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THE

CANADIAN

Naturalist & Geologist,

AND PROCEEDINGS OF THE

NATURAL HISTORY SOCIETY

OF MONTREAL.

CONDUCTED BY A COMMITTEE OF THE NATURAL HISTORY SOCIETY.

VOL. II. DECEMBER, 1857. No. 6.

Montreal:

B. DAWSON, No. 23, GREAT ST. JAMES STREET.

LONDON. SAMPSON LOW, SON & Co.

PRINTED BY JOHN LOVELL, MONTREAL.

Price Three Dollars per Annum, in Advance.

THE

Canadian Naturalist & Geologist.

NOTICE.—All business communications to be addressed, *prepaid*, to the Publisher. Articles and communications for the Journal may be addressed to the Editors, care of the Publisher.

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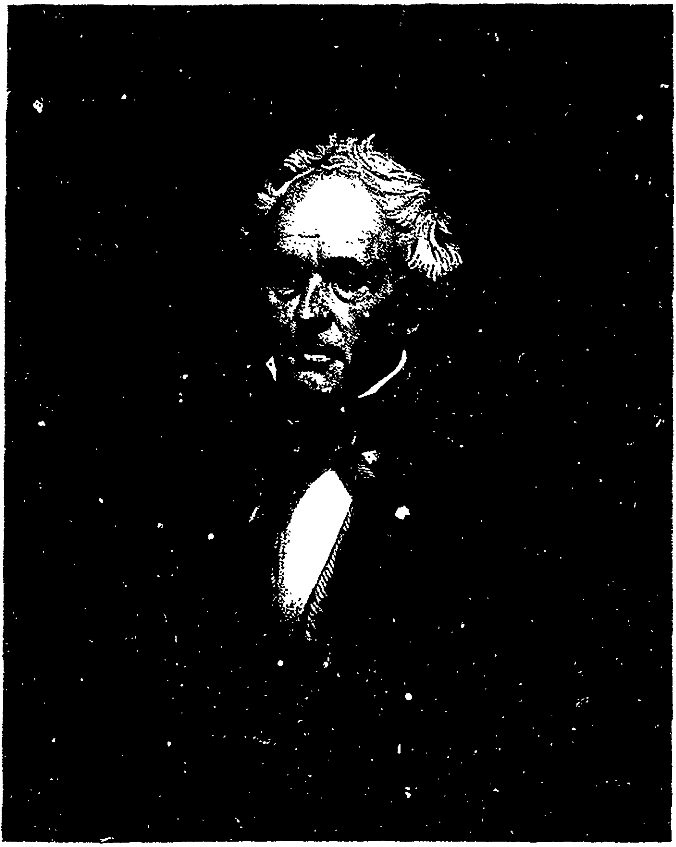
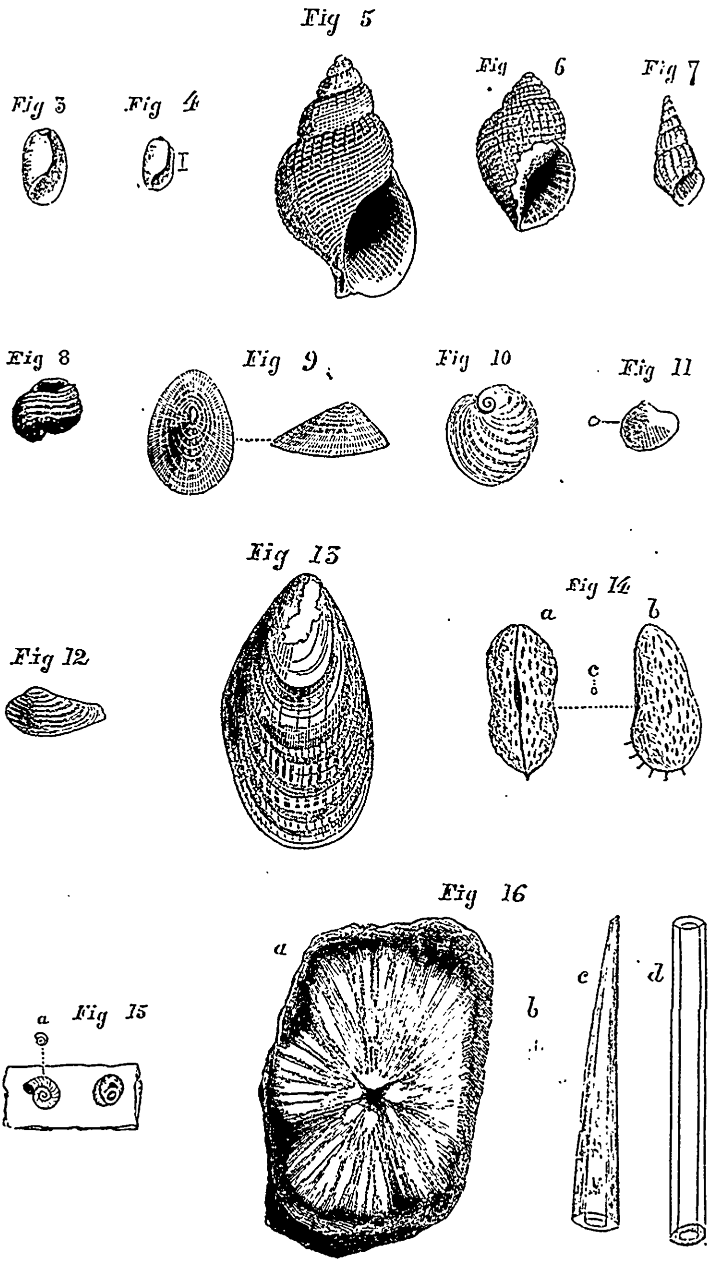


Yours truly

Wm C. Redfield

PLATE VII.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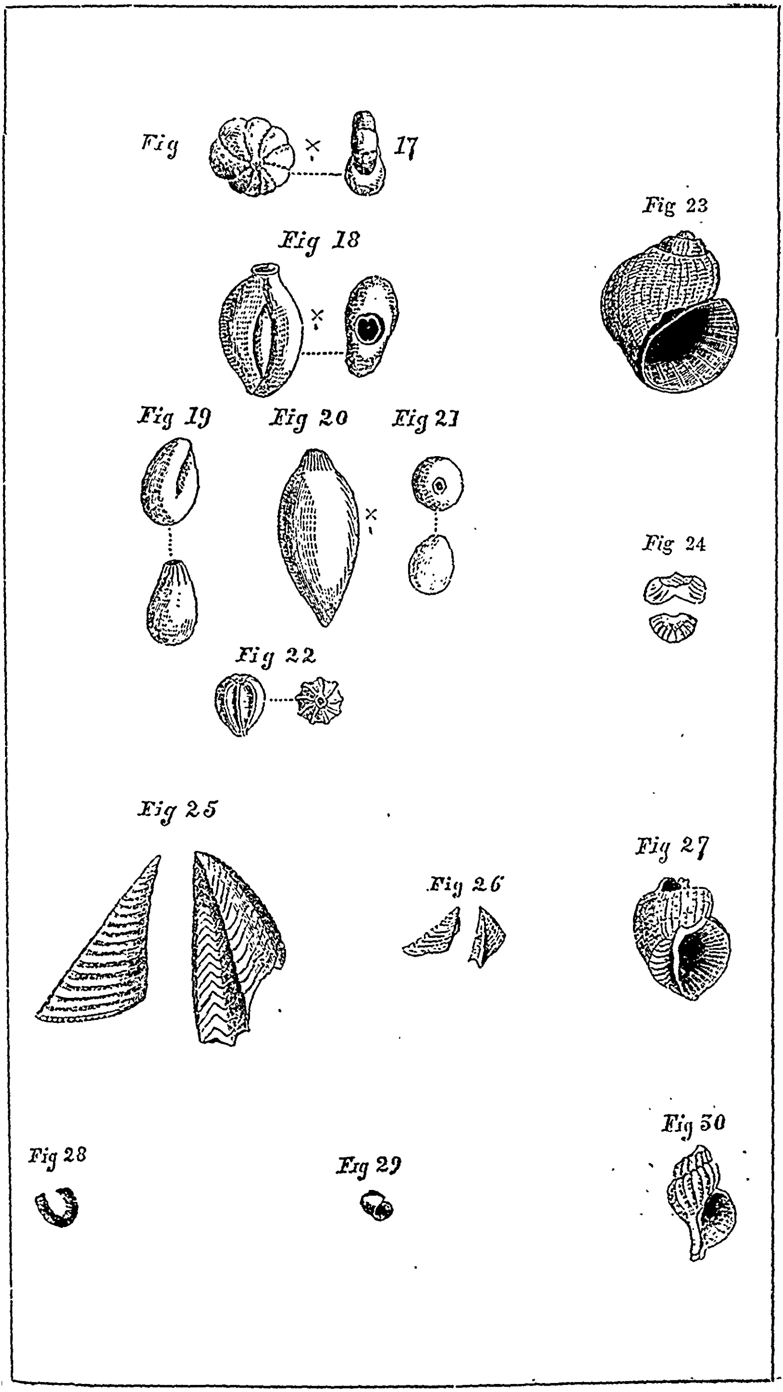
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THE

CANADIAN

NATURALIST AND GEOLOGIST.

VOLUME II. DECEMBER, 1857. NUMBER 6.

ARTICLE XXXVI.—*On the Newer Pliocene and Post Pliocene Deposits of the Vicinity of Montreal, with notices of fossils recently discovered in them.* BY J. W. DAWSON, L.L.D., F.G.S., Principal of McGill College.

(Read before the Natural History Society of Montreal, Nov. 30, 1857.)

The deposits to which this paper relates, belong to that wide spread sheet of superficial detritus, by which the greater part of the northern hemisphere was covered at the close of the tertiary and commencement of the recent period. This formation, as it occurs in the lower part of the valley of the St. Lawrence, has been described by Dr. Bigsby, Rear Admiral Bayfield, Sir C. Lyell, Sir W. E. Logan, and Professor Emmons. More recently an excellent summary of the previous publications, with many new facts, was given by Mr. Billings in this Journal; and a paper by the writer on additional fossils recently discovered, was read before the American Association at its late meeting in Montreal.*

* Annals of New York Lyceum, 1st series. Transactions Geological Society, 1839; Proceedings Geological Society, 1851; Lyell's Travels in North America; Reports of Canadian Survey; Emmons' Report on Geology of New York; Canadian Naturalist, vol. 1. The few pages devoted to Montreal in Lyell's Travels, contain a remarkably graphic and accurate view of these deposits as they occur here, and will enable any one not familiar with the subject, much more readily to comprehend the additional details given in this paper.

In the present paper I propose to notice the arrangement of the beds in the vicinity of Montreal, and the assemblage of fossils which they contain, in connection with the distribution of the species as inhabitants of the modern seas, and the inferences as to climate and other conditions deducible from them.

The isolated eminence of trap which rises in the mountain of Montreal to a height of about 700 feet, forms up to that elevation, a tide-guage of the Post Pliocene sea, marked on its sides by a series of sea cliffs and elevated beaches, indicating the stages of gradual or intermittent elevation of the land as it rose to its present level. The most strongly marked of these sea margins are at heights of 470, 440, 386 and 220 feet above Lake St. Peter on the St. Lawrence;* or 450, 420, 366, and 200 above the river at Montreal.

The highest of these beaches contains sea shells of existing species. Below the lowest, and at an elevation of about 100 feet above the river, spreads the great tertiary plain of Lower Canada, everywhere containing marine shells, and presenting a series of deposits partly unstratified and partly assorted by water. In this vicinity the regular sequence is as follows:

1. Fine uniformly grained sand, in some places underlaid or re-placed by stratified gravel. Marine shells in the lower part.
2. Unctuous calcareous clay, of gray and occasionally of brown and reddish tints. A few marine shells.
3. Compact boulder clay filled with fragments of various rocks, usually partially rounded and often scratched and polished.

Fig. 1.

SECTIONAL VIEW OF TERRACES AND POST PLIOCENE BEDS—MONTREAL.

a Trap. *b* Limestone with trap dykes. *c* Elevated Beach. *d d* Terraces on front of Mountain. *e* Saxicava Sand. *f* Leda Clay. *g* Boulder Clay. *h* Fluviatile Gravel.

* The first of these measurements is given on the authority of the Geological Survey. The others were ascertained for me by Professor Hamilton of McGill College, by levelling. The terraces are not quite level nor their limits always very distinct.

The thickness of these beds is at least 100 feet, of which the lower or boulder clay constitutes the greater part, but the sand often attains the thickness of 10 feet, and the fine clay that of 20 feet.

The boulders are not confined to the boulder clay, properly so-called. The stratified clays and sands often contain large rounded stones, partly of the mountain trap and partly of the older metamorphic rocks of the Laurentian formation, lying to the northward of the St. Lawrence valley. Dr. Bigsby long ago remarked that the boulders derived from the mountain have been drifted principally to the S. W.; in which direction they have been traced as far as the South Shore of Lake Ontario, 270 miles distant from their original position. On the other hand, the successive terraces are best seen on the North East side of the mountain, which is bare and abrupt.

Wherever I have observed the rock surfaces under the boulder clay, they present the striated and polished appearance usual in such positions. On the North East side of Montreal mountain the directions observed were from S. 70° W. to S. 50° W., corresponding to the direction of the drift mentioned above.

In some places the surface of the boulder clay has been deeply cut into furrows by the currents which deposited sand and gravel upon it. In like manner the surface of the stratified clay is sometimes cut into trenches filled by the overlying sand. On the other hand, in places which have been more sheltered, the boulder clay passes into the finer clay or into gravel, and the latter into sand. It is in these last localities, where evidences of denudation are absent, that marine fossils most abound.

The City of Montreal is built on the deposits just described. In the upper part of the city, at the base of the mountain, and at the height of about 100 feet above the river, we see in many places a fine yellowish sand, and about the same level, a little further East, at the mile-end quarries, are stratified gravel and sand. Below this sand we find the fine unctuous clay, forming a thick bed in the upper part of the city, and at the brick yard on the St. Lawrence Road, as well as at the village of the Tanneries. Under this is the thick bed of boulder clay and clay gravel seen in excavations on Dorchester and Lagauchetiere Streets; and at the gravel pits on the Lachine Railway. The steep descent at Beaver Hall Hill, at St. Patrick's Hospital, and along the Lachine road is the true margin of the river bottom, and marks the limit of the cut made by the St. Lawrence in these tertiary deposits.

In this bottom we have in Craig Street, and toward the Tanneries, river gravel, occasionally with fresh-water shells. In some places the river has probably cut through the boulder clay quite to the underlying rock, but in other places this is not the case. In the bottom of one of the most advanced coffer-dams of the Victoria Bridge, I observed a great depth of the original boulder clay, on which the river had made no impression. The mud brought up by the dredging machines from the current immediately below Montreal, and from some parts of Lake St. Peter, is evidently the undisturbed marine clay. In the former place I found in it one of its characteristic fossil shells, Tellina grœnlandica.

All the beds above referred to belong to the close of the tertiary period, and they are all marine; but they may have been deposited at distant intervals of time, and in waters of very various depth and area. The climates and other physical conditions appertaining to the times of their deposition, may have been different from each other and from that which now prevails. On these subjects the best evidence that we can obtain is that of fossil remains. We may therefore proceed to consider these, as they exist in different localities and at different levels; and first with reference to the lower level referred to, that of the plain or terrace at the height of 100 to 120 feet above the river.

At and near the Tanneries, shells are found in superficial sand, and also in tenacious gray and reddish clay underlying it. In the former and at the surface of the latter, the prevailing shell is Saxicava rugosa, along with which Sir C. Lyell mentions Mytilus edulis, which I have not yet seen at this place. These may be regarded as in this latitude littoral or shallow water shells. In the clay the only abundant shell is Nucula (Leda) Portlandica. This, judging from the habits of its modern congeners, must be a deep sea shell, inhabiting quiet muddy bottoms at from 10 to 50 fathoms in depth, or perhaps still lower.*

At this place then there appears to have been a shallow water or littoral deposit, superimposed on one that must have been deposited in deeper water. Under both is the boulder clay.

In the grounds of McGill College, the excavations for the main pipe of the water work, have exposed an interesting section of

* Living specimens of Nucula tenuis and Yoldia lucida have been dredged from a depth of 200 fathoms on the coast of Norway by M'Andrew & Barrett.

these deposits. The overlying sand is here of a light yellow color; the clay below very fine and unctuous, and of a grey colour. Both contain a few large boulders, and are underlaid by boulder clay, which toward the base of the mountain, comes up to the surface. In some places the top of the clay is cut into deep furrows filled by the sand, but in others the latter rests on an unbroken surface, and a layer of greyish sandy clay forms a transition between them. The sand contains no shells. The thin transition bed of sandy clay abounds in the following species, arranged as nearly as possible in the order of their relative abundance:—

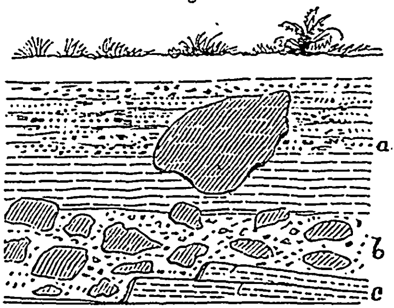
Tellina Groenlandica.
Saxicava rugosa.
Mya arenaria.
Mytilus edulis.
Astarte Laurentiana.
Tellina calcarea.
Trichotropis borealis.
Fusus tornatus.
Bulla oryza.
Leda Portlandica.

In the clay below, very few shells occur; and these exclusively Leda Portlandica and Astarte Laurentiana; which are found principally in its upper layers, and have their valves attached. Here again we have evidence of a deep sea bed overlaid by one that is littoral; and it is also worthy of notice that the two species found in the former are not now known as American shells, at least in this latitude; while those in the upper bed are common American species. For convenience we may name the upper bed the *Saxicava Sand*, and the lower the *Leda Clay*. (See Fig. 1.)

At the cutting of the Montreal and Ottawa railway near St. Denis street, and at the brick yards, the Leda clay and Saxicava sand occur as before. From the latter of these places Sir W. E. Logan has obtained a number of caudal vertebrae of a cetacean and part of the pelvis of a seal, as well as fragments of wood of the common American cedar (Thuja occidentalis). These remains were apparently contained in the Leda Clay.

At the Mile End quarries, the limestone has in places a thin coating of boulder clay, over which are stratified sand and gravel, with layers of shells in the lower part. This place is on the summit of a slight ridge, and the thick fine clay of the brick-yard and Sherbrooke St t, has apparently not been deposited on it, or has been swept away, so that the littoral sand and gravel rest immediately on the boulder clay, and in some places on the rock. (*See Fig.* 2.)

Fig. 2.



a Stratified Sand and Gravel with marine shells, and a large boulder. *b* Hard Boulder Clay. *c* Silurian Limestone.

The following is the assemblage of shells at this place :

Saxicava rugosa, (by far more abundant than any other.)
Mya truncata.
Tellina Groenlandica.
Astarte Laurentiana.
Mytilus edulis.
Mya arenaria.
Tellina calcarea.
Balanus crenatus. (Bal. miser of some lists. It is usually attached to the mussel shells.)
Trichotropis borealis.
Bulla oryza.
Natica clausa.
Spirorbis sinistrorsa, (attached to stones and loose valves of Mya Truncata.

All these may be regarded as littoral, or circum-littoral shells, the deep sea deposit being here absent.

Between the slight ridge at the quarries, and another near the house of James Logan, Esq., produced by a thick dykö of trap, is a slight depression, in which excavations for drains have exposed the richest collection of Post Pliocene shells that I have anywhere seen. In this flat, there occur sands with purely littoral shells, as Mytilus edulis, Mya arenaria, &c., and sandy clay with a variety of other species, inhabitants, at least in part, of deeper water; but I could not certainly ascertain the superposition of these beds. I presume that it is, in descending order; littoral sand, sandy clay deposited in deeper water, a thin layer of deep sea clay, and boulder clay.

At this place, in addition to all the species already noticed, I have found:

Buccinum ciliatum.
Buccinum undatum.
Admete viridula.
Acmæa cæca.
Nucula minuta.
Lacuna neritoides.
Natica helicoides ?
Fusus scalariformis.
Serpula vermicularis.
Margarita arctica.
Modiolaria discors.
Rissoa minuta.
Trichotropis arctica.
Cytheridea Mulleri ?

All these mollusks and articulates are known as inhabitants of modern seas, and most of them are boreal or arctic species.

In addition to these, there are at this place several species of Foraminifera, very abundantly distributed in the clay, and masses of silicious spicula of a sponge (Tethea). These sponges have evidently abounded in this quiet depression, and being covered by clay, their spicula have, on the decay of the animal matter, been imbedded in situ, so that at first sight they look little masses of asbestus, for which, indeed, they have been mistaken.

The large number of additional species collected at this place, shows that much may be done in adding to the fauna of this period. The circumstance which has favoured the accumulation here of so many species, is apparently the sheltered situation of this little hollow, and the deeper water in its bottom, as compared with that on the neighbouring ridges; on which, however, many of the shells may have lived, and may have been drifted into the intervening trough, so that we have here the inhabitants of different depths, or perhaps, more properly, a very rich spot of the sea bottom representing the laminarian zone intermediate between the purely littoral and coralline belts, but in its upper bed tending to the former, and in its lower part to the latter. The more fossiliferous part of the clay at this place, may thus represent a depth intermediate between that of our Saxicava sand and that of our Leda clay.

In many parts of Lower Canada, sea shells occur at the same level as those above described, and in similar beds, but not having examined them, I am not prepared to say much as to their bathymetrical conditions.

The celebrated locality of the capelin and lump-sucker, at Green's Creek on the Ottawa, appears to belong to this level, its elevation being 118 feet above Lake St. Peter.* The shells that I have seen from this place are littoral, principally Mytilus edulis and Saxicava rugosa, but I have been favoured by Sir W. E. Logan with the inspection of a collection of the nodules found in the clay at this place, among which is one containing Leda Portlandica, and the young of another resembling Leda pygmaea, in a tuft of delicate seaweed, in which they may have been drifted to the shore. In another of these nodules are the remains of an organism which appears to have been a star fish of the family Ophiuridae. Other nodules contain seaweeds of several species, and leaves of land plants, which will be noticed in the sequel.

The locality at Beauport, near Quebec, rendered classic by Captain Bayfield and Sir C. Lyell, belongs to this same level, and has afforded the following species not hitherto found at Montreal, beside many of those above enumerated.

Natica Groenlandica.
Natica heros.
Turritella erosa.
Scalaria Groenlandica.
Littorina palliata.
Cardium Groenlandicum.
Cardium Islandicum.
Pecten Islandicus.
Rhynconella psittacea.
Echinus granulatus.

I infer from the sections given by Lyell, Bayfield, and Emmons, that there may be at Beauport, as at Montreal, a distinction between the beds containing oceanic and deep sea shells,

* Mr. Murray, Reports of Geological Survey.

as Rhynconella psittacea and Pecten Islandicus, and those containing Saxicava rugosa and other littoral shells. It is also observable that the shells occurring at Beauport and not at Montreal, are more of an oceanic character than those of the latter locality; and this may, perhaps, be connected with the vicinity of the open sea at Quebec. Sir W. E. Logan informs me that the Beauport locality seems to be at the entrance of an ancient inlet. This would account for a mixture of shore and sea shells.

We may next direct our attention to the shore limits of the waters in which the shells of our one hundred feet level lived. It is evident that if in a given locality a bed occurs containing deep sea shells, say indicating depths of 20 to 50 fathoms, and another containing littoral shells, we must suppose that the shores appertaining to these two beds must have been very different, if, as we have every reason to suppose, the country was elevated and depressed en masse. In the Saxicava Sand, strictly littoral shells, as Mya arenaria and Mytilus edulis, are found with both valves attached, and apparently in situ, at a height of about 100 feet above the river. and at the base of the mountain. A sea level of this elevation would reach in a long bay up the Ottawa as far as Ottawa City. On the St. Lawrence it would not extend above the rapids, and south of the river it would reach but a short distance from the bank, except along the vallies of tributary streams. It would open into the Gulf of St. Lawrence by a strait of no great width. The sea area so characterized would be but a limited upward extension of the Gulf of St. Lawrence, not communicating directly with the ocean, receiving much fresh water, and subject to no ice drift, except that originating on its own shores. In such a basin the Mya arenaria and truncata, Mytilus edulis, Tellina groenlandica, and Saxicava rugosa, would find sufficiently congenial haunts, though their size might, as we find in some of the localities, be dwarfed by access of fresh water, or the extreme changes of temperature. In such a basin also, there might be deep channels affording passage to the tides, and containing shells of more oceanic character, and these might be expected to abound most toward the open sea on the north east. Locally there would be gravelly beaches, muddy inlets, sand banks, and deep oosy hollows, in each of which different species might predominate.*

* All these conditions may be observed in the bottom of the present Gulf of St. Lawrence, and in its quieter depths there are beds of clay closely resembling the Leda clay of this paper, and inhabited by two species of that genus of shell-fish.

If the land were slowly rising, so as to narrow the basin and limit the supply of sea water, species previously abundant might be diminishing in size and numbers; and in places storms and inundations might shut up shoaling bays, and inclose and destroy marine fishes frequenting such spots, entombing their remains along with those of sea weeds and of leaves of land plants drifted or blown from the shore. During such elevation, also, the positions of beaches, sand banks, and muddy bottoms, would be continually changing, so that similar alternations of argillaceous and coarse beds might be found at very different levels.

Such I suppose to have been the condition of the latest of the newer Pliocene, or post Pliocene sea areas of this part of the St. Lawrence valley, represented by the littoral sand and gravel of the lowest terrace or plain.

The clay which underlies this plain is of greater age, and is characterized by one deep sea shell which may represent a depth of from 100 to 300 feet or more, or a shore level of 200 to 400 feet above the river. We should, of course, expect to find the littoral shells belonging to this sea bottom at a higher level on the mountain, and at a greater distance from the river on the surrounding high lands.

Two of the most strongly marked terraces on the mountain occur at heights of 220 and 386 feet above Lake St. Peter. On these no shells have been found. If they existed, they have perhaps been swept away by land floods, or by the recession of the waters. Westward of Montreal, Sir W. E. Logan reports that gravel, sand and littoral shells occur near Kemptville on the Prescott Road, at an elevation of 250 feet above Lake St. Peter. Another locality in Winchester is 300 feet high, another in Kenyon 270 feet, and two others in Locheil 264 and 290 feet. Sand and shore shells occur at Hobbes Falls, Fitzroy, at a height of 350 feet. At Dulham Mills on the De L'Isle, according to Mr. Murray, shells occur at a height of 289 feet above the St. Lawrence. Eastward of Montreal, Mr. Barnard, C. E., informs me that shells occur in gravel, near Upton Station, on the Portland and St. Lawrence railroad, 257 above the St. Lawrence, and in circumstances indicating shallow water. Still further to the east and north, on the River Gouffre, near Murray Bay, Sir W. E. Logan found two terraces with littoral shells at heights of 130 and 360 feet above high water level. The first probably corresponds to our 100 feet level at Montreal, the latter to one of the higher shores above mentioned.

These facts, to which many others might probably be added, from the Reports of the Geological Survey and other sources, rudely mark out parts of the shores of a larger and older gulf probably contemporaneous with the newer portion of the Leda clay of the lower plateau. In this condition of the St. Lawrence Valley, it would still be a land locked gulf, and while we might expect shore ice and breakers to mix many boulders with the gravel at its margin, only a few large stones would be dropped into the clay in its deeper parts by drifted ice cakes. The Leda clay, for this reason, contains few boulders.

There are, however, still higher terraces on the mountain: and one of these 470 feet above Lake St. Peter, contains shells, and is the highest fossiliferous deposit of this period known in Canada. This beach is best seen on the property of D. Davidson, Esq., above Cote des Neiges. It has been well described by Sir C. Lyell, who recognized at once its littoral character. An excavation kindly made for me by the proprietor, shows the following succession, in descending order:

1. Angular stones and sand 8 feet.
2. Fine gravel, with inclined layers of shells, principally Saxicava rugosa, 5½ feet.
3. Stratified Sand, few shells, 6 feet.

These beds are of very limited breadth, and rest against the steep side of the mountain, fronting the mouth of the Ottawa. They are evidently the remains of a beach thrown up at the mouth of a little cove or perhaps strait, intervening between the greater and lesser summits of the mountain, which must then have been rocky islets of very small size.

The sea that washed up this beach may have reached the escarpment of Niagara, and communicated with the ocean over the whole of the lower lands of Lower Canada and New England. It was, however, limited on the North by the high lands extending along that side of the St. Lawrence Valley; and on the Ottawa, in the 4th concession of Nepean, Sir W. E. Logan has observed a similar beach at a height of 410 feet. On the west, the highest terrace observed by the U. S. Geologists on the south side of Lake Ontario, appears to correspond with this sea level; and the gravel and sands containing elephantine remains near Hamilton, may have been washed into its western extremity from the neighbouring land. It does not appear, however, that marine shells have yet been found west of Kingston.

I know little of the fauna of this older sea area. The locality above referred to affords only Saxicava rugosa, Mya (fragments), Mytilus edulis, Tellina Grœnlandica; and we do not certainly know that even the Leda inhabited the deep sea bottom around Montreal at this time, since the lower part of the Leda clay appears destitute of fossils. It was then over 60 fathoms under water, and probably not tenanted by many animals. The waters of this sea must have been traversed by the arctic currents, ice laden in the spring, and its northern shores probably had a climate of as low mean temperature as that of Labrador, though perhaps less extreme.

At a still earlier period than that indicated by the beaches last described, the waters had been far higher; for large boulders of laurentian rocks are found on the summit of the mountain, and much higher than this on the sides of the mountains of the Eastern Townships and of New England. The limited seas therefore in which the marine fossils above named lived, were preceded by a state of things in which an extensive oceanic surface was spread over North America, and probably only a few isolated peaks and ridges projected above the waters. Of the shores of this ocean and the animals that may have lived near them, I know nothing; and the sea deposit corresponding to this period is the lower part of the Leda clay and the surface of the great bed of boulder clay below it, neither of which have afforded fossils.

I have not as yet referred to this lower member of the formation, and I have nothing new to offer in relation to it. All my observations, whether in Nova Scotia or Canada, incline me to adhere to the view long advocated by Sir C. Lyell, and recently very ably illustrated by Professor Hitchcock,* that the true boulder clay has resulted from the gradual subsidence of the land under the influence of a cold climate, producing a deposit along the shores, resulting from the joint action of ice and water; and this, as the land sunk, spreading itself over the whole surface. As an additional fact confirmatory of this view, I may mention the appearance of successive ridges presented by the surface of the drift, and the linear distribution of stones in it, where it approaches elevated land. These appearances are often observable in cuts made in the drift in the vicinity of Montreal. This explanation of course implies that the land whose elevation we have

* Smithsonian Publications, 1856.

been considering, had previously to the beginning of the Post Pliocene period sunk below the waves. Its subsidence must have been very slow, to give time for the accumulation of so thick a bed of travelled stones and clay; and that its re-elevation was also slow is evidenced by the cliffs cut by the waves, the beds of clay and sand deposited, and the multitudes of shellfish which lived and died during the process.

These stupendous changes of level, however slow, must have caused great vicissitudes of climate, and must seriously have affected animal and vegetable life, both on the land and in the sea. If, as seems probable, before the great boulder period subsidence, the land had attained its present extent and elevation, the climate might have resembled that which now prevails. As the land sunk, its climate would become less extreme, but of lower mean temperature, and the opening up of easier access to the arctic currents might greatly reduce the temperature of the sea. This would be especially the case, if, as seems probable, the loss of land was greater in the south, and extensive tracts remained above water in the north, producing quantities of drift ice.

The fossils correspond with such views. All the species, so far as determined, except one or two, are still living, and most of them in this latitude, though there is a prevalence of the more northern forms, and an absence of many species now extending as far north on the American coast. This conclusion was announced by Sir C. Lyell as far back as 1839, and it is confirmed by the species since found, which are stated by Dr. Gould of Boston, to form on the whole, a sub-arctic assemblage. Sir C. Lyell says, (Geol. Trans., 1839) "It is very probable that in the period immediately antecedent to the present, the climate of Canada was even more excessive than it is now, and that the shells resembled still more closely that small assemblage now found in high northern latitudes." Dr. Gould, in a letter to the author, says in reference to the group of additional species lately discovered: "Its character is sub-arctic, like that of Behring's Straits, Kamtschatka and Greenland." This character of the fauna corresponds with the indications of ice afforded by the presence of boulders, with the low mean temperature likely to result from a great depression of the land, and with the southward extension of the Arctic Ocean, and the great facilities thus afforded for the migrations of Arctic species both in longitude and latitude. On the other hand the resemblance of this fossil fauna to that of the American seas in modern times, is increased by the direction of the present arctic currents, which give a boreal character to the marine fauna of Eastern America, as far south as Cape Cod.

In conclusion of this part of my subject, I may state that the precise limitation of the sea basins that occupied the St. Lawrence valley is of very great geological interest, when taken in connection with the conditions of life indicated by the fossils. The extension of observations on the fossils and the beds in which they are contained, is therefore very desirable; and I beg to invite to it the attention of observers. All the localities of the marine fossils should be observed, with the elevation and nature of the beds containing them. Any remains of land animals or plants imbedded with the shells would be of especial interest. Facts and specimens bearing on these points will always meet with attention if sent to the Geological Survey, to the author, or to the editors of this journal for communication to the Natural History Society.

I now proceed to give a list of the fossils found in these deposits; and as an aid to other inquirers, and a basis for future additions which I hope to make, I have thought it desirable to include not only the species recently obtained or identified by myself, (amounting to about 30, and indicated in the list by asterisks), but those previously known, with references to published figures and descriptions, synonymy, and new facts as to distribution in recent seas. Figures are also given of a few species not previously figured from this formation, or presenting peculiarities of interest.

I have to acknowledge the aid received from Dr. A. Gould, of Boston, who has kindly employed his extensive knowledge of American shells, in determining several species which I had not the means of identifying. Bathymetrical facts are given chiefly on the authority of Stimpson, ("Marine mollusks of New England"). Littoral extends to low water mark; Laminarian to 15 fathoms; Coralline to 50 fathoms; Deep Sea Coralline to 100 fathoms.

List of Canadian Tertiary Fossils.

(Species marked thus* have not been previously published as Canadian Fossils. (Lit.) denotes littoral, (Lam.) Laminarian; (Cor.) Coralline; (D. S. Cor.) Deep Sea Coralline; (C. G. S.) Collection of the Geological Survey of Canada.)

VERTEBRATA.

Phoca—Species not determined. Bones of posterior extremities, discovered by Mr. Billings, at Green's Creek, Ottawa, and described by Prof. Leidy, Proc. Ac. Sci., Phila., April, 1856. Figured in Canadian Naturalist, Vol. 1. Also portion of a pelvis in C. G. S.

Cetacean—Species not determined; obtained by Sir W. E. Logan from clay near Montreal. Vertebræ in C. G. S.

Mallotus Villosus.—Capelin: Nodules from Green's Creek, in C. G. S., &c.

Cyclopterus Lumpus (Lumpus Anglorum)—Lump sucker. Nodules from Green's Creek, in C. G. S.

**Cottus*—A small fish from Green's Creek, found by Sheriff Dickson, of Kingston; imperfect, but probably of this genus.

MOLLUSCA.

(*Gasteropoda.*)

**Bulla Oryza*, Totten, (Fig. 3) Montreal, base of Saxicava Sand; rare, but of larger size than recent specimens. Recent on American coast, Maine and southward (Lit).

**Bulla Debilis*, Gould, (Fig. 4) Montreal, Logan's Farm. A single small specimen, with a visible spire, apparently referable to this species. It may be the young of the species figured by Emmons in the New York reports, and it much resembles B. Regulbiensis of Wood's crag Mollusca.

Buccinum Undatum, Lin. The specimens found at Montreal, St Nicholas and Beauport, and referred to this species, differ very much from recent specimens whether British or American. The body is much smaller in proportion to the spire, which is more elongated. The shell is much thinner, its revolving striæ finer and more uniform, and its transverse folds less distinct or absent. It always has one or more strong revolving ridges, giving in some specimens an angular appearance to the whorls. It resembles in form but not in markings, the variety figured by Sowerby (Min, Con. Tab., C X.) as B. elongatum, and also, though less closely. the variety læviusculum of Wood's crag Mollusca. It corresponds more nearly with the description of B. Donovani, Gould, If not as I suspect, a distinct species from B. Undatum, this shell must be a delicate variety produced by a muddy bottom and sheltered inland situation, a kind of habitat in which I have not seen the living B. Undatum. I trust to obtain a more complete suite of specimens to determine this question (Lit to Cor.)

**Buccinum ciliatum*, O. Fabr., (Fig. 5), Logan's Farm, Montreal. This species now lives on the American banks, also in

Greenland. Fossil in British pleistocene. Specimens found in Montreal are of small size (Cor.)

**Fusus tornatus*, Gould. Montreal, between Saxicava sand and Leda clay. This shell I suppose to be the F. Carinatus of the lists; but Dr. Gould assures me that it cannot be referred to that species, nor to the F. despectus of Linnæus, nor does it correspond precisely with any of the varieties of the Trophon antiquum of Wood's crag Mollusca, but it is evidently closely allied to that species. It corresponds exactly with Dr. Gould's description and figure*, and with recent specimens collected in Gaspé by Sir W. E. Logan. I have about 50 specimens, and they present no well marked variety of form. Recent on American banks (Cor).

**Fusus scalariformis*, Gould, (Trophon Scalariforme, Wood); very rare in Montreal, with F. tornatus. Recent Massachusetts Bay and northward; also in Spitzbergen, Behring's Straits and North Sea. Fossil in British crag. (Cor. and D. S. Cor.) (Fig.30.)

**Fusus* (Trophon) *harpularius*, Couthouy. Two specimens in the collection of the Geological Survey, correspond with this species. Recent in Massachusetts Bay. It closely resembles Clavatula castanea of Wood's crag Mollusca.

Trichotropis borealis, Brod. and Sow. Abundant at Montreal in Saxicava sand. Recent Cape Cod and northward, also in British crag. (Cor).

**Trichotropis arctica*, Middendorff. (Fig. 27) A single specimen found at Logan's farm, Montreal, is referred by Dr. Gould to this species, figured as Cancellaria arctica in the Malac, Rossica, and found recent at Behring's Straits.

**Admete* (*Cancellaria*) *viridula*, Stimpson (Fig. 6) (C. Costellifera, Wood's crag Mol). Montreal, with Fusus tornatus, &c. Larger than recent specimens, but resembles, according to Dr. Gould, large specimens figured by Middendorff. Recent Cape Cod and northward. Fossil in British crag. (Cor.)

Velutina zonata, Gould, (Fig. 10,) (V. Undata? Wood's crag Mol.) A single specimen from Logan's farm Montreal, given to me by Arthur Ross, Esq., appears to belong to this species. It is probably the same with that mentioned by Sir C. Lyell without specific name. Recent Massachusetts Bay and northward (Cor.)

Natica clausa, Brod. and Sow (Fig. Can. Nat., Vol. 1.) Plen-

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*The figures given by Sir C. Lyell, Prof. Emmons, and in Can. Nat. Vol. 1, represent small specimens with the lip broken.

tiful at Montreal and Beauport in Saxicava sand; of very large size at Logan's farm. There are two distinct varieties, one corresponding to the typical N. clausa (see Fig. in Can. Nat., Vol. 1), the other possibly identical with N. Occlusa of Wood's crag Mol., which it resembles in its more elevated spire and thinner lips. Recent from Cape Cod and northward; Fossil in British crag (Cor.)

**Natica helicoides*, (?) Johnston, (Fig. 24,) The specimens represented by Fig. 24 correspond so closely with N. helicoides, as described and figured by Wood, that I had ventured to give them that name; but Dr. Gould, though he considers the shell distinct from N. Clausa, thinks it cannot be identified with the recent N. helicoides as described by Forbes, &c., unless indeed a larger number of specimens should connect it with that species as a very decided variety. These specimens differ from N. Clausa in their deeply channeled suture, open though small umbilicus, prominent inner lip and distinct revolving lines. The shell has evidently been of a more dense texture and less easily weathered than that of N. Clausa.

**Natica Grœnlandica*, Beck,This shell occurs in some specimens collected by Rev. Mr. Kemp at Beauport. Recent Cape Cod and northward (Lam. to Cor.)

**Natica Heros*, Say. A shell collected by Rev. Mr. Kemp, at Beauport appears to belong to this species. Recent American coast (Lit.)

**Menestho* (Chemnitzia) *albula*, Möller, (Fig. 7.) Some shells in the Col. of the Geological Survey appear referrable to this species, though much larger than recent American specimens. They resemble the shell figured by Emmons as Turritella. Recent Cape Cod and northward (Lam. to Cor.)

Scalaria Grœnlandica, Gould, (Fig. in Can. Nat., Vol 1,) Beauport, but not yet found at Montreal. Recent Massachusetts and northward. Fossil in British crag (Cor. to D. S. Cor.)

**Turritella erosa*, Couth, (Fig. 8.) Fragments from Beauport, larger than recent specimens. Recent coast of N. England (Cor. to D. S. Cor.)

**Rissoa minuta*, Stimp.—Found in interior of larger univalves at Montreal. It is difficult to secure such small and fragile shells in a perfect state, and I am therefore not quite confident of the species. Recent on American coast, (Lit.)

Littorina palliata, Say. In Lyell's list of Beauport shells.

I have received a specimen from Chicoutimi, Gaspé, from a littoral deposit a few feet above the level of the high tide, containing Saxicava rugosa, Balanus hameri, and Natica clausa. Recent American coast, (Lit.)

**Margarita Arctica*, Gould, (M. helecina, Moll,) Montreal with Fusus, &c. Some of the specimens are of large size and may be detected even when in fragments by their pearly appearance. Recent Cape Cod and Northward, (Lit. Lam.)

**Lacuna neritoidea*, Gould. A single specimen with Fusus, &c., Montreal. Recent on New England coast.(Lit. Lam.) (Fig. 29.)

**Acmaea*, (Propilidium,) *Caeca*, Mon. (Fig. 9.,) (P. Candida, Couthouy,) Montreal, with Fusus, &c. The specimens are of larger size than recent. This is probably the shell figured in N. Y. Reports as Patella. Recent Cape Cod and northward, also Greenland, Finmark, Spibergen. (Coral., D. S. Cor.)

**Amicula vestita*, Gray. (Fig. 24.) (Chiton Emersonii, Gould.) With Fusus, &c., at Montreal. Recent Cape Cod and northward. (Cor.)

Acephela.

Saxicava rugosa, Lam. (Fig. Can. Nat. vol. 1.) This is the most abundant shell in the littoral deposits at Montreal, Beauport, &c. Though not strictly a littoral shell, it was probably driven to the beach by breakers acting on the stony bottom of drift, or on the ledges of shale and limestone, in which it sheltered itself. At Beauport the size is small, and this is also the case at Green's Creek, and the higher levels at Montreal; but at Logan's Farm and at St. Nicholas, these shells are as large as any modern specimens that I have seen. On the surfaces of drift and Leda clay, this species seems, as on the American coast at present, to have sheltered itself among stones and in patches of sea weed and mussels; but from the abundance of perforated pieces of limestone, I suspect that it also burrowed in the softer submerged ledges, and that this may account in part for its great abundance. At present this shell is generally distributed over the North Atlantic. It ranges from low water to great depths, and is of larger size in the Arctic Seas and in deep water.

Mya arenaria, Linn. Abundant at Montreal; but always of small size, rarely more than half the size of recent shells from the gulf of St. Lawrence; but there are in C. G. S. very large and thick specimens from a raised beach at Rivière du Loup. (Lit.)

Mya truncata, Linn. (Fig. Can. Nat. vol. 1.) More abundant and larger at Montreal than M. arenaria. Recent American Banks. (Lit. to Cor.)

Tellina Grœnlandica, Beck. (Fig. Can. Nat. vol. 1.) Very abundant in Saxicava sand, Montreal, &c. Recent in Arctic Seas, &c. Fossil in British Pleistocene. I suppose it identical with the T. fusca, recent in gulf of St. Lawrence. (Lit. Lam.)

Tellina calcarea, Lyell. (Fig. Can. Nat. vol. 1.) Probably T. Proxima and sordida of American authors. Less abundant than the preceding species at Montreal, very plentiful at St. Nicholas. Recent Cape Cod and northward. (Cor.)

Astarte Laurentiana, Lyell. (Fig. Lyell's Elements and Can. Nat. vol. 1.) Common at Montreal in Saxicava sand and less so in Leda clay, supposed to be extinct, but closely allied to A. Sulcata, recent.

Cardium Islandicum, Lin. Beauport. (Lyell.) Cape Cod and northward. (Cor.)

Cardium Grœnlandicum, Gould, Beauport. (Lyell.) Cape Cod, &c. (Cor)

Leda Portlandica, (L. truncata Wood's Crag. Mol.) Characteristic of the Leda clay, Montreal. Rare in Saxicava sand. Fossil in British crag, and recent in Arctic Seas, if identical with L. truncata; but Dr. Gould after examining a suite of very perfect specimens from Montreal, thinks it distinct from any recent species known to him.

**Leda pygmaea*, Wood, (Fig. 11.) A few small specimens entangled in a delicate sea-weed, in a nodule from Green's Creek in C. G. S., have the form of this or some closely allied species.

**Leda minuta*, Gould, (Fig. 12.) Rare at Montreal. Dr. Gould says: "I think our L. tenuisulcata, Couthouy, a different species; but I have a specimen from our northern seas corresponding with this fossil, and with one sent by Dr. Loven, from Scandinavia as L. minuta." I suppose this to be the L. caudata of Wood's Crag. Mol. (Cor.)

Mytilus edulis, Lin. (Fig. 13.) Common at Montreal in Saxicava sand. It differs from the common recent varieties in its obtuse beaks, short rounded hinge line, oval outline, strongly marked and coloured lines of growth, and small size. Fig. 13 is the common form at Montreal. It resembles the var. elegans of Wood's Crag. Mol. Recent north Atlantic. (Lit.)

**Modiolaria, discors*, Lin. (M. discrepans, Montagu.) A single specimen found with Fusus, &c., at Montreal. Being a pearly shell it crumbles and can scarcely be preserved entire. Dr. Gould remarks:—"The synonymy is not quite clear; a very different shell has usually been held for M. discors. Neither M. discors nor discrepans of Gould is this shell; but M. nexa is the young. It is figured by Beck in Gaimard Voy. en Iceland et au Greenland, as M. striatula. A northern shell."

Pecten Islandicus, Mull. (Fig. Can. Nat. vol. 1.) Beauport. Recent Connecticut and northward. Fossil British Crag, (Lam. and Cor.)

Rhynconella psittacea, Chemnitz, (Fig. Can. Nat. vol. 1.) Beauport. Recent Gulf St. Lawrence. Fossil in British Crag, (D. S. Cor.)

ARTICULATA.

Balanus Hameri, Ascanius, (Fig. Can. Nat. vol. 1.) Beauport and St. Nicholas, not as yet at Montreal. This is the B. uddevallensis of Lyell's list, and appears to be the B. miser of the New York Reports. Fossil in European and British pleistocene; recent in British and American seas. I have a fine specimen with the animal from the coast of Nova Scotia. (Cor.) A deep water shell according to Darwin. Fig. 25 represents the opercular valves from St. Nicholas.

Balanus crenatus, Brug. Abundant at Montreal, &c. The variety elongatus is very plentiful, also the depressed variety. It is often attached to mussel shells and to pebbles in the stratified gravel. (Deep water,—Darwin.) As I am not aware that the opercular valves of this species have been previously found in Canada, I have represented a pair in Fig. 26.

Balanus porcatus, Da Costa. Darwin, in the Palaeontographical Society's publications, gives this as one of the Beauport species in Sir C. Lyell's collection.

**Cytheridea*, (Fig. 14.) At Logan's farm, Montreal, with sponge spicula, &c. It resembles C. Mülleri (Münster), recent in the Zuyder Zee, fossil in the Pliocene of the Netherlands and in the Eocene of England, so closely that I have not much hesitation in referring it to that species: (see Jones in London Geological Journal, vol. x. 160.)

**Spirorbis sinistrorsa*, Montagne, (Fig. 15.) At Mile end quarries, Montreal, attached to shells of Mya truncata and to pebbles in stratified gravel. Recent George's Bank, (Cor.)

**Serpula vermicularis*, Lin. (Fig. 28.) A small specimen, Montreal, supposed by Dr. Gould to be this species.

RADIATA.

Echinus granulatus, Say. Found at Beauport by Sir C. Lyell. (Lamin.)

**Ophiura*.—In a nodule from Green's Creek in C. G. S., are the remains of an organism which appears to have been a star fish of the family Ophiuridae.

**Tethea*, Lamarck, (Fig. 16.) Silicious spicula, referable to sponges of this genus, abound at Logan's farm, Montreal, and as I am informed at other places in the tertiary clays, though they have hitherto been supposed to be of mineral origin. They occur in radiating flattened masses, just as they have existed in the living sponges, some of which must have attained a diameter of nearly three inches. They have either grown on the clay or attached to dead shells. The long cuticular spicula are $\frac{3}{10}$ths of an inch in length, slightly curved, pointed at both ends, and with a large internal cavity, which appears in the large as well as in the small specimens. Under a high power the points appear slightly truncated and open. The shorter internal spicula are about $\frac{1}{10}$th of an inch in length. Mr. Bowerbank of London, who has kindly examined these curious fossils, has no doubt that they belong to the genus Tethea; but does not refer them to any species. The spicula resemble the simple ones of T. Cranium, as figured by Johnston; but our fossils do not afford any that are tricuspidate. In the mean time, therefore, until this species can be identified with any previously described, I may claim for it, as one of the most curious fossils of these deposits, the name of T. Logani, in honour of the head of the Canadian Geological Survey, who has kindly placed at my disposal for this paper many of the materials he had collected for the description of these tertiary deposits, to which the pressure of more important departments of his work has hitherto prevented him from devoting much of his attention.

Mr. Bowerbank informs me that the recent species of Tethea range from low water mark to 200 fathoms.

**Foraminifera*.—The calcareous shells of several species of these minute creatures, occur with the sponges above mentioned. My means of reference do not permit me to refer them with any certainty to their species, though I presume they are all living forms; nor have I yet had time to examine all the specimens collected. Figs. 19 to 22 represent some of the forms observed. Fig 17 appears to be a Rosalina. Fig. 18 is probably the Quinqueloculina occidentalis of Bailey, obtained from the Atlantic soundings from a depth of 20 fathoms. Fig. 21 may be the widely diffused Orbulina universa, also found in the Atlantic soundings. Figs. 19 and 20 appear to be species of Polymorphina.

I might add to this list of animal remains, a Lymnea, apparently elodes, and a Cyclas, but I suspect them to be recent and accidental. The same remark applies to shells of Ostrea borealis occasionally found in the surface soil over the marine beds.

PLANTAE.

**Populus balsamifera*—Balsam poplar.—In a nodule found by Sheriff Dickson of Kingston, at Green's Creek, is a leaf of this species. Another, less perfect, is in C. G. S. This is a northern species widely difiused.

**Potentilla Norvegica.*—In a nodule from Green's Creek in C. G. S., is a leaf which, according to Prof. Barnston, cannot be distinguished from a cauline one of this species. This also is a widely diffused northern plant.

**Thuja occidentalis*—the common Cedar of Canada.—Branches in C. G. S., from brick clay pits near Montreal, show the structure of this species.

**Algae.*—In nodules in the C. G. S. are at least three species. These sea-weeds have been examined by Rev. A. Kemp, who states that one of them is apparently a stem of Laminaria, and that others are probably referable to the genera Fucus, Polysiphonia, and Porphyra, but that their state of preservation does not admit of accurate specific determination.

Nearly all the fossils in the above list have been obtained in beds belonging to the plateau, elevated about 100 feet above the St. Lawrence. Two of the species, Leda Portlandica and Astarte Laurentiana, are characteristic of the stratified clay, and these are the only species which we have any reason to believe extinct. A number of recent species belong to the littoral sand and gravel, and several of these occur at all heights up to 470 feet. A very large number of species have been obtained from what I regard as the intermediate deposit of Logan's farm near Montreal.

At Montreal, then, we have a littoral group of shells, a group belonging to the Laminarian and Coralline zones, and a group probably belonging to the Coralline and deep sea Coralline zones. Perhaps the reason why the two shells characteristic of these last zones have not yet been recognised as recent, is that the deep sea muddy bottoms on the American coast, have not yet been well explored. It must be observed, however, that as the land was rising at the time when these beds were deposited, in the lower levels these three belts are stratigraphically superimposed on each other, and mark not only difference of depth but lapse of time. To what extent the precise order of these deposits, as observed at Montreal, may hold in other parts of the St. Lawrence valley is not yet known, but I hope to extend my observations with relation to this point; and from facts published by other observers, I have reason to believe that they will be found somewhat generally prevalent.

With respect to the divisions into which these deposits may be separable, the presence of recent shells alone in the upper beds, would refer them to the Post-Pliocene period, while on similar grounds the Leda clay and boulder clay might be regarded as Newer Pliocene. Strictly speaking, however, the whole formation belongs to the period of transition from the Pliocene to the modern epochs. The great boulder clay indicates a subsidence at the close of the former, and the overlying beds the conditions of deposit and of life during the re-emergence of the land; so that if we regard physical change as our guide, I should with several previous writers on the subject, consider the whole of the stratified beds overlying the boulder clay as one group of "modified" as distinguished from "unmodified" drift, a division which I long ago adopted for the non fossiliferous drift of Nova Scotia. This view would be farther strengthened by the probability that the high beaches containing recent shells may be contemporary with the low lying clays having species supposed to be extinct, and the farther probability that these last may yet be found living. In the meantime, therefore, I prefer to consider these deposits as extending through portions of the Newer Pliocene and Post Pliocene periods, without establishing any lines of division other than those stamped on the deposits in the locality to which this paper principally relates.

By the kindness of Arthur Ross, Esq. of Montreal, I have been favoured with a collection of fossil shells, from St. Nicholas, 15 miles above Quebec," on the south side of the St. Lawrence, at the head of a rocky ravine, 400 yards from the river, and 180 feet above its level." These shells belong to a level much higher than that which has afforded the greater number of the species at Montreal and Quebec. The assemblage is considerably different from that at other localities. Tellina calcarea predominates, and is of very large size, some specimens being 1½ inch in length. Balanus Hameri is a very abundant, and sometimes has its opercular valves. also Mya truncata, the latter of small size. The only other shells are Saxicava rugosa, and Astarte Laurentiana, Trichotropis borealis and Buccinum undatum. The matrix is stony clay. This deposit though at a considerable elevation, was probably formed in deep water.

As I observe in a note in the Edinburgh New Philosophical Journal for October, *that Professor H. J. Rogers is still disposed* to consider the shells found at a height of 470 feet on the Montreal Mountain, as having been "swept thither from a much lower level," I presume by earthquake waves; I think it necessary to add to the statements above given, that the shells occur only in stratified sand and fine gravel, alternating in thin layers precisely in the manner of a modern beach. The shells are of course not precisely in situ, being arranged in layers among the sand, but their arrangement indicates merely the ordinary action of the waves on the shores of a bay. The error of Professor Rogers may have been caused by his confounding the stratified fossilferous sand with the unstratified debris which overlies it, and which may perhaps indicate subsidence and ice drift subsequent to the formation of this beach. I think it more probable, however, *that this overlying confused mass has resulted from the* sobaerial waste of the steep slope above the beach. The existence of this incoherent terrace of sand and shells perched on a steep and exposed hill side, is one of the most convincing proofs that could be desired that no cataclysmal waves have swept over the Montreal Mountain since the sea stood at this level. It is proper to add that Sir C. Lyell, writing in 1845,* clearly distinguishes the stratified shell bearing beds from the unstratified mass above.

A very interesting collection of recent shells from the mouth of the St. Lawrence, has just been brought to Montreal by Mr. Bell, a young gentleman employed on the Geological Survey. It

* Travels in North America, vol. 2.

i..cludes numerous specimens of Buccinum undatum, but none of them present the peculiarities of the fossil variety. Fusus tornatus is represented by a single specimen, quite similar to the fossil individuals. Natica heros is abundant, as are Mytilus edulis, Mya arenaria, Tellina groenlandica, Littorina palliato, and Pecten Islandicus. There is a single specimen of Tellina calcarea, said to have been found in brackish water at Bay St. Paul. Scalaria groenlandica, Mya truncata, Astarte Sulcata, and Cardium Islandicum are represented by single specimens. Balanus crenatus and a Spirorbis, apparently nautiloides, are attached to mussels and to Pecten Islandicus. Saxicava rugosa does not appear in the collection. Purpura lapillus, Mactra ovalis, Littori tenebrosa, Solen eusis and Mesodesma arctata, are numerous, though they have not yet been found in the tertiary clays.

The specimens of Mya arenaeia are large and coarse in comparison with those found at Montreal. The mussels have not the antique form. Tellina groenlandica has precisely the character of the fossils; and the more common variety, (Sanguinolaria fusca) is also represented by specimens said to have been found in brackish water.

The collection may be regarded as showing the prevalent shells, in that part of the gulf of St. Lawrence nearest to those ancient extensions of the same gulf described in this paper.

Other materials have been accumulating since the above paper was written; and I hope in some future number of the *Naturalist* to follow up the subject.

REFERENCE TO FIGURES.

Fig. 3.	Bulla oryza, ...	Montreal.
4.	Bulla debilis, ...	Do.
5.	Buccinum ciliatum, ...	Do.
6.	Admete viridula, ...	Do.
7.	Menestho albula, , ...	Do.
8.	Turritella erosa (fragment), ...	Do.
9.	Acmaea caeca, ...	Do.
10.	Velutina Zonata, ...	Do.
11.	Leda pygmaea? nat. size and magnified, .	Green's Creek,
12.	Leda minuta, ...	Montreal.
13.	Mytilus edulis (var. Laurentiana), . . .	Do.
14.	Cytheridea (nat. size and magnified), .	Do.
15.	Spirorbis sinistrorsa (nat. size and magnified),	Do.
16.	Sponge (Tethea Logani), (*a*) nat. size in situ, (*b*) spicules, (*cd*) large spicules magnified.	

17 to 22. Foraminifera (magnified), . . . Montreal.
23. Natica helicoides? . . . . Do.
24, Amicula vestita, two anterior valves, . Do.
25. Opercular Valves of Balanus Hameri.
26. Opercular Valves of Balanus crenatus, three times natural size.
27. Trichotropis arctica.
28. Serpula vermicularis.
29. Lacuna neritoidea.
30. Fusus scalariformis.

ARTICLE XXXVII.—*Biographical Memoir of William C. Redfield*; by Professor DENISON OLMSTED, L.L.D., of Yale College.

[From an Address delivered before the American Association for the Advancement of Science, at Montreal, August 14th, 1857.]

Gentlemen of the Association.

SINCE last we met, the Destroyer has been very busy in our ranks. Besides other beloved and respected associates, our earliest and our latest Presidents have suddenly vanished from our midst;—*Redfield*, who was the first to suggest the idea of the American Association on its present comprehensive plan, and the first to preside over its deliberations, and *Bailey* who, we fondly hoped, would occupy the same distinguished position on the present occasion. From the vision of both, as we humbly trust, the veil which permits us here to see only through a glass darkly, is removed, and the grand laws of Nature, and the infinitessimal no less than the infinite in God's works, are revealed to them in the clear light of heaven.

With Mr. Redfield my acquaintance has been long and intimate. I was conversant with his earliest researches on the subject which is so closely associated with his name, and I have been constantly a witness of his untiring self-sacrificing labors in the cause of science, through all the subsequent years of his life. I respected him as a man, I admired him as a philosopher, I loved him as a friend. We miss him here, always the earliest to come and the latest to depart. We miss his gentle tones, his kindly greetings. We miss still more the radiance which his clear mind cast upon our pathway up the hill of science. I am thankful for the opportunity of presenting before this learned assembly a synopsis of his scientific labors. Some brief notice, also, of his personal history may be acceptable, not only as to satisfy the wishes of his friends, but for the benefit of his example, which, I trust, will especially commend itself to the self-taught votary of science, and to all who are engaged in the pursuit of knowledge under difficulties, both as an incentive and a model. A life passed in the ordinary walks of business, or in the quiet of philosophical research, affords little of that romantic incident which lends a charm to biography ; still we think the life of Mr. Redfield affords an interesting and instructive theme for contemplation in a three-fold point of view,—as affording a marked example of the successful pursuit of knowledge under difficulties, —as happily illustrating the union, in the same individual, of the man of science with the man of business,—and as exhibiting a philosopher, whose researches have extended the boundaries of knowledge, and greatly augmented the sum of human happiness.

William C. Redfield was born at Middletown, Connecticut, on the 26th of March, 1789. He was of pure English descent both by the father's and mother's side. His father from a natural love of adventure, chose in early youth a sea-faring life, and afterwards followed the seas as a profession to the time of his death, which happened when this, his eldest son, was only thirteen years old. His early training, therefore, devolved chiefly on his mother, who was a woman of superior mental endowments, and of exalted Christian character.

The slender pecuniary resources of the family would not allow young Redfield any opportunities of school education beyond those of the common schools of Connecticut, which, at that time, taught little more than the simplest rudiments—reading, spelling, writing, and a little arithmetic ; and all access to the richer treasures of knowledge seemed to be forever denied him, when, at the early age of fourteen, he was removed to Upper Middletown, now called Cromwell, and apprenticed to a mechanic, whose tasks engrossed every moment of his time except a part of his evenings. These brief opportunities, however, he most diligently spent in the acquisition of knowledge, eagerly devouring every scientific work within his reach. He was denied even a lamp for reading by night, much of the time during his apprenticeship, and could command no better light than that of a common wood fire in the chimney corner. Under all these disadvantages, it is evident that before he was twenty-one years of age he had acquired no ordinary amount and variety of useful knowledge. During the latter part of his apprenticeship he united with other young men of the village in forming a debating society under the name of "The Friendly Association," with which was connected a small but growing library. To this humble literary club, Mr. Redfield always ascribed no small agency in inspiring him with a love of knowledge, and a high appreciation of its advantages; and during his future years, he nursed and liberally aided by his contributions this benefactor of his youth.

Fortunately for young Redfield, a distinguished and learned physician, Dr. William Tully, fixed his residence in the same village, and generously opened to him his extensive and well-selected library; and what must have been equally inspiring to youthful genius, Dr. Tully furnished him with a model of an enthusiastic devoted to knowledge, and of a mind richly stored with intellectual wealth. The modest youth who first presented himself as a suppliant for the loan of a book from the Doctor's library, was soon recognized as a congenial spirit, and was admitted to an intimate friendship, which lasted to the day of his death. Dr. Tully has favored us with the particulars of his first acquaintance with our friend. On his application for a book to occupy such moments as he could redeem from his daily tasks, the Doctor, being then ignorant of his acquirements or his taste, opened different cases of his library, submitting the contents of each to his selection. Among a great variety of authors, that which determined his choice was Sir Humphry Davy's Elements of Chemistry. As this was one of the earliest systematic works that contained the doctrine of Chemical Equivalents, a subject then considered as peculiarly difficult, and one understood by few readers of the work, the Doctor had little expectation that his young inquirer after knowledge, would either understand or relish it. In a short time he returned the book, and surprised the Doctor by evincing a thorough acquaintance with its contents, and expressing a high satisfaction, in particular, with the doctrine of chemical equivalents, which he said, he had then met with for the first time.

Some time before young Redfield reached the end of his apprenticeship, his widowed mother had married and removed to the state of Ohio. He was no sooner master of his time than he set out on foot to pay her a visit in her new home, distant more than seven hundred miles. It was a formidable undertaking, in that early period before the age of steamboats and railways, and when a large part of the way was covered with dense forests, with hardly an open path even for the pedestrian. Stage coaches, indeed, ran on the nearer portions of the route, but these were too expensive for the slender finances of our young adventurer. Accompanied, therefore, by two other young men, he shouldered his knapsack and commenced the arduous journey. Every evening he noted down the incidents and observations of the day. This journal is now in my possession, and I have perused it with deep interest for the graphic sketches it contains of the countries he passed through, then mostly new settlements, and for the indications it affords of those powers of observation, which afterwards led to the development of the laws of storms. The style of composition is far superior to what might reasonably have been expected from one who had enjoyed so few literary advantages, evincing two qualities for which Mr. Redfield was always distinguished—good sense and good taste. The sketches of Western New York, and of Northern Ohio, taken while the sites of Rochester and Cleveland were dark and gloomy forests, and Buffalo was a mere hamlet, possess no ordinary degree of historical interest. Instead of a "Lake Shore" road, traversed by the iron horse, as at present, our young pedestrians could find no better paths in which to travel over the southern side of Lake Erie, than to course along the beach. Yet in twenty-seven days they made good their journey, having rested four days on the way, making an average of about thirty-two miles per day. After passing the winter with his friends in Ohio, he resumed his way homeward on foot and alone, returning by a more southern route, through parts of the states of Virginia, Maryland and Pensylvania. We shall soon see to what valuable account he afterwards turned the observations made on these early pedestrian tours, in tracing the course as well as originating the project, of a great railway connecting the Hudson and the Mississippi rivers.

Returning to his former home in 1811, Mr. Redfield commenced the regular business of life. No circumstances could seem more unpropitious to his eminence as a philosopher, than those in which he was placed for nearly twenty years after his first settlement in business. A small mechanic in a country village, eking out a scanty income by uniting with the products of his trade the sale of a small assortment of merchandize, Mr. Redfield met with obstacles which in ordinary minds would have quenched the desire of intellectual progress. Yet every year added largely to his scientific acquisitions, and developed more fully his intellectual and moral energies. Meanwhile his active mind left its impress on the quiet community where he lived, in devising and carrying out various plans for advancing their social comfort and respectability, in the improvement and embelishment of their streets, school houses and churches, and in promoting the interests of the literary club, from which he himself, in early youth, had derived such signal advantages. From deep domestic trials which afflicted him about the year 1820, he had recourse for solace both to the word and the works of God. It was soon after one of the severest of these trials, that his attention was first directed to the subject of Atlantic Gales.

On the 3rd of September, 1821, there occurred, in the eastern part of Connecticut, one of the most violent storms ever known there, and long remembered as the "great September Gale." Shortly after this, Mr. Redfield being on a journey to the western part of Massachusetts, happened to travel over a region covered by marks of the ravages of the recent storm. He was accompanied by his eldest son, then a young lad, who well remembers these early observations of his father, and the inference he drew from them. At Middletown, the place of Mr. Redfield's residence, the gale commenced from the southeast, prostrating the trees towards the northwest; but on reaching the northwestern part of Connecticut, and the neighboring parts of Massachussetts, he was surprised to find that there the trees lay with their heads in the opposite direction, or towards the southeast. He was still more surprised to find, that at the very time when the wind was blowing with such violence from the *southeast* at Middletown, a *northwest* wind was blowing with equal violence at a point less than seventy miles distant from that place. On tracing further the course and direction of prostrated objects, and comparing the times when the storm reached different places, the idea flashed upon his mind that the storm was a *progressive whirlwind.* A conviction thus forced upon his mind after a full survey of the facts was not likely to lose its grasp. Amid all his cares, it clung to him, and was cherished with the enthusiasm usual to the student of nature, who is conscious of having become the honored medium of a new revelation of her mysteries. Nothing, however could have been further from his mind, than the thought that the full development of that idea, would one day place him among the distinguished philosophers of his time. So little, indeed, did he dream of fame, that for eight or nine years after the first conception of his theory, he gave little attention to the study of the phenomena of storms, but was deeply engrossed in other enterprises which, although foreign to this subject, were alike evincive of his original and inventive turn of mind. Of these we may take a passing notice.

Before the scientific world, Mr. Redfield has appeared so exclusively in the character of a philosopher, especially of a meteorologist, that they have been hardly aware of the important services he has rendered the public in the character of *naval engineer*, particularly in the department of steamboat navigation. His attention was turned professionally towards this subject as early as the year 1820, when he became much interested in an experiment with a small boat propelled by an engine of new and peculiar construction, the invention of Franklin Kelsey, Esq., a townsman of his. Although the enterprise was not successful to the company, yet to himself it was not destitute of valuable results, as it was the occasion of his acquiring a more intimate knowledge of the properties of steam, of steam navigation, and of ship building. On the ruins of that enterprize was erected another, which after some vicissitudes acquired a permanent success, and opened to him a sphere of professional labor which constituted ever afterwards the leading object of his life, as a man of business. Several disastrous steamboat explosions had spread alarm through the community and created a general terror of steamboats. Redfield was the first to devise and carry into execution the plan of a line of *safety barges* to ply on the Hudson between New-York and Albany. The scheme was, to construct a passenger boat to be towed by a steamboat at such a distance from it as to avoid all apprehension of danger to the passengers. Large and commodious barges were built, fitted up with greater taste and luxury than had at that time been exhibited by steamboats. With those were connected two large and subtantial steamers; and in the excited state of public mind, these safety barges became great favorites with travellers, especially with parties of pleasure. But our countrymen never hold their fears long: a short interval of exemption from steamboat accidents ended the excitement, while the greater speed attained by the ordinary boats, and the lower fare, gradually drew off passengers from the safety barges, until they could be no longer run with profit to the company, and were abandoned. But the idea was not without profit, for it suggested to him the system of *tow boats* for conveying freight, which was established in the spring of 1826, and still continues under its original organization. The fleets of barges and canal boats, sometimes numbering forty or fifty, which make so conspicuous a figure on the Hudson river, were thus set in movement by Mr. Redfield, and for thirty years the superintendence of the line first established, constituted the appropriate business of our friend. In its management he employed unwearied industry, superior mechanical genius for contriving expedients, and a knowledge of both the science and art of steam navigation possessed by few men of business. Seldom have we seen the inductive philosopher so happily united with the practical engineer, each character borrowing aid from the other. I know not that any other man connected with the management of a steam navigation concern as his profession ever carried into his business more of the spirit of true science, and it is chiefly on this account that I have thought it fitting to attend our associate into the familiar walks of business, for the purpose of seeing how compatible, and how productive of useful results is the happy union, in the same person, of the philosopher and the man of business. No one else could have so thoroughly connected the statistics of the professsion in this country, embracing all the facts relating to the explosion of steamboat boilers, as they successively occurred — the number of lives lost — the number of deaths by steam compared with those by lightning—and the number compared with those lost by other modes of travel. Moreover, while Mr. Redfield was diligently pursuing his daily business and conducting with success the affairs of the "Steam Navigation Company," he was also collecting facts for the improvement of the art itself, or for securing the safety of passengers. He devised simpler, cheaper, and safer forms of apparatus than those in general use. He investigated the influence of legal enactments for regulating steam navigation, and pointed out to legislatures and governments the inefficacy or inexpediency of such enactments, and suggested the true measures to be taken to promote the convenience and secure the safety of the public. He addressed a series of letters through the public prints to one of our prominent naval commanders, setting forth the adaptedness of steam as an agent of national defense. He responded to the call of the Secretary of the United States Treasury to point out the causes of steamboat explosions and to suggest the means of safety. Happy would it be, if in all the great operations of the mechanical arts, the true spirit of the philosopher were so fully conjoined with the practical knowledge and skill of the engineer. How rapid would be the improvement of the art! How science and art would walk hand in hand, and mutually aid and illustrate each other!

We turn now to another subject which engaged the attention of Mr. Redfield, and brought into exercise his remarkable sagacity and forecast. He was the first to place before the American people the plan of a system of railroads connecting the waters of the Hudson with those of the Mississippi. His pamphlet containing this project, issued in 1829, is a proud monument of his enlarged views, of his accurate knowledge of the topography of the vast country lying between these great rivers, of his extraordinary forecast, anticipating as he did the rapid settlement of the western states, the magic development of their agricultural and mineral wealth, and the consequent rapid growth of our great commercial metropolis. The route proposed is substantially that of the New York and Erie railroad so far as this goes; but his views extended still further, and he marked out, with prophetic accuracy, the course of the railroads which would connect with the Atlantic states, the then infant states of Michigan, Indiana, and Illinois. These, he foresaw, would advance with incredible rapidity the settlement of those regions of unbounded fertility, and would divert no small portion of the trade from the Mississippi to the great metropolis of the east.

It must be borne in mind that railroads for general transportation were unknown in this country until 1826, when the project of constructing the Albany and Schenectady railroad was first entertained. As yet the advantages of railroads had not with us been practically demonstrated, and especially their advantages over canals were not generally understood or appreciated. At the moment when the Erie canal, having just been completed, was at the summit of its popularity, Mr. Redfield set forth in his pamphlet under nineteen distinct heads, the great superiority of railroads to canals, advantages which, although then contemplated only in theory, have been fully established by subsequent experience. He had even anticipated that after the construction of the proposed great trunk railway connecting the Hudson and the Mississippi, many lateral railways and canals would be built, which would bind in one vast net-work the whole great west to the Atlantic states. "This great plateau (says he) will indeed one day be intersected by thousands of miles of railroad communications; and so rapid will be the increase of its population and resources, that many persons now living will probably see most or all of this accomplished." How well has this remarkable prediction, uttered in 1829, when there was not a foot of railroad in all the country under review, been fulfilled, and how truly has it happened that many of the elder members of this association still live to witness its accomplishment!

The motives which impelled Mr. Redfield to spread this subject before the American people at that early day, when railroads were scarcely known in this country, were purely patriotic. He had no private interests to subserve in the proposed enterprize, and the whole expense of preparing and publishing two editions of the pamphlet embodying these enlarged and prophetic views, was defrayed from his own limited resources.

In 1832, Mr. Redfield, in company with Mr. Morgan, civil engineer, reconnoitered the series of interior valleys through which the Harlem railroad now runs, with a view to the establishment of the New York and Albany railroad. He was instrumental in obtaining the charter of that road, and published a pamphlet entitled "Facts and Suggestions relating to the New York and Albany Railroad." About the same period, in connection with James Brewster, Esq. of New Haven, he explored the route of a railroad leading from New Haven to Hartford, which afterwards resulted in the construction of the Hartford and New Haven railroad. As early as 1829, he addressed a memorial to the Common Council of the City of New York, asking permission to lay an experimental railroad in Canal street. The project of a railroad through one of the public streets of New York was at that time considered as chimerical, but time has developed the wisdom of the plan, and illustrated the sagacity and forecast that first devised it.

When the project of the Hudson River Railroad was started, he entered into it with his characteristic enthusiasm, and was a member of the board of directors, which brought that road to its final completion. In the progress of the work he was deeply interested, frequently visiting all parts of the line, and at different periods examining on foot the entire road between New York and Albany. His associates of the board acknowledged themselves indebted to him for many valuable suggestions relating to its construction.*

But we turn from these noble enterprises in which the philosopher and the engineer were happily united in the same individual, to the consideration of the great subject which, from this time, formed the leading object of his life, namely, to perfect his *theory of storms.* Nor do we turn away from great practical subjects to such as are merely speculative. The lives and property which Redfield's desinterested labors in behalf of steam navigation contributed to save, would, we believe, be of small amount compared with the sailors and ships which the rules founded on his theory of storms, when fully applied to practice, will save from shipwreck.

We have already seen that the attention of Mr. Redfield was first drawn to the subject of storms in the year 1811, by examining the position of trees prostrated by the great September gale, which passed over Connecticut and the western part of Massachussetts that year. Although he had never lost sight of the theory of storms, yet the multifarious business concerns which engrossed the greater part of his time for a number of years afterwards, prevented his bringing it distinctly before the public until the year 1831. I chanced at that period to meet him for the first time on board a steamboat on the way from New York to New Haven. A stranger accosted me, and modestly asked leave to make a few inquiries respecting some observations I had recently published in the American Journal of Science on the subject of Hailstorms. I was soon made sensible that the humble inquirer was himself a proficient in meteorology. In the course of the conversation, he incidentally brought out his theory of the laws of our Atlantic gales, at the same time stating the leading facts on which his conclusions were founded. This doctrine was quite new to me, but it impressed me so favorably, that I urged him to communicate it to the world through the medium of the American Journal of Science. He manifested much diffidence at

* From the outset Mr. Redfield maintained that the low rate of fares at first adopted would prove inadequate to sustain the road, and published in the papers of that day series of articles to show that the road could not be supported at a less rate than two cents per mile. These views met with much opposition at the time, not only from residents on the line of the road, but from members of the board of directors. But the result has proved the soundness of his judgment on that point.

appearing as an author before the scientific world, professing only to be a practical man little versed in scientific discussions, and unaccustomed to write for the press. At length, however, he said he would commit his thoughts to paper, and send them to me, on condition that I would revise the manuscript and superintend the press. Accordingly, I soon received the first of a long series of articles on the laws of storms, and hastened to procure its insertion in the Journal of Science. Some few of the statements made in this earliest development of his theory, he afterwards found reason for modifying; but the great features of that theory appear there in bold relief. Three years afterwards he published, in the 25th volume of the same journal, an elaborate article on the hurricanes of the West Indies, in the course of which he gives a full synopsis of the leading points of his doctrine as matured by a more extended analysis of the phenomena of storms than he had made when he published his first essay.

Possibly some of those whom I have the pleasure to address, may not have fully acquainted themselves with Redfield's theory of storms, and would desire to be informed of its leading principles. I understand this theory to be substantially as follows:

That all violent gales or hurricanes are great *whirlwinds*, in which the wind blows in circuits around an axis either vertical or inclined; that the winds do not move in horizontal circles, as the usual form of his diagrams would seem to indicate, but rather in spirals towards the axis, a descending spiral movement externally and ascending internally.

That the *direction of revolution* is always uniform, being from right to left, or against the sun, on the north side of the equator, and from left to right, or with the sun, on the south side.

That the *velocity of rotation* increases from the *margin towards* the center of the storm.

That the whole body of air subjected to this spiral rotation is, at the same time, *moving forward* in a path, at a variable rate, but always with a velocity much less than its velocity of rotation, being at the minimum, hitherto observed, as low as four miles, and at the maximum forty-three miles, but more commonly about thirty miles per hour, while the motion of rotation may be not less than from one hundred to three hundred miles per hour.

That in storms of a particular region, as the gales of the Atlantic, or the typhoons of the China seas, *great uniformity exists in regard to the path pursued*, those of the Atlantic, for example usually issuing from the equatorial regions eastward of the West India islands, pursuing, at first, a course towards the northwest as far as the latitude of 30°, and then gradually wheeling to the northeast and following a path nearly parallel to the American coast, to the east of Newfoundland, until they are lost in mid-ocean, the entire path when delineated resembling a parabolic curve whose apex is near the latitude of 30°.

That their *dimensions* are sometimes very great, being not less than 1000 miles in diameter, while their path over the ocean can sometimes be traced for 3000 miles.

That the *barometer*, at any given place, falls with increasing rapidity as the centre of the whirlwind approaches, but rises at a corresponding rate after the center has passed by; and finally,

That the phenomena are more uniform in large than in small storms, and more uniform on the ocean than on the land.

These laws Mr. Redfield claims as so many facts independently of all hypothesis; as facts deduced from the most rigorous induction, which will ever hold true, whatever views may be entertained respecting the origin or causes of storms.

The *method* adopted by the author of this theory, in all his inquiries,—the method which first led him to the discovery of the whirlwind character of storms, and afterwards fully confirmed the doctrine,—was first to collect and then to collate as many records as possible of vessels that had been caught in the storm, in various parts of the ocean. The most laborious and profound investigation of this nature of which he has left us an example, is in the case of the Cuba hurricane of October, 1844. First, he examined all accessible marine reports of vessels that had arrived in port after encountering the storm; secondly, he inspected the log-books of all such vessels, as far as was practicable, and carefully transcribed their records; and, thirdly, by an extended correspondence, he obtained a great number of written statements from shipmasters, who of all men would be the most accurate and vigilant observers. The different independent accounts obtained from these various sources amounted to no less than one hundred and sixty-four, all of which were reduced to the form of tables, containing the latitude and longitude of each vessel or place at the time of observation; the exact date and duration of the gale; the successive directions of the stormwind: the state of the barometer; and, finally, every additional particular that was deemed of the least importance in determining the peculiar characteristics of the storm. With these data before him, he spread out a marine chart, and having noted on it the position of each vessel and place with the direction and force of the wind the plot itself proclaimed to the eye the whirlwind character of the storm: and the comparison of dates, and corresponding courses of the winds, and respective states of the barometer, showed the dimensions of the storm, its rotary and progressive velocities, its duration at any given place, and its various degrees of violence at different distances from the center. In the character of the researches before us, conducted as they were, not in the shades of philosophic retirement and learned leisure, but in hours redeemed from the pressing avocations of an onerous and responsible business, or borrowed from the season allotted to sleep, we trace qualities of mind that belong only to the true philosopher.

The benevolent and practical mind of Redfield had no sooner established the laws of storms, that it commenced the inquiry, what rules may be derived from it, to promote the safety of the immense amount of human life and of property that are afloat on the ocean, and exposed continually to the dangers of shipwreck; in this, imitating our Franklin, who as soon as he had discovered the identity of lightning with the electricity of our machines, hastened to the inquiry. How may we so apply our knowledge *of the laws of electricity as to disarm the thunderbolt of its terrors?* We might pursue the comparison and say, that as every building saved from the ravages of lightning by the conducting rod, is a token both of the sagacity and the benevolence of Franklin, so every vessel saved from the horrors of shipwreck by rules derived from these laws of storms, is a witness to the sagacity and benevolence of Redfield. Other writers on the laws of storms, especially Reid and Piddington, have lent important aid in establishing rules for navigators, until it is now easy for the mariner by the direction in which the gale strikes his ship to determine his position in the storm, and the course he must steer in order to escape from its fury. Nor are testimonies wanting of the successful applicating of these rules. The most accomplished navigators (we might instance particularly Commodores Rodgers and Perry, and Commander Glynn, of the U. S. Navy) have testified that within their own observation, many ships have owed their deliverance from the perils of shipwreck to a faithful observance of the rules derived from Redfield's theory of storms. In no department, perhaps, of the studies of nature have mankind been more surprised to find things governed by fixed laws, than in the case of the winds. It is now rendered in the highest degree probable, that every breeze is a part of some great system of aerial circulation and helps to fulfil some grand design. "Inconstant as the winds" has long been a favorite expression to denote the absence of all uniformity or approach to fixed rules; but the researches of the meteorologists of our times, force on us the conclusion that the winds, even in the violent forms of hurricanes and tornadoes, are governed by laws hardly less determinate than those which control the movements of the planets.

It has been often noticed in the history of science and the arts, that great discoveries and inventions spring forth simultaneously from different independent sources. Thus the discovery of oxygen gas, the greatest single discovery in chemistry, was made almost at the same moment by Priestley in England and Scheele in Sweden; and the method of fluxions, or the infinitesimal calculus, was invented at nearly the same time by Newton and Leibnitz. Such discoveries and inventions are the true resultant of innumerable forces, which at that moment, and never until then since the origin of time, all conspired. It is remarkable that the idea that great storms are progressive whirlwinds, was, for the first time, embraced nearly at the same instant by Redfield and Dové, although the conclusion was arrived at by totally different methods of investigation. Mr. Redfield says in a note to his paper on the Cuba hurricane, published in 1846, that it was not until seven years after the publication of his theory of the rotary and progressive character of storms, that he became acquainted with the suggestions and opinions of Col. Capper, and with the particular views and elucidations published by Professor Dové in his paper on Barometric Minima found in Poggendorff's Annalen for 1828. To all who were personally acquainted with Redfield, it would be quite unnecessary to adduce any other evidence than his simple declaration, of the perfectly original and independent character of his theory of the laws of storms. But we might refer to the circumstances under which it was conceived, when he was far removed from all libraries, and all intercourse with the scientific world; and as respects Dové, in particular, whose essay was communicated to the public in 1828, it may be said, that at that period there was scarcely a copy of Poggendorff's Annalen, in which Dové's essay appeared, in the United States; and being in the German language, nothing could be more improbable than that its contents were then known to Redfield. In 1838, our friend found to his great joy a most able ally in Col. Reid of the Royal English Engineers, then stationed in the island of Barbadoes. The earliest inquiries of Col. Reid were based on a violent hurricane, which occurred in that island in the year 1831. Searching for accounts of previous storms, he met with nothing satisfactory until he fell in with Redfield's earliest paper respecting the September gale of 1821, published in the American Journal of Science. With the view of testing Redfield's doctrines, he submitted to the closest scrutiny the records which the Barbadoes storm had left of its ravages,—an investigation which ended in a perfect conviction that this storm was a progressive whirlwind. A friendly correspondence was shortly afterwards opened between these two congenial spirits, which resulted in an intimacy unbroken except by the hand of death. Commodore Perry, in the recent Report of his Japan Expedition, thus expresses himself in an introductory note to Mr. Redfield's Essay (the latest of his published works) on the Cyclones of the Pacific, addressed to Commodore Perry, and forming a part of his volume. "It was my good fortune (says the Commodore) to enjoy, for many years, the friendly acquaintance of one as remarkable for modesty and unassuming pretensions, as for laborious observation and inquiry after knowledge. To him and to Gen. Reid of the Royal Engineers of England (now governor of Malta) are navigators mainly indebted for the discovery of a law which has already contributed and will continue to contribute, greatly to the safety of vessels traversing the ocean. It is true that subsequent writers have furnished additional information on this subject; but to Redfield and Reid should be ascribed, the credit of the original discovery of this undeniable law of nature and its application to useful purposes; and there can be nothing more beautiful, as illustrative of the character of these two men, than the fact, well known to myself; that notwithstanding their *simultaneous* observations and discoveries, in different parts of the world, neither claimed the slightest merit over the other, but each strove to give to his co-worker in research the meed of superior success in the great object of their joint labors; and thus, without ever meeting, a strong friendship was formed between them, growing out of congenial aspirations for an honorable fame, and mutual admiration of the generous and enlightened views exhibited by each other; and this ennobling feeling was kept alive to the last by friendly correspondence."

The idea of whirlwinds is indeed much older than Redfield or Reid, being as old as the writings of the Psalmist and the Prophets; and we safely admit further, that the doctrine of ocean gales being sometimes of a rotary character, had been hinted at by several writers, as hints of such a principle as gravitation had long preceded the investigations of Newton; but the honor of having established, on satisfactory evidence, the rotary and progressive character of ocean storms, and determining their modes of action or laws, it is due alike to the memory of the departed, and to our country's fame, to claim for WILLIAM C. REDFIELD.

Back of the laws that govern these ocean gales, as first determined by Redfield and confirmed by Dové, Reid, Piddington, Thom, and other well known writers, lies a more profound inquiry, How are these laws themselves to be accounted for? What sets the storm in motion, and gives it the whirlwind character, and at the same time carries it forward, and in so definite a path? What makes it revolve always from right to left on the north side of the equator, and from left to right on the south side? Why does its violence increase towards the centre of the storm, and why is its force there so tremendous? Laws, it must be remembered are facts, and merely express the modes in which nature acts: they are themselves phenomena to be accounted for. To which of the ultimate causes of physical phenomena is their origin, in the present case, to be traced? Is it heat? Is it electricity? Is it gravity? Is it connected in some way with the grand system of planetary motion? Questions of this kind were pressed on Mr. Redfield from various sources by those who assailed his theory. At first he declined any attempts at their solution. He claimed that the whirlwind character of storms, and the laws which he had assigned to them, are matters of fact, as established not only by himself, but also by Reid, Milne, Dové, and Piddington; that never having attempted to establish a theory of winds, nor the origin or first cause of storms, he had no occasion to go into these inquiries, but had long held the proper inquiry to be, *What are storms?* not *How are storms produced?* He however incidentally, at different times, indicated his opinions on the ultimate causes of storms. Electricity, Redfield entirely rejected as an agent in the production of winds and storms, considering its presence and development rather as a consequence than as a cause of atmospheric changes. To heat he assigned only a limited and local effect, denying its agency in producing either the great and established movements of the atmosphere, or the extraordinary commotions which constituted the chief objects of his study, hurricanes and tempests. But he considered what he called the "dynamics of the atmosphere," as connected with and resulting from the diurnal and annual motions of the earth. While, from the first, I have heartily embraced Redfield's doctrine that ocean gales are progressive whirlwinds, and have further fully believed that he *had established their laws or modes of action on an impregnable* basis, a regard to truth and candour obliges me to say, that I have never been a convert to his views respecting the ultimate causes of storms, especially so far as he assigned for these causes what he denominates the "diurnal and orbitual motions of the earth," but his notions on this point have always appeared to me unsatisfactory. Nor, while I have been impressed with the belief that *heat* is, in general, by far the most influential of all natural agents in destroying the equilibrium of the atmosphere, and of causing its motions, both in established currents, as the trade winds and the monsoons, and in its violent commotions, as in hurricanes and tornadoes, yet I am compelled to think that but little progress has yet been made in determining its *modus operandi*, or in tracing the *connection* between changes of temperature and the actual phenomena of winds and storms:—why, for example, the Atlantic gales originate where they do, in the tropical regions—why they first pursue a path to the northwest as far as the latitude of 30°, and then gracefully wheel in parabolic curves towards the northeast, and pursue this course for the remainder of their way—why they revolve on their axes and always in one direction—whence they acquire so tremendous a force, especially towards the central parts—why the barometer is so low in the center and so high on the margin of the storm. These and various other points connected with the whirlwind character of storms, seem to me to have met hitherto with but a partial and doubtful solution. The laws constitute the true theory of storms: the rest is yet hypothesis.

Various writers have severally displayed great ingenuity and profound knowledge of atmospheric phenomena, in their endeavours to solve these problems, but with respect to the causes which lie back of the laws of storms, we still remain to a great degree in ignorance. Each of the combatants appears to me to be more successful in showing the insufficiency of the other's views, than in establishing his own. With respect to him who is more particularly the subject of my remarks, whose logical powers I have always admired, I have almost regretted that he did not adhere to the ground he originally took, namely, that he had not undertaken to explain the reason *why* the winds blow, but only to show *how* they blow. So far was matter of fact: all beyond was hypothesis. His facts are impregnable: his hypothesis doubtful. The conclusions derived legitimately from these facts constitute the laws of storms; and being, as we believe, like the other laws of nature immutable, the name indissolubly associated with their discovery, acquires a fame alike imperishable. Redfield might therefore have safely stopped where Newton stopped. "Newton (says one of his biographers) stopped short at the last fact which he could discover in the solar system—that all bodies were deflected to all other bodies, according to certain regulations of distance and quantity of matter. When told that he had done nothing in philosophy; that he had discovered no cause; and that, to merit any praise, he must show how this deflection was produced; he said, he knew no more than he had told them; that he saw nothing causing this deflection; and was contented with having described it so exactly, that a good mathematician could now make tables of the planetary motions, as accurate as he pleased, and hoped in a few years to have every purpose of navigation and philosophical curiosity completely answered."

Various other contributions to science of our departed friend must, for want of space, be passed by with hardly a notice. Such are his published meteorological essays*—his reports of meteorological observations, which contain many original hints of much value—his paper on the currents of the Atlantic—and his researches in geology, which occupied much of his attention during the latter years of his life—all of which speak the skilful observer, the judicious philosopher, the lover of science, the lover of his country and of his kind. His meteorological researches, although they engrossed a large share of the hours he could redeem from the urgent claims of business, did not prevent his taking a strong interest in other branches of science. He attentively watched the progress of knowledge in various departments, but Geology had for him special attractions. His powers of observation were early employed, even in his pedestrian tour to Ohio in 1810, in noting facts which appeared to him then to be unaccounted for

* Originally prepared for Blunt's Coast Pilot.

but which the progress of the science has since fully explained. In the meetings of the American Association he was an attentive listener to the geological papers, and frequently took part in the discussions which they called forth, exhibiting a thorough acquaintance with the subjects under consideration. The phenomena of the drift period, as evincive of glacial action in various forms had deeply interested him; and he had collected, and closely studied, the shells of recent species which, in the vicinity of New York are found beneath the deposits of drift. His published geological papers, however, relate chiefly to the sandstones of Connecticut and New Jersey, particularly to their fossils, their ripple-marks, and their rain-drops. His residence in early life was within sight of the extensive quarries of this kind of sandstone, at Portland, Connecticut, and his frequent visits afterwards to that region, afforded him opportunity for close observation. In December, 1836, his son Mr. John H. Redfield, who inherits much of the scientific taste of his father, described† some of the fossil fishes from this locality, and shewed that their structural affinities indicated for the so called "New Red Sandstone" a higher position than had previously been assigned to it. Redfield pursued the track thus opened by his son, and published, in the American Journal of Science, descriptions of several new species of Ichthyolites. The last paper which he read before the American Association was upon the Geological Age of the Sandstones of Connecticut and New Jersey, and the contemporaneous deposits in Virginia and North Carolina, He proposed for them the denomination of the *Newark Group*, and showed that the Ichthyolites contained in them pointed unerringly to the Jurassic period. In the course of these investigations he had given close study to the subject of Fossil Fishes, and had formed a collection of them, probably unequalled in this country, with special reference to a contemplated monograph of the Ichthyolites of the Newark Group.

In 1839, Yale College conferred on Mr. Redfield the honorary degree of Master of Arts, and the enlarged sphere in which his labors for the promotion of science and the good of his fellow men, were known and appreciated, was evinced by his election into many learned societies in his own and foreign countries.

Three distinguishing marks of the true philosopher met in William C. Redfield—originality to devise new things; patience to

† Annals Lyc. Nat. History, New York, vol. iv.

investigate; and logical powers to draw the proper conclusions. The impress of his originality he left, in early life, upon the village were he resided; he afterwards imprinted it still deeper on his professional business, as naval engineer; and most of all on his scientific labors, his observations, and his theories. "Patient thought" was the motto of Newton, and in this attribute, Redfield was eminently distinguished. In collecting facts bearing upon his main purpose, and in submitting them to severe and long continued comparison, he has illustrated this quality in its highest forms, as his laborious investigations of the phenomena of hundreds of storms, most fully evince. Originality to invent without patience to investigate, leads to hasty and wild speculations; but united they lay the deep foundations for a severe logic. His powers of reasoning have always appeared to me to be of high order, and he has been fitly characterized by another eminent writer* on the laws of storms, as the "clear-headed" Redfield. Opinions which he had thus formed, after an extensive and patient investigation of the facts, and a severe process of reasoning, he held with great tenacity. But though firm, he was not obstinate. *Obstinacy* we define to be an unyielding adherence to our opinions because we have adopted them: *firmness*, a similar adherence to our opinions, because we believe them to be right.

Few men have given more signal proof of an original inherent love of knowledge Whether we contemplate the apprentice-boy after the toils of the day, seeking for knowledge by the dim light of an open fire: or the father of a young family, through dark scenes of domestic affliction and mournful bereavements, still adding largely year by year to his intellectual stores; or the man of business in the whirl of the great metropolis, loaded with onerous and responsible cares, giving every interval of leisure, and the seasons chiefly employed in pleasure or repose to the study of the laws of nature; or if permitted, as has been my privilege, to be a guest at the house fitted up to be the retreat of his old age, we see the library, the collections of natural history, the many sources of high mental enjoyment, which in the period gained at last of ease and affluence, distinguish the different apartments of his dwelling; or finally whether we call to mind the ever increasing interest with which he attended the meetings of the American Association for the Advancement of Science, and the de-

* Reid.

light which he experienced in the society of learned men, we observe in all, a mind in love with truth, ever searching and ever expending. In society he was courteous, sincere, upright, and benevolent; in his family, tender, affectionate, wise in counsel and pure in example; in all his walk and conversation, and especially in the church of God, a devout and humble christian.

As the evening of life was passing thus serenely, it hastened to a peaceful close. Mr. Redfield's health had been generally good during his later years, and had seemed particularly so in the early part of the winter which proved his last. On the first of January, he made his usual calls on his friends, and the cheerfulness and vivacity of his manners and healthful expression, were never more remarkable. Near the last of January he was seized with alarming symptoms, which indicated effusion in the chest. His disease made rapid and sure progress. The last book which had engaged his attention previous to his illness was Dr. Kane's recent Narrative of his Arctic Expedition, and his own feverish dreams, during the earlier nights of his sickness, were confusedly identified with the toils, the difficulties, and the sufferings of that heroic commander and his brave companions. With a general tendency to delirium were mingled intervals of calmness, and throughout his illness his countenance would light up with the smile of affection, as he recognized the relations and friends around him. From the first he entertained but slight hopes of recovery; but as the crisis drew near, his mind was at peace, and in calm resignation to the will of his Maker, and in the full exercise of christian faith, he gently breathed his last on the morning of February 12, 1857.

Happy if we who have so long journeyed with him in the delightful walks of science, may enjoy an evening as serene, and find its close as peaceful.

ARTICLE XXXVIII.—*On the Star-Nosed Mole of America.*

Genus, CONDYLURA. (Illiger.)

DENTAL FORMULA.

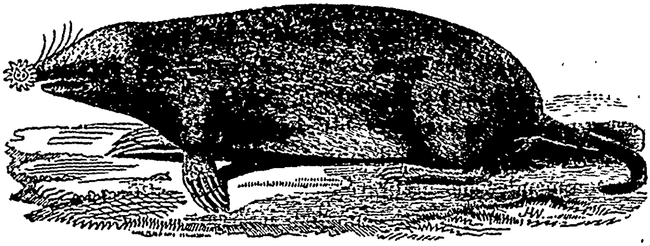
Incisive $\frac{2}{4}$; *Canine* $\frac{1}{1}$-$\frac{1}{1}$; *Molar* $\frac{8}{7}$–$\frac{8}{7}$=40.

Generic Characters :—Body thick, furry; muzzle much elongated, bordered with membranous crests, disposed star-like round the opening of the nostrils; no ears; eyes small; feet five-toed, nails formed for digging; those behind slender and weak. The generic name is from the Greek (*kondule*) a swelling, and (*oura*) a tail, in allusion to the swollen state of the tail of this animal sometimes observed. Only one species of this remarkable genus is known, which is the following:—

CONDYLURA CRISTATA. (Linn.)

Synonymes.

SONERE CRISTATA; Linn, Ed. 12, p. 73.
TALPA LONGICAUDATA. Pennant's Hist. Quad., Vol 2, p. 232.
CONDYLURA LONGICAUDATA. Richardson, Fauna, p. 13.
C———— MACROURA. " id. p. 234.
C———— CRISTATA. Audubon & Bachman, Vol. 2, p. 139.



The length of the star-nosed mole from the point of the nose to the root of the tail is about 5 inches, length of tail three inches, from heel to end of claw $\frac{7}{8}$ of an inch, breadth of palm $\frac{6}{8}$. The head is long pointed and terminated in a snout which, at its extremity is surrounded by a fringe of about twenty cartilaginous points. The body is cylindrical, the neck short, and the eyes small. The moustaches are few and short. There is an orifice in place of an external ear, which does not project through the skin. The fore feet are longer than those of the common American shrew mole, the palms destitute of hairs, but covered with scales; claws, flattened, sharp, channelled beneath; hind extremities longer than the fore ones, placed far back; feet nearly naked, scaly; tail sub-cylindrical, sparingly covered with coarse hair. The fur is brownish black; some of the specimens have dark brown feet, others pale ashy brown or even white.

This animal is a harmless little creature, subsisting on insects, worms and larvæ of various kinds. According to Dr. Godman it prefers the banks of small streams or swampy land, where in many places the burrows are so numerous that "it is scarcely possible to advance a step without breaking down their galleries. The excavations which are most continuous, and appear to be most frequented, are placed at a short distance below the roots of the grass on the banks of small streams; these are to be traced along their margins, following every inflexion, and making frequent circuits in order to pass large stones or roots of trees, to regain their usual proximity to the surface nearest the water." Audubon says that the burrows are deeper than those described by Godman, and that the chamber of habitation at the end is spacious, with a comfortable nest of withered leaves and dry grass. Out of one of these he took three young ones about a week old, and found that the radiations of the nose were then so slightly developed that the animals might have been mistaken for the young of the common mole. When confined in a box they would eat meat.

The use of the extraordinary appendage at the end of the nose is not known with certainty. It is only barely probable that as the animal subsists by groping about under the ground in search of worms and other small prey, the ornament on his muzzle may assist it in the search.

At certain seasons it is observed that the tail of the star-nosed mole is much swollen, and hence the mistake of Dr. Harlow, who, upon a specimen taken in this condition, made a new species with the name *macroura*, or long tailed mole. This species is found in Canada but rarely, although it appears to be distributed all over the province. In the United States it occurs in all the northern and eastern portions and as far south as the borders of South Carolina.

ARTICLE XXXIX.—*On the Mink*, (*Putorius vison.*)

Genus Putorius.—(Cuvier.)

Dental Formula.

Incisive, $\frac{6}{6}$; *Canine*, $\frac{1}{1}$—$\frac{1}{1}$; *Molar*, $\frac{4}{5}$—$\frac{4}{5}$ = 34.

Generic Characters.—There are two false molars above, and three below; the great carnivorous tooth below, without an internal tubercle; the tuberculous tooth in the upper jaw, very long.

Head, small and oval; muzzle, short and blunt; ears, short and round; body, long and vermiform; neck, long; legs, short; five toes on each foot, armed with sharp crooked claws; tail, long and cylindrical. Animals of this genius emit a fetid odour, and are nocturnal in habit; they are separated from the martens in consequence of having one tooth less on each side of the upper jaw; their muzzle is also shorter and thicker than that of the marten. The species are generally small in size, and seldom climb trees like the true martens.

There are about fifteen well determined species of this genus, six of which belong to America, and the remainder to the Eastern continent.

The generic name *putorious* is derived from the Latin word *putor*—a fetid smell.—*Audubon & Bachman, Quadrupeds of America*, vol. 1, p. 250.

PUTORIUS VISON.—Linn.

THE MINK.

The fur of this animal has of late years become so highly esteemed as an article of comfortable dress during the severe cold of our long winters, that perhaps few of our lady readers could believe herself prepared for a drive without clothing herself to a greater or less extent in the rich and warm jacket once the exclusive property and protection of Mr. Putorius vison. The usual color of the Mink is an uniform brown or tawny, with light brownish or yellow fur beneath, next the body. Some of the specimens are much darker than others. There is a white spot under the throat and another on the breast; the lower jaw is also white. The length of the head and body is about 13 inches, and of the tail 7 inches. The body is long and slender, the head small and flattish, neck long, legs short, and feet partly webbed. The geographical distribution of the species appears to be co-extensive with the North American Continent. It is known in all parts of Canada and the United States, and Sir John Richardson met with it as far north as latitude 66°. The word Mink is a corruption of the Swedish Moenk, a name given to a closely allied species in Sweden. In fact the *Musicla lutreola* of Northern Europe is still believed by many naturalists to be the same as the American *P. vison.* It affords one of the many proofs of the close relationship that exists between the northern faunæ of the two continents. Thus the moose deer can scarcely be distinguished from the Scandinavian elk, the cariboo of the barren grounds (*Tarandus arcticus*) from the reindeer of Lapland; the pine marten of Canada is also found in Europe; the musk ox formerly inhabited Britain; and the American beaver is identical with the European species. Between the southern extremities of the old and new worlds no such affinities exist. We believe the fauna of South America is totally different from that of Africa.

This animal is an expert hunter, and although of an aquatic habit, subsists much upon birds, mice, and other small animals. Audubon gives the following account of its exploits:—

"There is a small brook, fed by several springs of pure water, which we have caused to be stopped by a stone dam to make a pond for ducks in the summer and ice in the winter; above the pond is a rough bank of stones through which the water filters into the pond. There is a little space near this where the sand and gravel have formed a diminutive beach. The ducks descending to the water are compelled to pass near this stony bank. Here a Mink had fixed his quarters with certainly a degree of judgment and audacity worthy of high praise, for no settlement could promise to be more to his mind. At early dawn the crowing of several fine cocks, the cackling of many hens and chickens, and the paddling, splashing, and quacking of a hundred old and young ducks would please his ears; and by stealing to the edge of the bank of stones, with his body nearly concealed between two large pieces of broken granite, he could look around and see the unsuspecting ducks within a yard or two of his lurking place. When thus on the look out, dodging his head backward and forward he waits until one of them has approached close to him, and then with a rush seizes the bird by the neck, and in a moment disappears with it between the rocks. He has not, however, escaped unobserved, and like other rogues deserves to be punished for having taken what did not belong to him. We draw near the spot, gun in hand, and after waiting some time in vain for the appearance of the Mink, we cause some young ducks to be gently driven down to the pond—diving for worms or food of various kinds while danger so imminent is near them—intent only on the objects they are pursuing, they turn not a glance toward the dark crevice where we can now see the bright eyes of the Mink as he lies concealed. The unsuspecting bird remind us of some of the young folks in that large pond we call the world, where, alas! they may be in greater danger than our poor ducks or chickens. Now we see a fine hen descend to the water; cautiously she steps on the sandy margin and dipping her bill in the clear stream, sips a few drops and raises her head as if in gratitude to the Giver of all good; she continues sipping and advancing gradually; she has now approached the fatal rocks, when with a sudden rush the Mink has seized her; ere he can regain his hole however, our gun's sharp crack is heard and the marauder lies before us."

"We acknowledge that we have little inclination to say anything in defence of the Mink. We must admit, however, that although he is a cunning and destructive rogue, his next door neighbour, the ermine or common weasel, goes infinitely beyond him in his mischievous propensities. Whilst the Mink is satisfied with destroying one or two fowls at a time, on which he makes a hearty meal; the weasel, in the very spirit of wanton destructiveness, sometimes in a single night puts to death every tenant of the poultry-house!"

"Whilst residing at Henderson, on the banks of the Ohio river, we observed that Minks were quite abundant, and often saw them carrying rats which they caught like the weasel or ferret, and conveyed away in their mouths, holding them by the neck in the manner of a cat."

"Along the trout streams of our Eastern and Northern States the Mink has been known to steal fish that having been caught by some angler, had been left tied together with a string while the fisherman proceeded farther in quest of more. An angler informed us that he had lost in this way thirty or forty fine trout, which a Mink dragged off the bank into the stream and devoured, and we have been told that by looking carefully after them, the Mink could be seen watching the fisherman and in readiness to take his fish, should he leave it at any distance behind him. Mr. Hutson of Halifax informed us that he had a salmon weighing four pounds carried off by one of them."

"We have observed that the Mink is a tolerably expert fisher. On one occasion, whilst seated near a trout-brook in the northern part of the State of New York, we heard a sudden splashing in the stream and saw a large trout gliding through the shallow water and making for some long overhanging roots on the side of the bank. A Mink was in close pursuit, and dived after it; in a moment afterwards it re-appeared with the fish in its mouth. By a sudden rush we induced it to drop the trout, which was upwards of a foot in length."

"We are disposed to believe, however, that fishes are not the principal food on which the Mink subsists. We have sometimes seen it feeding on frogs and cray-fish. In the Northern States we have often observed it with a Wilson's meadow-mouse in its mouth, and in Carolina the very common cotton-rat furnishes no small proportion of its food. We have frequently remarked it coursing along the edge of the marshes, and found that it was in search of this rat, which frequents such localities, and we discovered that it was not an unsuccessful mouser. We once saw a Mink issuing from a hole in the earth, dragging by the neck a large Florida rat."

"This species has a good nose, and is able to pursue its prey like a hound following a deer. A friend of ours informed us that once while standing on the border of a swamp near the Ashley river, he perceived a marsh-hare dashing by him; a moment after came a Mink with its nose near the ground, following the frightened animal, apparently by the scent, through the marsh.

"In the vicinity of Charleston, South Carolina, a hen-house was one season robbed several nights in succession, the owner counting a chicken less every morning. No idea could be formed, however, of the manner in which it was carried off. The building was erected on posts, and was securely locked, in addition to which precaution a very vigilant watch-dog was now put on guard, being chained underneath the chicken-house. Still, the number of fowls in it diminished nightly, and one was as before missed every morning.

"We were at last requested to endeavour to ascertain the cause of the vexatious and singular abstraction of our friend's chickens, and on a careful examination we discovered a small hole in a corner of the building, leading to a cavity between the weather-boarding and the sill. On gently forcing outward a plank, we perceived the bright eyes of a Mink peering at us and shining like a pair of diamonds. He had long been thus snugly ensconced, and was enabled to supply himself with a regular feast without leaving the house, as the hole opened toward the inside on the floor. Summary justice was inflicted of course on the concealed robber, and peace and security once more were restored in the precincts of the chicken yard.

"This species is very numerous in the salt-marshes of the Southern States, where it subsists principally on the marsh-hen, (*Rallus crepitans*,) the sea-side finch, (*Ammodramus maritimus*,) and the sharp-tailed finch, (*A. caudacutus*,) which, during a considerable portion of the year, feed on the minute shell-fish and aquatic insects left on the mud and oyster-banks, on the subsiding of the waters. We have seen a Mink winding stealthily through the tall marsh-grass, pausing occasionally to take an observation, and sometimes lying for the space of a minute flat upon the mud: at length it draws its hind-feet far forwards under its body in the manner of a cat, its back is arched, its tail curled, and it makes a sudden spring. The screams of a captured marsh-hen succeed, and its upraised fluttering wing gives sufficient evidence that it is about to be transferred from its pleasant haunts in the marshes to the capacious maw of the hungry Mink.

"It is at low tide that this animal usually captures the marsh-hen. We have often at high spring tide observed a dozen of those birds standing on a small field of floating sticks and matted grasses, gazing stupidly at a mink seated not five feet from them. No attempt was made by the latter to capture the birds that were now within his reach. At first we supposed that he might have already been satiated with food and was disposed to leave the tempting marsh hens till his appetite called for more; but we were after more mature reflection inclined to think that the high spring tides which occur, exposing the whole marsh to view and leaving no place of concealment, frighten the Mink as well as the marsh-hen; and as misery sometimes makes us familiar with strange associates, so the Mink and the marsh-hen like neighbour and brother hold on to their little floating islands till the waters subside, when each again follows the instincts of nature. An instance of a similar effect of fear on other animals was related to us by an old resident of Carolina: some forty years ago, during a tremendous flood in the Santee river, he saw two or three deer on a small mound not twenty feet in diameter, surrounded by a wide sea of waters, with a cougar seated in the midst of them; both parties, having seemingly entered into a truce at a time when their lives seemed equally in jeopardy, were apparently disposed peaceably to await the falling of the waters that surrounded them.

"The Minks which resort to the Southern marshes, being there furnished with an abundant supply of food are always fat, and appear to us considerably larger than the same species in those localities where food is less abundant.

"This species prefers taking up its residence on the borders of ponds and along the banks of small streams, rather than along large and broad rivers. It delights in frequenting the foot of rapids and waterfalls. When pursued it flies for shelter to the water, an element suited to its amphibious habits, or to some retreat beneath the banks of the stream. It runs tolerably well on high ground and we have found it on several occasions no easy matter to overtake it, and when overtaken, we have learned to our cost that it was rather a troublesome customer about our feet and legs, where its sharp canine teeth made some uncomfortable indentations; neither was its odour as pleasant as we could have desired. It is generally supposed that the Mink never resorts to a tree to avoid pursuit; we have, however, witnessed one instance to the contrary. In hunting for the ruffed-grouse, (*T. Umbellus*,) we observed a little dog that accompanied us, barking at the stem of a young tree, and on looking up, perceived a Mink seated in the first fork, about twelve feet from the ground. Our friend, the late Dr. Wright, of Troy, informed us that whilst he was walking on the border of a wood, near a stream, a small animal which he supposed to be a black squirrel, rushed from a tuft of grass, and ascended a tree. After gaining a seat on a projecting branch, it peeped down at the intruder on its haunts, when he shot it, and picking it up, ascertained that it was a Mink.

"We think, however, that this animal is not often seen to ascend a tree, and these are the only instances of its doing so which are known to us.

"This species is a good swimmer, and like the musk-rat dives at the flash of a gun; we have observed, however, that the percussion-cap now in general use is too quick for its motions, and that this invention bids fair greatly to lessen its numbers. When shot in the water the body of the Mink, as well as that of the otter, has so little buoyancy, and its bones are so heavy, that it almost invariably sinks.

"The Mink, like the musk-rat and ermine, does not possess much cunning, and is easily captured in any kind of trap; it is taken in steel-traps and box-traps, but more generally in what are called dead-falls. It is attracted by any kind of flesh, but we have usually seen the traps baited with the head of a ruffed grouse, wild duck, chicken, jay, or other bird. The Mink is exceedingly tenacious of life, and we have found it still alive under a dead-fall, with a pole lying across its body pressed down by a weight of 150 lbs., beneath which it had been struggling for nearly twenty-four hours.

"This species, as well as the skunk and the ermine, emits an offensive odour when provoked by men or dogs, and this habit is exercised likewise in a moderate degree whenever it is engaged in any severe struggle with an animal or bird on which it has seized. We were once attracted by the peculiar and well-known plaintive cry of a hare, in a marsh on the side of one of our Southern rice-fields, and our olfactories were at the same time regaled with the strong fetid odour of the Mink; we found it in possession of a large marsh-hare, with which, from the appearance of the trampled grass and mud, it had been engaged in a fierce struggle for some time.

"The Mink, when taken young, becomes very gentle and forms a strong attachment to those who fondle it in a state of domestication. RICHARDSON saw one in the "possession of a Canadian woman, that passed the day in her pocket, looking out occasionally when its attention was roused by any unusunl noise." We had in our possession a pet of this kind for eighteen months; it regularly made a visit to an adjoining fish-pond both morning and evening, and returned to the house of its own accord, where it continued during the remainder of the day. It waged war against the Norway rats which had their domicile in the dam that formed the fish-pond, and it caught the frogs which had taken possession of its banks. We did not perceive that it captured many fish, and it never attacked the poultry. It was on good terms with the dogs and cats, and molested no one unless its tail or foot was accidentally trod upon, when it invariably revenged itself by snapping at the foot of the offender.

"It was rather dull at mid-day, but very active and playful in the morning and evening and at night. It never emitted its disagreeable odour except when it had received a sudden and severe hurt. It was fond of squatting in the chimney-corner, and formed a particular attachment to an arm-chair in our study.

"The Mink brings forth about five or six young in the latter part of the Spring, but it does not appear that more than one litter is produced in the season."

ARTICLE XL.—*The Common Weasel*, (*Putorius erminea.*)

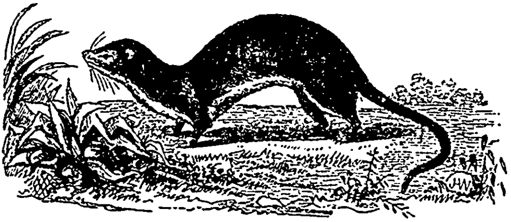
PUTORIUS ERMINEA.—Linn.

WHITE WEASEL.—STOAT.

The common Weasel of Canada is the true ERMINE, the animal which in the feudal ages yielded the fur for the most choice mantles of nobles and kings. The best naturalists, after the most careful examination and comparison of specimens from all the countries inhabited by this species, have failed to detect any difference whatever of sufficient importance to justify the separation of the American from the European or Asiatic Ermine. Its geographical range therefore is enormous, being nearly the whole of the northern part of the world as far south as latitude 40°.

The length of the ermine from the point of the nose to the root of the tail is about ten inches, length of tail five inches and a-half. The color is pure white or yellowish-white in winter, and in summer reddish-brown above and white beneath. The tip of the tail is always black. The body is slender, legs short, five toes on each foot, inner toe the shortest, ears broad and rounded, the fur soft and short, and the tail somewhat bushy at the end.

Audubon describes the Weasel as "*fierce and bloodthirsty, possessing an intuitive propensity to destroy every animal and bird*



within its reach, some of which, such as the American rabbit, the ruffed grouse, and domestic fowl, are ten times its own size. It is a notorious and hated depredator of the poultry house, and we have known forty well grown fowls to have been killed in one night by a single Ermine. Satiated with the blood of probably a single fowl, the rest, like the flock slaughtered by the wolf in the sheepfold, were destroyed in obedience to a law of nature, an instinctive propensity *to kill.* We have traced the footsteps of this bloodsucking little animal on the snow, pursuing the trail of the American rabbit, and although it could not overtake its prey by superior speed, yet the timid hare soon took refuge in the hollow of a tree, or in a hole dug by the marmot, or skunk. Thither it was pursued by the Ermine, and destroyed, the skin and other remains at the mouth of the burrow bearing evidence of the fact. We observed an Ermine, after having captured a hare of the above species, first behead it and then drag the body some twenty yards over the fresh fallen snow, beneath which it was concealed, and the snow tightly pressed over it; the little prowler displaying thereby a habit of which we became aware for the first time on that occasion. To avoid a dog that was in close pursuit it mounted a tree and laid itself flat on a limb about twenty feet from the ground, from which it was finally shot. We have ascertained by successful experiments, repeated more than a hundred times, that the Ermine can be employed, in the manner of the ferret of Europe, in driving our American rabbit from the borrow into which it has retreated. In one instance, the Ermine employed had been captured only a few days before, and its canine teeth were filed in order to prevent its destroying the rabbit; a cord was placed around its neck to secure its return. It pursued the hare through all the windings of its burrow and forced it to the mouth, where it could be taken in a net, or by the hand. In winter, after a snow storm, the ruffed grouse has a habit of plunging into the loose snow, where it remains at times for one or two days. In this passive state the Ermine sometimes detects and destroys it. In an unsuccessful attempt at domesticating this grouse by fastening its feet to a board in the mode adopted with the stool pigeon, and placing it high on a shelf, an Ermine which we had kept as a pet, found its way by the curtains of the window and put an end to our experiment by eating off the head of our grouse."

"Nothwithstanding all these mischievous and destructive habits, it is doubtful whether the Ermine is not rather a benefactor than an enemy to the farmer, ridding his granaries and fields of many depredators on the product of his labour, that would devour ten times the value of the poultry and eggs which, at long and uncertain intervals, it occasionally destroys. A mission appears to have been assigned it by Providence to lessen the rapidly multiplying number of mice of various species and the smaller rodentia."

"The white-footed mouse is destructive to the grains in the wheat fields and in the stacks, as well as the nurseries of fruit trees. LeConte's pine-mouse is injurious to the Irish and sweet potato crops, causing more to rot by nibbling holes into them that it consumes, and Wilson's meadow-mouse lessens our annual product of hay by feeding on the grasses, and by its long and tortuous galleries among their roots.

"Wherever an Ermine has taken up his residence, the mice in its vicinity for half a mile round have been found rapidly to diminish in number. Their active little enemy is able to force its thin vermiform body into the burrows, it follows them to the end of their galleries, and destroys whole families. We have on several occasions, after a light snow, followed the trail of this weasel through fields and meadows, and witnessed the immense destruction which it occasioned in a single night. It enters every hole under stumps, logs, stone heaps and fences, and evidence of its bloody deeds are seen in the mutilated remains of the mice scattered on the snow. The little chipping or ground squirrel, *Tamias Lysteri*, takes up its residence in the vicinity of the grain fields, and is known to carry off in its cheek pouches vast quantities of wheat and buckwheat, to serve as winter stores. The Ermine instinctively discovers these snug retreats, and in the space of a few minutes destroys a whole family of these beautiful little *Tamiæ;* without even resting awhile until it has consumed its now abundant food, its appetite craving for more blood, as if impelled by an irresistible destiny, it proceeds in search of other objects on which it may glut its insatiable vampire-like thirst. The Norway rat, and the common house-mouse take possession of our barns, wheat stacks, and granaries, and destroy vast quantities of grain. In some instances the farmer is reluctantly compelled to pay even more than a tithe in contributions towards the support of these pests. Let however an Ermine find its way into these barns and granaries, and there take up its winter residence, and the havoc which is made among the rats and mice will soon be observable. The Ermine pursues them to their farthest retreats, and in a few weeks the premises are entirely free from their depredations. We once placed a half domesticated Ermine in an outhouse infested with rats, shutting up the holes on the outside to prevent their escape. The little animal soon commenced his work of destruction. The squeaking of the rats was heard throughout the day. In the evening, it came out licking its mouth, and seeming like a hound after a long chase, much fatigued. A board of the floor was raised to enable us to ascertain the result of our experiment, and an immense number of rats were observed, which although they had been killed on different parts of the building, had been dragged together, forming a compact heap."

"The Ermine is then of immense benefit to the farmer. We are of the opinion that it has been over-hated and too indiscriminately persecuted. If detected in the poultry house, there is some excuse for destroying it, as, like the dog that has once been caught in the sheepfold, it may return to commit further depredations; but when it has taken up its residence under stone heaps and fences, in his fields, or his barns, the farmer would consult his interest by suffering it to remain, as by thus inviting it to a home, it will probably destroy more formidable enemies, relieve him from many petty annoyances, and save him many a bushel of grain."

The Ermine brings forth its young from four to seven at a litter in the months of April and May, and it is said that the family usually remain in the same locality until autumn. With respect to the change of colour, Audubon is of opinion that it is effected by shedding the hair, the new coat coming out in a different color. On the other hand, an European naturalist, Mr. Bell, thinks that the hair changes colour. Upon this subject, and also upon the habits of the species in Britain, we make the following extract from Knight's English Cyclopædia, page 1006:—

With regard to the mode in which this alteration is brought about, Mr. Bell expresses his belief that the winter change is effected not by the loss of the summer coat and the substitution of a new one, but by the actual change of colour in the existing fur; and he cites, in proof of this view of the subject, the case of the Hudson's Bay Lemming, which in Captain Sir John Ross's first Polar Expedition was exposed in its summer coat on the deck to a temperature of 30° below zero, and the next morning the fur on the cheeks and a patch on each shoulder had become perfectly white. Next day the shoulder-patches had considerably extended, and the posterior part of the body and flanks had turned to a dirty white. At the end of a week the winter change was complete, with the exception of a dark band across the shoulders prolonged down to the middle of the back.

That change of temperature, and not merely change of season is necessary to effect the alteration of colour is evident from Mr. Hogg's observations. (5th vol. of Loudon's 'Magazine of Nat. Hist.;' Bell, 'British Quadrupeds.')

Mr. Hogg, whose remarks appear to have been made in the county of Durham, states that within the last nine years from the date of his communication he had met with two Ermines alive, and in the most different winters that had occurred for many years. One was observed in the extremely severe winter (January to March) of 1823; the other in the extremely mild January of 1832.

"In consequence of the months of December, 1831, and January, 1832, having been so extremely mild, I was," says Mr. Hogg, "greatly surprised to find this stoat clothed in his winter fur; and the more so, because I had seen about three weeks or a month before, a stoat in its summer coat or brown fur. I was therefore naturally led to consider whether the respective situations which the brown and white stoats seen by me this warm winter inhabited, could alone account for the difference of the colour of their fur, in any clear and satisfactory manner. The situation then where the Brown Stoat was seen, is in nearly 54° 32′ N. lat., 1° 19′ W. long., upon a plain elevated a very few feet above the level of the river Tees, in the county of Durham. Again, the place where I met with the Ermine, or White Stoat, on the 23rd of January, 1832, is in the North Riding of Yorkshire, in nearly 54° 12′ N. lat., 1° 13′ W. long.; it is situated at a very considerable elevation, and in the immediate neighbourhood of the lofty moorlands called the Hambledon Hills. These constitute the south-western range of the Cleveland Hills, which rise in height from 1100 feet to 1200 feet above the sea. At the time, the Ermine was making his way towards the hills, where, no doubt, he lived, or frequently haunted; and consequently the great coldness of the atmosphere, even in so mild a winter, upon so elevated and bleak a spot as that moorland, would satisfactorily account for the appearance of the animal in its white fur; although the place is, in a direct line, more than 23 miles distant to the south of the fields near the Tees, inhabited by the Brown Stoat."

The Ermine-Weasel, the length of whose head and body is 9 inches 10 lines, the tail being 4 inches 8 lines, is the Carlwm of the Welsh; Stoat, Stout, and greater Weasel of the English; L'Hermine and Le Roselet of the French; Armellino of the Italians; Armino and Armelina of the Spanish; Hermelin of the Germans; Hermelin and Lekatt of the Swedes; Hermilyn of the Dutch; Hermelin and Lekat of the Danes; Seegoos and Shacooshew of the Cree Indians; and Terreeya of the Esquimaux.

The Ermine is found generally in temperate Europe, but common only in the north. The finest, that is, those with the longest and thickest fur, and of the purest and brightest colour, are imported from the high latitudes. Russia, Norway, Sweden, Siberia, and Lapland, furnish them abundantly. The British importation, in 1833, was 105,139; and 187,000. In America it is found from the most northern limits to the middle districts of the United

States. Ermine-skins formed part of the Canada exports in the time of Charlevoix; but they have so sunk in value, that they are said not to repay the Hudson's Bay Company the expense of collecting them, and very few are brought to this country from that quarter.

"It appears that in England generally," says Mr. McGillivray, "the Ermine is less common than the Weasel; but in Scotland, even to the south of the Frith of Forth, it is certainly of more frequent occurrence than that species; and for one Weasel I have seen at least five or six Ermines. It frequents stoney places and thickets, among which it finds a secure retreat, as its agility enables it to outstrip even a dog in a short race, and the slimness of its body allows it to enter a very small aperture. Patches of furze, in particular, afford it perfect security, and it sometimes takes possession of a rabbit's burrow. It preys on game and other birds, from the grouse and ptarmigan downwards, sometimes attacks poultry or sucks their eggs, and is a determined enemy to rats and moles. Young rabbits and hares frequently become victims to its rapacity, and even full-grown individuals are sometimes destroyed by it. Although in general it does not appear to hunt by scent, yet it has been seen to trace its prey like a dog, following its track with certainty. Its motions are elegant, and its appearance extremely animated. It moves by leaping or bounding, and is capable of running with great speed, although it seldom trusts itself beyond the immediate vicinity of cover. Under the excitement of pursuit however its courage is surprising, for it will attack, seize by the throat, and cling to a grouse, hare, or other animal, strong enough to carry it off, and it does not hesitate on occasion to betake itself to the water. Sometimes when met with in a thicket or stoney place, it will stand and gaze upon the intruder, as if conscious of security; and, although its boldness has been exaggerated in the popular stories which have made their way into books of natural history, it cannot be denied that, in proportion to its size, it is at least as courageous as the tiger or the lion."

Mr. Bell was informed by the Rev. F. W. Hope that the latter, while shooting in Shropshire, was attracted by the loud shrill scream of a hare which he thought had been just caught in a poacher's snare. He ran towards the spot, and there saw a hare limping off, apparently in great distress, with something attached to the side of the throat. This proved to be a stoat, and the stricken hare made its way into the brushwood with its enemy still holding on. In England it takes advantage of the galleries of the mole for its winter retreat, as well as the rabbit burrow.

Captain Lyon, R.N., saw the Ermine hunting the footsteps of mice in the North as a hound would hunt a fox, and observed their burrows in the snow, which were pushed up in the same manner as the tracks of moles in Britain. These passages ran in a serpentine direction, and near the hole or dwelling-place the circles were multiplied as if to render the approach more intricate.

The same graphic voyager gives a lively description of a captive Ermine;—" He was a fierce little fellow, and the instant he obtained day light in his new dwelling, he flew at the bars, and shook them with the greatest fury, uttering a very shrill passionate cry, and emitting the strong musky smell which I formerly noticed. No threats or teasing could induce him to retire to the sleeping-place, and whenever he did so of his own accord, the slightest rubbing on the bars was sufficient to bring him out to the attack of his tormentors. He soon took food from the hand, but not until he had first used every exertion to reach and bite the fingers which conveyed it. This boldness gave me great hopes of being able to keep my little captive alive through the winter, but he was killed by an accident."

Sir John Richardson states that the Ermine is a bold animal, and often domesticates itself in the habitations of the fur-traders, where it may be heard the live-long night pursuing the white-footed mouse (*Mus leucopus*). He remarks that, according to Indian report, this species brings forth ten or twelve young at a time. In this conntry it produces about five in April or May.

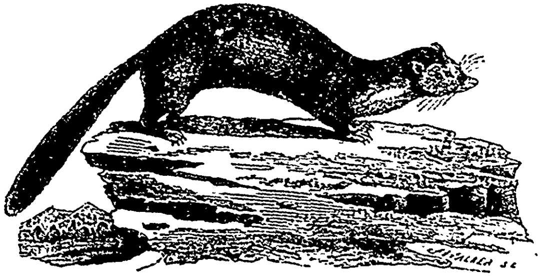
In Siberia, Ermines are taken in traps baited with flesh; and in Norway they are either shot with blunt arrows, or taken in traps made of two flat stones, one being propped up with a stick, to which is fastened a baited string. This the animal nibbles, when the stone falls and crushes it. Two logs of wood are used for the same purpose and in the same manner in Lapland.

ARTICLE XLI.—*On the Pine Marten.* (*Mustela martes.*)

MUSTELA MARTES.—(Linn.)

The Marten, also called the Pine Marten, is larger than the mink, and almost always of a lighter colour. The body is slender, the head long and pointed, ears broad and obtusely pointed, legs stout, eyes small and black, and the toes with long, slender and compressed nails concealed by hair; tail bushy and cylindrical. Hair of two kinds, the outer long and rigid, the inner soft and somewhat wooly. The length from point of nose to root of tail is about eighteen inches, length of tail seven inches.

The colour varies a good deal in different individuals, but it is generally yellowish, shaded with more or less black,—the throat is yellow. The Marten is an exceedingly active and destructive little animal,—but as its habits confine it to the depths of the forest, it seldom visits the farm-yard, and consequently is no annoyance to man. Its food consists of birds, mice, squirrels, and other small animals, and its activity is such that it climbs trees with



great facility. The female brings forth six or eight young at a litter, in a burrow under ground, a hollow tree, or in some warm nest constructed in a crevice among the rocks. The species is found in the Northern and Eastern States, throughout Canada, and in all the wooded districts of the Hudsons Bay Company's Territories. It ranges across the continent from the Atlantic to the Pacific, and is supposed to be identical with the species of Northern Europe. Sir John Richardson, the celebrated Northern traveller, in the North West, says that particular districts produce different varieties of this animal, the fur of some of the varieties being of more value than that of others. It is easily caught with traps. "A partridge's head with the feathers is the best bait for the log traps in which it is caught. It does not reject carrion, and often destroys the hoards of meat and fish laid up by the natives, when they have accidentally left a crevice by which it can enter. When its retreat is cut off it shews its teeth, sets up its hair, arches its back, and hisses like a cat. It will seize a dog by the nose and bites so hard, that unless the latter is well used to the combat it escapes. Easily tamed it soon becomes attached to its master, but is not docile. The flesh is occasionally eaten, but not prized by the Indians. The females are smaller than the males, go with young about six weeks, and produce from four to seven at a time, about the end of April. When caught in traps this species is often devoured by its near relation the Fisher. Pennants marten (*Mustela Canadensis.*)

As an article of commerce and of luxurious and ornamental dress, the fur of this animal is well known. It is said that 100,000 skins are annually taken to Britain. Yet as the species is very prolific, it is still a common animal in the large forests. In the settlements, however, it soon becomes exterminated. The fox lingers around among the agriculturists, and pays his attentions to the farm-yard long after the marten has left the scene of advancing civilization.

ARTICLE XLII.—*Extracts from the Proceedings of the British Association for the Advancement of Science.* Dublin, August 26,—September 2, 1857.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

Professor HENNESSY read a paper on the *Direction of Gravity at the Earth's Surface.* For all practical purposes, he said, the direction of gravity was considered perpendicular to the earth's surface; and a similar assumption was often made in writings claiming a high degree of scientific accuracy. This arose from defining the earth's surface as the surface of equilibrium of the waters. If the earth were stripped of its fluid covering, the irregular surface so laid bare might be intersected by a surface so placed that the volume of all the eminences rising above it would be equal to the volume of all the depressions. With the data at present possessed it would be nearly possible to have the mean surface. They were not in a position to say how far it approached or differed from a surface of equilibrium, or in other words, they could not assume that gravity was rigorously perpendicular to such a surface. Actual observation showed that in many places it was not so, and this non-perpendicularity was generally referred to irregularities of surface. If, as everything led them to believe, the earth was originally in a state of fusion from heat, all the strata of equal density of the fluid mass would be surfaces of equilibrium. Following out the theory, the paper went on to show that if it could be ascertained what was the form of the outer surface of the earth's solidified crust, and the distribution of the water over it, they might be able to determine whether changes of internal structure took place within the earth subsequent to the formation of that crust. Observations showed that such internal changes had taken place, and consequently that the direction of gravity might have changed.

Major-General SABINE *on the Amount and Frequency of the Magnetic Disturbance and Aurora at Point Barrow, on the Shores of the Polar Sea.* The lecturer stated that his results were derived from observations made by Captain Maguire and the officers of the Plover, between July 1852 and July 1854. Point Barrow is situated on the most northern coast of America. Tables made on a large scale were used, exhibiting the variations with and without the disturbances at different hours of the day at Point Barrow and at Toronto. The horizontal force of the earth at Toronto was about double what it was at Point Barrow. It was found that when the disturbances were greatest in amount, the greatest displays, which he considered a magnetic phenomenon, took place. The last letter he had received from Sir John Franklin expressed that navigator's determination to put up instruments for the observation of those phenomena at the several stations at which he might winter It could not be doubted that such obervations were made and recorded with the instruments they took for that purpose. It could not be doubted that when they were detained at some point the following year they carefully made the observations, and it was possible they might have even extended them to another winter. These observations were numerous, and were of such a kind as would have been left in the ships when the explorers proceeded overland. When he (General Sabine) was with Captain Parry in 1848, they made observations as to the figure of the earth, and various other matters, on their way to Behring's Straits. They were exposed to considerable risk of the ships being lost, and when about to take to the boats and proceed overland, they merely carried with them an abstract of the observations, leaving the full records deposited in cases in the cabins of the ships. He had no doubt that in the ships of Sir John Franklin his observations were to be found; and this was the reason why men of science were so anxious to recover the ships; for, first of all, the journals would contain valuable information, and next, it was a sacred duty to those who had lost their lives in gaining such important results to do them the justice and honour of bringing them to light.

Mr. J. J. Murphy read a paper containing *A Proposal for the Establishment of a Uniform Reckoning of Time over the World, in connection with the Electric Telegraph.* The period in all probability was not remote when the telegraph would effect an almost instantaneous communication between parts of the world which were separated by an extensive arc of longitude, and differed in their solar time by several hours. The system which was introduced all over Great Britain, of keeping Greenwich time could not be applied over extensive arcs of longitude. A difference of half an hour between solar time and clock time at any place was no inconvenience, but a difference of six hours would be much too great. It would be necessary for distant places to continue to keep their local solar time; but in order to time the receipt and dispatch of telegraph messages, it would be necessary either to reduce the time of one place to that of any time for all. Mr. Murphy proposed a simple self-acting method for meeting the requirements of the case. Let every electric telegraph station that communicates with distant stations be furnished with a clock, similar in other respects to a common clock, provided with a double circle of figures on the dial, the inner circle being fixed as in the common clock, but the outer one being capable of being moved round. Let some one meridian, say that of Greenwich, be chosen as that to which all others shall be referred. Let every such clock throughout the world indicate Greenwich time on the inner or stationary circle of figures; but when a clock is set up at any station, let the outer circle be moved round and set, so that while the hour hand shows Greenwich time on the inner circle, it may show local solar time on the outer circle. The perfect convenience of this plan is obvious. It reconciles the necessity of keeping local time with the advantage of uniform time, and gets rid of any trouble in reducing the one to the other. The system might be rendered more workable still by abolishing the distinction of east aud west longitude, reckoning either all east or all west from 0 to 360, and by abolishing the distinctions of a. m. and p. m., reckoning time from midnight up to 24 o'clock.

Section B.—Chemical Science.

Dr. Daubeny gave an account of *a New Method of Refining Sugar*, conducted at Plymouth by Mr. Oxland, and known by his name. It consists in the adoption of the superphosphate of alumina in conjunction with animal charcoal, as a substitute for the albumen usually employed for that purpose. In both cases the object is to separate and carry down the various impurities which colour and adulterate the pure saccharine principle present in the syrup expressed from the cane or other vegetable which supplies it. As, however, bullock's blood is the material usually procured for the purpose of supplying the albumen, a portion of uncoagulated animal matter, together with certain salts, is left in the juice in the ordinary process of refining, which impairs its purity and promotes its fermentation—thus occasioning a certain loss of saccharine matter to result. Nothing of the kind happens when the superphosphate is substituted, and so much more perfect a purification of the feculent matters, under such circumstances, takes place, that several varieties of native sugar, which, from being very highly charged with feculent matters, are rejected in the ordinary process of refining, are readily purified by this method The employment of superphosphate of alumina also gets rid of so much larger a portion of the impurities present in the sugar, that much less animal charcoal is subsequently required for effecting its complete clarification than when bullock's blood has been resorted to. The quantity of superphosphate necessary for effecting the object is, for ordinary sugars, not less than twelve ounces to the ton; whereas, for the same quantity, as much as from one to four gallons of bullock's blood is found to be required. Dr. Daubeny suggested that this re-agent might be advantageously resorted to not only in the purification of sugar, but also in other processes of the laboratory, when the removal of foreign matters, intimately mixed with the solution of a definite component, becomes a necessary preliminary in its further examination.

Mr. R. L. Johnson then read a paper *on Illuminating Peat Gas.* He stated that it is now nearly half a century since a Parliamentary Commission appointed by Government to report on Irish peat, named the town of Sligo and the Hill of Howth as the extreme points of a straight line, and Galway and Wicklow Head as the extreme points of another straight line, between which two straight lines lay the six sevenths of all the peat in Ireland, the remaining one seventh being distributed throughout localities on either side of these lines. Having named the different localities where peat is distributed, the total number of which in acres appears to be three millions, Mr. Johnson entered into a detailed description of the mode by which he obtained illuminating gas from common peat or turf, which he produced by the double decomposition of the constituents of the peat. He stated that works for the production of gas have been recently erected, and are in actual operation in two places in Ireland. The gas was good, and its cost, as stated to him by a gentleman who was using it, less than two shillings the thousand cubic feet. He stated that from one single pound weight of common peat an hour's light may be produced, and that, its cost being so very small, it should ultimately be extensively used throughout Ireland, and in its production there was one third of charcoal.

Professor Sullivan corroborated Mr. Johnson's statement, and said that he saw the gas produced when the experiments were going on, and that it appeared good; and from what he had seen and heard from men who gave the study of peat considerable attention, Mr. Johnson had succeeded in producing a cheap and good light from a heretofore valueless though abundant source.

Professor CAMERON read a paper *on Urea as a Direct Source of Nitrogen in Vegetation.* He showed that nitrogen was also available, as food for plants, when a constituent of urea, as in its ammonial combination; or, in other words, that urea, without being converted into ammonia, may be taken up into the organisms of plants, and there supply the necessary quantity of nitrogen. He described the experiments which led him to this conclusion, which were very elaborate, and were made on barley plants in confined spaces supplied with air freed from ammonia. The following conclusions were deducible from the result of his experiments, viz.:—1. That the perfect development of barley can take place, under certain conditions, in soil and in air destitute of ammonia and its compounds. 2. That urea in solution is capable of being taken unchanged into the organisms of plants. 3. That urea need not be converted into ammonia before its nitrogen becomes available for the purposes of vegetation. 4. That the fertilizing effects of urea are little if at all inferior to the salts of ammonia. 5. That their exists no necessity for allowing drainings or other fertilizing substances containing urea to ferment, but that, on the contrary, greater benefits must be derived from their application in the recent or unfermented condition.

Mr. J. W. Rogers read a paper *on the Chemical Properties of the Potato, and its Uses as a General Article of Commerce if properly manipulated.* The object of this paper was to show that the matter of the potato was in reality equal in nutritive value to the dry matter of wheat, whilst the quantum of food produced from a given quantity of land was nearly four times that produced from wheat. He exhibited some very interesting specimens of the production of the potato in meal, flour, &c., and gave the following results of analysis :—

	Starch.	Gluten.	Oil.
Components of the potato per cwt.	84.077 lb.	14.818 lb.	1.104 lb.
Do. of wheat, do.	78.199 "	17.536 "	4.265 "

And gave the following results as to the quantum of food from an acre of land :—

	Starch.	Gluten.	Oil.
Dry matter of potato, - - - -	3427 lb.	604 lb.	45 lb.
Dry matter of wheat, - - - -	825 "	185 "	45 "

The concluding communication was made by Dr. Gilbert being *a Preliminary Notice of Researches on the Assimilation of Nitrogen by Plants, by Messrs. Lawes, Gilbert, and Pugh.* The great importance of settling the question, Whether or not plants can assimilate the free nitrogen of which the atmosphere to such an extent consists? was first insisted upon. In a purely scientific point of view the question was of high interest, and if answered in the affirmative this would add a very striking fact to the history both of nitrogen itself and of the vegetable functions. A true theory of many agricultural facts and practices also required a definitive solution of this debated point. Earlier writers supposed that the free nitrogen of air could be taken up by plants. De Saussure and others came to an opposite conclusion; and this latter view had been pretty generally adopted by scientific observers. Boussingault in particular had brought experimental evidence to show that plants did not assimilate the nitrogen of the air. But during the last few years a most elaborate and extensive series of investigations had been made by M. G. Ville of Paris, the results of which led him to conclude that plants assimilated a considerable amount of free nitrogen. M. Boussingault had followed up the inquiry in various ways, and still maintained the opposite opinion. It was hence of the highest importance that a third party should undertake the subject, and it was to this end, and the results so far obtained, that the authors brought their plan for discussion before the Section. They described the several methods adopted by MM. Boussingault and Ville, and then illustrated by drawings their own methods and results. In all cases the plants were growing in soil and atmosphere destitute of all combined nitrogen in the first instance. To some, however, as their growth seemed to indicate the need, small and known quantities of ammonia were added. Drawings of the progress of the plant showed an enormous increase of growth where the ammoniacal supply was given. In these cases the plants promised to yield seed, and their height and general development was pretty natural. In the other instances, owing to the combined nitrogen of the seed sown and the free nitrogen of the air the plants were exceedingly small, and withered before coming to perfection. The final result, however, could not be known until the growing plants, the soil, and the pots in which they grew were analysed, when the debtor and creditor account, so to speak, of the nitrogen could be made up. Other researches were also in progress to determine the relation of the gases evolved during the growth of plants, to the constituents actually assimilated.

Section C.—Geology.

General Sketch of the Districts already visited by the Geological Survey of India. By Thomas Oldham, A.M., F.R.S., G.S., &c., Superintendent of Geological Survey of India.

The labours of the Geological Survey of India have been conducted hitherto under great difficulties. More recently, however, the liberality of the Government of India had greatly extended the establishment of the survey, and he trusted that their future progress would be rapid and effective. The only general sketch-map of the geology of India which they had was that published by the late Mr. Greenough. This was a work of great value, and gave abundant proof of the extent and labour of its author in its compilation. As might be anticipated under the circumstances, it was full of errors; and perhaps few could speak more confidently of this than himself. But at the same time it was a most valuable contribution, and would prove a most useful guide to future observers. The officer of the geological survey had examined several districts of considerable area in detached positions, and the results which he was able to lay before the section might therefore appear less connected than he could wish. But every day would tend to unite them more closely; and his object was now simply to report progress, and to show that something had been done to elucidate the structure of India. Referring first to the districts to the east of the Bay of Bengal, the Tennasserim Provinces extend for about six degrees of latitude along the east shores of the Bay of Bengal. In breadth they seldom exceed more than one degree of longitude. From Siam, on the east these provinces are separated by an interrupted range of mountains, occasionally rising to 7000 or 8000 feet high, but the general height of which is to the north about 4000, diminishing in passing southwards to 3000 feet or less. The main direction of this range is north and south: this being also the general direction of the coast line, of the minor and outlying ranges of hills, and, therefore, of the rivers. The geological structure is tolerably simple, although at first sight apparently complicated, from the great disturbances to which the Rocks have been subjected. The central range is of granite, occasionally, but not frequently of syenitic character; itself traversed by thick veins of large crystaline felspathic granite, and often along its outer edges, or near its junction with overlying slates, characterized by the presence of tinstone as an ingredient of the mass disseminated among the other mineral constituents. This granite axis is succeeded by highly metamorphic rocks of gneissic and micaceous character, themselves cut up by numerous veins of granite, which, however, do not extend far from the junction. Upon these is a great accumulation of bluish and bluish-black earthy beds, thinly laminated, of thin-bedded grits, and of pseudo-porphyritic rock, the normal character of which is an earthy hard rock with small irregularly disseminated sub-crystaline felspar, passing, on the one hand, into slates, and, on the other, into grits, often coarse and conglomeritic. These harder rocks form all the higher grounds of the outer ranges of hills. This series being best seen in the southern province of Mergin, has been provisionally called the "Mergin" series. The total thickness is about 9000 feet. It is succeeded uncomformably by hard sandstones in thick and massive beds, with their earthy partings, generally of reddish tints, occasionally deep red and yellowish. A few beds are slightly calcareous, and in the upper portion a few thin and irregular bands of earthy blue limestone occur. Above these rest about 200 feet of soft sandstone in thin beds, upon which apparently rests the massive limestone of the country so largely seen near to Moulmien. The thickness of the ntire group is about 6000 feet, an l as some of its members are but seen in the northern province of Moulmein, I have provisionally called it the "Moulmein" series. To determine the age of the older of these two groups (the Mergin) we have no data. The aspect of much of the rocks is very similar to the trappean ashes and felstones so abundant in the silurian rocks of this country, while others are lithologically like Devonian; but these resemblances are very deceptive. The age of the Moulmien series is, however, tolerably defined by its organic contents. These appear to fix the age of the group as distinctly carboniferous. The whole of these rocks were, subsequently to their induration and disturbance, widely and greatly denuded, and on their upturned edges at intervals is found a series of conglomerates and sandstones and imperfectly coherent shales, with thick beds of coal, generally of lignitic character. None of the conglomerates are coarse; the sandstones are fine, gritty and pebbly, or clean white quartzose grits; the shales thinly laminated; the coal itself thinly disposed in thin flaky laminæ, with earthy streakings marking its structure. In addition to the total unconformity of these rocks, the imbedded organic remains are quite distinct. They consist of dicotyledonous plants (leaves) belonging to the group of the Laureaceæ, and probably to the genus Laurophilum of Goppert. In the thin papery shales which overlie the coal are also remains of fish (scales, &c.) of fresh-water character; the whole referring the beds to a very recent epoch, probably corresponding in part to the pliocene of European geologists. It is curious to notice here the absence of any coal in the carboniferous rocks below, and its abundant presence in those newer beds. The total thickness of these beds does not exceed 900 to 1000 feet. They are never continuously traceable; they occur heaped up against and separated by the projecting ridges of the higher ground, and must have been deposited when the physical conformation of the country was very similar to that now existing. They appear to be the result of a series of fresh-water deposits, formed in small lake-like expansions along the lines of the great drainage valleys of the country, and to mark a line of general and greater depression between the main ridge of hills dividing Siam from the British dominions, and the outer ridges which occur between this and the sea. The direction of the main drainage of the county is determined, as already remarked, by the direction of these ranges, and is discharged into the sea through narrow rocky gorges, which have a direction nearly into the east and west, and which are due to lines of breakage and dislocation. To this is due the sudden alteration in the direction of the courses of the larger rivers, as may be seen on maps. Rocks similar to those situated in the Tenasserim provinces extends northwards up the course of the Salween River, and into the adjoining districts of Burmah, to the north-east of Pegu. And, again, close to the capital of Burmah, and stretching nearly north and south, as far as examined, high ridges of metamorphic rocks are again met with, consisting of gneiss, micaceous schists, and highly crystalline limestones, occasionally of a fine white colour, and largely used by the Burmese for sculpture. But the great valley of the Irrawady is, throughout a very large extent of its course, bounded on either side by a thick series of rocks, chiefly sandstones, but with massive limestones also, which are locally rich in fossils, and which, from this evidence, may be clearly referred to the eocene period. These stretch on both sides of the river as far north as Pugahu, beyond which the higher grounds recede from the river banks; but they are in all probability continued thence into Munipoor, and so united with the nummulitic rocks of the Khasi and Cachar Hills. These rocks have been considerably disturbed and broken, but have a general and prevailing strike nearly north and south, which strike, throughout many miles, has determined the general course of the River Irrawady Their thickness is considerable, certainly exceeding 5000 feet. Above these eocene rocks, and resting upon them with slight unconformity, is a series of beds of no very great thickness, characterized by an abundance of gypsum disseminated in the layers and veins, and in the lower beds of which occur the deposits of clays and of vegetable matter, from which are derived the larger supplies of petroleum. These rocks are well seen at Senan Kyoung ("stream of fœtid water") and are traceable northwards to near Amarapura. In the beds which appear to form the uppermost part of this group, but which may possibly belong to another and distinct series, are found some of the fossil bones of the larger animals which occur abundantly in this district. About forty miles north of Amarapura we again meet with sandstones, shales, and coal, resting uncomformably on the metamorphic rocks, and characterized by remains of dicotyledonous trees similar to, if not identical with, those found in the coal-yielding group of the Tenasserim provinces, and which are therefore referred to the same age (pliocene): This series, so far as examined, proved of no great extent or thickness. We pass now to the Khasi Hills, which form a comparatively isolated range, rising suddenly from the great plains of Bengal in the south, and divided in the north by the valley of Assam from the great Himalaya or Bhotan range. On the southern face of this range rises almost perpendicularly from the plains, which are continual from the Bay of Bengal, with scarcely a perceptible change of level to the very foot of the hills, and, with the exception of a comparatively small thickness of metamorphic rocks at the base, are composed of nearly horizontal beds of sandstones, a few shaly layers and limestone, long known for the abundance and beauty of the nummulites it contains. These beds dip slightly to the south, and die out towards the north, when the metamorphic rocks come to the surface in the hills. Disregarding here any details as to the older rocks, the age of the sand stones and limestones is unquestionably fixed by their organic contents, and therefore, also, the epoch of the coal, which is associated with them, as belonging to the great eocene period of geologists. No newer group, of rocks is definitively seen in these hills. Along the southern face of the range there is evidence of a great dislocation extending for many miles, and possibly along the entire scarp, which has brought down to the level of the plains the rocks which are seen at the top of the hills. This line of dislocation has in all probability tended to give the nearly rectilinear direction of the escarpment; its date is fixed as at least subsequent to the formation of all the eocene rocks here seen. An older group of sandstones, considerably altered, is seen further to the north, within the hills, and also a series of highly metamorphosed schists and grits resting upon the gneissic and granitic rocks; but the details of these are reserved. Passing thence still further to the north and east, at the base of the Sikkim Himalayas, under the hill station of Darjiling, another section was described. The great mass of the lofty hills is here composed of schistoze rocks of various characters, considerably disturbed and contorted. These, although hitherto coloured similarly, and considered as of the same age, were decidedly different from, and more recent than, the gneissoze rocks of the greatest portion of India. Near the base of the hills, and faulted against these rocks at high angles, there is a small extent of sandstone and black shales, which contain vertebrata, pecopteris, &c., similar to those occurring in the great coal-fields of Bengal These fossils are peculiarly interesting, from the fact of their being changed into graphite, and occurring in beds which themselves have a very strongly marked graphitic character. They are of very limited extent; the greater portion of the sandstones, which in this section exhibit a thickness of some thousand feet, belonging to a series of much more recent date, and which has been subjected to a much smaller amount of disturbance and alteration. The exact relation of these, too, it has not been possible to observe. This upper group contains many large stems, in all observed cases prostrate, and in most cases giving evidence of great wear and long exposure previously to being imbedded; and in some of the finer and more earthy deposits an abundance of leaves occur, of the same general character as those already noticed as occurring in Bunah and Tenasserim. This group was therefore provisionally referred to the same age (pliocene). No traces of the great nummulitic series had been observed in this district. In the more central portions of India three very large districts had been examined, to which he would now refer. One of these was to the south of Calcutta, in the district of Cuttack; the second included all the country between the great coal-field of the Damoodah, which had previously been mapped by Mr. Williams, and the River Ganges, extending northwards to Rajmahal and Bhagulpore; and the third extended along the valley of the Nerbudda from west of the Hosungabad to many miles east of Jubbulpur. For the details of the first of these he was indebted chiefly to his able assistants, the Messrs Blandford; for the last to Mr. Jos. Medlicott, who had very zealously worked it out, having to carry on the formation of a topographical map at the same time. In all these cases the sedimentary rocks, to which he would refer, formed portions of a series once more widely extended, and probably continuous ove the whole country, now separated by denudation, from removal by which they have been in great part protected, by being faulted into and against the highly metamorphose gneiss, &c., which surround them. The Talcheer field extends for about 70 miles from east to west, with an average breadth of 15 to 20 miles. and is bounded both on the north and south by great parallel faults, the former of which has an agregate throw of upwards of 2000 feet; these faults are not truly east and west, but to the south of east and north of west. The section in ascending order of the basin shows at the base sandstone and blue shale, but slightly fossiliferous in thickness from 500 to 600 feet; over these is a series of shales and sandstones often micaceous, occasional beds of ironstone and thin lays of coal and coally shale, giving a total thickness of about 1800 feet; and over these again is a distinct series of quartzose grits, conglomerates, and sandstones, in thickness from 1600 to 2000 feet. These three groups are unconformable each to the other; the unconformity between the two lower being, however much less marked than that between the two upper. To the lower group, as having been first recognised and described in this district, the name of "Talcheer" series has been given; the second group, which, from its imbedded vegetable remains, was proved to be identical with the rocks of the extensive Damoodah coalfield when these were first described, has been denoted the "Damoodah" series; while the upper group, supposed to represent the great series of rocks, so magnificently seen in the Mahadeva Hills of Central India, has been called the "Mahadeva" series. Thus these series can be recognised in each of the extensive fields referred to, although with varying developments and thicknesses. At the base of the Talcheer series there is a remarkable bed, consisting of very large and only slightly rounded masses of granite and gneiss, imbedded in a fine silt, and occurring under such conditions as induce the opinion that the action of ground ice has been the cause of its formation. In the Rajmahal district there is a very limited development of the lower beds, above which unconformably comes the Damoodah series, here exhibiting a greater extension upward than in Cuttack; but unfortunately the sequence of the rocks is interrupted by the intercalation of several successive floes of basaltic trap, the intervals between which have been marked by the continued and tranquil deposition of the mechanical rocks going on. These floes have been repeated six or seven times, and the phenomena of contact are in all cases marked; the upper layers of the mechanical deposits in contact with the trap being in all cases greatly altered, while the lower layers are in no cases changed, but rest unaltered on the degraded surface of the underlying trap. But while the actual physical sequence of the deposits cannot be here traced, the fact of their all belonging to the same great series is attested by the occurrence of some identical fossils throughout. A few species pass upwards through the series, but there is a very marked change in the general facies of the flora in the upper as compared with the lower portion of the group; the latter characterized by the abundance of vertebrata, pecopteris, trizzgia, &c., the former by the abundance of zamia-like plants. The series, therefore, has been divided into Upper and Lower Damoodah rocks. For the details of the structure of the district, reference was made to the maps. In the Nerbudda district the series was less interrupted, and there also the same general results were obtained. The southern boundary of this great field was for a large part of its course produced by a great fault, having, *quam proxime*, the same general direction as that of the faults bounding the Talcheer field. The age, geologically considered, of these Damoodah rocks was briefly referred to. A large series of drawings of the fossil plants from them were exhibited, and the fact of the general oolitic facies of this group, especially of those from the upper beds, pointed out. The difficulty of the question was alluded to, especially in connection with the discovery, on the one side, of several species identical with those found in these Indian rocks in the Australian coal-fields, associated with numerous animal remains distinctly referable to the lower carboniferous era, and, on the other hand, to the discovery in Cuth of other species, also identical with some of these Indian forms, in beds associated with animal remains, undoubtedly referable to the oolic epoch. It must, however, be borne in mind that the latter forms, or those which the evidence of associated animal remains would show to be oolitic, are only found in the upper beds of the Damoodah series, while those which are common to the Australian fields are those chiefly found in the lower beds. Unfortunately, no animal remains whatever have been found with these plants in the districts examined. excepting some annelide tracts useless as distinctive forms. He preferred, under these circumstances, waiting for further evidence before giving any definite opinion as to the age of this widely-extended and important group of rocks. Mr. Oldham then stated that there seemed good reason for separating altogether from the several groups of rocks to which he had referred the whole of the great thickness of sandstones which formed the great Vindhyan range, extending almost entirely across India, from the mouths of the Nerbudda to the Ganges at Monghyr. These appeared to be of prior date, and there was a probability that there was a great line, or a group of lines, of dislocation passing along the general line of the valley of the Nerbudda, and the effects of which might be traced over a very large area, extending towards the north-east possibly even into the Valley of Assam. Besides the examination of these districts, which together included an area of more than 30,000 square miles, the geological survey had been able to add to the knowledge of the structure of the country in other ways.

An excellent selection of fossils from the neighbourhood of Verdchellum in Madras, for which they were indebted to Brooke Cunliffe, Esq., who had been associated with the Rev. Mr. Cay in the first examination of these fossils, had enabled them to add largely to the lists of Forbes, and to establish more conclusively than before the cretaceous age of these deposits. The exertions of Captain Keatinge at Mundlaiser, to whom Mr. Oldham had pointed out the interest of the inquiry, had collected a good set of organic remains from the limestone at Bang, to the west of Mhow, which had enabled him to fix the age of those deposits as contemporary, or nearly so, with the cretaceous beds of Trichinopoly and Verdachellum. This discovery gives rise to many important speculations as to the age of other beds, and also as to the epoch of the elevation of all Central India, but more data were required before these could fairly be entered upon.

Section D.—Zoology and Botany, including Physiology.

Dr. Daubeny read a *Final Report on the Vitality of seeds.* He stated that about sixteen years since Mr. Strickland and others and himself suggested the advisability of instituting experiments for the purpose of ascertaining, by way of experiment, as far as possible, the terms to which different seeds would retain their vitality. They were all well aware of the statement as to the germination of mummy seeds, and it was with the view of determining the various questions which arose that a commitee was formed in 1840 to make experiments, which were made in the following manner:—A considerable number of seeds of as many kinds as could be procured were placed in porous stone jars, covered so as to exclude insects and rapid circulation of air, and so as to secure a slow circulation. The experiment had been carried on for seventeen years, and each year a report was given, stating the number of seeds which had germinated, which were resown until their vitality ceased. As the seeds which had originally been procured had, with the exception of four, lost vitality, the inquiries were considered to have come to a close, and the final report was brought forward. He submitted a paper to the meeting containing a general summary of the experiments from 1841 to 1857, and a tabular statement, showing the relative vitality of different kinds of seeds, from which it would be seen that the greater number of seeds lost their vitality at eight years, and that forty-three years was the longest period to which they retained it. The experiments made by the Association did not confirm the common belief regarding the indefinite vitality of certain seeds, for instance, the mummy seed. If any naturalist would suggest a better mode of preserving the plants, it would be well to institute a new set of experiments; but as far as was at present known, the plan that was adopted was the most likely to preserve their vitality.

Professor GEORGE WILSON read a paper on the *Employment of the Living Electric Fishes as medical Shock Machines*, of which the following is an abstract:—The author, in prosecuting inquiries into the early history of electrical machines, did not originally contemplate going farther back than the seventeenth century, or commencing with any earlier instrument than that of Otto Guerick. His attention had been turned to the living torpedo as a remedial agent, and he now felt satisfied that living electrical fish were the most familiar and earliest electrical instruments employed by mankind. He adduced the testimony of Galen and others in proof of the practice, and as proving that "shocks" had been used as a remedy in paralytic and neuralgic affections before the Christian era. Still higher antiquity had been claimed for the electric Silurus, on the supposition that its Arabic name, "Raad," signified "Thunder Fish" and implied the nature of the shock; but the best Arabic scholars had shown that this was not the case. In proof of the generality of the practice of employing zoo-electrical machines, he alluded to the remedial application of the torpedo by the Abyssinians—of the gymnotus by the South American Indians, and the recently discovered electrical fish by the dweller, on the Old Callabar River, which falls into the Bight of Benin. The native women, he said, had a habit of keeping one or more of those fishes in water, and of bathing their children therein with the view of strengthening them by the shocks which they received, which were very powerful. Having observed on the proofs of the antiquity as well as generality of the practice under notice, he concluded by directing the attention of naturalists to the probability of additional kinds of electrical fishes being discovered, and to the importance of obtaining the views of the natives familiar with them in reference to the sources of their therapeutic employment.

DR. REDFERN read a *Notice of a Simple Method of Applying the Compound Microscope to the examination of the Contents of Aquavivaria*. He stated that he had for some time made use of a very simple and convenient arrangement for examining objects in aquaria with magnifying powers up to those given in the half circle objective. It consisted of a vertical stem of one-inch brass tubing, about two feet long, supported by a heavy cast-metal foot. In this stem a three-inch piece of tube slides, and is supported at any height by a ring and pinching screw below it. This short sliding table has another like piece attached to it, and rotating on an axis at right angles to the vertical stem. Through this second piece a tube, two feet long, slides horizontally, its best working position being such that three-fourths of its length projects on one side of the vertical stem, and the other fourth on the opposite. To the shorter end of this horizontal tube a stem, carrying the tube of the body of the microscope, is attached by a ball-and-socket joint, admitting of a coarse adjustment by a sliding tube, and of a fine adjustment by acting on the long arm of the lever formed by the transversely sliding tube to the end of which it is attached. By this means the compound microscope is capable of being applied to any part of the surface of the side of an aquarium measuring two feet, or to the surface of the fluid which it contains. The whole arrangement can be made by a gas-fitter for the sum of about 25s., with sufficient accuracy for the uses for which it was designed. Abundant illumination may be obtained in cylindriform vessels by a small flat mirror let down into the aquarium, and moved into any position by wires, which can be attached to it in a very simple manner.

EDITORIAL NOTICE.

The readers of the Journal are informed that each number of the coming volume will contain a summary of Scientific Intelligence, in which the various departments of Natural History will be considered under their respective heads.

MONTHLY METEOROLOGICAL REGISTER, SAINT MARTIN'S, ISLE JESUS, CANADA EAST, (NINE MILES WEST OF MONTREAL,) FOR THE MONTH OF OCTOBER, 1857.

Latitude, 45 degrees 32 minutes North. Longitude, 73 degrees 36 minutes West. Height above the level of the Sea, 118 feet.

BY CHARLES SMALLWOOD, M.D., LL.D.

Day	Barometer corrected and reduced to 32° F. (English inches.)			Temperature of the Air. F.			Tension of Aqueous Vapour.			Humidity of the Atmosphere.			Direction of Wind.			Mean Velocity in Miles per hour.			Amo'nt of Rain in inches.	Amo'nt of Snow in inches.	Weather, Clouds, Remarks, &c., &c. [A cloudy sky is represented by 10, a cloudless one by 0.]		
	6 a. m.	2 p. m.	10 p. m.	6 a. m.	2 p. m.	10 p. m.	6 a. m.	2 p. m.	10 p. m.	6 a. m.	2 p. m.	10 p. m.	6 a. m.	2 p. m.	10 p. m.	6 a. m.	2 p. m.	10 p. m.			6 a. m.	2 p. m.	10 p. m.
1	29·895	29·902	29·907	36·0	57·0	41·5	·192	·398	·253	·84	·84	·92	S. W.	S. S. E.	N. by E.	1·87	3·57	1·97	0·376		C. C. Str. 4.	Str. Ni. 6.	Cirr. St. 8. Thunder.
2	30·005	30·114	30·214	30·0	57·8	37·2	·177	·376	·199	·95	·79	·85	N. by E.	E. N. E.	N. E.	7·50	9·35	1·43			Clear.	Clear.	Clear.
3	224	139	224	35·0	54·9	42·2	·203	·295	·243	·91	·66	·85	N. E.	N. E.	E. N. E.	11·87	14·42	2·97			"	"	Cirr. 2.
4	114	047	095	36·2	65·0	46·5	·192	·425	·303	·83	·68	·93	N. E. by E.	S. S. W.	W. S. W.	2·54	0·18	0·86			"	"	Clear.
5	130	056	29·997	41·2	68·2	50·5	·253	·435	·349	·92	·75	·90	S. W. by S.	W. S. W.	S. W.	0·22	0·05	0·17			C. C. Str. 4.	C. C. Str. 8.	C. Str. 10.
6	29·800	29·656	833	48·1	61·6	51·3	·349	·383	·274	·94	·71	·76	W. S. W.	W.	N. W.	0·71	5·05	5·32			C. Str. 10.	C. Str. 8.	Clear.
7	800	820	846	44·1	64·0	47·0	·261	·401	·291	·85	·67	·86	W. N. W.	S. S. W.	S. W.	3·62	3·37	3·75			Clear.	Clear.	"
8	712	612	681	46·2	68·2	55·7	·303	·445	·394	·92	·65	·88	S. W.	S. W. by W.	S. W. by W.	10·98	4·95	8·90			C. Str. 6.	"	Cir. Cum. 2.
9	839	828	30·050	39·0	57·9	41·0	·220	·316	·217	·88	·66	·79	N. E.	W. N. W.	N. E.	4·50	1·20	0·09			Clear.	"	Clear.
10	30·098	30·076	120	36·0	68·0	40·3	·192	·366	·227	·85	·63	·85	E. N. E.	N. E. by E.	E.	0·62	1·98	0·17			"	"	"
11	026	29·989	29·930	37·7	69·0	44·6	·229	·461	·282	·91	·68	·92	E.	S.	S. E. by E.	0·00	2·10	0·06			"	"	"
12	29·975	846	820	35·8	67·0	57·5	·203	·480	·447	·89	·72	·94	S.	S. by E.	S. W. by W.	0·12	3·75	0·35			Light Cirri.	C. C. Str. 6.	Str. 10.
13	800	842	873	37·0	64·0	49.1	·446	·562	·336	·96	·90	·91	S. W. by W.	S. W. by W.	W. S. W.	0·00	0·10	0·51	0·350		Ni. 10.	Ni. 10.	Clear.
14	929	866	893	40·4	61·8	43·3	·253	·456	·272	·91	·84	·91	W. S. W.	S. S. E.	N. W. by W.	0·00	0·01	0·00			Fog.	C. C. Str. 6.	"
15	756	542	448	44·0	48·7	46·5	·282	·324	·303	·91	·90	·94	N. by E.	N. E. by E.	N. E. by E.	5·70	15·03	13·56	0·933		C. Str. 10.	Ni. 10.	Ni. 10.
16	308	403	473	46·0	50·0	46·5	·313	·304	·282	·93	·81	·86	N. E. by E.	N. by E.	N. N. W.	20·56	6·90	5·86	1·176		Ni. 10.	C. Str. 9.	Cum. St. 10.
17	511	698	819	38·0	48·0	57·0	·200	·225	·219	·79	·64	·91	W.	W.	S. W. by W.	16·82	9·72	6·20			Str. 4.	Clear.	" 4.
18	883	30·075	30·117	39·9	50·7	58·6	·196	·246	·226	·76	·65	·90	W. S. W.	W.	S. S. E.	4·22	11·77	2·92			C. Str. 8.	C. Str. 4.	" 10.
19	940	29·562	29·571	42·1	50·0	44·6	·263	·341	·282	·91	·89	·90	S. S. E.	S. S. E.	W. by N.	0·87	9·80	4·67	0·478		Ni. 10.	Ni. 10.	Ni. 10.
20	564	512	716	57·0	33·0	32·5	·218	·197	·191	·91	·95	·94	W. by S.	W. by S.	W. by N.	6·62	11·76	6·13	0·300	Inapp.	Ni. 10. Sleet.	C. Str. 8.	C. Str. 8.
21	974	891	30·047	52·0	37·2	29·1	·191	·182	·152	·91	·76	·88	W. N. W.	N. W.	W. by N.	23·75	10·70	9·80			C. Str. 4.	" 8.	Clear.
22	30·131	30·113	173	24·0	44·0	51·1	·091	·241	·171	·63	·79	·89	N. W. by N.	S. S. W.	S. by E.	3·40	2·01	0·20			Clear.	" 2.	Clear.
23	111	29·943	100	31·0	58·0	57·6	·158	·367	·218	·81	·75	·95	S. S. E.	S. S. E.	S. by W.	0·00	0·02	0·50			C. St. 4.	Light Cirr. 7.	Clear. Aurora Borealis.
24	002	942	29·906	42·0	49·2	42·8	·182	·290	·263	·89	·80	·90	S. S. E.	S. E.	E.	0·08	0·03	0·06			Clear.	C, Str. 9.	C. St. 4. " "
25	29·836	704	684	42·9	46·0	44·0	·263	·303	·292	·61	·93	·95	S. E. by E.	N. E. by E.	N. E. by E.	0·31	1·18	13·75	1·497		C. C. Str. 6.	Rain.	Rain.
26	525	454	529	42·6	49·0	45·0	·272	·326	·282	·96	·91	·89	N. E. by E.	N. E. by E.	N. N. E.	26·24	23·33	36·80	1·713		Rain.	"	C. Str. 9.
27	680	721	823	34·2	38·6	34·0	·170	·226	·178	·79	·90	·83	N. N. E.	N. E.	N. E.	32·46	10·06	20·61			Str. 8.	C. Str. 9.	C. Str. 10.
28	800	755	800	30·0	32·7	51·7	·160	·187	·175	·86	·89	·87	N. E.	N. E.	N. E. by E.	14·77	14·90	6·22			C. Str. 6.	" 10.	C. Str. 10.
29	640	658	650	32·1	35·5	33·5	·160	·203	·187	·84	·90	·90	N. E. by E.	N. E. by E.	N. E. by E.	0·81	0·15	0·35			" 10.	" 10.	C. Str. 10.
30	631	658	752	33·1	41·0	38·1	·188	·235	·226	·89	·85	·91	W. S. W.	S. W. by W.	S. S. W.	0·00	0·06	0·08	Inapp.		" 10.	" 9.	C. Str. 8.
31	786	733	774	35·0	44·0	38·2	·203	·261	·226	·91	·85	·91	S. S. W.	S. E.	S. E. by E.	0·12	0·60	0·32	Inapp.		" 8.	" 10.	C. Str. 10.

REPORT FOR THE MONTH OF NOVEMBER, 1857.

Day	Barometer			Temperature			Tension			Humidity			Direction of Wind			Mean Velocity			Rain	Snow	Weather		
	6 a. m.	2 p. m.	10 p. m.	6 a. m.	2 p. m.	10 p. m.	6 a. m.	2 p. m.	10 p. m.	6 a. m.	2p. m.	10 p. m.	6 a. m.	2 p. m.	10 p. m.	6 a. m.	2 p. m.	10 p. m.			6 a. m.	2. p. m.	10 p. m.
1	29·698	29·616	29·601	38·2	44·6	38·3	·226	·223	·226	·91	·75	·91	S. W.	S. W. by W.	S. by W.	0·12	4·23	1·63			C. C. Str. 4.	C. Str. 8.	C. C. St. 8.
2	460	384	431	37·1	45·0	35·5	·218	·253	·210	·91	·80	·91	S. by W.	S. W.	S. by E.	7·35	7·75	0·76	0·416		Cum. Str. 8.	" 6.	C. Str. 4.
3	484	649	694	36·0	40·4	36·0	·210	·227	·210	·91	·85	·91	W. S. W.	W. S. W.	W. by N.	4·65	10·17	2·65			" 8.	" 6.	" 10.
4	872	937	30·026	30·1	37·5	27·5	·168	·218	·146	·88	·88	·88	W.	W. by N.	E. N. E.	9·91	2·08	2·12			Clear.	C. C. Str. 8.	Clear.
5	954	842	29·697	29·0	40·6	38·7	·161	·210	·234	·89	·79	·92	E. N. E.	N. E. by E.	E. by N.	0·50	5·80	2·22	0·330		C. Str. 10.	C. Str. 4.	Rain, Thunder.
6	420	472	432	37·0	60·4	48·0	·218	·371	·290	·91	·71	·81	S. W.	S. W. by W.	W. S. W.	15·13	8·97	10·05	0·530		" 8.	Clear.	Clear Lightn'g in N.E, at 7
7	652	760	890	40·3	51·0	42·0	·210	·274	·243	·79	·70	·85	W. S. W.	W. S. W.	N. E. by E.	5·22	4·27	0·07			Clear.	C. Str. 2.	C. Str. 10. [P. M.
8	860	957	939	34·4	38·5	38·2	·203	·226	·246	·91	·91	·99	N. E. by E.	N. E. by E.	N. N. E.	19·96	9·80	14·61	1·120		Ni. 10.	Rain.	Rain.
9	610	553	595	46·0	64·1	55·0	·292	·565	·420	·89	·94	·98	S. E.	S. S. E.	W. S. W.	13·35	4·22	9·37	1·642		Rain.	C. Str. 10.	C. Str. 6.
10	784	883	30·009	44·0	44·9	34·1	·289	·241	·178	·96	·79	·83	W. S. W.	W. S. W.	W. S. W.	4·73	24·85	9·22	0·330		Rain.	" 4.	Clear.
11	30·092	30·084	187	32·0	40·9	37·3	·191	·210	·199	·93	·79	·83	S. W.	S. W.	W. S. W.	10·02	3·91	8·66			Clear.	" 8.	C. Str, 10.
12	042	29·848	29·725	30·1	35·0	34·1	·160	·203	·195	·86	·90	·89	S. E. by E.	S. W. by S.	W. S. W.	1·51	1·81	5·20	0·160		C. Str. 9.	Sleet.	Rain.
13	29·654	585	721	33·0	43·0	31·0	·197	·233	·185	·95	·79	·90	W. S. W.	W. S. W.	N. by W.	5·65	4·83	12·82	0·202		" 6.	C. Str. 8.	C. Str. 6.
14	883	930	30·082	20·0	25·6	20·0	·089	·123	·120	·68	·79	·82	N. W.	W. N. W.	W.	2·42	8·50	8·96			Clear.	" 4.	" 2.
15	30·107	975	000	22·7	34·0	32·5	·127	·204	·197	·88	·89	·94	W. S. W.	W. S. W.	W. S. W.	7·27	6·42	6·65			Str. 10.	" 10.	" 10.
16	29·998	781	29·650	30·0	37·8	31·1	·177	·218	·185	·95	·90	·96	W. S. W.	S. E.	S. E.	1·73	1·62	2·27			Cirr. Str. 6.	" 4.	Snow.
17	401	297	221	32·8	37·1	34·0	·189	·201	·204	·90	·85	·94	W. S. W.	W. S. W.	W. S. W.	4·60	2·81	3·00	Inapp.	2·01	" 8.	" 10.	C. Str. 8.
18	158	147	247	32·4	38·4	34·1	·197	·214	·204	·95	·86	·95	S. S. W.	S. S. W.	S. S. W.	7·31	4·77	9·10		Inapp.	" 8.	" 2.	" 8.
19	133	003	010	33·2	47·7	33·6	·204	·271	·204	·96	·80	·92	E. by S.	S. E.	W. S. W.	6·42	1·83	23·48			" 10.	" 4.	Sleet.
20	104	140	218	25·4	27·6	20·6	·147	·157	·101	·92	·82	·77	W. S. W.	S. W.	S. W.	15·70	11·68	17·57	0·376	Inapp.	" 4.	" 10.	Clear.
21	212	380	513	23·5	32·1	27·0	·112	·167	·143	·77	·82	·88	W. S. W.	W. S. W.	S. by E.	15·57	11·02	12·67			C. C. Str. 4.	" 9.	Light Snow. Mock Lunar.
22	504	500	797	26·4	38·0	26·6	·146	·178	·135	·88	·70	·83	S. W.	S. W.	W. S. W.	4·30	8·31	7·11			C. Str. 10.	" 6.	Cirr. Str. 2.
23	684	244	340	26·4	34·0	33·0	·146	·195	·197	·88	·91	·94	E. N. E.	S. E.	W. S. W.	2·22	3·27	10·73	0·643	Inapp.	" 10.	" 6.	" 10.
24	484	508	637	16·0	25·6	18·0	·093	·147	·106	·85	·90	·87	W. S. W.	S. W. by W.	N. W.	12·83	13·81	7·60			" 4.	" 8.	" 4.
25	30·076	30·201	30·300	1·0	13·0	9·7	·043	·068	·079	·84	·67	·86	W. N. W.	W.	W. S. W.	17·64	15·82	12·81			Clear.	Clear.	Clear.
26	344	291	306	10·1	28·3	25·1	·082	·119	·129	·90	·68	·82	W. S. W.	S. W.	S. W.	7·90	7·65	5·20			C. C. Str. 4.	C. Str. 10.	C. Str. 9.
27	197	164	235	23·0	36·0	31·8	·112	·192	·182	·77	·83	·90	S. W. by W.	W. S. W.	S. S. W.	14·32	5·45	4·06			Clear.	C. C. St. 6.	" 8.
28	282	102	229	34·1	37·2	35·2	·199	·199	·203	·91	·83	·91	S. by W.	W. S. W.	W. S. W.	5·03	8·85	3·55			C. Str. 4.	C. Str. 8.	" 10.
29	242	277	331	34·6	47·0	33·0	·203	·271	·197	·91	·80	·94	S. W.	E.	N. E. by E.	0·01	0·50	7·31	Inapp.		" 10.	Cirr. Str. 2.	Clear.
30	198	058	29·967	32·8	42·6	40·9	·199	·243	·253	·93	·85	·92	N. E. by E.	S. E. by E.	S. S. E.	8·36	4·52	14·76			" 9.	C. Str. 8.	C. Str. 10.

REMARKS FOR OCTOBER, 1857.

Barometer.
- Highest, the 3rd day, 30·224 inches.
- Lowest, the 16th day, 29·308 "
- Monthly Mean, 29·824 inches.
- Monthly Range, 0·916 "

Thermometer.
- Highest, the 8th day, 70°0.
- Lowest, the 22nd day, 23°6.
- Monthly Mean, 44°19.
- Monthly Range, 43°40.

Greatest intensity of the Sun's rays, 98°4.
Lowest point of Terrestrial radiation, 22°1.
Mean of Humidity, 859.

Amount of Evaporation, 3·86 inches.
Rain fell on 10 days, amounting to 6·823 inches; it was raining 90 hours and 56 minutes, and was accompanied by Thunder on 1 day.
Snow fell on one day, the 20th, inappreciable.
Most prevalent wind, N. E. by E. Least prevalent wind, the E.
Most windy day, the 26th day; mean miles per hour, 28·78.
Least windy day, the 14th day; mean miles per hour, 0·03.
The Electrical state of the Atmosphere has indicated feeble intensity.
Ozone was in large quantity.
Aurora Borealis was visible on 2 nights.

REMARKS FOR NOVEMBER, 1857.

Barometer.
- Highest, the 26th day, 30·344 inches.
- Lowest, the 19th day, 29·003 "
- Monthly Mean, 29·681 inches.
- Monthly Range, 1·341 "

Thermometer.
- Highest, the 9th day, 64°1.
- Lowest, the 25th day, 1°0.
- Monthly Mean, 33°69.
- Monthly Range, 63°1.

Greatest intensity of the Sun's rays, 69°6.
Lowest point of Terrestrial radiation, —1°0.
Mean of Humidity, ·871.

Rain fell on 12 days, amounting to 5·749 inches; it was raining 74 hours and 15 minutes, and was accompanied by Thunder on 1 day.
Snow fell on 4 days, amounting to 2·01 inches; it was snowing 12 hours 10 minutes.
Most prevalent wind, W. S. W. Least prevalent wind, E.
Most windy day, the 25th day; mean miles per hour, 22·09.
Least windy day, the 1st day; miles per hour, 1·99.
The Electrical state of the atmosphere has indicated moderate intensity.
Ozone was in rather large quantity.