly convex with no revolving lines. The canal is long and tortuous. Length, 2 inches; breadth, $1\frac{1}{10}$ inches. It did not occur to us on the Labrador coast.

Mörch (Journal de Conchyliologie, 3d Ser. T. II. 36, Pl. I. fig. 1,) describes from Newfoundland a closely allied species, *Fusus* (*Sipho*) *lividus.*

Fusus syrtensis n. sp. [Plate VII., fig. 13.]

Shell thin, very short, ovate; spire rapidly acuminate, cylindrical, broadly conico-fusiform, a little more than one half as long as the rest of the shell. Aperture large ovate; canal remarkably short, oblique, very wide, the aperture contracting less than usual; whorls, especially the first one, with fine revolving lines, becoming larger in the middle of

the lower whorl and disappearing toward the suture. Longitudinal costæ eighteen in number on the lowest whorl, becoming more prominent toward the suture; on the second and third whorls they are larger and more contiguous, and waved. Whorls six, much less convex, sutures very shallow.

Length, .40; breadth, .17 inch.

A remarkably short conico-fusiform shell which from its thick, broad canal, resembles a Bela, and in this respect differs from the group *Sipho islandicus*, or *Fusus pullus* of Reeve, from Newfoundland.

One specimen was dredged on a shelly bottom in thirty fathoms, Square Island Harbor.

Fusus tornatus Gould.

A large specimen, tenanted by a hermit crab, was dredged in fifty fathoms.

Trichotropis borealis Brod. and Sowb.

Taken frequently at a depth varying from ten to fifty fathoms. Long Island, fifteen fathoms; Hopedale, ten fathoms.

Admete viridula Stimps.

Thick, heavy specimens, an inch in length, were dredged in forty to fifty fathoms.

Trophon scalariforme Stimps.

Large specimens from the Bank, Straits of Belle Isle; Chateau Bay, fifty fathoms; at Henley Harbor, twenty fathoms.

Isthmia (Pupa) Hoppii Beck.

Common at Strawberry Harbor, in company with the succeeding species. This species with the other land shells, was identified by Mr. E. S. Morse.

Zoögenetes harpa (Say), Morse.

One specimen of this was found in moss at Caribou Island.

Conulus (Helix) Fabricii Beck et Möller.

At Strawberry Harbor, July 26. Found under sticks in a retired and protected valley.

Hyalina electrina (Say).

Common at Belles Amours, in wet, protected places.

Vitrina angelicæ Beck et Möller.

Common, generally occurring with the preceding species. Taken at Strawberry Harbor.

Limax agrestis Linn.

Not uncommon at Strawberry Harbor and at Square Island, under stones.

Besides these shells, the Anticosti Expedition from Cambridge collected at the Mingan Islands *Vitrina angelicæ*, *Succinea obliqua* Say, *Succinea avara* Say, *Succinea Verrillii* Bland, *Pupa badia* Adams, *Zua lubricoides* Stimps., *Helix chersina* Say, *Helix arborea* Say, and *Helix striatella* Anthony.

The only Cephalopod known is the common Squid, *Ommastrephes todarus?*

Vermes.

Syrinx? n. sp. [Plate VIII., fig 10.]

A small slender species occurred in eight fathoms, sandy bottom, at Caribou Island, which is provisionally described here, as no specimens were observed in a living state, and even the genus is doubtful. It is slender, cylindrical, the anterior half of the body gradually increasing in size towards the mouth, where in our alcoholic specimens it is suddenly truncated, or, as in another specimen, this part of the body is swollen into an ovate enlargement and slightly constricted just before the mouth. The surface is very minutely granulated with a delicate peach-like pubescence, and is dull white in spirits; posterior half of the body smooth, being scarcely granulated or striated. Posteriorly the body is suddenly truncated, with a large anal opening. At the mouth are five indistinct lobes, which are probably the retracted tentacles, but there are no traces of any bristles. Length, .35–.40 inch; breadth, .04 inch. Found free in the sand, not inhabiting shells.

Phascolosoma hamulatum n. sp. [Plate VIII., fig. 8.]

Body long, slender, cylindrical, anteriorly finely corrugated transversely with minute granulations; much swollen toward the head, into a large, globose dilatation, which is smoother than the adjacent parts. Mouth surrounded with about twenty short tentacles placed on a neck-like constriction. The posterior part of the body, concealed within a deserted shell, is much longer than the anterior, sac-like, loose, and soft, increasing in width toward the end, surface not wrinkled except at the end, which is suddenly rounded, but covered with flat granular scales; posteriorly the flattened granulations terminate in hard corneous, curved points bent toward the head, which probably act as hooks to retain the animal within its domicile. The mouth of the shell is prolonged by a tube of fine granules of sand, like those of Sabella.

Length, .50 inch; smallest diameter, just posterior to the dilatation behind the head, .04 inch; diameter of the thickest portion of the sac, .10 inch.

But one specimen was taken in eight fathoms, Caribou Island, Straits of Belle Isle, inhabiting a dead shell of *Aporrhais occidentalis*.

This interesting form differs from *Phascolosoma granulatum* F. S. Leuckart, (Brevis animalium quorandam descriptiones, p. 22, fig. 5, 1828,) in its much more elongated body, and in possessing tentacles of which Leuckart's specimens apparently had none, though they may have been withdrawn within the body in the specimen before him. The anterior part of the body of Leuckart's species does not merge so gradually into the posterior sac, and it is thicker at the middle of the body, where in our species the body increases in thickness toward the end.

Gordius lacustris Fabr? Fauna Grönl.

This species occurred quite frequently in shallow, fresh-water pools.

Pontobdella sp.

A very young specimen was found between tide marks in the Straits of Belle Isle, and a large specimen, afterwards lost, was found attached to the under side of a *Crangon boreas* in four fathoms, Henley Harbor.

Pontobdella? livida nov. sp. [Pl. VIII., fig. 9.]

A large livid, greenish, cylindrical worm, belonging undoubtedly to one a little thicker on the anterior third of the body, gradually tapering to a point anteriorly, and more obtuse posteriorly. The mouth is a single longitudinal narrow slit; the surface is finely and irregularly transversely wrinkled, the sides of each furrow being very regularly and minutely sinuated, the corrugations of unequal length and wedged in between each other. There are no longitudinal lines except on the posterior extremity where the transverse corrugations become longitudinal, and their sides are scarcely sinuate. Toward the mouth the surface is smooth. This specimen was not observed while living, so that the soft retractive ends of the body, which probably would then have been seen, are, if present at all, retracted in spirits. Belles Amours, eight fathoms, mud. Rare.

Cerebratulus (Meckelia) olivacea Rathke, Nova Acta Nat. Cur. xx. 1, 2, 3, 4, p. 237. Diesing, Syst. Helm. i. p. 264.

My specimens agree well with the description of Diesing, which was evidently copied by that author from Rathke's description. His specimens came from Norway. It is olivaceous in hue, and alcoholic specimens are apt to be broken into several sections. Common at Salmon Bay in ten fathoms, deep mud. Belles Amours, eight fathoms, soft mud. Henley Harbor, twenty fathoms.

Cerebratulus cylindricus nov. sp. [Pl. VIII., fig. 11.]

Body long, slender, cylindrical, of uniform width throughout, not tapering toward either end; mouth consisting of a long slit, extending down each side of the conical head; posteriorly the body is flattened from above, downwards. The figure represents the anterior part of the body including the head. One specimen at Belles Amours, in eight fathoms, mud.

Omaloplea Stimpsoni Girard, Stimps. Mar. Inv. Grand Menan.

Taken at Anticosti at a depth of fifteen fathoms, by the Anticosti Expedition.

Lumbricus terrestris Linn.

Small specimens, nearly an inch in length, were found in the peaty soil at Hopedale and Square Island.

Spirorbis vitrea (Fabr.)

Near Strawberry Harbor, in fifteen fathoms, on pebbles. Straits of Belle Isle, in forty to fifty fathoms. Found along the whole coast.

Spirorbis sinistrorsa Montagu.

Common at Henley Harbor, at a depth of four fathoms, on Algae.

Spirorbis porrecta Müll.

Common in ten to thirty fathoms, on Hydroids and Polyzoa. Found along the whole coast.

Spirorbis cuncellata (Fabr.)

Common on the whole coast in deep water. Straits of Belle Isle, in forty fathoms, on a stony bottom.

Spirorbis granulata (Müll.)

Found of large size along the whole coast, in ten to forty fathoms.

Spirorbis spirillum (Linn.)

This species occurs along the whole coast. Found on Fucus.

Vermilia serrula Stimps.

Dredged in the Straits of Belle Isle, at a depth of fifty fathoms.

Amphitrite cirrata Müll.

Terebrella cirrata Montagu, Trans. Linn. Soc. xii.

It constructs its tubes of fine sand. Cateau Harbor, Long Island. Caribou Island, Straits of Belle Isle, eight fathoms, sandy bottom. Common along the whole coast.

Amphitrite? sp.

A specimen too imperfect for description; has two long fleshy tentaculum-like cirri on the fourth and fifth rings from the head, arising from just behind the uncinæ, which are composed of a single seta, one on each side of the ring. The specimen also wants the usual papilla at the base of the seta.

Ampharete Grubei Malmgren, Nordiska Hafs-Annulater. 363. Pl. XIX., fig. 44.

It constructs a tube, which reminds us of the cases of some Phryganeæ, of bits of seaweeds and sand loosely placed together. The color of alcoholic specimens is livid, with a slight greenish tinge. Length, .50 inches. One specimen agrees well with Malmgren's description, and figures as observed by this author. It is very different from Grube's figure (Wiegmann's Archiv. xxvi. Tab. v. fig. 6), of *Amphicteis acutifrons*, from Greenland. Henley Harbor, in four fathoms; not uncommon.

Cistenides granulata Linn. non Johnst.

Pectinaria grænlandica Grube.

Occurs along the whole coast. Found in abundance from near low-water mark to fifty fathoms depth.

Praxilla Mülleri Malmg. l. c. p. 191.

Clymene Mülleri Sars, Fauna litt. Nor. II., p. 13. Pl. I., figs. 1–7.

A specimen of the anterior part of the body agrees well with Sars's description, but the head is contracted, and thus not recognizable in alcohol. Chateau Bay, thirty to forty fathoms, in hard sand. Cateau Harbor, Long Island, in fifteen fathoms, sand.

Nicomache lumbricalis Malmg. l. c..

Sabella lumbricalis Fabr. Fauna Grönlandica, 374. *Clymene lumbricalis* Sars, l. c. 16. Tab. II., figs. 23–26.

Caribou Island, eight fathoms, sand. This species constructs its tube of fine sand, a little more than a line in thickness and two and a half inches long.

Another species closely allied to the preceding, forms a much larger tube of sand, which is rolled on itself, in thirty to forty fathoms, Chateau Bay.

Spiochætopteras typicus Sars, l. c. ii. p. 1. Pl. I., figs. 8–21.

The tubes resemble very closely Sars's figure. On one side is a longitudinal median furrow where the transverse ridges are interrupted. The occurrence of this genus on our coast is interesting. The animal itself was obtained. Chateau Bay, in thirty to forty fathoms, hard sandy bottom. Sars's specimens, from Bergen, Norway, occurred also at the depth of forty fathoms. Several fragments of tubes were also found fossil in the quaternary beds at Caribou Island.

Arenicola piscatorum Lamk.

A specimen was found in the stomach of a codfish, taken in fifteen to twenty fathoms, at Belles Amours.

Siphonostomum asperum Stimps. l c. p. 31.

Dredged at Caribou Island, in eight fathoms of water, on a sandy bottom.

Siphonostomum plumosum Müll. (fide Stimps.)

This species was found at Salmon Bay, at a depth of ten fathoms, on a muddy bottom.

Cinatulus cirrata (Fabr.)

Cinatulus borealis Lamk.

Taken from the stomach of a codfish caught in ten fathoms, Straits of Belle Isle, off Belles Amours.

Heteronereis arctica Oërsted ?

Quite commonly found swimming on the surface of the water, in harbors.

Nephthys longisetosa Oërsted. Grönl. Ann. Dorsib. p. 43. Tab. VI., figs. 75, 76.

N. longisetosa Malmg. Nord. Hafs Annulater, p. 106. Tab. XII. fig. 20.

Dredged at Belles Amours, at a depth of five fathoms, on a muddy bottom.

Nephthys cæca OËRSTED. l. c. 41, figs. 73, 74, 77, 79–86.

Nephthys cæca Malmg. l. c. p. 104. *Nereis caeca* Fabr. Faun. Grön. p. 304. Tab. xii. 18.

Abundant on the whole coast, especially the young which were dredged in deep, soft mud, in Salmon Bay and Belles Amours in from five to twenty fathoms, and at Cateau Harbor, in fifteen fathoms, sand. Chateau Bay thirty fathoms, hard sandy bottom.

Eteone cylindrica OËRSTED, l. c. p. 35, figs. 42–49, 57.

This species was found at Belles Amours in five fathoms of water, on a muddy bottom.

Phyllodice grœnlandica OËRSTED. l. c. p. 40, figs. 19, 21, 22, 29, 32.

P. grœnlandica Malmg. l. c. p. 96.

Dredged at Square Island, in fifteen to twenty fathoms, on a shelly bottom. Frequent at Caribou Island in eight fathoms, sand. At Belles Amours in five fathoms, mud.

Onuphis Eschrichtii OËRSTED. l. c.

My specimens differ from those received from Greenland, through Dr. Lütken, and labelled *O. Eschrichtii*, in having the tentacular cirri but one half as long as the middle pair especially, and the lateral cirri are much larger and thus more prominent, the posterior cirri especially are much longer, while in the Greenland specimens they are more papilliform. Chateau Bay twenty-five to thirty fathoms. Salmon Bay fifteen fathoms. Cateau Harbor fifteen fathoms, sand.

Nereis pelagica (LINN.) OËRSTED. l. c.

Occurs frequently from Anticosti to Square Island, in ten to thirty fathoms.

Nereis sp.

Allied, according to Dr. Stimpson, to *N. denticulata* Stimps. Mar. Inv. Grand Menan, which is common on the coast of Maine between tide marks, Salmon Bay.

Pholoë minuta OËRSTED. l. c. p. 169. Tab. I., figs. 3, 4, 8, 9, 16.

A common species at Belles Amours, found in eight fathoms, on a muddy bottom.

Harmothoë imbricata LINN.

Aphrodita imbricata Linn. Syst. Nat. Ed. xii. 1767. *Aphrodita cirrata* Müller. Prodr. Zoöl. Dan. n. 2644. Fabr. Faun. Grönl. p 308, n. 290. Tab. 1, fig. 7. *Lepidonota cirrata* Oërsted. l. c. p. 14, figs. 1, 5, 6, 11, 14, 15. *Harmothoë imbricata* Malmgren, l. c. p. 66. Tab. ix. fig. 8.

Caribou Island eight fathoms, sand. Sloop Harbor six to eight fathoms, sand, common. Cateau Harbor fifteen fathoms, sand. Sandwich Bay at Dumplin Harbor, four fathoms.

This species is very variable in the color of its scales (" elytra "), which in some individuals are uniformly pale, in others partially red, while others have a central spot, and a broad, dark, curved band.

Lepidonotus squatmaus (LINN.)

Aphrodite squamata Linn. Syst. Nat. Ed. x. 655. *Polynoë squamata* Andouin et Milne Edwards. Hist. Nat. Litteral du France, II. 1834. *Aphrodite punctata* Müller, Prodr. Zoölogica Danica. *Lepidonote punctata* Oërsted. l. c. p. 12, figs. 2, 5. 39, 41, 47, 48.

Common along the whole coast. Occurs all the way from low water to twenty fathoms.

CRUSTACEA.

Nymphon grossipes FABR. Faun. Grönl.

This species was dredged at Salmon Bay and Square Island, in from fifteen to thirty fathoms.

Coronula diadema (LINN.)

Taken quite frequently from the skin of whales caught in the Gulf of St. Lawrence.

Balanus crenatus BRUG.

A common species, found along the whole coast.

Balanus balanoides LINN.

Balanus porcatus DA COSTA.

This species occurs along the whole coast, and is found only in deep water.

Peltogaster paguri RATHKE.

Not as yet found in Labrador, but a specimen has occurred at Eastport, Maine, on *Eupagurus pubescens*, an arctic crab.

Leonæa branchialis LINN.

Specimens of this animal were found attached to the skin of the codfish.

Daphnia sp.

This is a large species allied to *D. rectispina*, and is found abundantly in all the fresh-water pools.

Cypridina excisa STIMPS. l. c. p. 39. Fig. 28.

Branchipus paludosus MÜLL.

Found abundantly at "Indian Tickle," on the north shore of Invuctoke Inlet, in a pool of fresh water.

Nebalia bipes FABR.

This species was dredged at Henley Harbor, at a depth of four to eight fathoms.

Bopyrus mysidum nov. sp. [Pl. VIII., fig. 5.]

Body long and narrow, head much rounded; body behind the middle rapidly tapering to

a point ending in two short, obtuse, papilla-like stylets. The last three abdominal segments are distinct, those of the middle of the body indistinguishable. Seen laterally it is convex, flattened beneath. The legs are curved, one quarter as thick as long, rapidly thickening toward the head. Length, .09; breadth, .04 inch. A female. It differs from *B. squillarum* Rathke, and *B. hippolytis* Kr., in its much narrower, more linear body, slenderer legs, and in the presence of the caudal stylets. The drawing is a rude one, as the specimen had unfortunately dried before it was finished, but the general contour is given accurately.

Ægа sp.

One specimen was taken from the under side of a cod in the Straits of Belle Isle.

Tanais filum STIMPS. Marine Invert. Gr. Menan, p. 43.

This specimen was dredged at Caribou Island, in eight fathoms, on a sandy bottom. Rare.

Praniza cerina STIMPS. l. c. 42.

Found at Chateau Bay, Long Island, at a depth of fifteen fathoms, on a sandy bottom.

Jæra nivalis KROYER.

This species is abundant at low water under stones at Indian Harbor, Sandwich Bay.

Asellus grœnlandicus KROYER.

Specimens agreeing in length with those noticed by Fabricius, Fauna Grönlandica, were common at Square Island and Hopedale, in soil under stones, etc., in company with Limax.

Idotæa marmorata nov. sp. [Pl. VIII., fig. 6.]

A stout, thick, reddish-brown species, with the surface slightly nodulated and marbled; body rather short; head more transverse and shorter than in *I. nodulosa* Kr., not armed with sharp tubercles in front; anterior edge emarginate, acutely rectangular on the sides, with an angulated slight excavation, and a narrow, deep, but small, mesial notch; eyes large and prominent. Superior antennæ of much the same proportions as in *I. nodulosa*, but the joints are thicker. Inferior pair of antennæ long and slender; peduncle stout, with the second joint two thirds as long as the third; flagellum longer than the peduncle, where in *I. nodulosa* they are considerably shorter; each joint terminating in a thin verticil of hairs. Segments of the body convex, on the sides distinctly emarginate; the edges of each segment are straight, not convex as in *I. nodulosa*. Upper surface of the body thick, with short, impressed, broken lines diverging in their general direction from the median line of the body. Abdomen short, thick, mesially very convex; tips truncated, with a sinus at the end. Legs stout, hairy. Color purplish, reddish on the edge of the segments, and the limbs are slightly brownish, in the single alcoholic specimen in the Museum of the Society. Length, .70; breadth, .28 inch.

It differs from specimens of *I. nodulosa* Kr. in its short, thick, convex body having a much more solid, dense crust than any species found southward. The outer edge of the

segments are straight, while in *I. nodulosa* they are very convex; and it may also be readily known by the truncated, sinuated tip of the abdomen.

Sloop Harbor, Kyuetarbuck Bay, seven fathoms, on a sandy bottom.

Caprella septentrionalis KROYER.

Squilla lobata Fabr. Faun. Grönl.

Found abundantly along the whole coast, in from four to thirty fathoms, among weeds.

Themisto sp. (*fide* STIMPSON.)

Found at Anticosti. Brought home by the Anticosti Expedition.

Hyperia medusarum BATE, Cat. Amph. Br. Mus. p. 295. Pl. XLIX., fig. 1.

Metœcus medusarum (Fabr.) Kr.

Found with numerous young in the stomach-cavity of *Cyanea arctica*, at Domino Harbor.

Dulichia porrecta (*fide* BOECK).

This is a rarely found species.

Cerapus rubriformis STIMPS. Mar. Inv. Gr. Menan, p. 46.

Inhabits flexible tubes in *Halecium halecina*. Eight fathoms, sand, Caribou Island, Straits of Belle Isle. The young had just been hatched on June 20th.

Amphithœ maculata STIMPS. l. c. 53.

The specimen obtained at Henley Harbor in eight fathoms, is punctured all over the body, forming dorsal bands on the posterior half of the segments. It is punctured irregularly on the epimera and legs, while on the antennæ, especially toward the base, the dots are arranged in rings.

Gammarus locusta (LINN.) LEACH.

Gammarus mutatus Lilljeb.

As usual, this species is found in great abundance along the whole coast.

Gammarus dentatus KROYER.

Gammarus purpuratus Stimps., l. c. p. 55.

A comparison of the European specimens sent by Dr. Lütken, leads us with Mr. Bate to unite these two species. Square Island, fifteen to thirty fathoms; Straits of Belle Isle, fifteen fathoms, mud; Chateau Bay, twenty to thirty fathoms.

Paramphitæ panopla KROYER, Grönland's Amfipoda. (*fide* BOECK.)

This species was rarely met with.

Calliope læviuscula BATE, l. c. p. 148. Pl. XXVIII., fig. 2.

Amphithoë læviuscula Kr., Grönl. Amfip. p. 53, Tab. III., fig. 13.

Found at Henley Harbor, in four fathoms, very abundant; at Stag Bay in fifteen fathoms, on a hard, weedy bottom. Anticosti, Anticosti Expedition.

Amphitonotus Edwardsii BATE, l. c. 151, Pl. XXVIII., fig. 5.

Amphithoë Edwardsii (Sabine) Kr. l. c.

Our specimens were dredged at Square Island, at a depth of thirty fathoms.

Amphitonotus cataphractus STIMPS. l. c. p. 52.

Taken at Henley Harbor, at a depth of four fathoms, among weeds. Not uncommon.

Atylus vulgaris BATE, l. c. 140.

Iphimedia vulgaris Stimps. l. c. p. 53.

At Henley Harbor, in four fathoms; at Square Island, in fifteen fathoms; and at Stag Bay, in fifteen fathoms, on a hard, weedy bottom.

Atylus (Paramphitoe) inermis (KROYER, *fide* BOECK) [Pl. VIII., fig. 3.]

Cephalothorax produced into a small, flat, acute rostrum, much as in *A. bispinosus*. The first three abdominal segments are produced into three strongly hooked projections, the third of which is much the largest; fourth segment deeply, broadly sinuate. Eyes broadly elliptical, pale. The antennæ are long and slender, subequal in size and length; superior pair three fourths the length of the body, with the peduncle scarcely longer than the antennal ring. Gnathopoda stouter than in *A. bispinosus*, with the propodos rather broad, subtriangular, palm oblique. The posterior pair of abdominal feet extend to the end of the telson which is much longer and slenderer than in the other species, and as in that species, they extend considerably beyond the anterior pair of abdominal legs.

Differs from *A. bispinosus* Bate, in the very hamulate dorsal projection of the first three abdominal rings, in the sinuate fourth ring and the broader gnathopoda, and the much longer abdominal legs and telson. Henley Harbor, ten to twenty fathoms, hard, weedy bottom.

Atylus (Paramphitoe) bispinosus BECK, sp.

Paramphitoe elegans Brug. *fide* Bœck.

Identified by Dr. Boeck, from specimens sent to the Zoölogical Museum at Copenhagen. It occurred rarely with the other species of the genus.

Monoculodes nubilatus nov. sp. [Pl. VIII., fig. 4.]

Female. Cephalic ring produced into an obtuse, tumid rostrum, smaller than in *M. carinatus* Bate, of the British shores; the segments of the thorax and abdomen are not carinated above as in that species, being nearly smooth, while the abdominal segments are slightly sinuated just behind each suture. Eyes small, round, situated just above and opposite the in-

sertion of the superior antennæ; not colored in the adult, but black in the young. Superior antennæ a little longer than the peduncle of the inferior pair; inferior antennæ reaching to the hind edge of the fourth thoracic, including the cephalic, ring; the penultimate and last joint of the peduncle equal in length; flagellum about half the length of the whole antenna. Both pairs of gnathopoda very equal in size, the propodos being long, ovate; anterior pair slenderer than in *M. carinatus*, palm very oblique, with minute hairs; dactylos two thirds the length of the propodos; carpus minute, not prominently produced as in *M. carinatus*, but rather continuous with the propodos. The second pair are much stouter and more ovate than in *M. carinatus*, according in this respect more with that of *M. demissus* Stimps. In form it closely repeats that of the anterior pair; carpus with a long, slender, spine-like prolongation from the palm, forming a thumb closely appressed to the propodos but not extending to the middle. Palm of the propodos on the anterior half fringed with hairs. Dactylos one half as long as the propodos. Anterior pair of thoracic legs subequal; posterior pair of thoracic legs twice as long and much larger than the anterior, coxæ regularly short, pyriform. Abdominal legs large, equal in size, reaching nearly to the tip of the caudal stylets, which are lanceolate, very slender, acute; the first pair being a very little longer than the third. Color pale, mottled with slate. Length, .50 inch.

It differs from *M. demissus* of Grand Menan, in its color, and the very unequal antennæ. From *M. carinatus* of the British Isles it may be readily distinguished by the very equal gnathopoda and non-carinated segments, the slenderer antennæ, and the smaller, round eyes.

Caribou Island, eight fathoms, sand. At Henley Harbor a female, with several young attached to the under side, was dredged in four fathoms, the last of June.

Ampelisca Gaimardi (*fide* Beck.) [Pl. VIII., fig. 1, 1 a.]

A slender, thin, much compressed, dorsally wedge-shaped species; head scarcely as much produced as in *A. ingens* Stimps. Eyes four, distinct, small, round and black, situated very near the front margin; rostrum short, rather obtuse. Antennæ remarkably long and slender; superior pair a little more than half the length of the body; basal joint of the peduncle very thick, globose, while the two succeeding joints are very slender; the third joint being very short. The peduncle of the inferior antenna is two thirds as long as the whole superior antenna, being very long and slender, with the basal joint large, cylindrical, the last joint being nearly as long as the penultimate; flagellum long and slender, with long feathery hairs. First pair of gnathopoda small, propodos broad, produced inferiorly; carpus larger than in *A. ingens;* second pair much shorter and stouter than in *A. ingens;* carpus but one fourth longer than the propodos, which is larger and broader than in *A. ingens*, ovate; dactylos long and slender, reaching beyond the middle of the propodos; inferior margin of the joint with fasciculi of long uneven hairs. Legs much as in *A. ingens*, hinder pair of legs shorter and stouter, basos with the expansion reaching to the last joint of the leg, when in *A. ingens* it is short, not reaching beyond the fourth joint from the end; its outer edge is straight; within, full and rounded, convex, edged with thick set hairs; joints of the legs with long feathery hairs. Pleopoda well developed, of nearly even length. Abdomen slightly sinuate, giving a slightly tuberculate outline to the dorsum. Telson long, narrow, much as in *A. ingens.* Length, .50 inch.

This graceful form is readily distinguished from *A. ingens*, apparently its nearest ally, by its remarkably long and slender antennæ, with the globular basal joint of the peduncle of the superior pair; by its compressed cuneate body, the long, broad basos of the hindermost

thoracic leg, with its much shorter terminal joints, and short propodos of the second gnathopod.

Not uncommon in Chateau Bay, in thirty fathoms. Cateau Harbor, Long Island, fifteen fathoms, sand. Appearing different from Bate's figures and description of *A. Gaimardi*, I had described it as a new species, but refer to Mr. Beck's identification of my specimen.

Ampelisca pelagica (Stimps.) Pack., Can. Nat. Dec. 1863.

Pseudophthalmus pelagicus Stimps. Gr. Menan. p. 57.

Found at Chateau Bay, in thirty fathoms. At Stag Bay, in ten fathoms, hard bottom. At Caribou Island, in eight fathoms, sand. At Long Island, in fifteen fathoms, sand. Near Strawberry Harbor, in fourteen fathoms, hard bottom.

Ampelisca Eschrichtii Kroyer.

Taken at Caribou Island, in fourteen fathoms. This species was identified by Dr. Stimpson, and also by Mr. Beck.

Haploops tubicola Kroyer.

This is quite a different genus from the foregoing, as specimens received from Dr. Lütken show us. Our specimens agree well with some from Denmark.

Cateau Harbor, Long Island, ten miles above Domino Harbor, in fifteen fathoms, sand, dredged in company with the species of Ampelisca.

Pontoporeia femorata "Kroyer, Nat. Tidsskr. iv. p. 153; Voyage en Scand. pl. 23, fig. 2."

P. femorata Bate, l. c. p. 82. Pl. XIV., fig. 1.

Body robust; antennæ subequal in length; superior pair with the first joint of the flagellum one fourth shorter than the cephalon; whole antenna extending to the third joint of the thorax; appendiculus minute. The first pair of gnathopoda have the propodos longer than the carpus, which is not produced beneath; inferior margin of propodos curved, and nearly parallel with the superior margin. Second pair of gnathopoda with the propodos ovate, twice as long as wide, one third shorter than the carpus, and densely fringed. Basos of the last pair of thoracic legs large, orbicular, hinder edge entire, well rounded; last pair of pleopoda longer than the others. Fourth abdominal segment with a high, erect, stout, very prominent spine, ending in two acute spinules. Length, .40 inch. Kroyer does not figure the spine in the drawing reproduced by Bate; but specimens received from Dr. Lütken agree in all respects with ours. Belles Amours, Straits of Belle Isle, abundant in five to eight fathoms, muddy bottom.

Anonyx ampulla (Phipps), Voyage, 1773.

This species occurred at Dumplin Harbor, Sandwich Bay, in four fathoms. Compared with arctic specimens received from Copenhagen.

Anonyx lagena Kroyer.

Taken at Sloop Harbor in eight fathoms, sand.

Anonyx Hörringii, *fide* Boeck.

A common form, occurring abundantly on the coast of Maine, in Casco Bay, ten fathoms.

Anonyx producta, *fide* BOECK.

These two forms were found together in fifteen fathoms, sand.

Lysianassa appendiculata KROYER.

Forty fathoms, pebbly bottom, three miles from land off Henley Harbor, Straits of Belle Isle.

Alauna Goodsiri BELL in Belcher's Last of the Arctic Voyagers. App. Pl. XXXIV., figs. 2, 3, p. 403.

All of my specimens are of the form, fig. 3, which differs in some characters, such as the less convex form of the carapace, more distinct rugæ anteriorly, and the presence of an acute point on each side of the last leg-bearing segment.

It is an abundant species, being common in from ten to fifty fathoms. Belles Amours, six fathoms. Thomas Bay, fifteen fathoms, mud. Square Island, fifteen to thirty fathoms. Henley Harbor, eight fathoms. Cateau Bay, Long Island, fifteen fathoms, sand.

Mysis oculata FABR.

Abundant along the whole coast. The young go in schools, and the sea-trout consume great numbers of them.

Pandalus annulicornis LEACH.

Abundant on the whole coast, especially in weeds on a clear pebbly bottom twenty fathoms, Henley Harbor. Sloop Harbor, six fathoms. Hopedale, ten fathoms.

Hippolyte aculeata (FABR.) KROYER.

Caribou Island, fourteen fathoms. Square Island, fifteen to thirty fathoms. Domino Harbor, seven fathoms. Straits of Belle Isle, ten fathoms.

Hippolyte polaris (SABINE) KROYER.

It differs from Kroyer's figure in having the upper edge of the rostrum entire, and the terminal spines of the tail are more uniform in size, the three intermediate ones being larger than in Kroyer's figure. Square Island, fifteen to thirty fathoms. Straits of Belle Isle, ten fathoms.

Hippolyte Phippsii KROYER.

One specimen dredged in Domino Harbor, at a depth of seven fathoms.

Hippolyte turgida KROYER.

Found at the Straits of Belle Isle, off Belles Amours, in ten fathoms, on a rocky bottom.

Hippolyte macilenta KROYER.

A rare form, dredged at Square Island, at a depth of fifteen to thirty fathoms.

Hippolyte Sowerbyi LEACH.

This species was obtained with the preceding; it is not common.

Hippolyte Gaimardi M. Edwards.

Common on the whole coast. Caribou Island, fifteen fathoms. Square Island, thirty fathoms. Henley Harbor and Sloop Harbor, eight fathoms. Hopedale, ten fathoms.

Hippolyte Fabricii Kroyer.

Found in Domino Harbor, at a depth of seven fathoms; it is not common.

Argis lar Owen.

This species was dredged at Square Island, in thirty fathoms; it is not common.

Sabinea septemcarinata Sabine.

This species occurred in Thomas Bay, at a depth of fifteen fathoms.

Crangon boreas (Phipps.)

Caribou Island, eight fathoms, and Straits of Belle Isle, ten fathoms. Square Island, thirty fathoms, and Henley Harbor, ten fathoms; whole coast. One specimen taken at Henley Harbor in four fathoms, had a Pontobdella an inch long attached to the under surface.

Crangon vulgaris Fabr.

This species was only noticed on the mud flats at Caribou Island, where it was abundant.

Homarus americanus M. Edw.

Found at Henley Harbor; rare. This seems to be the northern limits of the Lobster.

Eupagurus pubescens Stimps.

Abundant on the whole coast from low-water mark to fifty fathoms. Straits of Belle Isle, fifty fathoms. Hopedale, ten fathoms.

Eupagurus Kroyeri Stimps.

This species was found with the preceding ones, but not in such abundance.

Hyas coarctata Leach.

Dredged at a depth of thirty fathoms, in Henley Harbor. It is not very common.

Hyas aranea (Linn.)

Abundant, and often of large size, found along the whole coast from five to fifty fathoms.

Chionœcetes opilio (Fabr.)

Not uncommon in the Straits of Belle Isle, in ten to fifty fathoms; at Chateau Bay, in thirty to fifty fathoms.

Cancer borealis Stimps.

Not uncommon at Caribou Island, Straits of Belle Isle, but it did not occur to us northward. I was informed that it was found in Hamilton Inlet, where the temperature of the water must be higher than on the coast.

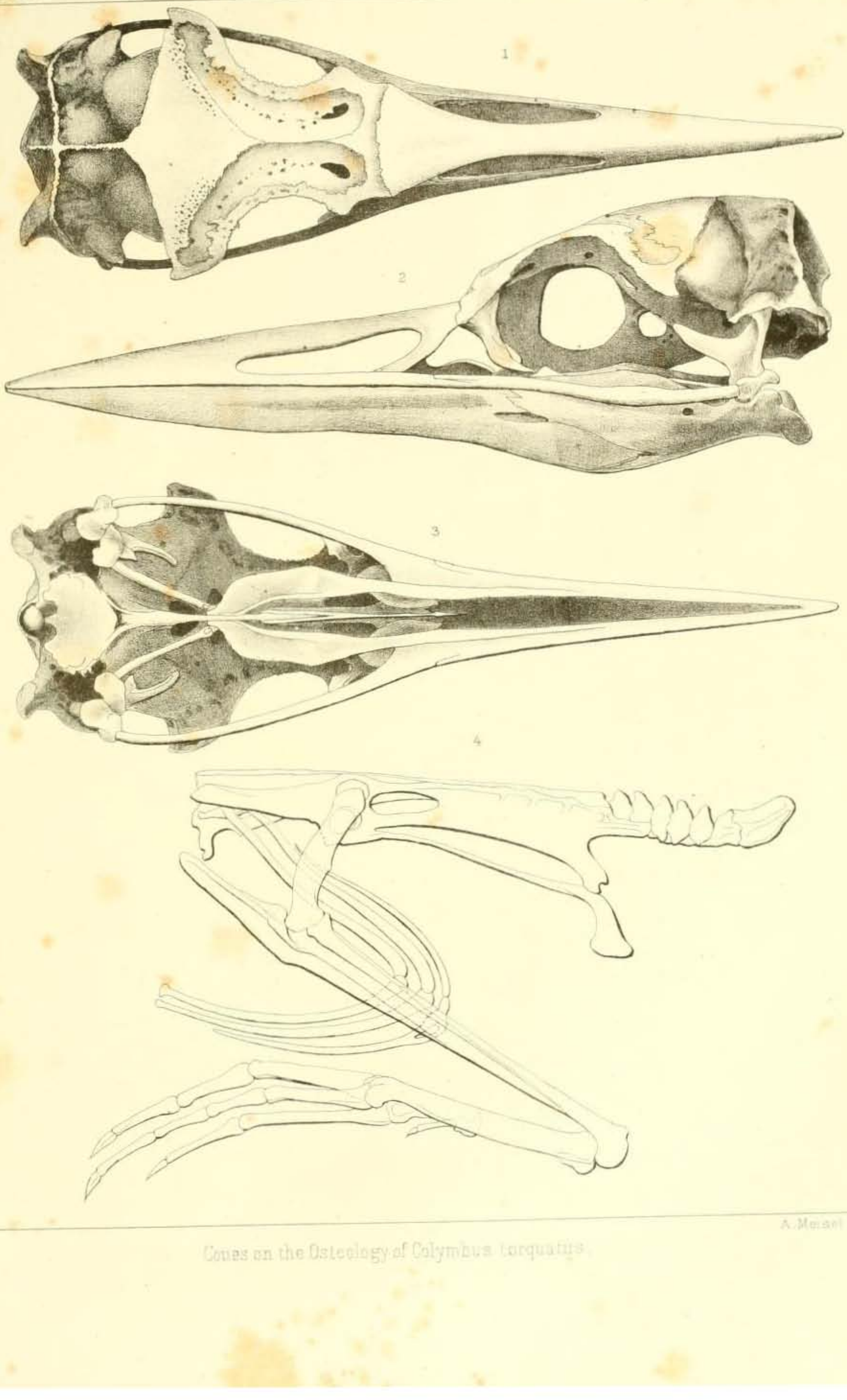
Explanation of Plate VII.

Fig. 1. — Astarte striata Leach.
Fig. 2. — Macoma fusca Stimpson *var.*
Fig. 3. — Buccinum undulatum Möller *var.* (young.)
Fig. 4. — " " " (adult.)
Fig. 5. — " grœnlandicum Hancock, fossil, Labrador. 5*a*. Fossil, Chateau Bay. 5*b*. Recent. 5*c*. Operculum of recent specimen.
Fig. 6. — Buccinum tenue (scalariforme) Gray.
Fig. 7. — " cretaceum Reeve.
Fig. 8. — Fusus labradorensis Packard.
Fig. 9. — Buccinum cyaneum Brug. fossil from Montreal.
Fig. 10. — " " " recent from Newfoundland.
Fig. 11. — Bela americana Packard *var.*
Fig. 12. — " robusta Packard.
Fig. 13. — Fusus syrtensis Packard.
Fig. 14. — Cardium Hayesii Stimpson.
Fig. 15. 15*a*. — Margarita campanulata Morse.
Fig. 16. — Flustra digitata Packard.
Fig. 17. — Eschara papposa Packard. 17*a*. Avicularium when gaping. 17*b*. The same, seen laterally.
Fig. 18, 18*a*. 18*b*. — Teeth of the Bison, from the Leda Clays of Gardiner, Maine.

Explanation of Plate VIII.

Fig. 1. — Ampelisca Gaimardi. 1*a*. Anterior foot.
Fig. 2. — Calliope læviuscula Kroyer, anterior foot. 2*a*. The same with dactyls open.
Fig. 3. — Atylus inermis (Kroyer) abdomen. 3*a*. Anterior foot. 3*b*. The same with the claws closed.
Fig. 4. — Monoculodes nubilatus Packard.
Fig. 5. — Bopyrus mysidum ♀ Packard, underside.
Fig. 6. — Idotæa marmorata Packard.
Fig. 7. — Pontoporeia femorata Kroyer, second gnathapod.
Fig. 8. — Phascolosoma hamatula Packard.
Fig. 9. — Pontobdella? livida Packard.
Fig. 10. — Syrinx sp.
Fig. 11. — Cerebratulus cylindricus Packard, head.
Fig. 12. — Geological Map of the Coast of Labrador south of Hopedale.

Published May, 1867.



A. Meisel lith.

Cones on the Osteology of Colymbus torquatus.

Fig 1

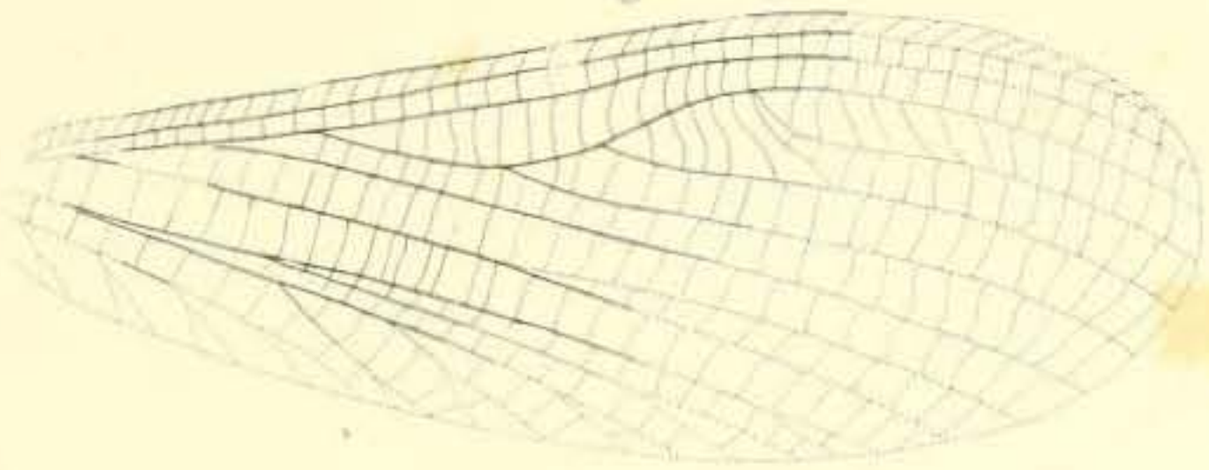


Fig 2

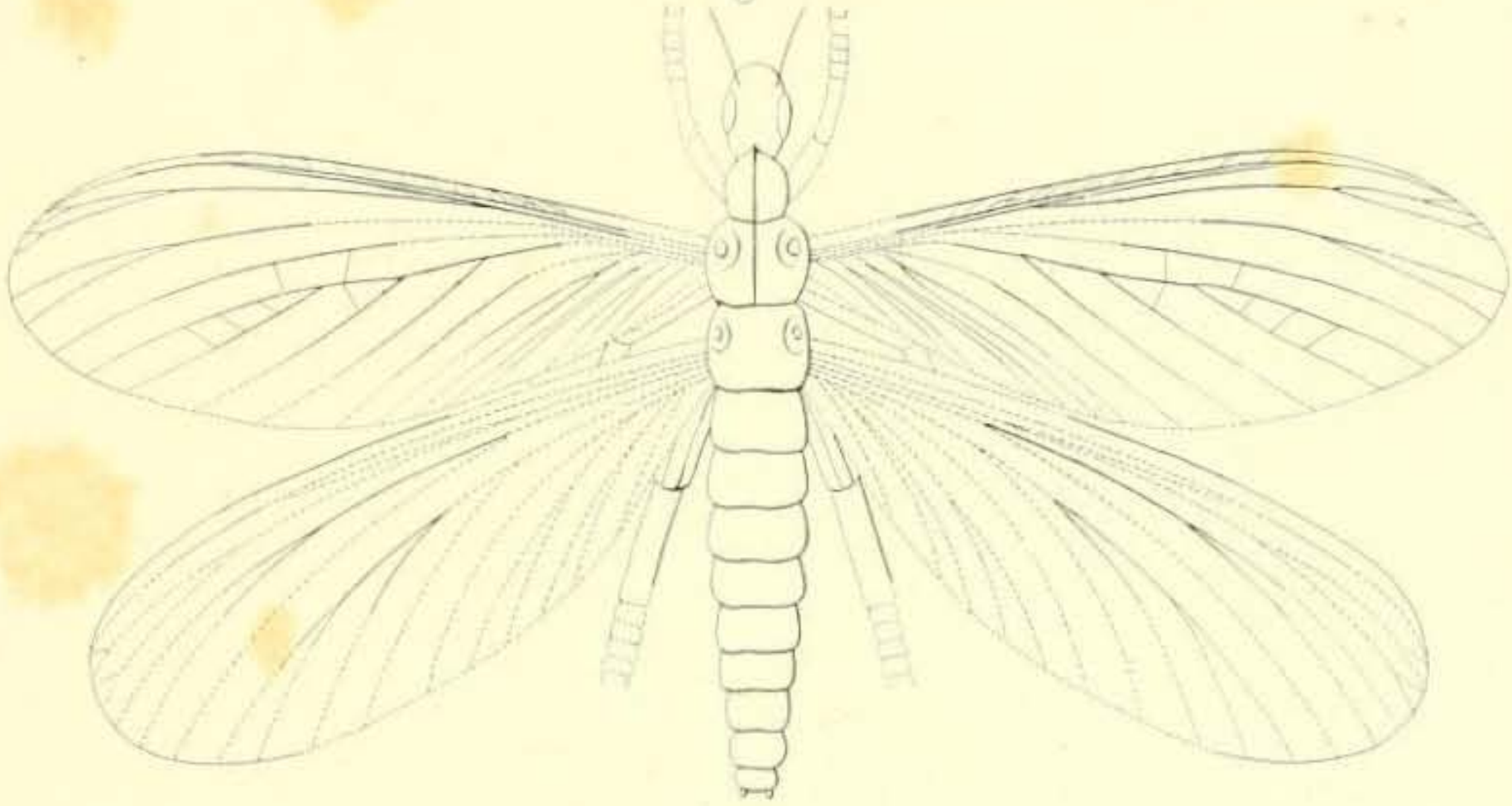


Fig. 3

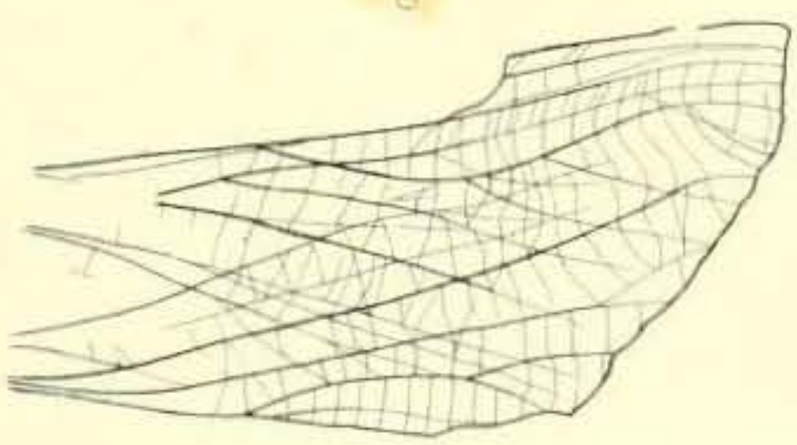
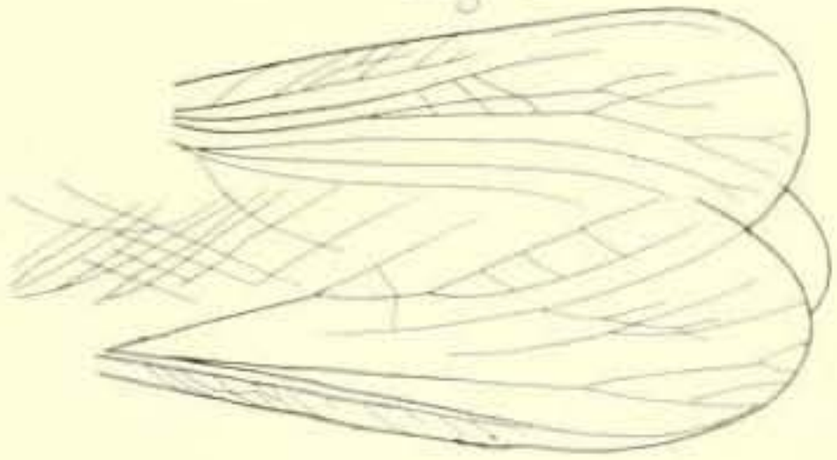


Fig 4



16

18

18a

17

17b

17a

17c

5a

2

18b

8

15

14

15a

5

5b

3

1

12

9

6

10

11

4

7

5c

13

L. Trouvelot, ad nat.

Printed by J. Mayer

Packard on the Glacial Phenomena and marine Invertebrates of Labrador.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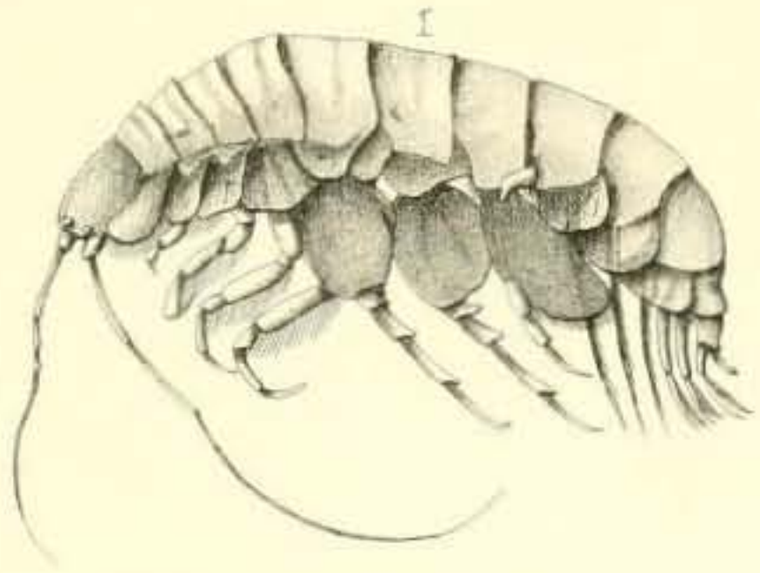
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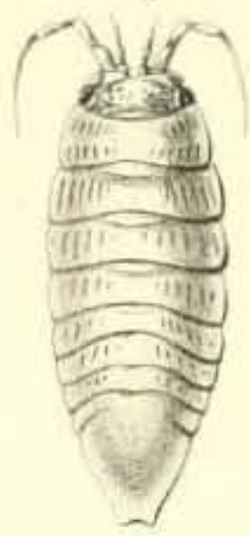
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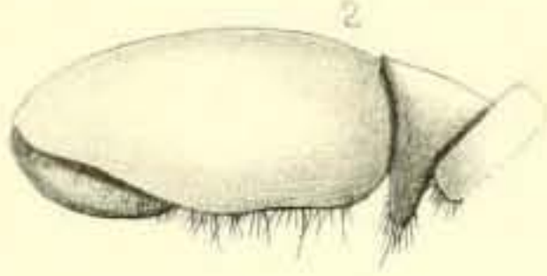
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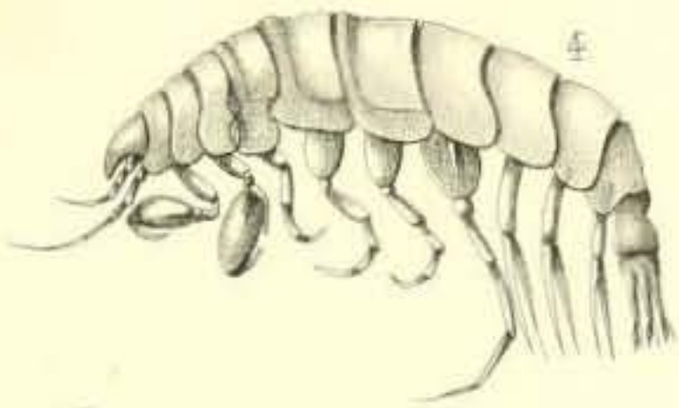
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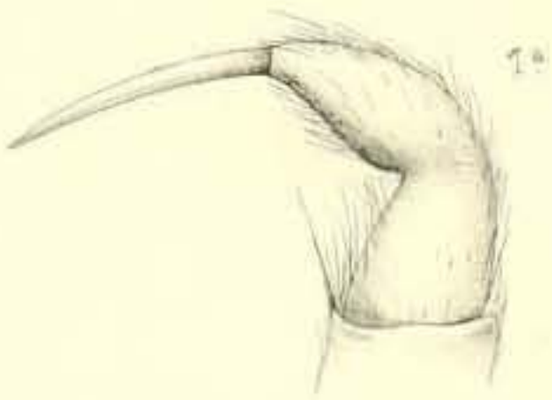
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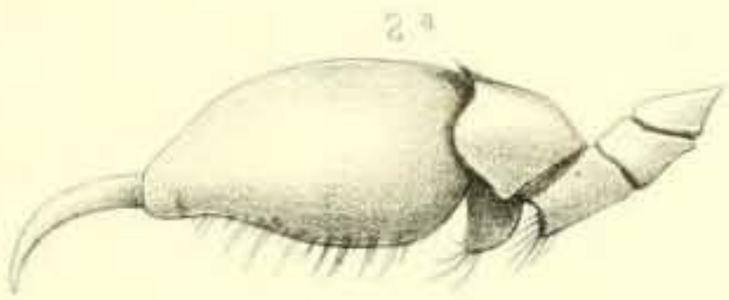
2a


7


3b


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9

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11

Morse from nat. L.T. Meyers Lith.

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