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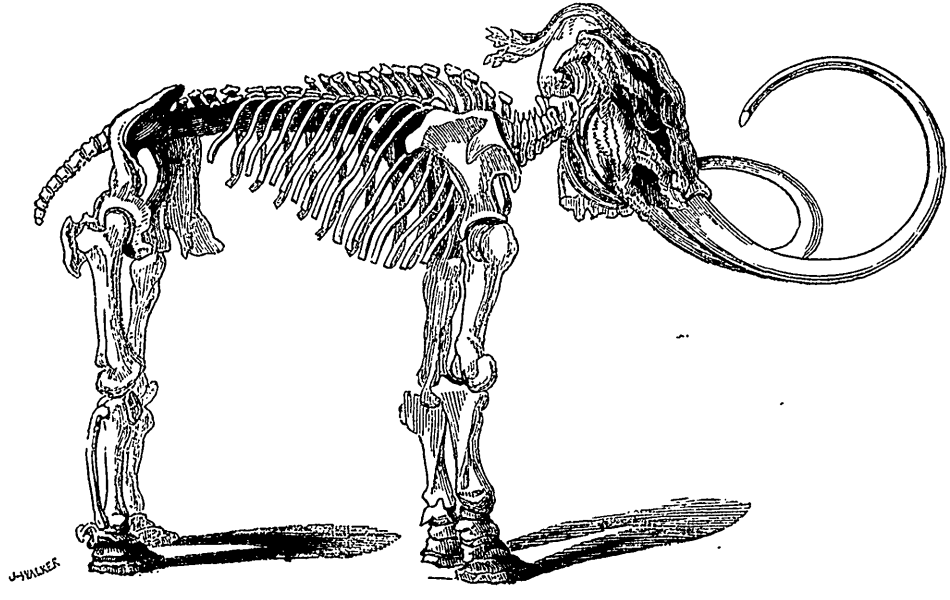
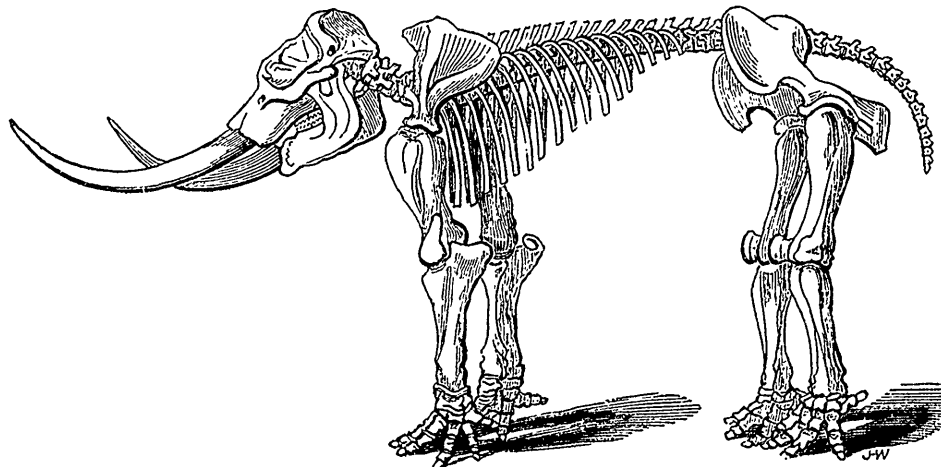


THE MAMMOTH.—(See page 879.)



THE MASTODON.—(See page 379.)

THE

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NATURALIST AND GEOLOGIST.

BY E. BILLINGS.

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ARTICLE XLVII.—*On the Tertiary Rocks of Canada, with some account of their Fossils.*

The Tertiary Rocks of Canada are supposed to consist of two divisions, the "Glacial Drift," or simply the "Drift," so called because its materials have been either wholly or in part transported or drifted from the north, and the Lawrencian Formation, which takes its name from the St. Lawrence, it being extensively developed in the valley of that stream. The glacial drift is also known by the name of the "Boulder Formation," on account of the great number of boulders or loose blocks of stone it contains.

The drift constitutes the principal portion of those vast beds of clay, sand, gravel and loose stones that may be seen almost every where, not only in Canada, but also spread out over all the northern regions of Europe, and a part of Asia. Of all the geological formations this is the most remarkable, and although more universally diffused than any other in those countries where

the science has been brought to the greatest degree of perfection, yet there is no system of rocks concerning the precise nature of whose origin so much doubt remains. It appears to have been produced by operations of nature very different from those under the influence of which the more ancient rocks were accumulated. The regular strata, that may be seen in all the quarries and cliffs of the ordinary sandstones and limestones, the perfection of the organic remains they contain, and the homogenous texture of the consolidated materials, prove that these are nothing more than the beds of sediment quietly, and during long periods of time, deposited on the floors of the oceans, and afterwards, by some process of petrifaction, converted into solid stone. But the drift, on the other hand, presents evidence of having been formed during a season when a force of some kind, not yet ascertained to the satisfaction of all investigators, was applied to the northern portion of the planet in such a manner as to grind down the surface, and transport the fragments southward. The real character of that force has been made the subject of a vast deal of discussion, and although it has for many years engaged the attention of the ablest men of the civilized world, yet it may be safely said that no theory has yet been advanced which explains all the phenomena. To those who have not studied the subject this will appear the more remarkable, when it is added that there is abundant proof that the formation is one of the most recent of all, its date being immediately before the creation of the existing species, so that the unsettled state of the problem places the Geologist in this unpleasant predicament, that while he can boldly and truly answer for events that occurred myriads of ages before the advent of his race, yet when questioned concerning that which comes almost within the period of human history, he must confess his inability to give any but a conjectural reply. That such should be the case, however, is no discredit to the science, but rather a proof that the principles already adopted are the results of mature deliberation.

As there is scarcely a square mile of the surface of Canada where some portion of the drift cannot be examined, the opportunites for studying it are abundant, but the most favorable localities are where deep excavations have been made for railway or canal purposes. In such places the lower portion of the deposit may be seen to consist of a confused mass of rounded stones of every size, from that of a small pebble to a huge boulder, weighing

several hundreds of tons. These are usually imbedded in a tough clay, and sometimes so cemented together as to require the aid of blasting in order to proceed with the work. The boulders are many of them of the same kind of rock as that which exists in the neighbourhood, while a large proportion consist of materials only known in some distant part of the country. These latter are more rounded than the former, a consequence of the rough usage they have received during their transportation from the parent bed. The drift is often overlaid by beds of clay or sand, containing a few or no boulders; but where this is not the case, and the drift constitutes the surface, then the farmer who owns the field will find himself greatly annoyed by the innumerable round stones that impede his plough. From such fields the boulders may all be removed from the surface, and after a few years a fresh crop will take their place, having worked up from the deposit of drift below, which extends downwards to the solid rock. Stoney fields are so common in Canada that they are not usually looked upon as objects of curiosity; and yet the question of how the stones came there is the most curious one in the science of geology. If it could be proved that they were created on the spot where we now find them, there would be an end of the question; but then the more a person examines them, the more convinced he will feel that they have been transported from some locality more or less distant. It is not our purpose to enter into all the proofs, but we shall mention a few of the most striking evidences that boulders are what they appear to be, and are often called travelled stones.

It has been already mentioned in this journal in several places, that the Lawrencian Rocks occupy the northern frontier of Canada, while a broad stripe all along the southern margin, from the mouth of the St. Lawrence to Lake Huron, is underlaid by the Silurian and Devonian Formations, only concealed from view by the drift which, with a slight admixture of vegetable matter, constitutes the ordinary agricultural soil of the country. The principal exception is between Brockville and Kingston, where the Lawrencian Formation comes down from the north, and crosses the St. Lawrence into the State of New York. Were a person to journey from the east towards the west along the base of the Lawrencian hills, he would have continually upon his left hand the flat country, underlaid by the sandstones, limestones and shales of the fossiliferous formations, and occasionally he would see places where these are laid bare, and abut against the gneissoid rocks which

constitute the hills. He would also soon observe that the flat floors of limestone or sandstone which terminate at the base of the mountain are encumbered by fragments of rock identical in composition with that of the precipice, and the proof that they had been broken off and rolled down to their present position would be sufficiently convincing to satisfy any reasonable mind. But let him turn towards the south, and travel away from the hills across Canada, and proceed several hundred miles into the United States, and he will be able to trace fragments of the same rock, in the shape of more or less rounded boulders, the whole distance. It will be observed also that towards the south they are smaller and much more worn than they are near the point of their departure, a necessary consequence of the greater length of their journey. The States of New York, Ohio, Pennsylvania, Michigan, Illinois, and in fact all the country north of the Appalachian Mountains are covered over with boulders that have travelled from the Lawrencian regions, across Upper Canada and the great lakes. That these rocks have been transported from the north towards the south is almost self evident, from the facts that they rest upon fossiliferous strata, and also, that no rock of the same kind exists in any place in the Western States, but only in the northern regions.

The same formation occurs not only in this country but in the north of Europe and Asia, and also in the southern hemisphere. In fact, the drift surrounds both the north and the south poles of our planet, while in the tropical regions there is a broad belt completely encircling the earth, where no drift is found. Sir Charles Lyell states, of the European drift, that, "In tracing this remarkable deposit through the borders of the Baltic, we sometimes find fragments of rock which must have travelled hundreds of miles from their point of departure; and as a general thing, we find that they grow larger in size as we approach the region from which they were derived. This I found to be the fact in going north from the margin of the Rhine to Holstein and Denmark, where I found fragments of Scandinavian Rocks, from Sweden, nine and sometimes forty feet in diameter; and at last, the whole country was made up of these rocks."* The rocks to which he alludes have all been transported bodily across the Baltic Sea.

* Lyell's Lectures on Geology, page 49.

In Switzerland, thousands of huge blocks of granite have been transported from one ridge of mountains to another, across the wide and deep valley that separates them, with so little injury that their angles are not at all worn. This is the most remarkable of all the known localities of erratic stones. The Alps are here separated from the Jura Mountains by a distance of 30 miles between their bases, but the distance between the highest points of these two chains is 80 miles. The Jura is of secondary limestone, and yet upon its slopes, 800 feet above the level of the lake of Neufchatel, which lies in the valley below, there is a long line of granitic blocks extending for miles, and consisting of a material only found in the distant chain of the Alps. Professor Forbes states of these, that "wherever seen they fill the mind with astonishment, when it is recollected that as a matter of certainty these vast rocks, larger than no mean cottages, have been removed from the distant peaks of the Alps, visible in dim perspective amidst the eternal snows, at the very instant we stand on their debris. The most notable of these masses, called the *Pierre à Bot* (or Toad Stone,) lies in a belt of wood not far from a farm house, about two miles west of Neufchatel, and near the road to Vallengin and La-Chaux-de-Fonds. The first height above the lake being gained, (vine clad on its lower slopes,) we come rather abruptly upon a small cultivated terrace, where the farm house just mentioned is situated. This hollow in the hill permits some accumulation in the soil, which elsewhere is very thin and bare. Immediately behind, however, the hill again rises, covered with thick wood, in every part of which not a few, but hundreds and thousands of travelled blocks may be found. Some small and rounded, but a vast number exceeding a cubic yard in contents, and perfectly angular, or at least with only the corners and edges slightly worn, but without any appearance whatever of considerable attrition, or of any violence having been used in their transport. Indeed such violence would be quite inconsistent with their appearance and present position.

"The dimensions of the *Pierre à Bot* are 50 feet long, 20 wide, and 40 high, containing 40,000 cubic feet (French.) It froms a stupendous monument of power. It is impossible to look at it without emotion, after surveying the distance which separates it from its birth place. No wonder that Geologists have vied with one another in attempting to account for so extensive and surprising a phenomenon."*

* Professor J. D. Forbes' Travels through the Alps, page 49.

In Canada we have never seen boulders at all comparable for their size with the stupendous blocks here mentioned as occurring in Europ Fragments from ten to fifteen feet in diameter are often met with, but we know of no instance at all approaching the magnificent dimensions of forty feet long, and fifty feet high. This may be in some measure due to the fact that there is very little granite in the regions where our boulders had their origin. The rocks are there stratified, and it would be almost impossible to find a mass of any great size that would not be easily separated into numerous thin pieces corresponding to the thickness of the strata. Perfectly coherent strata, fifty feet thick, must be rare; but granite, not being stratified, may form much larger boulders. M. A. Archiac, in his history of the progress of Geology, says that "A block of granite on the calcareous mountain near Orsières contains more than 100,000 cubic feet. Above Mouthey, many blocks derived from the Val de Fernet, and which have thus travelled a distance not less than eleven leagues, contain from 8,000 to 50,000 and 60,000 cubic feet. One of the blocks of granite near Seeberg measures 61,000 feet, and has travelled about sixty leagues." In the Eastern States, where granite is more common, the boulders are larger than they are in Canada. Professor Hitchcock mentions one in New Hampshire which was thirty feet in diameter, and another that measured one hundred and fifty feet in horizontal circumference.

In Mr. Murray's Report for 1844, he thus describes the drift of that part of the Province which came under his observation during that year:—"It cannot but have struck every one who has travelled over the western part of Canada, that nearly the whole of it is very much covered and concealed by a vast deposit of soft or loose derivative material, and it is only where the country is intersected by rivers, or on the lake shores, or in that mountain ridge which extends from Queenston to Hamilton, and thence to Nottawasaga Bay on Lake Huron, that an outcrop of the older stratified rock is to be seen.

"In the district which has on the present occasion been more immediately the subject of my investigation, the deposit consists of various beds of clay, sand and gravel, interspersed with large boulders; the thickness it attains is generally very considerable, and frequently reaches 200 or 300 feet. The clay cliffs of Scarborough are 320 feet; the central bridges, as they are called, running parallel to the north shore of Lake Ontario, are probably

200 or 300 feet; and the highlands in Oxford are frequently 100 or 200 feet, and even more; and the banks of the Grand River often expose a very considerable amount.

"As to the sources whence the material is derived, the finer parts, considered by themselves, present less evidence than the coarser; the clay gives no evidence at all. In some portions of the sand, however, magnetic iron ore exists, as on the shore of Lake Ontario at Toronto, where the quantity is so considerable on Gibraltar Point, that if a magnet be thrust into the arenaceous detritus comprising it, on being withdrawn it will be found covered with small grains of the ore. The origin of this is probably the primary region where magnetic iron ore abounds. The evidence of the gravel and coarser material is more direct. The calcareous pebbles in the country on the south shores of Lake Simcoe are identical with the limestones of Rama, to the north, and their fossil, as well as their minerological character, is an incontestible proof of the source from which they are derived. The testimony of fossils is brought to bear also in the district of country separating Lake Ontario from Lake Erie, and by them it is readily determined that the coarser detritus reposing upon each successive formation, is made up, with the addition of whatever is of primary origin, of material derived from the formation itself, or of the ruin of some lower deposit whose outcrop is to the north, or of a mixture of both. The ruins of southern outcrops never repose on northern formations for great distances, and only occasionally for short ones, where the southern outcrop occupying an elevated position in an escarpment, the northern deposit stands at a lower geographical level. Instances of this last condition may be seen on the flank and at the base of the ridge skirting the south side of the lake, where fragments of the Niagara limestones, which constitute its summit, may frequently be found resting on the red marls lower down. But on the contrary, high up the side of the mountain, in the same range, 110 feet above the lake level, often may be encountered the remains of the subjacent blue shales, whose outcrop is buried either beneath the waters of the lake or must be looked for on the opposite shore; and though the fragments of this individual formation may not extend to the margin of Lake Erie, the detritus resting there upon the upper limestones consists chiefly of their own debris, with that of the gypseous series to the north. The great erratic blocks or boulders, when rounded by distant travel,

are almost all of primary origin, and the evidence they present is in unison with that derived from the gravel and sand, to prove that at some remote period the surface has been covered with water having a current from the north.

"As bearing upon the probable direction of this current, it may be mentioned that in several places between Niagara and Hamilton, along the mountain or ridge which has been alluded to, where the drift has been removed, the rock beneath has been found to present a smooth and almost polished condition, with a gently undulating surface, marked by deep parallel grooves and scratches, whose general direction is from north to south. These grooves are well displayed in the quarry of Mr. Kifler, at Thorold."*

The smoothing, polishing and grooving of the rock surfaces are phenomena intimately connected with the origin of the drift, and present so many different features that it has been found impossible to devise any one theory that would account for them all. Where the drift is removed, and the surface of the solid rock laid bare, it is found to have been almost everywhere subjected to a grinding process, as if an immense sheet of sand paper had been drawn over the country from the north towards the south. Sometimes flat surfaces of limestone several acres in extent will be found in part polished like a looking glass, but usually furrowed by long parallel scratches, as fresh in appearance as if they had been made but yesterday. In places where the strata are tilted up, so that their edges project, these will often be found planed down to an uniform level. Where mountains or low hummocks of rock have been subjected to this process, the striæ are often seen to pass up the slope and over the summit. In such cases it is always the north side of the mountain that has received the polish, while the southern extremity remains untouched, thus affording another proof that the whatever it was that produced the scratches or polish moved from the north towards the south. In geology the abraded end of the mountain is called the strike side, and the other the lee side. On any good recent exposure of these glacial striæ, the observer will be instantly struck, not only with their freshness, but also with their exact parallelism. In different parts of the country their direction is also different, but in the same neighborhood they follow the same course, even over

* Report on the Progress of the Geological Survey of Canada, 1844, by Alexander Murray, Esq., Assistant Geologist.

the summits of the hills. Sometimes two sets of striæ may be seen on the same surface, crossing each other at a small angle; but in such instances, all the lines belonging to each will be parallel. The hard parts of the rock are ground down to the same level with the soft, as if they had been rasped with a file of steel; and further, thousands of boulders may be seen thrown out of new excavations, which are covered with similar scratches.

It is generally believed that in each section of the country the direction of the glacial striæ is the same as that in which the boulders of the neighborhood have proceeded. Dr. Bigsby, a gentleman who travelled over a large portion of British North America some years ago, states, in a paper read before the Geological Society of London in 1851, that boulders have been carried from the Mountain of Montreal up the valley of the St. Lawrence. "It is curious," he says, "to trace the well marked angitic trap of Montreal, stretching up the St. Lawrence, and occurring at successive distances, until the last bit I observed was on the Genesee River, on the south shore of Lake Ontario, 270 miles to the south-west. The boulders of this rock are, however, in far greater quantity on the southern levels between Montreal and Lake Champlain."*

On the map which accompanies Dr. Bigsby's paper, he has laid down a line extending from the rear of the Island of Montreal, across the Isle Perrot, through the northern part of the State of New York, the Thousand Islands, and Lake Ontario, to Rochester, as the direction in which the boulders have travelled. We are not aware that this line was drawn with reference to any glacial striæ observed by him; but very recently, in the cutting of the Grand Trunk Railway on the Isle Perrot, we had an opportunity of observing the striæ where the Potsdam sandstone has been laid bare. Their course is there about north-east and south-west, which corresponds very nearly with the line on the map. Another proof that the course of the drift was up the St. Lawrence, may be seen, we think, at the north-west corner of the Mountain of Montreal, at Côte St. Antoine, where a long ridge of drift runs south-west, pointing in the direction of Lachine and Caughnawaga. This line would be about parallel with the other, but several miles further south. It is found that where a mountain of rock like that at Montreal stands alone in the midst of a

*Bigsby on Canadian Erratics—Quarterly Journal of the Geological Society, vol. 8, page 234.

level plain, the strike side, or that which was exposed to the current, has been swept clean, while the lee side has a long ridge of drift stretching away from it. Such mountains are called "crag and tail," and from the little we have seen of the hill in question, we think it affords a good example. The Barrack Hill, at the City of Ottawa, is another, but with the tail turned towards the south-east, extending in a line running from the old military hospital in the direction of the canal basin.

The courses of the glacial striæ in the valleys of the Ottawa and St. Lawrence, so far as we have observed them, are at right angles to each other. On the Barrack Hill, in the City of Ottawa, at the village of New Edinburgh, at Stegman's Rapids, on the Rideau, five miles from Ottawa, near the first toll-gate on the road to Aylmer, in the Township of Hull, and also in the Township of March, we have seen them, and in all these localities their course is from the north-west towards the south-east. Further up the Ottawa, on the road between the village of Renfrew and Burnstown, and also in the Township of Ross, they have the same bearing. It thus appears that while the glacial stream ran down the valley of the Ottawa it flowed up the St. Lawrence, a state of things which would lead to one more of those complexities which have so long made the question of drift the most unsettled one in geology.

Where these striæ are found in valleys bounded on each side by shores of rock, they often follow the windings of the ravine as if it had been the channel of a stream. A remarkable instance of this fact was observed by Sir W. E. Logan, while examining the geology of the upper part of the Ottawa. Under the head of "*Glacial Action*," he states:—"Fresh water shell marls occur in many places in the alluvial deposits of the Ottawa, and among the phenomena which come within the recent period, rounded and polished rock surfaces, bearing parallel grooves and scratches, are of not unfrequent occurrence. They were met with on the Gatineau, half-way between Farmer's and Blasdell's mills, where the direction of the scratches is about S. 36° E.; on Glen's Creek, in Pakenham, where they are about N. and S.; on the Allumettes Lake, at Mongomery's Clearing, where they are S. 25° E.; but on the shores of Lake Temiscamang they are so numerous, and are combined with other circumstances of so marked a character, as to deserve particular notice. The lake has already been described as long and narrow. Its banks are in general bold and rocky,

rising into hills 200 to 400 and sometimes 500 feet above its surface, with the exception of the mouths of several transverse valleys occuring on the left bank, among the slates, sandstones and limestones on the north side of the anticlinal axis. The general valley of the lake, thus bounded, presents several gentle turns, the directions connected with two of which, reaching down to the mouth of the Keepawa River (thirty-five miles) are 158°, 191°, 156°, numbering the degrees from north as zero round by east. The parallel grooves in these reaches of the valley turn precisely with their bearings, and they are registered on various rounded and polished surfaces projecting into the lake, and sometimes rising to thirty and forty feet over its level. It was not easy to follow them to higher surfaces, for these usually were covered with the moss and trees of the forest, but they were occasionally traced to spots where they thus became concealed. These projecting points never were found to deflect the grooved lines in the slighest degree, and one remarkable instance of this occurs on the east side of the lake about a mile above the lower large island, at the south horn of a pretty deep bay. The rock belongs to the slate conglomerates, and it is composed of pebbles and boulders of igneous origin. Its face is a clean, smooth, rounded surface cutting through the pebbles, which are polished down with other parts. It is very deeply grooved with parallel furrows in the bearing 160°, and from the water's edge they run obliquely up the face (an inclined plane of 60° in an upward direction of 102°,) and continue on in the same bearing of 160° on the rounded or rather flattened top, thirty-five feet above the lake; so that whatever body moving downward in the valley may have caused the grooves; it was not deflected by meeting with a surface, presenting a thirty-five feet height of front, so steep as 60°, notwithstanding it impinged upon it at an angle of no more than 32°. On the summit of the rock there is another set of parallel grooves, not so deeply marked, which cross the former at an acute angle, the bearing being 185°. In another place, about six miles higher on the lake, on the same side, a polished surface, not over four or five feet above the water, belongs to the very base of the limestone formation. Vast boulders and fragments of the sandstone below lie in a calcareo-arenaceous cement, some of the imbedded circular slices or half boulders being nine feet in diameter, while in some parts the solid sandstone strata are seen, and great cracks or worn fissures in them are filled with cement.

The rock, in short, is a collection of great boulders and blocks of sandstone, which were lying immediately on the strata from which they were derived, when they became enveloped by the succeeding formation. The whole is planed to a smooth tesselated surface, and marked with parallel grooves. In the same vicinity, the parallel grooves occasionally appear on the flat surfaces of successive steps, formed by one layer of sandstone resting on another. They, however, do not always come up to the vertical sides of the steps, and these ungrooved parts are usually rough and uneven, as if they had but recently been fractured or deprived of their protecting cover. The Company's post stands on a point on the east side, which cuts the lake nearly in two, at about eighteen miles from the head, and it is opposite a less prominent point on the other side. These points approach to within a quarter of a mile of one another. Both are composed of sand and gravel, which on the east form a hill 130 feet high. The southern face of this hill runs in the bearing 65°, and the gravel towards the eastward rests on flat sandstone strata, which have a smooth and partially rounded surface. The gravel and the rock constitute the north side of a deep bay. The polished rock surface exhibits well marked grooves, which come from beneath the gravel hill, nearly at right angles to the margin of the water. There is here, as in some other instances, more than one set of parallel scratches. Two of these sets cross one another in the directions 140° and 196°. The gravel may once have been continuous across the lake, and may have been broken or worn down for the escape of the water, which now flows past in a gentle current through the gap. The mass is not unlike the remains of an ancient moraine, and, combined with the smooth rounded surfaces and parallel grooves and scratches, and the changes in their direction, the circumstances of the case may well suggest that this part of the valley of the Ottawa may have been the seat of an ancient glacier. A difficulty appears to stand in the way of the hypothesis, in the horizontality of the valley. There is little fall in it for seventy miles, and the total height of the lake above the sea is only 612 feet. What descent there may be in the valleys which lead into it on the north, having their origin in the watershed, about forty-five miles distant, in which the ice behind might press on the ice before, has not yet been ascertained, but it is not reported to be very great. But as Professor J. D. Forbes appears to have demonstrated, in his Travels through the Alps, that in glaciers

there is a flow, the particles of ice moving on one another, it must be the fact that uncounterpoised superincumbent pressure from unequal accumulation would be a perfectly good cause of movement, and thus the horizontality of the valley would be no difficulty. In the eastern bay at the head of the lake, near the mouth of the Otter River, parallel grooves were remarked running in the bearing 105°, which is the upward direction of the valley of that stream; and about a mile westward of the Blanche in the same bay, in the bearing 130°, partaking of the direction of the valley, bounded by the escarpment of the limestone described as running back into the interior. The discrepancy between these bearings and those lower down is considerable, but being in the general direction of valleys joining the main one, the grooves may be the result of tributary glaciers. It has already been stated that accumulations of boulders, gravel and sand are met with in several parts of the river lower down, occasionally so obstructing its course as to produce rapids. Some of these may owe their origin to the same causes which have produced the gravel hill of Fort Temiscamang. It is scarcely necessary to remark, that the present effects of ice on the lake appear wholly inadequate to account for even those parallel furrows least removed above its level, though it may sometimes produce results analagous, but less important and uniform. On the east side of the lake, three boulders were remarked which had been moved by the ice of the previous winter. One of them, measuring thirty-two cubic feet, had been moved nine feet in the direction 90°; another, one hundred cubic feet, had been moved fourteen feet in the direction 350°; another, eighty cubic feet, had been moved fourteen feet in the direction 35°; each had left behind it a deep broad furrow through the gravel of the beach down to the clay beneath. In front of the first was accumulated a heap of gravel, one foot high, with an area of nine square feet; and in front of the second was an accumulation of small boulders, weighing from 80 to 100 lbs. each. To move the second and third, the progress of the ice must have been up the lake, and the first across it. Had the gravel rested on a surface of rock instead of clay, parallel scratches would have been the result in each case." *

The fact that in valleys the glacial striæ upon the rocks follow the windings of the channel has also been confirmed by numerous

* Sir W. E. Logan's Report of Progress of the Geological Survey of Canada, 1846.

observations in the United States and in Europe. In addition to this it can be shewn that in some districts where there are groups of high mountains the boulders have travelled in all directions away from one of these hills, which is therefore called a centre of dispersion. We have not ascertained that any such centres exist in British North America, although they have been found in the Eastern States. These centres of dispersion must be regarded as mere local phenomena, confined to comparatively small tracts of country, while the glacial drift, in its widest sense, appears to have been a grand process, extending its operations over the whole northern hemisphere, in a continuous sheet, flooding the earth, sweeping along huge boulders from the north towards the south, and scouring, polishing and grinding down all the formations over which it passed.

THEORIES OF THE DRIFT.—The theories that have been devised in order to account for the phenomena of the drift are principally the following:—Some Geologists have supposed that in consequence of a great subterranean convulsion the bottom of the sea at the north pole was suddenly elevated, and the superincumbent waters caused to rush violently southward over the continents, dashing among the hills, tearing up rocks, and carrying the ruins along with them in their tumultous career. This, we believe, is called the "*debacle* theory," and the flood caused by the elevation of the sea-bottom, the "the *debacle* or wave of translation."* The objections to this theory are that while it is purely hypothetical, there is, besides, evidence that the work of polishing and grooving rock surfaces appears to have been a slow operation, instead of a rapid and violent one. It is evident that the worn and completely rounded condition of the greater number of the boulders must have been produced by the long continued action of water. A disturbance that could only continue for a few days, or while the wave was passing over the continent, must have been utterly incompetent to produce even a tenth part of all the phenomena that may be observed in connection with the drift.

In a work published in Paris in 1844, (*Etudes sur l'Histoire de la Terre,*) the author, M. de Boucheporn, accounts for the erratic blocks of Europe by supposing a sudden displacement of the axis of the earth, in consequence of which the North Pole was brought to take a position in the neighborhood of the Baltic Sea, somewhere near and north of Prussia or Poland. But as

* From the French *débâcle,* the breaking up of a frozen river.

this theory would not account for the drift of America, he supposes a second displacement, whereby the pole was removed to the vicinity of the City of Boston, in the United States. Great quantities of ice and snow accumulated in Europe and America during these periods, which on the return of the pole to its present position melted, occasioning great floods, which dispersed the boulders and spread the drift over the land. The theory which has received the greatest amount of respect is that which attributes the drift to vast glaciers that covered a large portion of the Arctic and North temperate regions, and by their continual flow towards the south, shoved along or otherwise transported the boulders and debris of which the drift is composed. This theory was suggested by observations made among the Alps, where, in those mountains covered with perpetual snow, the ravines that descend their sides are full of ice, which moves or rather flows down—for this glacier ice is not solid, but in a viscid state—with exceeding slowness, bearing upon its surface or embedded in it masses of rock of all sizes, which it deposits on the plains below. These glaciers polish the solid rocks over which they pass in a manner similar to the polishing and grooving referred to in the drift of this and other countries. This theory has for its supporters some of the most distinguished philosophers of the age, among whom may be mentioned Professor Agassiz. It is called the Glacial Theory, and supposes a period of extreme cold, during which the Antarctic climate was experienced so far south as the present United States.

The "Iceberg Theory," much advocated by Sir Charles Lyell, has also many very eminent men for its supporters. According to this view, during the period of the drift, the northern portions of the present continents of Europe and America were submerged beneath the ocean, but to no great depth, and the boulders were transported by icebergs floating from the north towards the south. These bergs in their course rubbed along the bottom, and while they polished the rock surfaces, the stones imbedded in the ice occasioned the long parallel grooves and scratches which may be seen wherever the drift is removed. That the icebergs of the present day do carry boulders, gravel, sand and clay, which have become attached to them while in contact with the northern sea coasts, is a well established fact. Their course in the Atlantic is always towards the south, and when they enter the warm climates of the sea, they melt away, and drop the boulders and other mate-

rials with which they are freighted, to the bottom. Should the bed of the ocean between America and Europe become dry land, there is not the least doubt but that we should find it strewn over with blocks of stone, much in the same way as our fields are strewn. This theory has many able advocates, but still it does not satisfy all.

THE LAWRENCIAN FORMATION.—What is considered to be the true drift lies at the bottom of the mass of loose material which covers Canada, and consists of clay, sand, gravel and boulders, broken from every formation, and mixed confusedly together in one common ruin; but above this, there are in many extensive tracts of country regularly stratified beds, which appear to have been quietly deposited, and which also contain organic remains of species identical with those now living in the Gulf of St. Lawrence and northern seas. This deposit occupies the vallies of the St. Lawrence and Ottawa, and consists of fine clay, sand and gravel, which generally make a good and fertile soil. While it was in the course of being deposited, there can be no question but that all Canada, east of Kingston, was submerged beneath the ocean. At the same time, the sea was tenanted by a considerable number of the same species of marine animals that are now to be found in it. The late Professor E. Forbes, in an elaborate and beautiful memoir "on the geological relations of the existing Fauna and Flora of the British Isles," gives a list of 174 species of animals whose remains have been found fossil, either in the drift of Europe or the Lawrencian deposit of America; and since that paper was published (1846) many other species have been found. He thus classifies them :—

Mammalia	5
Pisces	1
Mollusca	155
Cirrhipeda	5
Annellida	3
Echinodermata	2
Zoophyta	2
Plantæ	1
	174

The Mammalia of this list are altogether of the whale tribe; the single species of fish to which he alludes is the common

Capelan of the Gulf of St. Lawrence, first found fossil in Canada at Green's Creek, in the Township of Gloucester, near the City of Ottawa, and taken to England by Sir W. E. Logan, who afterwards discovered another species, the Lumpsucker (*Cyclopteris lumpus,*) in the same locality. Of the Mollusca mentioned in his list, about twenty species have been found in the Lawrencian deposit of Canada, some of which we shall figure in this article. The identity of so many species with those of Britain, and even with those of the elevated sea-beds of Sweden, still further from us, appears to prove that England, Scotland, Ireland, together with Canada, and much of Northern Europe, were under water at the same time.

The line between the drift and the Lawrencian formation does not appear to us to be very distinctly marked. This latter deposit contains boulders imbedded in it, and upon its surface are often to be seen some of the largest blocks. At the village of Renfrew, in the county of Renfrew, we have seen two species of fossil shells, *Saxicava rugosa* and *Tellina Grœnlandica*, the latter in great abundance in a stratified bed of gravel, above which there were numerous very large boulders. In this place, we can see at one glance both the transported rocks which characterise the drift, and also the stratification and organic remains, considered to be marks of the Lawrencian rocks. Above the fish bed at Green's Creek, and in the same clay with these remains, there are boulders, and in many other places the same phenomena may be observed. We have never, however, discovered any fossils in the lower part of the deposit, or what is especially termed the drift. If the iceberg theory be the true one, then the whole subject may perhaps be explained by supposing that during the commencement of the the glacial epoch the seas of America were but sparsely or not at all inhabited, and that towards its close the bottom descended to a depth so great that the gradually accumulating beds of clay and sand could no longer be disturbed and commingled by the passing ice, while at the same time they would receive the boulders dropped as the icebergs melted away. But as we have already made this article too long, we shall for the present withhold any further remarks upon the subject, only recommending such of our readers as have not done so, to examine the drift for themselves, and in good excavations they will find much to reward them for their investigations. The principal facts may be thus summed up:

1. Canada, and the greater portion of the continent north of 40° of north latitude, is covered over with a deposit consisting of clay, sand, gravel and broken stones, the ruins of all geological formations mixed confusedly together.

2. The lower part of this deposit is unstratified, and constitutes what is called the "drift," while the upper portion is distinctly stratified, consists of materials which appear to have been accumulated during a period of less violence, and contains organic remains. This part of the deposit is called the Lawrencian. West of Kingston, the formation is not known to contain marine remains, although, in other respects, it is similar to that lying in the country east to the mouth of the St. Lawrence.

3. The rock beneath the drift is smoothed, polished and grooved with long parallel scratches.

4. There is some evidence to induce the belief that the boulders have travelled in the direction of the grooves in the rocks.

5. There is some evidence to shew that from the Island of Montreal the drift moved north-westerly up the St. Lawrence.

6. We have also some proof that it moved in the upper part of the Ottawa in a general direction from north-west to the south-east, down the valley of the Ottawa, and in a direction at right angles to the drift of the St. Lawrence.

7. Although in certain districts the course of the drift has been either towards the east or west of south, yet upon the whole, it has moved southerly, except in the neighbourhood of high mountains, where local centres of dispersion have been ascertained.

The above summary contains the principal facts, but there are many other phenomena connected with the events of the period of the drift, such as the river and lake ridges and terraces, the conveying of rocks from lower to higher levels, and others of an analagous nature, of which we may hereafter give some account.

The following are some of the fossils most frequently found in the Lawrencian deposit of Canada:

Fig. 1. *Saxicava rugosa.*—This little shell varies much in its form, and belongs to a group of species not easily distinguished from each other on account of these variations. This species is, however, the only one of the genus found fossil in Canada, and may be easily recognised by its elongated shape and rough concentrically striated exterior. It is a member of the family of LITHOPHAGIDÆ, or "stone-eaters," so called on account of the wonderful faculty they possess of boring holes in rocks, where they permanently

locate themselves. "Mr. Sowerby remarks that they are frequently found on the outside of oysters, protected by their irregularities, and in the clefts of rocks or corals, roots of sea-weeds, and perforating oysters, chalk, limestone and hardened clay." It is living, according to Professor E. Forbes, "in all the seas of Northern and Arctic Europe, Northern America and Greenland. It ranges as far south as the Canary Isles. Its vertical range is very great. In the British Seas, it is found abundantly in the laminarian and coralline regions. In the Mediteranean, it has been observedalive at all depths between twenty and eighty fathoms."*

Fig. 1.

Fig. 2.

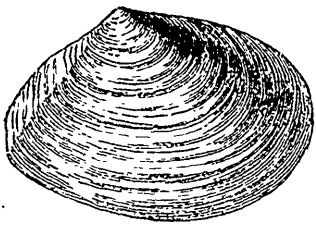

Fig. 3.

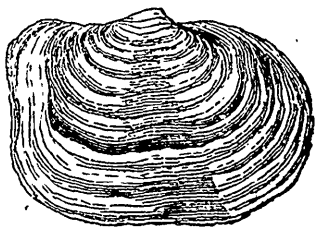

Fig. 4.

Fig. 1.—*Saxicava rugosa.*
Fig. 2.—*Tellina Grœnlandica.*
Fig. 3.—*Tellina calcarea.*
Fig. 4.—*Mya truncata.*

In Canada it is found fossil in very numerous localities over all the valley of the St. Lawrence and the flat country south of the Ottawa. On the mountain of Montreal it occurs at a level of more than 400 feet above the St. Lawrence. Along the base of the mountain we have seen it at the brick-yard near the toll-gate, St. Lawrence Street, near McGill College, at several places on Sherbrooke Street, and at Côte St. Antoine. The most astonishing locality, however, is at Beauport, three miles from Quebec. There is

* Forbes, in Memoirs of Geological Survey of Great Britain, vol. 1, page 410.

here a bed about ten feet in thickness composed of nothing but shells of *Saxicava rugosa*, with scarcely any earth intermixed. It reposes upon other beds containing a number of other species in a deposit of gravel, with small boulders. The place may be found by going to the mill at Beauport and proceeding up the creek about 300 yards, where the cliff will be seen nearly white from the profusion of the shells it contains.

Professor Forbes says: "It occurs in all the Irish, Scotch, and English fossiliferous drifts and glacial clays," and in the upraised lands of Sweden it is also abundant; in association with other species found with it in Canada. *Saxicava*—Latin, "*saxum*," stone, and "*cava*," to excavate; "*rugosa*," rough.

Fig. 2. *Tellina Grœnlandica.*—This little shell occurs in nearly all the localities of *Saxicava rugosa.* It is at present living in Arctic seas, and according to Capt. Bayfield, in the Gulf of St. Lawrence. The generic name is from the Greek, "*telline*," a kind of mussel. It is said that there are 200 species of Tellina living, and 130 fossil in all the formations from the oolite upwards.

Fig. 3. *Tellina calcarea.*—Living in the Arctic seas, Behring's Straits and Greenland; fossil at Beauport, Montreal and numerous other localities in Canada, also in Scotland and Russia. *Calcarea,* (Latin,) pertaining to lime.

Fig. 4. *Mya truncata.*—This is a thick strong shell, easily recognised by the abrupt truncation of one of its extremities. One of the valves has on the inside, immediately beneath the umbo, a remarkable projection called the cartilage process. There is another species, *Mya arenaria*, about the same size, but not truncated, also found fossil in Canada. "The Myas frequent soft bottoms, especially the sandy and gravelly mud of river mouths; they range from low water to 25 fathoms, rarely to 100 or 125 fathoms. *Mya arenaria* burrows a foot deep; this species and *Mya truncata* are found throughout the northern and Arctic seas, from Ochotsk and Sitka to the Russian Ice Meer, the Baltic, and British coast; *in the Mediterranean they are only found fossil.* They are eaten in Zetland and North America, and are excellent food. In Greenland they are sought after by the walrus, the Arctic fox and birds."* Both these species are living in the Gulf of St. Lawrence; fossil at Beauport, Montreal, &c.

Mya, a mussel; *truncata*, cut off; *arenaria*, pertaining to sand.

* Woodward's Recent and Fossil Shells, page 317.

Fig. 5. *Astarte Laurentiana.*—This species was first found by Sir Charles Lyell at Quebec, or among shells procured there. It is not known to be living in any sea, and is perhaps extinct. It may be recognized by the very regular concentric ridges which cover its surface. Occurs at Beauport and Montreal. *Astarte*, the name of a goddess of the Sidonians and Assyrians, called in Scripture, Ashtaroth.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 5.—*Astarte Laurentiana.*
Fig. 6.—*Pecten Islandicus.*
Fig. 7.—*Natica clausa.*
Fig. 8.—*Scalaria borealis.*

Fig. 6. *Pecten Islandicus.*—The Pectens, or Scallops, have the power of swimming through the waters. Woodward, page 257, says:—"The Rev. D. Landsborough observed the fry (young) of *P. opercularis*, when less than the size of a six-pence, swimming in a pool of sea water left by the ebbing of the tide. Their motion was rapid and ziz-zag; they seemed, by the sudden opening and closing of their valves, to have the power of darting like an arrow through the waters. One jerk carried them some yards, and then by another jerk they were off in a moment on a different track." There are 120 species living, and 450 fossil, from the carboniferous upwards.

P. Islandicus inhabits the Atlantic from Nova Scotia to Greenland. It occurs fossil at Beauport. Some of the specimens are four times the length of the one figured. Occurs fossil in Russia and Sweden. *Pecten*, a comb; *Islandicus*, Iceland.

Fig. 7. *Natica clausa.*—This little shell is rather plentiful in the deposit at Beauport, and is also found fossil in the Scottish, Manx, Irish and north of England glacial beds. It is living in the Arctic Seas and Gulf of St. Lawrence. At Beauport, numerous specimens of Tellina and Mya may be collected, with small circular holes drilled through them. According to Gould, (Invertebrata of Massachusetts, p. 232,) these perforations have been made by a Natica, probably this species. They are carnivorous, "and have the power of perforating shells, it is generally supposed, by discharging an acid which decomposes the shell, and through the aperture they extract the juices, and destroy the lives of the otherwise secure inhabitants. Their foot is large, so as completely to envelope the objects on which they prey. In moving, they burrow in the sand, so as to be almost entirely concealed by it, and their place is generally indicated by a small heap of sand." *Natica*, probably from *nato*, to swim or move with a fluctuating motion; *clausa*, from *clausus*, shut up or inclosed.

Fig. 8. *Scalaria borealis.*—Belongs to the celebrated family of *Wentle-traps*, once so highly prized by shell-collectors, that one hundred guineas has been paid for a single specimen of a favorite species, the Royal or Precious Wentle-trap, *S. pretiosa.* The species of this genus live in from 7 to 80 fathoms in sandy mud. *S. borealis*, living in the Arctic Seas; fossil at Beauport and in Sweden. *Scalaris*, like a ladder; *borealis*, northern.

Fig. 9. *Buccinum undatum.*—May be recognized by the folds that cross the whorls; most prominent on the upper part of the whorl. It is also marked with "raised lines, from one-fifth to one-tenth of an inch apart, with minute intervening striæ." (Gould, p. 306.) In the fossil shells, the exterior often exfoliates so that these markings cannot always be seen. The protuberance on the left-hand side of the aperture in Fig. 9 does not occur on all the specimens. This shell is also called *Tritonium Anglicanum.* It once lived in the Mediterranean, but, as well as *Mya truncata*, has become extinct there,—a fact of great geological importance, as it proves that the sudden disappearance of a fossil from the strata of one country is no proof that it may not be found in a higher formation in another.

B. undatum inhabits the Atlantic from Cape Cod northwards. Fossil at Beauport, Montreal, and various other places in Lower Canada; also in Britain, Sweden and Russia. Name from *buccina*, a trumpet; *undatus*, waved. It is called a *whelk* in Britain. Our fossil is considered a variety.

Fig. 9.

Fig. 10.

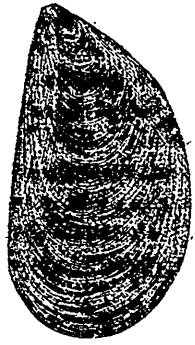

Fig. 11.

Fig. 9.—*Buccinum undatum.*
Fig. 10.—*Fusus carinatus.*
Fig. 11.—*Mytilus edulis.*

Fig. 10. *Fusus carinatus*, called also *Tritonium fornicatum*.—Living in the Gulf of St. Lawrence, Arctic Seas, Greenland; fossil at Beauport. *Fusus*, a spindle; *carinatus*, carinated, in allusion to the carinæ or keel-like ridges that wind round the shell, ascending spirally to the apex; these are more conspicuous in some specimens than in others.

Fig. 11. *Mytilis edulis.*—Fossil at Beauport, Montreal, &c.; living abundantly in the seas of Europe and America. The mussels, while living, are attached to rocks, sea-weeds, or other marine substances, by a flexible ligament like a bundle of fine threads, which issues from within outward, passing between the valves. This organ is called a byssus. Violent sickness is sometimes occasioned in Britain by eating the animal of this shell at certain seasons. There are 50 living and 80 fossil species. Some palæontologists are of opinion that the genus existed during the Lower Silurian period. *Mytilis*, (Latin) a mussel; *edulis*, edible.

Fig. 12.—*Terrebratula psittacea*, or *Rhynconella psittacea*.—This little fossil is interesting, because although the catalogue of the genus contains upwards of 250 species, ranging from the Lower

Silurian upwards through all the formations, yet only two are living at the present day, of which *R. psittacea* is one. The race is on the decline, and will perhaps soon become extinct. It belongs to the class BRACHIOPODA, so fully represented by the fossils of the lower Silurian rocks of Canada. At Beauport, where the specimen figured was procured, *R. psittacea* occurs plentifully at the base of the bed holding the *Saxicava*. Specimens may be procured there with both valves in connexion. Living in the seas of Newfoundland, Labrador, Greenland and Norway; fossil in the drift of Ayrshire and Bramerton, Scotland, and at Beauport, Canada.

Rhynconella, from the Greek, *rhynkos*, a beak; *psittacea*, from *psittacus*, a parrot. The other living species is *R. nigricans*, found in the seas of New Zealand.

Fig. 12.

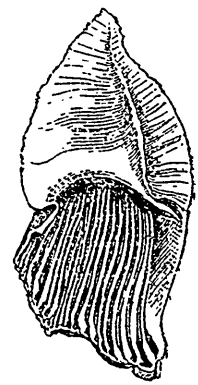

Fig. 13.

Fig. 12.—*Rhynconella psittacea.*
Fig. 13.—*Balanus Uddevallensis.*

Fig. 13. *Balanus Uddevalensis* is one of the loose valves of a large species of Balanus. These animals belong to the sub-kingdom Articulata, class Cirrhipeda. The fragments have a light grey or bluish colour, and are rather plentiful at Beauport. The living barnacles adhere to stones, floating pieces of wood, shell, fish, &c. In the Township of Gloucester, in the excavation made for the Ottawa and Prescott Railway, near Cunningham's Farm, many of the small boulders had the barnacles which lived in the

sea while Canada was beneath the waves still attached to them. *Balanus*, an acorn; Uddevalla is a town in Sweden, where this species is found not only fossil but living.

The above are the principal species found in the drift, and it should be remarked that many of them do not occur west of Montreal. *Tellina Grœnlandica* and *Saxicava rugosa* are the species most widely diffused, extending further inland than any of the others; *Mytilus edulis* and *Mya truncata* come next, having been found as far west as the City of Ottawa. East of Montreal, the species increase in number and individuals as we approach the ocean; west of Kingston no marine drift shells have been discovered. The following is a list of the Canadian fossils of the drift or Lawrencian periods:

1. *Whales.* Species not determined. There is part of a skeleton in the collection of the Geological Survey at Montreal. It was found in the clay near the city.

2. *Seals.* Species not determined. Green's Creek, Gloucester. Specimen's in collection of Geological Survey, Montreal. The bones of the posterior limbs found by Mr. P. A. McArthur, Ottawa, already figured in this journal.

3. *Mallotus villosus.* The common Capelan of the gulf, fossil at Green's Creek, and also at Flat Rapids, Madawaska River, County of Renfrew.

4. *Cyclopteris lumpus.* The lumpsucker, a fish common in the Atlantic, fossil at Green's Creek. It is said that these two species of fish are the only ones found, both in a living and fossil state.

MOLLUSCA.

5. *Buccinum undatum.*
6. *Fusus carinatus.*
7. *Trichotropis borealis.*
8. *Natica clausa.*
9. *Velutina* ——— *?* ———
10. *Scalaria Grœnlandica.*
11. *Scalaria borealis.*
12. *Littorina palliata.*
13. *Mya truncata.*
14. *Mya arenaria.*
15. *Saxicava rugosa.*
16. *Tellina Grœnlandica.*
17. *Tellina calcarea.*

18. *Astarte Laurentiana.*
19. *Cardium Grœnlandicum.*
20. *Cardium Islandicum.*
21. *Nucula sapotilla?*
22. *Mytilus edulis.*
23. *Pecten Islandicus.*
24. *Rhynconella psittacea.*
25. *Balanus miser.*
26. *Balanus Uddevalensis.*
27. *Echinus granulatus.*

In addition to the above in the nodules of indurated clay containing other fossils, there are found the leaves and twigs of trees, grass and weeds, shewing that land covered with vegetation existed at no great distance. These fossils, as a group, are supposed to belong more to an Arctic than a temperate climate, and in consequence, indicate a greater degree of cold during the latter part of the Tertiary than exists at present in Canada.

ARTICLE XLVIII.—*On the American Buffalo,* (*Bison Americanus.*)

GENUS BISON.

DENTAL FORMULA.

Incisive $\frac{0}{8}$; *Canine* $\frac{0}{0}—\frac{0}{0}$; *Molar* $\frac{6}{6}—\frac{6}{6} = 32.$

According to Mr. Vassey, a writer upon the Ox Tribe, the Buffalo differs somewhat from the common ox (*Bos taurus*) in its anatomical structure, having only twelve joints in its tail, while the ox has twenty-one. In that division also of the back bone which contains what anatomists call the dorsal vertebræ, there are fourteen joints in the Buffalo and thirteen in the ox. And lastly the Buffalo has only five sacral vertebræ, while the ox has six; thus although the whole number of joints in the back bone, excluding the tail, is the same, yet their anatomical characters and distribution are somewhat different. A difference in the number of caudal vertebræ would not constitute a generic distinction, unless there were other points of variance. Adubon and Bachman's account of the genus is as follows:—

"Head, large and broad; forehead, slighty arched; horns, placed before the salient line of the frontal crest; tail, short; shoulders, elevated; hair, soft and woolly."

"The generic name is derived from Pliny, who applied the word Bison, Wild Ox, to one of the species on the Eastern continent.

"There are five species of Buffalo that may be conveniently arranged under this genus: one existing in the forests of Southern Russia, in Asia, in the Circassian Mountains, and the Desert of Kobi, one in Ethiopia and the forests of India, one on the mountains of Central Asia, one in Ceylon, and one in America. In addition to this the genus Bos, which formerly included the present, contains five well determined species: one inhabiting the country near the Cape of Good Hope, one in Central Africa, one in the Himalaya Mountains and the Birman Empire, one in India, and one in the forests of middle Europe." (Adubon and Bachman, vol. 2, page 32.)

BISON AMERICANUS.—Gmel.

SPECIFIC CHARACTERS.—*Forehead, broad; slightly arched horns, small, short, diverted laterally and upwards; tail, short; legs, slender; shoulders, elevated; hair, soft and woolly.*"

"This, the most gigantic of the indigenous mammalia of America, once overspread the entire southern half of the continent. At the time of the discovery by the Spaniards, an inhabitant even down to the shores of the Atlantic, it has been beaten back by the westward march of civilization, until, at the present day, it is only after passing the giant Missouri and the head-waters of the Mississippi that we find the American bison or buffalo. Many causes have combined to drive them away from their old haunts: the wholesale and indiscriminate slaughter by the whites, the extension of settlements, and the changes of the face of the country; but, above all, that mysterious dread of the white man, which pervades animal life in general as a congenital instinct."

"Still it would appear that the buffalo was originally confined within certain limits, which, perhaps, varied from time to time, as they certainly have done within comparatively a recent period. We have already referred to the fact of their existence on the

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NOTE.—The account of the Buffalo here given, is taken from a paper "on the ruminating animals of North America, and their susceptibility of domestication," by Professor S. F. Baird, of the Smithsonian Institution.—"Patent Office Report," Washington, 1851.

Atlantic coast; how far north they extended is not exactly known. Their existence in Pennsylvania, however, is substantiated by the occurrence of bones of this species in alluvial deposits of rivers, bogs, and caves. At the first settlement of Canada they were not known there. As to their southern range, Lawson speaks of their being found on Cape Fear River, in North Carolina. Theuet, in the very rare work entitled "Les Singularitez de la France antarctique," Paris, 1557, gives, (p. 147,) in a representation of a curious beast of West Florida, a readily recognisable figure of the buffalo. In the Hudson Bay country they did not pass east of the latitude of Red River; south they were found throughout the Mississippi valley, the South Atlantic States, Texas, and Mexico. Their western range was strictly limited to the Rocky Mountains, none extending beyond."

"At the present time none are found in the Atlantic States, nor even east of the Missouri, except in Minnesota, in the region of the upper Mississippi and the prairies of the Red River of the north. Their main range, however, is between the Missouri and the Rocky Mountains, from Texas and New Mexico to the Saskatchewan, and even as far north as Great Martin Lake, lat. 64°. Of late years they have found their way through the Rocky Mountains to the plains of the Columbia by the great middle pass, and north of this on the head-waters of the Saskatchewan."

"Imagination can scarcely realize the numbers of buffalo which, even now, are found on the western plains. It is not uncommon to see the prairies covered with them as far as the eye can reach; and travellers have passed through them for days and days in succession, with scarcely any apparent diminution in the mass. The paths worn in the plains resemble more the beaten highways of civilization than the mere aggregation of individual hoof-marks. As their routes are, in most cases, selected with the unerring instinct of animal existence, extending in a straight line from one convenient crossing-place of river or ravine to another, and taking the most available springs or streams in their course, they well justify the remark of Mr. Benton as to their agency in defining the high roads of travel across the prairies, for which they frequently serve almost without an alteration."

"Still, vast as these herds are, their numbers are much less than in earlier times, and they are diminishing with fearful rapidity. Every year sees more or less change in this respect, as well as alterations of their great line of travel. To the Indian, dependent

for the very necessaries of life upon the buffalo, these facts come home with stern reality. His existence is bound up inseparably with that of the race of buffalo, and every consideration of humanity to the one prompts a care over the other."

"If it were possible to enforce game-laws, or any other laws on the prairies, it would be well to attach the most stringent penalties against the barbarous practice of killing buffalo merely for the sport, or perhaps for the sake of the tongue alone. Thousands are killed every year in this way. After all, however, it is, perhaps, the Indian himself who commits the mischief most wantonly. A frequent mode of hunting the buffalo by them consists in making a "surround." This is done by enclosing a large herd and driving them over a precipice upon the rocks, or into one of the profound ravines which intersect the prairies in various directions. In this way thousands are sometimes killed in a single day. Fires in prairies, too, do their share in the work of destruction, either by their immediate agency or by driving the maddened animals into the ravines just referred to."

Mr. Picotte, an experienced partner of the American Fur Company, estimated the number of buffalo robes sent to St. Louis in 1850 at 100,000. Supposing each of the 60,000 Indians on the Missouri to use ten robes for his wearing apparel every year, besides those for new lodges and other purposes, by the calculation of Mr. Picotte we shall have an aggregate of 400,000 robes. We may suppose 100,000 as the number killed wantonly, or destroyed by fire or other causualties, and we will have the grand total of half a million of buffalo destroyed every year. This, too, does not include the numbers slaughtered on Red River, and other gathering points.

It is, perhaps, unnecessary to state that the American bison is not found in the Old World. A European species of the same genus, *Bos*, and closely allied, is the *Bos urus*, aurochs of Germany, urus of Cæsar, bonassus of Aristotle, and bison of Pausanius and Pliny. This species, once of rather wide range, is now confined to the country between the Caspian and the Black Sea, where it is protected from injury by the severest legislative enactments. Other species are found in various other parts of the world.

The skins of the American buffalo are dressed as follows: "After being taken off the animal, they are hung on a post, and the adhering flesh taken off with a bone toothed something like a saw. This is performed by scraping the skin downward, requiring much

labor. The hide is then stretched on the ground, and fastened down with pegs; it is then allowed to remain a day or two, or till dry. After this, the flesh side is pared down with the blade of a knife fastened in a bone, called a grate, which renders the skin even, and takes off about a quarter of its thickness. The hair is taken off with the same instrument; and these operations being performed, and the skin reduced to a proper thickness, it is covered over either with brains, liver, or grease, and left for a night. The next day the skin is rubbed and scraped, either in the sun or by a fire, until the greasy matter has been worked into it, and it is nearly dry; a cord is then fastened to two poles, and over this the skin is thrown, and pulled, rubbed, and worked till quite dry. After this it is sewed together around the edges, excepting at one end. A smoke is made with rotten wood in a hole dug in the earth, and the skin is suspended over it on sticks set up like a tripod, and thoroughly smoked; which completes the tanning, and renders it capable of bearing wet without losing its softness or pliability afterwards."

Buffalo robes are dressed in the same manner, excepting that the hair is not removed, and they are not smoked. They are generally divided into two parts; a strip is taken from each half on the back of the skin where the hump was, and the two halves, or sides, are sewed together, after they are dressed, with thread made of the sinews of the animal, and then the robe is ready for market.

One of the most useful applications of buffalo meat consists in the preparation of pemmican—an article of food of the greatest importance, from its portability and nutricious qualities. This is prepared by cutting the lean meat into thin slices, exposing it to the heat of the sun or fire, and, when dry, pounding it to a powder. It is then mixed with an equal weight of buffalo suet, and stuffed into bladders. Sometimes venison is used instead of buffalo beef. Sir John Richardson, while preparing for his recent Arctic expedition, found it necessary to carry with him pemmican from England. This he prepared by taking a round or buttock of beef, cut into thin steaks, from which the fat and membraneous parts were pared away, and dried in a kiln until the fibre of the meat became friable. It was then ground in a malt-mill, and mixed with nearly an equal weight of beef suet or lard. This completed the preparation of the plain pemmican; but to a portion raisins were added, and another portion was sweetened with sugar. These latter changes were subsequently highly

approved by the voyageurs. The pemmican was then placed in tin canisters, and well rammed down; and after the cooling and contraction of the mass, these were filled with melted lard through a small hole left in the end, which was then covered with a piece of tin, and soldered up. The total amount of beef used by Sir John Richardson amounted to 35,651 pounds; of lard, to 7549 pounds; of currants, to 1008 pounds; of sugar, to 280 pounds. These material constituted 17,424 pounds of pemmican, costing at the rate of 1 shilling 7½ pence (36 cents) per pound.

The meat biscuit of Mr. Borden, now manufactured from beef by him at Galveston in large quantities, is also of much economical importance.

We conclude our article, already extended to unreasonable length, by presenting an account of some domesticated buffaloes, which, better than any language of our own, will present the question of domestication in a proper light. It is taken from Audubon and Bachman's Quadrupeds, as furnished these gentlemen by Robert Wickliffe, Esq., of Lexington, Ky., who has tried the experiment fully.

"The herd of buffalo I now possess have descended from one or two cows that I purchased from a man who brought them from the country called the Upper Missouri. I have had them for about thirty years; but from giving them away, and the occasional killing of them by mischievous persons, as well as other causes, my whole stock at this time does not exceed ten or twelve. I have sometimes confined them in separate parks from other cattle, but generally they herd and feed with my stock of farm-cattle. They graze in company with them as gently as the others. The buffalo cows, I think, go with young about the same time the common cow does, and produce once a year. None of mine have ever had more than one at a birth.

"Although the buffalo, like the domestic cow, brings forth its young at different seasons of the year, this I attribute to the effect of domestication, as it is different with all animals in a state of nature. I have always heard their time for calving in our latitude was from March until July; and it is very obviously the season which nature assigns for the increase of both races, as most of my calves were from the buffaloes and common cows at this season. On getting possession of the tame buffalo, I endeavored to cross them as much as I could with my common cows, to which experiment I found the tame or common bull unwilling to accede; and

he was always shy of a buffalo cow, but the buffalo bull was willing to breed with the common cow.

"From the common cow I have several half breeds, one of which was a heifer. This I put with a domestic bull, and it produced a bull calf. This I castrated, and it made a very fine steer, and when killed produced very fine beef. I bred from this same heifer several calves, and then, that the experiment might be perfect, I put one of them to the buffalo bull, and she brought me a bull-calf, which I raised to be a very fine, large animal,—perhaps the only one to be met with in the world of this blood, viz: a three-quarter, half-quarter, and half-quarter of common blood. After making these experiments, I have left them to propagate their blood themselves, so that I have only had a few half-breeds, and they always prove the same, even by a buffalo bull. The full-blood is not as large as the improved stock, but as large as the ordinary stock of the country. The crossed or half-blood are larger than either the buffalo or common cow. The hump, brisket, ribs, and tongue of the full and half blooded are preferable to those of the common beef; but the round and other parts are much inferior. The udder or bag of the buffalo is smaller than that of the common cow; but I have allowed the calves of both to run with their dams upon the same pasture, and those of the buffalo were always the fattest; and old hunters have told me that when a young buffalo calf is taken it requires the milk of two common cows to raise it. Of this I have no doubt, having received the same information from hunters of the greatest veracity. The bag or udder of the half-breed is larger than that of the full-blooded animals, and they would, I have no doubt, make good milkers.

"The wool of the wild buffalo grows on their descendants when domesticated, but I think they have less wool than their progenitors. The domesticated buffalo still retains the grunt of the wild animal, and is incapable of making any other noise, and they still observe the habit of having select places within their feeding-grounds to wallow in.

"The buffalo has a much deeper shoulder than the tame ox, but is lighter behind. He walks more actively than the latter, and I think has more strength than a common ox of the same weight. I have broken them to the yoke, and found them capable of making excellent oxen; and for drawing wagons, carts, or other heavily-laden vehicles, on long journeys, they would, I think, be greatly preferable to the common ox. I have as yet had no

opportunity of testing the longevity of the buffalo, as all mine that have died did so from accident, or were killed because they became aged. I have some cows that are nearly twenty years old, that are healthy and vigorous, and one of them has now a sucking-calf. The young buffalo calf is of a sandy-red or rufous color, and commences changing to a dark brown at about six months old, which last color it always retains. The mixed breeds are of various colors. I have had them striped with black on a gray ground, like the zebra; some of them brindled red; some pure red, with white faces; and others red, without any markings of white. The mixed bloods have not only produced in my stock from the tame and buffalo bull, but I have seen the half bloods reproducing, viz: those that were the product of the common cow and wild buffalo bull. I was informed that, at the first settlement of the country, cows that were considered the best for milking were from the half-blood down to the quarter, and even eighth, of the buffalo blood. But my experiments have not satisfied me that the half buffalo bull will produce again. That the half-breed heifer will be productive from either race, as I have before stated, I have tested beyond the possibility of doubt.

" The domesticated buffalo retains the same haughty bearing that distinguishes him in his natural state. He will, however, feed or fatten on whatever suits the tame cow, and requires about the same amount of food. I have never milked either the full blood or mixed breed, but have no doubt they might be made good milkers, although their bags or udders are less than those of the common cow; yet, from the strength of the calf, the dam must yield as much, or even more, milk than the common cow. "

ARTICLE XLIX.—*On the Musk Ox, (Ovibos moschatus.)*

The Musk-Ox, the most remarkable member of the whole Ox Tribe, is strictly confined to the Arctic portion o the British Provinces lying far north of Canada. The geographical range of the species is so distant from any climate endurable by civilized man, that it appears to be beyond the reach of even the Hudson's Bay Company. That an animal possessing the same arrangement of teeth as the domestic ox, and in other respects but very slightly differing from the comparatively helpless creature that man has made his servant, should be capable of leading a happy life amid

the perpetual ice and snow of the Arctic Circle, shews how a single delicate turn of the Creator's hand can adapt organic structures almost exactly similar, to very opposite conditions of existence. When we compare the musk ox with the common ox, and reflect upon the vast space that separates them, we can no longer wonder that the extinct elephant could have lived in Siberia, where its representatives of our day would have perished in a single season. The dental formula of the musk-ox is the same as that of the buffalo: incisive, $\frac{0}{8}$; canine, $\frac{0}{0}—\frac{0}{0}$; molar, $\frac{6}{6}—\frac{6}{6} = 32$. The horns spring out of the top of the head, being in contact at their bases, bent down the sides of the neck, then curved upwards. The body is low, and compactly built.

General colour of the hair, brown, long, matted, and rather curled on the neck and between the shoulders, where it is rather grizzled; on the back and hips, long but lying smoothly; on the shoulders, sides, and thighs, it is so long as to hang down below the middle of the leg. There is on the centre of the back a mark of a soiled brownish-white, called by Captain Parry the saddle. On the throat and chest the hair is very straight and long, and together with the long hair on the lower jaw, hangs down like a beard and dewlap. The short tail is concealed by the fur of the hips. There is a large quantity of fine brownish ash-coloured wool or down among the hair covering the body. The hair on the legs is short, dull brownish-white, unmixed with wool. The hoofs are longer than those of the caribou, but so similar in form that it requires the eye of a practised hunter to distinguish the impressions. In the cow, which is smaller than the bull, the horns are smaller, and their bases, instead of touching, are separated by a hairy space. The hair on the throat and chest is also shorter.

This is the Bœuf Musqué of Jeremie; Musk Ox of Drage, Dobbs, Ellis, Pennant, Hearne, and Parry; *Bos moschatus* of Gmelin, Sabine, and Richardson, (Parry's "Second Voyage;") Matech Moostoos (Ugly Bison) of the Cree Indians; Adgiddah-yawseh (Little Bison) of the Chepewyans and Copper Indians; and Oomingmak of the Esquimaux.

The barren lands of America lying to the northward of the 60th parallel are the principal habitations of the musk ox. Tracks were once seen by Hearne within a few miles of Fort Churchill, in lat. 59°; and he saw many in his first northern journey, in about lat. 61°. Richardson was informed that they

do not now come so far to the southward, even on the Hudson's Bay shore; and he adds that farther to the westward they are rarely seen in any numbers lower than lat. 67°, although, from portions of their skulls and horns which are occasionally found near the northern borders of the Great Slave Lake, he thinks it probable that they ranged at no very distant period over the whole country lying between that great sheet of water and the Polar Sea. He had not heard of their having been seen on the banks of Mackenzie's River to the southward of Great Bear Lake, and he states that they do not come to the south-western end of that lake, although they existed in numbers on its north-eastern arm. "They range," continues he, "over the islands which lie to the north of the American continent, so far as Melville Island, in lat. 75°, but they do not, like the rein-deer, extend to Greenland, Spitzbergen, or Lapland. From Indian information we learn that to the westward of the Rocky Mountains, which skirt the Mac-Kenzie, there is an extensive tract of barren country, which is also inhabited by the musk ox and reindeer. It is to the Russian traders that we must look for information on this head; but it is probable that, owing to the greater mildness of the climate to the westward of the Rocky Mountains the musk ox, which affects a cold barren district, where grass is replaced by lichens, does not range so far to the southward on the Pacific coast as it does on the shores of Hudson's Bay. It is not known in New Caledonia, nor on the banks of the Columbia, nor is it found on the Rocky Mountain ridge at the usual crossing places near the sources of the Peace, Elk, and Saskatchewan Rivers. It is therefore fair to conclude that the animal described by Fathers Marco de Niça and Gomara as an inhabitant of New Mexico, and which Pennant refers to the musk ox, is of a different species. The musk ox has not crossed over to the Asiatic shore, and does not exist in Siberia, although fossil skulls have been found there of a species nearly allied, which has been enumerated in systematic works under the name of *Ovibos [illegible]ianus*. The appearance of musk oxen on Melville Island in the month of May, as ascertained on Captain Parry's first voyage, is interesting, not merely as a part of their natural history, but as giving us reason to infer that a chain of islands lies between Melville Island and Cape Lyon, or that Wollaston and Banks' Lands form one great island, over which the migrations of the animals must have been performed. The districts inhabited by the musk ox are the proper lands of the Esquimaux;

and neither the northern Indians nor the Crees have an original name for it, both terming it Bison with an additional epithet."

Sir John Richardson, who had the best opportunities of coming at the truth, informs us that the country frequented by the musk ox is mostly rocky, and destitute of wood, except on the banks of the larger rivers, which are more or less thickly clothed with spruce trees. Their food, he tells us, is similar to that of the caribou, grass at one season and lichens at another; and the contents of its paunch are eaten by the natives with the same relish as that with which they devour the "nerrooks" of the caribou. The dung is voided in round pellets, which are larger than those which come from the caribou. The animal runs fast, short as are its legs, and hills and rocks are easily climbed by this ox of the northern deserts. One pursued by Richardson's party on the banks of the Coppermine River scaled a lofty sand-cliff with so great a declivity that they were obliged to crawl on hand and knees to follow the chase. The musk oxen assemble in herds of from twenty to thirty, are in their rut about the end of August and beginning of September, and bring forth one calf about the latter end of May or beginning of June. Hearne accounts for the few bulls which are seen by supposing that they kill each other in their contest for the cows.

Richardson thus graphically describes the terror of a huddled herd:—"If the hunters keep themselves concealed when they fire upon a herd of musk oxen, the poor animals mistake the noise for thunder, and, forming themselves into a group, crowd nearer and nearer together, as their companions fall around them; but should they discover their enemies by sight, or by their sense of smell, which is very acute, the whole herd seek for safety by instant flight. The bulls, however, are very irascible, and, particularly when wounded, will often attack the hunter, and endanger his life, unless he possesses both activity and presence of mind. The Esquimaux, who are well accustomed to the pursuit of this animal, sometimes turn its irritable disposition to good account; for an expert hunter having provoked a bull to attack him, wheels round it more quickly than it can turn, and by repeated stabs in the belly puts an end to its life."

Mr. Jeremie, who first brought the animal into notice, carried some of its wool to France, where some stockings were made of it, said to have been equal to the finest silk. Sir John Richardson says that this wool resembles that of the Bison, but is perhaps

finer, and would in his opinion be highly useful in the arts, if it could be procured in sufficient quantity. The same author informs us that when the animal is fat its flesh is well tasted, and resembles that of the caribou, but has a coarser grain. The flesh of the bulls is high flavoured, and both bulls and cows when lean smell strongly of musk, their flesh at the same time being very dark and tough, and certainly far inferior to that of any other ruminating animal in North America. The carcass of a musk ox weighs, exclusive of the offal, about three hundred-weight, or nearly three times as much as a barren-ground caribou, and twice as much as one of the woodland caribou. (Richardson, "Fauna Borealia-Americana," English Cyclopedea, &c.)

ARTICLE L.—*The Rocky Mountain Sheep.* (*Ovis montana.*)

GENUS OVIS.—Linn.

Dental Formula.

Incisive $\frac{6}{8}$; *Canine* $\frac{0}{0}—\frac{0}{0}$; *Molar* $\frac{6}{6}—\frac{6}{6} = 32$.

"Horns, common to both sexes; sometimes wanting in the females; they are voluminous, more or less angular-transversely wrinkled, turned laterally in spiral directions, and enveloping an osseous arch, cellular in structure.

"They have no lachrymal sinus, no true beard to the chin; the females have two mammæ; tail, rather short; ears, small, erect; legs, rather slender; hair, of two kinds, one hard and close, the other woolly; gregarious. Habit, analagous to the goats. Inhabit the highest mountains of the four quarters of the globe.

"The generic name is derived from the Latin *ovis*, a sheep.

"There are four well determined species: one, the mouflon of Buffon, musmon (*ovis musmon,*) is received as the parent of the domesticated races; it is found in Corsica, Sardinia, and the highest mountain chains of Europe; one inhabiting the mountains and steppes of northern Asia, Tartary, Siberia and the Kurile Islands; one the mountains of Egypt, and one America."

Ovis Montana—Desm.

Rocky Mountain Sheep or Big Horn.

"Specific Characters.—*Longer than the domestic sheep; horns of the male, long, strong and triangular; those of the female, com-*

pressed; colour, deep rufous gray, a large white disk on the rump." (Audubon and Bachman, vol. 2, page 163.)

The Rocky Mountain sheep is the only animal of the genus indigenous to North America, and is confined in its distribution strictly to the range of mountains from which it takes its name. It occurs as far north as latitude 60° and frequents the highest peaks of the mountains southward to California. In the far West there is an extraordinary tract of country called by the French Canadian hunters "mauvaises terres," covered over with thousands of conical hills, so narrow at the base and so high that they resemble a collection of vast irregular sugar loaves. These hills are composed of horizontal strata of hardened clay, coal and earth mixed with petrified shells, bones and plants. The same strata, recognized by their colour or composition, are seen in all the hills at the same elevation, thus proving that the valleys have been excavated by running water or some other cause, leaving the hundreds of tall pillar-like eminences as so many islands in the cavity of a sea that has become empty of its waters.

The Rocky Mountain sheep loves to climb the highest pinnacles of the "mauvaises terres," where neither the prowling wolf nor the wandering hunter can reach or ascend. It is said that they are so sure-footed that they run at full speed along narrow ledges in the face of perpendicular precipices, five hundred or more feet above the plain. They form paths around the lofty clay cliffs that are sometimes six to eight hundred feet or even fifteen hundred feet high, and mounting to the summit bid defiance to all enemies. One would scarcely suppose that the clumsy foot of a cow was the best adapted for climbing almost perpendicular walls, and yet we find that among the best climbers are the goats and the sheep, with feet constructed upon exactly the same plan. The adaptations of nature consist not only in the contrivance of organic structures, but in the faculty of applying these to most varied purposes, in order to attain certain desired ends.

The Rocky Mountain sheep is described as resembling a deer with the head of a large ram. "The horns are of immense size, being nearly three feet in length, and with their bases so large that they occupy the whole of the upper part of the head. They form a regular curve, first backwards, then downwards and outwards, the extremities being eighteen inches apart. They are flattened on the sides and deeply corrugated, the horns rising immediately behind.

"The ears and tail are short; the hair bears no resemblance to wool, but is similar to that of the American elk or reindeer. It is slighty crimped throughout its whole length, two inches in length on the back, and one inch and a-half on the sides. The general colour of the animal is greyish brown, but with the rump and belly greyish white. The tail and hoofs are black.

"The female resembles some of the finest specimens of the common ram. The neck is a little longer, as are also the head and legs, and in consequence it stands much higher. Its horns resemble more those of the goat than the sheep; in fact, whilst the fine erect body of the male reminds one of a large deer with the head of a ram, while the female looks like a fine specimen of antelope.

"They are shy, wary and most difficult of approach, and when wounded run up the precipice, where they die in places inaccessible to the hunter. They are gregarious, being often seen in flocks of from twenty to thirty. In the winter and spring the females and the young males band together. The ewes bring forth in June and July one or two at a birth. The old rams fight terrific battles with each other. It is said that they sometimes spring from the rocks and alight on their head upon the earth below without injury, the elasticity of their horns breaking a portion of the violence of the shock, while the strength of the neck, which in the sheep tribe is formed to resist violent concussions, is sufficient to withstand the remainder.

"Where they have often been fired at, they alarm their companions by a loud hissing noise, when the whole flock take to flight, and when once they get a view of the hunter they remain on the watch during the whole of that day. The flesh is compared to that of the most delicious venison. Like the deer they are fond of mineral waters, and are in the habit of paying daily visits to springs or caves in the mountains where saline efflorescences abound. Their food consists of grasses, tender vines and leaves.

"Although found in the British possessions, this animal does not descend into the plain country of the Hudson's Bay Territory, and it is not therefore made an article of commerce by the traders, for which in fact no part of the animal, except the skin and the head as a curiosity, could be of value."

"This animal has been known to Europeans since 1697, when Father Picolo, a Catholic missionary to California, represented it

"as large as a calf of one or two years old; its head, much like that of a stag, and its horns, which are very large, like those of a ram; its tail and hair, speckled, and shorter than a stag's, but its hoof is large round, and cleft as an ox's. I have eaten of these beasts, he says, and their flesh is very tender and delicious."

Dr. Gray, in his British Museum Catalogue, divides the Sheep Tribe into four genera, *Ovis*, *Caprovis*, *Pseudovis* and *Ammotragus*. To the first belongs the domestic sheep, *Ovis aries*, which contains thirty-three varieties. To the second belongs the Rocky Mountain sheep, and he calls it *Caprovis Canadensis*. There is a variety of species in California which some authors, but it appears without sufficient grounds, consider a distinct species, and they call it *Ovis Californica*. There is, however, in the opinion of AUDUBON and BACHMAN, who are certainly the best authorities on the viviparous quadrupeds of North America, no reason for the separation.

ARTICLE LI.—*On the Skunk, (Mephitis chinga.)*

GENUS MEPHITIS.—CUV.

DENTAL FORMULA.

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

GENERIC CHARACTERS.—Canine teeth, very strong, conical; two small anterior cheek teeth or false molars above, and three below, on each side; the superior tuberculous teeth, very large, as broad as they are long; inferior molars, having two tubercles on the inner side; head, short; nose, somewhat projecting; snout, in most of the species blunt.

Feet, with five toes; toes on the fore-feet, armed with long curved nails, indicating the habit of burrowing in the earth; heel, very little raised in walking.

Hairs on the body usually long, and on the tail very long.

The anal glands secrete a liquor which is excessively fetid. The various species of this genus burrow in the ground, or dwell in fissures of rocks, living on poultry, birds' eggs, small quadrupeds and insects. They move slowly, and seldom attempt to run from man, unless they chance to be near their burrows. They are, to a considerable extent, gregarious, large families being occasionally found in the same hole.

In the recent work of Dr. Lichenstein, (Ueber die Gattung Mephitis, Berlin, 1838,) seventeen species of this genus are enumerated, one of which is found at the Cape of Good Hope, two in the United States of America, and the remainder in Mexico and South America.

The generic name, *Mephitis*, is derived from the Latin word *mephitis*, a strong odour.

Mephitis Chinga.

Specific Characters.—*Size of a cat; general colour, blackish-brown, with white longitudinal stripes on the back; many varieties in its white markings; tail long and bushy.*—(Audubon and Bachman, vol. 1, page 317.)

This little animal has a broad, fleshy body, wider at the hips than at the shoulders, long coarse fur, and short legs. The head is small; nose, obtuse, covered with hair to the snout, which is naked; ears, short, broad and rounded; feet, broad, covered with hair, concealing the nails; palms, naked; trunk of tail, nearly half as long as the body. The hair on the tail is very long and bushy; the general colour blackish-brown; a white stripe commences on the nose, and runs to the top of the head; another patch of white on the back of the neck, and two stripes of the same on each side of the back. Sometimes the tail is tipped with white, but the amount of this colour varies a good deal on the different individuals.

The skunk is carnivorous, its prey being small birds, eggs, insects, mice, frogs and lizards. It is particularly destructive in the poultry yard. Like the fox, it burrows in the ground, but generally in a flat surface, rather than in the side of a hill, as is the habit with the former. These holes extend from six to eight feet horizontally, about two feet beneath the surface, and terminate in a chamber of considerable dimensions, where there is a large and comfortable bed of dry leaves. In this apartment, during winter, a number of skunks, sometimes, it is said, from five to fifteen, may be found snugly coiled up. Some of the dens have several entrances to the principal chamber. They retire to their holes in the latter end of autumn, and do not come out again until spring, like the bear, supporting existence upon the fat accumulated during the summer season. In the Southern States they are at large during the whole year, the climate being sufficiently warm during the winter months to suit their organization.

Although, in self-defence, capable of emitting an odour perhaps the most offensive in nature, yet the skunk is an exceedingly cleanly animal, and although a dozen may be concealed in a single burrow, yet not the slightest unpleasant smell can be detected at the entrance. The flesh is eaten by the Indians, and pronounced by them superior to that of the raccoon or opossum.

"The offensive fluid is contained in two small sacks, situated on each side of the roots of the tail, and is ejected through small ducts near the anus. When the skunk is irritated, or finds it necessary to defend himself, he elevates his tail over his back, and, by a strong muscular exertion, ejects it in two thread-like streams in the direction in which the enemy is observed. He appears to take an almost unerring aim, and almost invariably salutes a dog in his face and eyes. He can throw the fluid five yards or more. The notion of the old authors, that this fluid is the urine thrown to a distance by the aid of his long tail, is erroneous. The skunk never permits a drop to touch his fur, and while defending himself his tail is carefully thrown up over his back. It is only after being worried by dogs that the smell is perceived on the body of the animal, as well as upon his destroyers. If suddenly killed by a shot through a vital part, the skunk has no smell, and may be skinned with less inconvenience to the olfactory organ than would be experienced from skinning a mink or marten."

The young are produced in the early part of the spring, and from five to nine in a litter.

This species of skunk is found all over the British possessions, as high as 57° north, and ranges south to Kentucky, Carolina, and Alabama. It is rather common in Upper and Lower Canada.

In the month of April last we found a skunk in the Rideau Canal, which had apparently been drowned in attempting to swim across; and, a few days after, another was shot by Mr. Lett, of Ottawa. We have the skulls of both.

Audubon, from whose writings we have gleaned the greater portion of the above, says, that to capture a skunk was one of his first attempts at a collection of natural history, and he thus eloquently describes the result:—

"There is no quadruped on the continent of North America the approach of which is more generally detested than that of the skunk; from which we may learn, that although from the great and the strong we have to apprehend danger, the feeble and apparently insignificant may have it in their power to annoy almost

beyond endurance. In the human species we sometimes perceive that a particular faculty has received an extraordinary development, the result of constant devotion to one subject, whilst in other respects the mind of the individual is of a very ordinary character. The same remark will hold good applied to any particular organ of the body, which, by constant use (like the organs of touch in the blind man,) becomes so improved as to serve as a substitute in others; but in the lower orders of animals this prominence in a particular organ is the result of its peculiar conformation, or of instinct. Thus, the power of the rhinoceros is exerted chiefly by his nasal horn; the wild boar relies for defence upon his tusks; the safety of the kangaroo depends on his hind feet, which not only enable him to make extraordinary leaps, but with which he deals vigorous blows; the bull attacks his foes with his horns; the rattlesnake's deadly venom is conveyed through its fangs; and the bee has the means of destroying some of its enemies by its sting; whilst in every other power, for attack or self-defence, these various creatures are comparatively feeble.

"The skunk, although armed with claws and teeth strong and sharp enough to capture his prey, is slow on foot, apparently timid, and would be unable to escape from many of his enemies, it he were not possessed of a power by which he often causes the most ferocious to make a rapid retreat, run their noses into the earth, and roll or tumble on the ground as if in convulsions; and not unfrequently, even the bravest of our boasting race is by this little animal compelled to break off his train of thought, *hold his nose*, and run, as if a lion were at his heels!

"Among the first specimens of natural history we attempted to procure was the skunk; and the sage advice to "look before you leap" was impressed on our mind, through several of our senses, by this species.

"It happened in our early school-boy days, that once, when the sun had just set, as we were slowly wending our way home from the house of a neighbour, we observed in the path before us a pretty little animal, playful as a kitten, moving quietly along; soon it stopped, as if waiting for us to come near, throwing up its long bushy tail, turning round and looking at us like some old acquaintance; we pause and gaze: what is it? It is not a young puppy or a cat; it is more gentle than either; it seems desirous to keep company with us, and like a pet poodle, appears most happy when only a few paces in advance, preceding us, as if to

shew the path; what a pretty creature to carry home in our arms! It seems too gentle to bite; let us catch it. We run towards it; it makes no effort to escape, but waits for us; it raises its tail, as if to invite us to take hold of its brush; we seize it instanter, and grasp it with the energy of a miser clutching a box of diamonds; a short struggle ensues,—when faugh! we are suffocated; our eyes, nose and face are suddenly bespattered with the most horrible fetid fluid. Imagine to yourself, reader, our surprise, our disgust, the sickening feelings that almost overcome us. We drop our prize and take to our heels, too stubborn to cry, but too much alarmed and discomfited, just now, to take another look at the cause of our misfortune, and effectually undeceived as to the real character of this seemingly mild and playful little fellow."

The principal synonym of this species is *Mephitis Americana.* The name *Chinga* was given by Tiedimann, in 1808. As we have not access to that work, we cannot give the etymology of the word, unless it is derived from the Greek verb *chenga*, to pour out or diffuse.

ARTICLE LII.—*On the Canada Porcupine,* (*Hystrix dorsata.*)

GENUS HYSTRIX.—Linn.

Dental Formula.

Incisive, $\frac{2}{2}$; *Canine*, $\frac{0}{0}$—$\frac{0}{0}$; *Molar*, $\frac{4}{4}$—$\frac{4}{4}$ = 20.

Superior incisors on the anterior portion, smooth, cruciform at their extremity; inferior incisors, strong and compressed; molars, compound, with flat crowns, variously modified by plates of enamel, between which are depressed intervals. Head, strong; snout, thick and turned; ears, short and round; tongue, bristled with scaly spines; fore-feet, four-toed; hind feet, five-toed; all the toes armed with powerful nails.

Spines on the body, sometimes intermixed with hairs; tail, moderately long, in some species of the genus prehensile. Herbivorous, feeding principally on grain, fruits, roots and the bark of trees; dig holes in the earth, or nestle in the hollows of trees.

The generic name is derived from the Greek word *hustrix*, a porcupine; *hus*, a hog, and *trix*, a bristle. There are two species in North, and three in South America, one in Southern Europe, one in Africa, and one in India.

HYSTRIX DORSATA.—Linn.

CANADA PORCUPINE.

SPECIFIC CHARACTERS.—*Spines, short, partially concealed by long hairs; no mane; long bristles on the head and neck; colour varying between light brown and black.*

The porcupine, of all North American quadrupeds, possesses the strangest peculiarities in its organization and habits. In its movements it is the most sluggish of all our species. Although the skunk is slow of foot, he would prove in contemptible competition with it in a trial of speed. Under such circumstances the inquiry arises, what protection has this animal against the attacks of the wolverene, the lynx, the wolf and the cougar, and how long will it be before it becomes totally exterminated? But a wise Creator has endowed it with powers by which it can bid defiance to the whole ferine race, the grisly bear not excepted. If the skunk presents to its enemies a formidable battery, that stifles and burns at the same time, the porcupine is clothed in an impervious coat of mail glistening with bayonets.

This wonderful animal is found throughout North America from Labrador to the Rocky Mountains, and as far north as latitude 67°, on the Mackenzie River. Southerly, it ranges to the latitude of the northern parts of Pennsylvania, and is occasionally met with in Ohio. We are informed that in Gaspé, at the mouth of the St. Lawrence, it is very abundant. It exists, but not plentifully, in all parts of Upper and Lower Canada.

Its food is exclusively vegetable, and, like the beaver, in the winter season, it feeds upon the bark of trees. For this purpose nature has provided feet armed with long, strong and sharp claws, by the aid of which the porcupine readily ascends trees of all dimensions. The bark of the small ones, however, appears to furnish the favorite food, and these are completely stripped and destroyed. It is said that a single porcupine will destroy all the young trees on several acres of ground in one winter season. A writer (Cartwright) says: "When he mounts into a tree he does not come down until he has eaten the bark from the top to the bottom. He generally makes his course through the wood in a straight direction, seldom missing a tree, unless such as are old. He loves young ones best, and devours so much (only eating the inner part of the rind) that I have frequently known one porcupine to ruin nearly a hundred trees in a winter. A man who is

acquainted with these animals will seldom miss finding them when the snow is on the ground. If he can hit upon the rinding of that winter, by making a circuit around the barked trees, he will soon come on his track, unless a very deep snow should have chanced to fall after his last ascent. Having discovered that, he will not be long ere he find the animal."

In reference to the manner in which the porcupine defends itself with its quills, the same writer says:—"It is a received opinion that a porcupine can dart his quills at pleasure into a distant object; but I venture to affirm that this species cannot, (whatever any other may do,) for I have taken much pains to discover this fact. On the approach of danger he retreats to a hole, if possible; but where he cannot find one he seizes upon the best shelter that offers, sinks his nose between the forelegs, and defends himself by a sharp stroke of his tail or a sudden jerk of his back. As the quills are bearded at their points, and not deeply rooted in the skin, they stick firmly into whatever they penetrate; great care should be taken to extract them immediately, otherwise, by the muscular motion of the animal into which they are stuck, enforced by the beards of the quills, they soon work themselves quite through the part; but I never perceived the puncture attended with any worse symptoms than that of a chirurgical instrument."

A pet porcupine kept by Audubon "was occasionally let out of its cage to enjoy the benefit of a promenade in the garden. It had become very gentle, and evinced no spiteful propensities; and when its master called it, holding out at the time a sweet potatoe or apple, it would turn its head slowly towards him with a mild and wistful look, and then with a stately step advance and take the fruit from his hand. It then assumed an upright position, and conveyed the potatoe or apple to its mouth with its paws. When plagued it never evinced any spirit of resentment; but if a dog made his appearance, then in a moment it was armed at all points in defence. It would bend its nose downwards, erect its bristles, and, by a threatening sideway movement of the tail, give evidence that it was ready for the attack."

"A large, ferocious and exceedingly troublesome mastiff, belonging to the neighbourhood, had been in the habit of digging a hole under the fence and entering the garden. Early one morning he was observed making a dash at some object in the corner of the fence, which proved to be the porcupine, which had made its escape from the cage during the night. The dog seemed

regardless of its threats, and, probably supposing it to be an animal not more formidable than a cat, sprung upon it with open mouth. The porcupine seemed to swell up in an instant, to double its size, and as the dog pounced upon it, it dealt him such a sidewise lateral blow with its tail as caused the mastiff to relinquish his hold instantly, and set up a loud howl in an agony of pain. His mouth, tongue and nose were full of porcupine quills. He could not close his jaws, but hurried open-mouthed out of the premises. It proved to him a lesson for life; as nothing could ever afterwards induce him to revisit a place where he had met with such an unneighbourly reception. Although the servants immediately extracted the spines from the mouth of the dog, his head was much swelled for several weeks afterwards, and it was two months before he finally recovered.

"The porcupine ate almost any kind of vegetable food presented to it,—cabbages, turnips, potatoes, apples, and even bread, and it usually cut to pieces everything placed in the cage that it could not consume. There was a large sweet bay tree in the garden, and the instant the door of the cage was opened, the porcupine would make its way to this tree, and not only feed greedily upon its bark, but on its leaves also. When once it was fixed upon the tree it was exceedingly difficult to induce it to come down, and on such occasions only would it turn and growl at its master. At night it was occasionally heard to utter a shrill note, that might be called a low querulous shriek. This animal was kept in confinement at Charleston, in the Southern States, in a climate much warmer than that of its natural habitat, and as the hot season came on, the poor thing would lie for hours panting in the cage, lost its appetite, and died during the summer."

The nest of the porcupine is constructed in a hollow tree, or in small caves under rocks. The young are produced in April or May, generally two at a litter. Sometimes three, and even four, have been found in a nest. The flesh is eaten, and tastes somewhat like flabby pork. The Indians make considerable use of the quills, in ornamenting moccasins, shot-pouches, or birch-bark baskets, for which purpose they are dyed of various colours.

The following account of this singular creature is principally from Audubon and Bachman:—

"The body of this species is thick, very broad, cylindrical, and, to a high degree, clumsy. The back is much arched in a curve from the nose to the buttocks, when it declines in an angle to the tail.

"The whole upper surface of the body, from the nose to the extremity of the tail, is covered by long and rather coarse hair, intermixed with a dense mass of spines or quills. These are of a cylindrical shape, very sharp at the extremity, and pointed at the roots. The animal is capable of erecting them at pleasure, and they are detached at the slightest touch. They are barbed with numerous small reversed points or prickles, which, when once inserted in the flesh, will, by the mere movement of the limbs, work themselves deeper into the body. There seems to be in certain parts of the body of this species a regular gradation from hair to spines. These spines continue to lengthen on the hinder parts of the head, to increase in size on the shoulders, and are longer and more rigid on the buttocks and thighs. In specimens of old animals the whole upper surface of the body is covered by a mass of quills, with their tufts of long hairs, six inches in length, on the forehead, shoulders, and along the sides.

"Head, rather small for the size of the animal, and very short; nose, truncated, broad, flattish above, and terminating abruptly; the eyes are lateral and small; ears, small, rounded, covered by short fur, and concealed by the adjoining long hair; incisors, large and strong.

"Legs, very short, and rather stout; claws, tolerably long, compressed, moderately arched and channelled beneath.

"There are tufts of hair situated between the toes; palms, naked and nearly oval, hard and tuberculous; on the fore feet there are four short toes, the second, counting from the inside, longest, the third a little smaller, the first a size less, and the fourth smallest; on the hind foot there are five toes, with claws corresponding to those on the fore foot. The hairs are so thickly and broadly arranged along the sides of the soles that they give a great apparent breadth to the foot, enabling this clumsy animal to walk with greater ease on the snow. It is plantigrade, and, like the bear, presses on the earth throughout the whole length of the soles. Tail, short and thick, covered above with spines, beneath with long rigid hairs; when walking or climbing it is turned a little upwards.

"The colour of the incisors, or cutting teeth, is deep orange; whole upper surface blackish-brown, interspersed with long hairs, many of them being eight inches in length; these hairs are four-fifths of their length dark-brown, with the points from one to two inches wide. There are also long white hairs interspersed under

the fore legs, on the chest, and along the sides of the tail. The spines, or quills, which vary in length from one to four inches, are white from the roots to near their points, which are generally dark-brown or black, frequently brown and occasionally white. On some specimens the spines are so abundant, and protrude so far beyond the hair, that portions of the body, especially the hips, present a speckled appearance, owing to the preponderance of the long white quills tipped with black. The nails and the whole under surface are dark-brown."

There is a considerable difference both in the size and colour of different specimens. The length of the head and body is about 30 inches, of the tail (vertebræ) 7, to the end of the hair; 8½, breadth of nose, 1½; from heel to longest nail, 3½. Audubon mentions a specimen in his possession, from Missouri, which was 13 inches broad on the back. Some of them are quite black, others greyish; when the quills are very long, they appear to be speckled with white when seen at a short distance.

ARTICLE LIII.—*On the Northern Hare,* (*Lepus Americanus.*)

GENUS LEPUS.—Linn.

Dental Formula.

Incisive, $\frac{4}{2}$; *Canine,* $\frac{0}{0}—\frac{0}{0}$; *Molar,* $\frac{6}{5}—\frac{6}{5} = 28$.

Upper incisors, in pairs, two in the front, large and grooved, and two immediately behind, small; lower incisors, square; molars, with flat crowns and transverse laminæ of enamel; interior of the mouth, and soles of the feet, furnished with hair; ears and eyes, large; fore feet, with five toes; hind feet, with only four; hind legs, very long; tail, short; mammæ, from six to ten. The word *lepus* is derived from the Latin *lepus,* and Greek Æolic *leporis* a hare.

There are about thirty known species of this genus, of which rather the largest number (perhaps sixteen or seventeen species) exist in North and South America, while the remainder belong to the Eastern Continent.

Two species occur in British North America, of which that common in Canada, and somewhat famous from the amount of discussion it has received from Naturalists, is *Lepus borealis.* It occurs plentifully in all parts of the country, and especially in the

neighbourhood of Montreal. Those exposed for sale in the market of that city are, just now, 1st December, changing from the summer to the winter colour, some of them being white and others brown.

LEPUS AMERICANUS.—Erxleben.

SPECIFIC CHARACTERS.—*Length, about* 20 *inches from the point of the nose to the root of the tail; colour, in summer, reddish-brown above, white beneath; in winter, white; roots of the hairs, blue, nearer the surface, fawn colour, and the tips white; ears, a little shorter than the head.*

The following is a portion of the long and excellent article, in Audubon and Bachman, on the natural history of this animal. The remainder, consisting of a discussion upon the identity of the species, we shall give in some future number :—

SYNONYMES.

LIEVRE, (Quenton Malisia,) Sagard Theodat, Canada, p. 747, 1636.
SWEDISH HARE, Kalm's Travels in North America, vol. ii., p. 45, 1749.
AMERICAN HARE, Philos. Trans., London, vol. lxii., pp. 11, 376, 1772.
LEPUS AMERICANUS, Erxleben, Syst. Regni Animalis, p. 330, 1777.
" NANUS, Schreber, vol. ii., p. 881, pl. 234, fig.
" HUDSONIUS, Pallas, Glires, pp. 1, 30.
VARYING HARE, Pennant, Arct. Zool., vol. i., p. 95.
LEPUS VIRGINIANUS, Harlan, Fauna, p. 196, 1825.
" VARIABILIS, var. Godman, Nat. Hist., vol. ii., p. 164.
AMERICAN VARYING HARE, Doughty, Cabinet Nat. Hist., vol. i., p. 217, pl. 19. Autumn pelage.
THE NORTHERN HARE, Audubon, Ornithological Biog., vol. ii., p. 469. Birds of America, pl. 181, (in the talons of the Golden Eagle.) Winter pelage.
LEPUS AMERICANUS. Richardson, Fauna Boreali A., p. 217.
" VIRGINIANUS, Bach., Acad. Nat Sciences, Philadelphia, vol vii., p. 301.
" AMERICANUS, Bach, ib., p. 403, and ib., vol. viii., p. 76.
" AMERICANUS, Dekay, Nat. Hist. State of New York, p. 95, pl. 26.

DESCRIPTION.

Incisors, pure white, shorter and smaller than in *L. glacialis;* upper ones moderately grooved; the two posterior upper incisors very small. The margins of the orbits project considerably, having a distinct depression in the frontal bone; this is more conspicuous in the old than in the younger animals. Head rather short; nose blunt; eyes large and prominent; ears placed far back, and near each other; whiskers, long and numerous; body,

enlongated, thickly clothed with long loose hair, with a soft downy fur beneath; legs, long; hind-legs, nearly twice the length of the forelegs; feet, thickly clothed with hair, completely concealing the nails, which are long, thin, very sharp, and slightly arched. So thickly are the soles covered with hair that an impression by the nails is not generally visible in their tracks made while passing over the snow, unless when running very fast. Tail, very short, covered with fur, but not very bushy; the form of this species is, on the whole, not very elegant; its long hind legs, although remarkably well adapted for rapid locomotion, and its diminutive tail, would lead the spectator at first sight to pronounce it an awkward animal, which is, nevertheless, far from being the fact. Its fur never lies smooth and compact, either in winter or summer, as does that of many other species, but seems to hang loosely on its back and sides, giving it a somewhat shaggy appearance. The hair on the body is in summer about an inch and a-half long, and in winter, a little longer.

COLOUR.

In summer, the whole of the upper surface is reddish-brown, formed by hairs that are at their roots and for two-thirds of their length, of a blueish ash colour, then reddish-yellow, succeeded by a narrow line of darkbrown, the part next the tips or points, reddish brown, but nearly all the hairs tipped with black—this colour predominating toward the rump. Whiskers, mostly black, a few white, the longest reaching beyond the head; ears, brown, with a narrow black border on the outer margin, and a slight fringe of white hairs on the inner. In some specimens there is a fawn and in others a light coloured edge around the eyes, and a few white hairs on the forehead. The pupil of the eye is dark, the iris, light silvery-yellow; point of nose, chin, and under the throat, white; neck, yellowish-brown. Inner surface of legs, and under surface of body, white; between the hind-legs, to the insertion of the tail, white; upper surface of the tail, brown, under surface, white. The summer dress of this species is assumed in April, and remains without much change till about the beginning of November in the latitude of Quebec, and till the middle of the same month, in the State of New York and the western parts of Pennsylvania; after which season the animal gains its winter pelage. During winter, in high northern latitudes, it becomes nearly pure white, with the exception of the black edge on the

outer borders of the ears. In the latitude of Albany, New York, it has always a tinge of reddish-brown, more conspicuous in some specimens than in others, giving it a wavy appearance, especially when the animal is running, or when the fur is in the least agitated. In the winter season the hair is plumbeous at base, then reddish, and is broadly tipped with white. The parts of the body which are the last to assume the white change are the forehead and shoulders; we have two winter-killed specimens before us that have the forehead and a patch on the shoulders brown. On the under surface the fur in most specimens is white, even to the roots. A few long black hairs arise above and beneath the eyes, and extend backwards. The soles have a yellowish soiled appearance.

We possess a specimen of the young, about half grown, which in its general aspect resembles the adult; the colour of the back, however, is a shade darker, and the under surface an ashy white. The black edge is very conspicuous on the outer rim of the ear, and some of the whiskers are of unusual length, reaching beyond the head to the middle of the ear. The tail is very short, black above, and grayish-white beneath. The young become white in the autumn of the first year, but assume their winter colouring a little later in the season than the adults. We have met with some specimens in the New York markets, late in January, in which the change of colour was very partial, the summer pelage still predominating.

DIMENSIONS.

The size and weight of the northern hare we have found to vary very much. The measurements hitherto given were generally taken from stuffed specimens, which afford no very accurate indications of the size of the animal when living or when recently killed. Dr. GODMAN, on the authority of Prince CHARLES LUCIEN BONAPARTE, gives the measurement of a recent specimen as thirty-one inches, and Dr. HARLAN'S measurement of the same specimen after it had been stuffed was sixteen inches. We think it probable that the Prince and the Doctor adopted different modes of measuring. All stuffed specimens shrink very much; of a dozen now in our collection, there is not one that measures more than eighteen inches, from point of nose to root of tail, and several white adults measure but fifteen inches.

The following measurements are from the largest specimen we have procured, taken when the animal was recently killed:

From point of nose to root of tail . . .	19¼ inches.
Tail (vertebræ)	1¼ "
Do., to end of hair	2¼ "
From heel to end of middle claw . . .	5½ "
Height of ear	3½ "

Another specimen of moderate size.

From point of nose to root of tail . . .	16 "
Tail (vertebræ)	1½ "
Do., to end of hair	2½ "
From heel to end of middle claw . . .	5¼ "
Height of ear	3½ "

Weight.—This species in the beginning of winter varies from three to six and a-half pounds, but we consider 5½ pounds to be the average weight of a full-grown animal in good condition.

HABITS.

Our different species of hares, and more especially the present one and the little gray rabbit, have been so much mixed up in the accounts of authors that great confusion exists in regard to their habits, and their specific identity. The assertion of WARDEN, that the American hare retreats into hollow trees when pursued, applies to the gray rabbit, for which it was no doubt intended, but not to the northern hare. We are not aware that the latter ever takes shelter either in a hole in the earth or in a hollow tree. We have seen it chased by hounds for whole days, and have witnessed the repetition of these hunts for several successive winters, without ever knowing it to seek concealment or security in such places. It depends on its long legs, and on the thickness of the woods, to aid it in evading the pursuit of its enemies. When hunted, it winds and doubles among thick clusters of young pines and scrub-oaks, or leads the dogs through entangled patches of hemlock and spruce fir, until it sometimes wearies out its pursuers; and unless the hunter should appear, and stop its career with the gun, it is almost certain to escape.

In deep snows, the animal is so light, and is so well supported by its broad furry-feet, that it passes over the surface making only a faint impression, whilst the hounds plunge deep into the snow at every bound, and soon give up the hopeless pursuit. It avoids not only open grounds, but even open woods, and confines itself to the densest and most impenetrable forests. Although it wan-

ders by night in many directions in search of its appropriate food, we have scarcely ever seen its tracks in the open fields; it seems, cautiously to avoid the cabbage and turnip fields of the farmer, and seldom even in the most retired places makes an encroachment on his cultivated grounds.

The food of this species in summer consists of various kinds of juicy and tender grasses, and the bark, leaves, and buds, of several small shrubs; and these hares seem to be particularly fond of the young twigs of the wild allspice, (*Laurus benzoin,*) but in winter, when the earth is covered with snow, they gain a precarious subsistence from the buds and bark of such trees as are suited to their taste. Sometimes they scratch up the snow to feed on the leaves and berries of the various species of *Pyrola* found in the Northern States. The bark of the willow, birch, and poplar, and the buds of young pines, are sought after by them with avidity. We have seen persons in the northern part of the State of New York, who were desirous of shooting these animals by moonlight, watching near American black-poplar trees, (*Populus Hudsonica,*) which they had cut down for the purpose of attracting them to feed on their buds and tender twigs, in which they were often successful. Some of these hares which we had in a domesticated state, were fed on cabbage leaves, turnips, parsnips, potatoes, and sweet apples. During one very cold winter, when these could not be conveniently obtained, they were frequently supplied with clover-hay, to which, when more agreeable food was not given them, they did not evince any aversion; from time to time also, outer branches of willow, poplar, or apple trees, were thrown into their enclosure, the bark of which seemed to be greatly relished by them.

The northern hare, like most others of the genus, seeks its food only by night or in the early part of the evening. To this habit it is more exclusively confined during autumn and winter than in spring and summer. In the latter seasons, especially in spring, these animals are frequently observed in the morning, and as the sun is declining, in the afternoon, cautiously proceeding along some solitary by-path of the forest. Two or three may often be seen associated together, appearing full of activity and playfulness. When disturbed on these occasions, they stamp on the ground, making a noise so loud that it can be heard at some distance, then hopping a few yards into the thicket, they sit with ears erect, seemingly listening, to ascertain whether they are pur-

sued or not. This habit of thumping on the earth is common to most hares and rabbits. We have particularly noticed it in the domesticated rabbit, (*L. cuniculus*,) and in our common gray rabbit. They are more particularly in the habit of doing it on moonlight nights; it is indicative either of fear or anger, and is a frequent action among the males when they meet in combat. During cold weather this hare retires to its form at early dawn, or shelters itself under the thick foliage of fallen tree tops, particularly those of the pine and hemlock. It occasionally retires to the same cover for a number of nights in succession, but this habit is by no means common; and the sportsman who expects on some succeeding day to find this animal in the place from which it was once started is likely to be disappointed; although we are not aware that any other of our species of hare are so attached to particular and beaten paths through the woods, as the one now under consideration. It nightly pursues these paths, not only during the deep snows of winter, but for a period of several years, if not killed or taken, wandering through them even during summer. We have seen a dozen caught at one spot, in snares composed of horse-hair or brass wire, in the course of a winter, and when the snow had disappeared, and the spring was advanced, others were still captured in the same way, and in the same paths.

The period of gestation in this species is believed to be, (although we cannot speak with positive certainty,) about six weeks. Two females which we domesticated, and kept in a warren, produced young, one on the tenth and the other on the fifteenth of May; one had four, and the other six leverets, which were deposited on a nest of straw, the inside of which was lined with a considerable quantity of hair plucked from their bodies. They succeeded in rearing all their young but one, which was killed by the male of a common European rabbit. They were not again gravid during that season. Ill health, and more important studies, required us to be absent for six months, and when we returned, all our pets had escaped to the woods, therefore we could not satisfactorily finish the observations on their habits in confinement, which had interested and amused us in many a leisure hour.

We, however, think it probable that the females in their wild state may produce young twice during the season. Those referred to above were much harassed by other species which were

confined in the same warren, and might therefore have been less prolific than if they had enjoyed their liberty undisturbed, amid the recesses of their native woods. We have frequently observed the young of the northern hare in May, and again in July. These last must have been either from a second litter, or the produce of a young female of the previous year. The young at birth were able to see. They were covered with short hair; and appeared somewhat darker in colour than the adults, at that season. They left their nest in ten or twelve days, and from that time seemed to provide for themselves, and to derive little sustenance or protection from their mothers. The old males at this period seemed to be animated with renewed courage; they had previously suffered themselves to be chased and worried by the common English rabbit, and even retreated from the attacks of the gray rabbit; but they now stood their ground, and engaged in fierce combats with the other prisoners confined with them, and generally came off victorious. They stamped with their feet, used their teeth and claws to a fearful purpose, and in the fight, tore off patches of skin, and mutilated the ears of their former persecutors, till they were left in undisturbed possession of the premises!

The males did not evince the vicious propensity to destroy their young, which is observed in the domesticated English rabbit; on the contrary, they would frequently sit beside their little family, when they were but a day or two old, seeming to enjoy their playfulness, and to watch their progress to maturity.

The northern hare seems during summer to prefer dry and elevated situations, and to be more fond of grounds covered with pines and firs than of those that are overgrown with oak or hickory. The swamps and marshes soil their feet, and after having been compelled to pass through them, they are for hours employed in rubbing and drying their paws. In winter, however, when such places are hardened by the frost, they not only have paths through them in every direction, but occasionally seek a fallen tree top as a hiding or resting place, in the centre of a swamp. We have observed them in great numbers in an almost impenetrable thicket of black larch, or hackmatack, (*Larix pendula,*) considerable portions of which were during summer a perfect morass. In what are called the "bark clearings," places where hemlock trees have been cut down to procure tan bark, this species is sometimes so abundant that twenty or thirty of them may be started in a day's walk.

As an article of food, this is the most indifferent of all our species of hares; its flesh is hard, dry, almost juiceless, possessing none of the flavour of the English hare, and much inferior to that of our gray rabbit. Epicures, however, who often regard as dainties dishes that are scarce, and who, by the skilful application of the culinary art, possess means of rendering things savoury that are of themselves insipid, may dispute this point with us.

The northern hare, as is proverbially the case with all the species, has many enemies. It is pursued by men and dogs, by carniverous beasts of the forest, by eagles, by hawks, and by owls. In the northern parts of Maine, in Canada, and in the countries farther north, their most formidable enemies are the Canada lynx (*Lynx Canadensis,*) the jer falcon (*Falco Islandicus,*) and the snowy owl (*Surnea nyctea.*) In the New England States, however, and in New York, the red-tailed hawk, (*Burteo borealis*) is occasionally seen with one of these species in its talons. But its most formidable enemy is the great horned owl (*Bubo Virginianus.*) We have also, on one occasion, observed a common house-cat dragging a full-grown northern hare from the woods, to feed her young. Lads on their way to school entrap them with snares attached to a bent twig, placed along the paths they nightly resort to. The hunter finds recreation in pursuing them with hounds, whilst he places himself in some wood-path where they were last seen to pass. The hare runs from fifty to a hundred yards ahead of the dogs, and in its windings and turnings to escape from them frequently returns to the spot where the hunter is stationed, and falls by a shot from his gun.

The northern hare, when rapidly pursued, makes such great efforts to escape that the poor creature (as we have said already) is occasionally successful, and fairly outruns the hounds, whilst the hunter is cunningly avoided by it when doubling. After one of these hard chases, however, we have known the animal die from the fatigue it had undergone, or from having been overheated. We once saw one which had been closely pressed by the dogs nearly all the afternoon, return to a thicket after the hounds had been called off, and the sportsmen had given up the vain pursuit. Next morning we examined the place it had retired to, and to our surprise, discovered the hare sitting in its form, under a dwarfish, crooked, pine-bush; it was covered with snow, and quite dead. In this instance the hare had no doubt been greatly overheated by the race of the preceding day, as well as

exhausted, and terrified; and the poor thing, being in that condition very susceptible of cold, was probably chilled by the night air and the falling snow, until its palpitating heart, gradually impelling the vital fluid with fainter and slower pulsations, at length ceased its throbbings forever.

Sometimes we have found these hares dead in the woods after the melting of the snow in the spring, and on examination we found they were entangled in portions of wire snares, frequently, entwined round their necks; from which they had been unable to extricate themselves.

This species when caught alive cannot be taken into the hand, like the gray rabbit, with impunity; the latter, when seized by the ears or hind-legs; soon becomes quiet, and is harmless; but the northern hare struggles to escape, and makes a formidable resistance with its teeth and nails. On one occasion a servant who was expert at catching the gray rabbit in traps, came to us with a rueful countenance, holding a hare in his hands, exhibiting at the same time sundry severe scratches he had received, showing us his torn clothes, and a place on his leg which the animal had bitten, and declaring that he had caught "a rabbit as cross as a cat." We ascertained it to be a northern hare, in its summer dress, and although its captor had not been able to distinguish it from the gray rabbit by its colour, he certainly had had a practical lesson in natural history, which he did not soon forget.

A living individual of this species, which we have in Charleston in a partially domesticated state, for the purpose of trying to ascertain the effect of a warm climate on its changes of colour, is particularly cross when approached by a stranger. It raises its fur, and springs at the intruder with almost a growl, and is ready with its claws and teeth to gratify its rage, and inflict a wound on the person who has aroused its ire. When thus excited, it reminded us, by its attitudes, of an angry raccoon.

The skin of the northern hare is so tender and easily torn, and the fur is so apt to be spoiled and drop off on being handled, that it is difficult to prepare perfect specimens for the naturalist's cabinet. The pelt is not in much request among the furriers, and is regarded by the hatter as of little value. The hind-feet, however, are used by the latter in a part of the process by which the soft, glossy, surface is imparted to his fabric, and answer the purpose of a soft hair-brush.

This species is found in portions of the British possessions, as far as the sixty-eighth parallel of north latitude. It is, however, confined to the eastern portion of our Continent; RICHARDSON, who represents it as "a common animal from one extremity of the Continent to the other," seems to have mistaken for it another species which replaces it on the north-west coast. Although it does not range as far to the north as the polar hare, it is decidedly a northern species; it is found at Hudson's Bay, in Newfoundland, Canada, all the New England States, and in the northern portions of New York, Pennsylvania, and Ohio. Mr. DOUGHTY informed us that he had procured a specimen on the Alleghany Mountains in the northern part of Virginia, Lat. 40° 29, where it had never before been observed by the inhabitants. On seeking for it afterwards in the locality from which he obtained it, we were unsuccessful, and we are inclined to believe that it is only occasionally that some straggler wanders so far south among these mountains, and that its southern limit may be set down at about 41°.

ARTICLE LIV.—*On the Mammoth and the Mastodon.* *

The enormous bones of extinct elephantoid animals found in America belong to two species: the Mammoth, *Elephas primigenius*, and the Mastodon, *M. giganteus*, or *Ohioticus*. We have figured their skeletons on the plate which will be found at the commencement of this number.

The mammoth was a true elephant, but of a species different from either of the two at present existing; and, it appears, was fitted to endure the rigours of a climate of greater severity than that of Canada, as its bones are found abundantly from latitude 40° north to the Arctic circle. In Siberia and Russian America they occur in vast quantities, imbedded, in some instances, in ice which has never thawed since that remote period when these gigantic creatures lived. In the extract from Professor Owen's British Fossil Mammalia and Birds, which we shall give in this article, will be found an interesting account of the famed discovery of a mammoth with the flesh preserved. It is unfortunate that this specimen could not have been preserved entire, and placed in some museum, there to remain so long as the human

* See Plates 5 and 6.

race shall be permitted to exist on this planet. No merely terrestrial object ever seen by man could possess a thousandth part of the sublime interest that would be excited by this sole survivor in the flesh of a lost world of life.

The mammoth differs from the elephants of our day only specifically, or as much, perhaps, as the grizzly bear differs from the black bear; but the mastodon was of another, though closely allied, genus, principally characterized by the form of the molar teeth, which had the grinding surface provided with a number of conical protuberances, while the same surface of the tooth of the mammoth was flat, and crossed by narrow jagged ridges. The mastodon had shorter legs, a longer body, and was more bulky than the mammoth, although not so tall. It appears that both were larger than the largest Asiatic elephant, none of which exceed 10 feet in height, while a skeleton of ordinary size of the mastodon is 9½ feet. That figured on our plate is 9 feet 7 inches high and 20 feet long, as it stands in the British museum; and on the same platform, Dr. Mantell says, "there are five bones of the fore-foot nearly twice as large, in linear dimensions, as the corresponding parts of the above skeleton, of *Elephas meridionalis*, dug up in the brick-fields at Gray's, in Essex." The mammoth figured is 9 feet 4 inches high and 16 feet 4 inches long, without including the tusks, which are 9 feet 6 inches long.

The bones of these great extinct animals have been found in hundreds of places in the west, but appear to be totally wanting in the eastern part of America. Some of them have been exhumed in Canada within the last few years. In the collection of the Geological Survey at Montreal are two tusks and a portion of the lower jaw of the mammoth discovered at Hamilton in 1851, at Burlington Heights, thirty feet beneath the surface.

The locality was thus described in a letter we received from Mr. McQueen, editor of the *Huron Signal*, upon the subject:—

"Burlington Heights is a narrow peninsula, about three-fourths of a mile in length, and not more than half a furlong in width, which divides Burlington Bay and the Desjardines Marshes; an area of several thousand acres lying between the head of the bay and the town of Dundas, four miles distant. The marsh is still partially covered with water, and recent experiments have shown that the bottom is a soft floating mud, extending to a depth of 80 feet. Its present surface is scarcely above the waters of the bay. A sluggish stream from the high lands crawls down its

centre, and in a deep narrow gulf winds round the head of the peninsula into the bay, and now forms the Desjardines Canal. I have no doubt that the large mass of alluvial matter has been formed by the stream in its untiring perseverance. The peninsula is 110 feet in height. The land on each side of the amphitheatre in which the marsh is enclosed rises to a great height, say 150 feet above the level of the peninsula. The great puzzle to me is the cemented gravel; it begins at the surface, is 30 feet thick, is regularly bedded, like the strata in a limestone quarry, has a considerable dip, or inclination, and is all but impenetrable. It is as difficult to drill or blast as any limestone. The sand on which it is incumbent is too clean and too fine for building purposes; of this quality it continues for perhaps 30 feet downwards, and then turns into a loose, coarse gravel, like the beach of the lake. The bones were deposited in the fine sand, in which there was not a vestige of a shell of any description."

The most celebrated locality for these fossils is at Big Bone Lick, in Kentucky, where it is said the remains of not less than one hundred mastodons and twenty mammoths, with bones of the megalonyx, stag, horse and bison, have been discovered.

With respect to the time when the mammoth and mastodon became extinct, we have not the slightest evidence of their existence within the human period, although there is sufficient proof that they existed immediately before the advent of man. The Indians have a tradition bearing upon these remains, of which we find the following account in an old magazine, "The Bee," published December, 1791:—

Of the Enormous Bones found in America.

Between thirty and forty years ago, at a salt lick near the banks of the Ohio, the remains of several skeletons were discovered, which demonstrate the former existence of animals very far surpassing in size any at present known. There is now in the museum at *Yale* College teeth of a monstrous magnitude, sent thither from *Muskingum* by the late General Parsons. The one which the writer of this account saw was upwards of fifteen inches in circumference, and, including its fangs, twelve or thirteen inches in length.

In the year 1783, as a labourer was ditching a bog-meadow, belonging to a clergyman at Little Breton, in Ulbster county, he found a mass of bones, not two feet beneath the surface of the

ground, of the same kind, probably, with those observed at the Ohio; they were of a black colour, but very hard, and the shape perfect. A German physician, then with the army at New York, just before its departure, procured and took them all to Europe. Gentlemen of the first character in this country saw them, and declare that they were astonishingly large. The thigh bone in particular, a gentleman measured, and found it thirty-five inches in circumference.

It is impossible to arrive at the knowledge of the magnitude of an animal from an imperfect skeleton; but no one can hesitate supposing that the most gigantic quadrupeds at present known are mere pigmies compared to some of the former tenants of our western world; but of these, perhaps nothing more will ever be discovered than the memorials above related, and the following tradition existing among the natives. It is given in the very terms of a Shawnee Indian, to shew that the impression has been most forcible:

"Ten thousand moons ago, when nought but gloomy forests covered this land of the sleeping sun, long before pale men, with thunder and fire at their command, rushed on the wings of the wind to ruin this garden of nature, when nought but the untamed wanderers of the woods, and men as unrestrained as they were the lords of the soil, a race of animals were in being, huge as the frowning precipice, cruel as the bloody panther, swift as the descending eagle, and terrible as the angel of night. The pines crashed beneath their feet, and the lake shrunk when they slaked their thirst; the forceful javelin in vain was hurled, and the barbed arrow fell harmless from their side. Forests were laid waste at a meal, the groans of expiring animals were every where heard; and whole villages inhabited by man were destroyed in a moment. The cry of universal distress extended even to the region of peace in the West, and the good spirit interposed to save the unhappy. The forked lightening gleamed all aronnd, and loudest thunder rocked the globe. The bolts of heaven were hurled upon the cruel destroyers alone, and the mountains echoed with the bellowings of death. All were killed except one male, the fiercest of the race, and him even the artillery of the sky assailed in vain. He ascended the highest summit which shades the source of the *Mononga*hela, and, roaring aloud, bid defiance to every vengeance The red lightening scorched the lofty firs, and rived the knotty oaks, but only glanced upon the enraged monster. At length

maddened with fury, he leaped over the waves of the west at a bound, and this moment reigns the uncontroled monarch of the wilderness, in despite of even Omnipotence itself."

The following is from the work of Professor Owen, above referred to:

The remains of the mammoth occur on the Continent, as in England, in the superficial deposits of sand, gravel, and loam, which are strewed over all parts of Europe; and they are found in still greater abundance in the same formations of Asia, especially in the higher latitudes, where the soil which forms their matrix is perennially frozen.* Remains of the mammoth have been found in great abundance in the cliffs of frozen mud on the east side of Behring's Straits, in Eschscholtz's Bay, in Russian America, lat. 66° N.; and they have been traced, but in scantier quantities, as far south as the States of Ohio, Kentucky, Missouri, and South Carolina. But no authentic relics of the *Elephas primigenius* have yet been discovered in tropical latitudes,† or in any part of the southern hemisphere. It would thus appear that the primeval elephants formerly ranged over the whole northern hemisphere of the globe, from the 40th to the 60th and possibly to near the 70th degree of latitude. Here, at least, at the mouth of the River Lena, the carcass of a mammoth has been discovered, preserved entire, in the icy cliffs and frozen soil of that coast. To account for this extraordinary phenomenon, geologists and naturalists, biassed more or less by the analogy of the existing elephants, which are restricted to climes where the trees flourish with perennial foliage, have had recourse to the hypothesis of a change of climate in the northern hemisphere, either sudden, and due to a great geological cataclysm,‡ or gradual, and brought

* Hedenstrom, in his "Survey of the Laechow Islands," on the north-eastern coast of Siberia, remarks that the first of these islands is little more than one mass of these bones; and that although the Siberian traders have been in the habit of bringing over large cargoes of them (tusks) for upward of sixty years, yet there appears to be no sensible diminution.

† The fossil elephantine remains discovered in India belong to a species more nearly allied to the *Elephas Indicus*.

‡ Cuvier, 'Discours sur les Révolutions de la Surface du Globe.' It is obvious that the frozen mammoth at the mouth of the Lena forms one of the strongest as well as the most striking of the celebrated anatomist's assumed "proofs that the revolutions on the earth's surface had been sudden." Cuvier affirms that the mammoth could not have maintained its existence in the low temperature of the region where its carcass was arrested, and that at the moment when the beast was destroyed, the land which it trod became glacial. "Cette gelée éternelle n'occupait pas auparavant les lieux où ils ont été saisis; car ils n'auraient pas pu vivre sous une pareille température. C'est donc le même instant qui a fait périr les animaux, et qui a

about by progressive alternations of land and sea.*

I am far from believing that such changes in the external world were the cause of the ultimate extinction of the *Elephas primigenius;* but I am convinced that the peculiarities in its ascertained organization are such as to render it quite possible for the animal to have existed as near the pole as is compatible with the growth of hardy trees or shrubs. The fact seems to have been generally overlooked, that an animal organized to gain its subsistence from the branches or woody fibre of trees, is thereby rendered independent of the seasons which regulate the development of leaves and fruit; the forest-food of such a species becomes as perennial as the lichens that flourish beneath the winter snows of Lapland; and, were such a quadruped to be clothed, like the reindeer, with a natural garment capable of resisting the rigours of an Arctic winter, its adaptation for such a climate would be complete. Had our knowledge of the mammoth, indeed, been restricted, as in the case of almost every other extinct animal, to its bones and teeth, it would have been deemed a hazardous speculation to have conceived, *a priori*, that the extinct ancient elephant, whose remains were so abundant in the frozen soil of Siberia, had been clad, like most existing quadrupeds adapted for such a climate, with a double garment of close fur and coarse hair; seeing that both the existing species of elephant are almost naked, or, at best, scantily provided when young with scattered coarse hairs of one kind only.

The wonderful and unlooked for discovery of an entire mammoth, demonstrating the Arctic character of its natural clothing, has, however, confirmed the deductions which might have been legitimately founded upon the localities of its most abundant remains, as well as upon the structure of its teeth, viz., that, like the reindeer and musk ox of the present day, it was capable of existing in high northern latitudes.

The circumstances of this discovery have been recorded by Mr. Adams, in the 'Journal du Nord,' printed at Petersburg in 1807, and in the 5th volume of the 'Memoirs of the Imperial Academy of Sciences at St. Petersburg,' of which an excellent English translation was published in 1819.

rendu glacial le pays qu'ils habitaient. Cet événement a été subit, instantané, sans aucune gradation, &c."—Ossemens Fossiles, 8vo. ed., 1834, tom. i., p. 108.

* Lyell, 'Principles of Geology,' in which the phenomena that had been supposed "to have banished for ever all idea of a slow and gradual revolution,"† were first attempted to be accounted for by the gradual operation of ordinary and existing causes.

† Jameson's 'Cuvier's Theory of the Earth,' 8vo., 1813, p. 16.

Schumachoff, a Tungusian hunter and collector of fossil ivory, who had migrated in 1799 to the peninsula of Tamut, at the mouth of the River Lena, one day perceived amongst the blocks of ice a shapeless mass, not at all resembling the large pieces of floating wood which are commonly found there. To observe it nearer, he landed, climbed up a rock, and examined this new object on all sides, but without being able to discover what it was. The following year he perceived that the mass was more disengaged from the blocks of ice, and had two projecting parts. Towards the end of the next year (1801,) the entire side of the animal, and one of its tusks, were quite free from the ice. On his return to the borders of the Lake Oncoul, he communicated this extraordinary discovery to his wife and some of his friends, but their reception of the news filled him with grief. The old men related how they had heard their fathers say that a similar monster had been formerly discovered on the same peninsula, and that all the family of the person who discovered it had died soon afterwards. The mammoth was consequently regarded as an augury of future calamity, and the Tungusian was so much alarmed that he fell seriously ill; but becoming convalescent, his first idea was the profit he might obtain by selling the tusks of the animal, which were of extraordinary size and beauty. The summer of 1802 was less warm and more stormy than usual, and the icy shroud of the mammoth had scarcely melted at all. At length, towards the end of the fifth year (1803,) the desires of the Tungusian were fulfilled; for, the part of the ice between the earth and the mammoth having melted more rapidly than the rest, the plane of its support became inclined, and the enormous mass fell by its own weight on a bank of sand. Of this, two Tungusians, who accompanied Mr. Adams, were witnesses. In the month of March, 1804, Schumachoff came to his mammoth, and having cut of the tusks, exchanged them with a merchant, called Bultunoff, for goods of the value of fifty rubles.

Two years afterwards, or the seventh after the discovery of the mammoth, Mr. Adams visited the spot, and "found the mammoth still in the same place, but altogether mutilated. The prejudices being dissipated because the Tungusian Chief had recovered his health, there was no obstacle to prevent approach to the carcass of the mammoth; the proprietor was content with his profit from the tusks; and the Jakutski of the neighbourhood had cut off the flesh, with which they fed their dogs during the scarcity. Wild

beasts, such as white bears, wolves, wolverenes, and foxes, also fed upon it, and the traces of their footsteps were seen around." The skeleton, almost entirely cleared of its flesh, remained whole, with the exception of one fore-leg, (probably dragged off by the bears.) The spine, from the skull to the os coccygis, one scapula, the pelvis, and the three remaining extremities, were still held together by the ligaments, and by parts of the skin. The head was covered with a dry skin; one of the ears, well preserved, was furnished with a tuft of hair. The point of the lower lip had been gnawed; and the upper one, with the proboscis, having been devoured, the molar teeth could be perceived. The brain was still in the cranium, but appeared dried up. The parts least injured were one fore-foot and one hind-foot; they were covered with skin, and had still the sole attached. According to the assertion of the Tungusian discoverer, the animal was so fat that its belly hung down below the joints of the knees. This mammoth was a male, with a long mane on the neck; the tail was much mutilated, only eight, out of twenty-eight or thirty caudal vertebræ, remaining; the proboscis was gone, but the places of the insertion of its muscles were visible on the skull. The skin, of which about three-fourths was saved, was of a dark gray colour, covered with a reddish wool, and coarse long black hairs. The dampness of the spot where the animal had lain so long had in some degree destroyed the hair. The entire skeleton, from the fore part of the skull to the end of the mutilated tail, measured sixteen feet four inches; its height was nine feet four inches. The tusks measured along the curve nine feet six inches, and in a straight line from the base to the point three feet seven inches.

Mr. Adams collected the bones, and had the satisfaction to find the other scapula, which had remained not far off. He next detached the skin on the side on which the animal had lain, which was well preserved; the weight of the skin was such that ten persons found great difficulty in transporting it to the shore. After this, the ground was dug in different places, to ascertain whether any of its bones were buried, but principally to collect all the hairs, which the white bears had trod into the ground while devouring the flesh, and more than thirty-six pounds' weight of hair were thus recovered. The tusks were repurchased at Jatusk, and the whole expedited thence to St. Petersburg; the skeleton is now

mounted in the museum of the Petropolitan Academy, as it is represented in the plate.*

It might have been expected that the physiological consequences deducible from the organization of the extinct species, which was thus, in so unusual a degree, brought to light, would have been at once pursued to their utmost legitimate boundary, in proof of the adaptation of the mammoth to a Siberian climate; but, save the remark that the hairy covering of the mammoth must have adapted it for a more temperate zone than that assigned for existing elephants,† no further investigations of the relation of its organization to its habits, climate, and mode of life, appear to have been instituted; they have in some instances, indeed, been rather checked than promoted.

Dr. Fleming has observed that "no one acquainted with the gramineous character of the food of our fallow-deer, stag, or roe, would have assigned a lichen to the reindeer." But we may readily believe that any one cognizant of the food of the elk, might be likely to have suspected cryptogamic vegetation to have entered more largely into the food of a still more northern species of the deer tribe. And I can by no means subscribe to another proposition by the same eminent naturalist, that "the kind of food which the existing species of elephant prefers will not enable us to determine, or even to offer a probable conjecture concerning that of the extinct species." The molar teeth of the elephant possess, as

* A part of the skin, and some of the hair of this animal, were sent by Mr. Adams to Sir Joseph Banks, who presented them to the museum of the Royal College of Surgeons. The hair is entirely separated from the skin, excepting in one small part, where it still remains firmly attached. It consists of two sorts, common hair and bristles, and of each there are several varieties, differing in length and thickness. That remaining fixed on the skin is thick-set and crisply curled; it is interspersed with a few bristles, about three inches long, of a dark reddish colour. Among the separate parcels of hair are some rather redder than the short hair just mentioned, about four inches long, and some bristles nearly black, much thicker than horse-hair, and from twelve to eighteen inches long. The skin, when first brought to the Museum, was offensive to the smell. It is now quite dry and hard; and where most compact is half an inch thick. Its colour is the dull black of the living elephants.

† La longue toison dont cet animal était couvert semblerait même démontrer qu'il était organisé pour supporter un degré de froid plus grand que celui qui convient à l'éléphant de l'Inde." Pictet, Paléontologie, 8vo., tom. i., 1844, p. 71.

we have seen, a highly complicated and a very peculiar structure, and there are no other quadrupeds that derive so great a proportion of their food from the woody fibre of the branches of trees. Many mammals browse the leaves; some small rodents gnaw the bark; the elephants alone tear down and crunch the branches the vertical enamel-plates of their huge grinders enabling them to pound the tough vegetable tissue and fit it for deglutition. No doubt the foliage is the most tempting, as it is the most succulent part of the boughs devoured; but the relation of the complex molars to the comminution of the coarser vegetable substance is unmistakeable. Now, if we find in an extinct elephant the same peculiar principle of construction in the molar teeth, but with augmented complexity, arising from a greater number of the triturating plates and a greater proportion of the dense enamel, the inference is plain that the ligneous fibre must have entered in a larger proportion into the food of such extinct species. Forests of hardy trees and shrubs still grow upon the frozen soil of Siberia, and skirt the banks of the Lena as far north as latitude 60°. In Europe arboreal vegetation extends ten degrees nearer the pole, and the dental organization of the mammoth proves that it might have derived subsistence from the leafless branches of trees, in regions covered during a great part of the year with snow.

We may therefore safely infer, from physiological grounds, that the mammoth would have found the requisite means of subsistence at the present day, and at all seasons, in the sixtieth parallel of latitude; and, relying on the body of evidence adduced by Mr. Lyell, in proof of increased severity in the climate of the northern hemisphere, we may assume that the mammoth habitually frequented still higher latitudes at the period of its actual existence. "It has been suggested," observes the same philosophic writer, "that, as in our own times, the northern animals migrate, so the Siberian elephant and rhinoceros may have wandered towards the north in summer." In making such excursions during the heat of that brief season, the mammoths would be arrested in their northern progress by a condition to which the reindeer and musk ox are not subject, viz., the limits of arboreal vegetation, which, however, as represented by the dominating shrubs of Polar lands, would allow them to reach the seventieth degree of latitude.*

* In the extreme points of Lapland, in 70° north latitude, the pines attain the height of sixty feet; and at Enontekessi, in Lapland, in 68° 30' north latitude, Von Buch found corn, orchards, and a rich vegetation, at an elevation of 1356 feet above the sea. Lindley, Intr. to Botany, pp. 485, 490.

But, with this limitation, if the physiological inferences regarding the food of the mammoth from the structure of its teeth be adequately appreciated and connected with those which may be legitimately deduced from the ascertained nature of its integument, the necessity of recurring to the forces of mighty rivers, hurrying along a carcass through a devious course, extending through an entire degree of latitude, in order to account for its ultimate entombment in ice, whilst so little decomposed as to have retained the cuticle and hair, will disappear. And it can no longer be regarded as impossible for herds of mammoths to have obtained subsistence in a country like the southern part of Siberia, where trees abound, notwithstanding it is covered during a great part of the year with snow, seeing that the leafless state of such trees during even a long and severe Siberian winter would not necessarily unfit their branches for yielding sustenance to the well-clothed mammoth.

With regard to the extension of the geographical range of the *Elephas primigenius* into temperate latitudes, the distribution of its fossil remains teaches that it reached the fortieth degree north of the equator. History, in like manner, records that the reindeer had formerly a more extensive distribution in the temperate latitudes of Europe than it now enjoys. The hairy covering of the mammoth concurs, however, with the localities of its most abundant remains, in showing that, like the reindeer, the northern extreme of the temperate zone was its metropolis.

Attempts have been made to account for the extinction of the race of northern elephants by alterations in the climate of their hemisphere, or by violent geological catastrophes, and the like extraneous physical causes. When we seek to apply the same hypothesis to explain the apparently contemporaneous extinction of the gigantic leaf eating Megatheria of South America, the geological phenomena of that continent appear to negative the occurrence of such destructive changes. Our comparatively brief experience of the progress and duration of species within the historical period is surely insufficient to justify, in every case of extinction, the verdict of violent death. With regard to many of the larger Mammalia, especially those which have passed away from the American and Australian continents, the absence of sufficient signs of extrinsic extirpating change or convulsion, makes it almost as reasonable to speculate with Brocchi,* on the possibility that

* Cited by Lyell, 'Principles of Geology,' (1835,) vol. iii., p. 104.

species like individuals may have had the cause of their death inherent in their original constitution, independently of changes in the external world, and that the term of their existence, or the period of exhaustion of the prolific force, may have been ordained from the commencement of each species.

ARTICLE LV.—*On the Genus Tellinomya, and allied Genera*, with Illustrations, by Professor JAMES HALL, Palæontologist to the State of New York; written for the CANADIAN NATURALIST AND GEOLOGIST.

In the investigations of Palæozoic fossils, it often happens that the most important parts for the determination of the generic characters are obscured or entirely hidden by the adhering stony matter. This is particularly true of the Gasteropoda and Lamelli branchiata, and the generic characters are often necessarily derived from the external features of the shell. It is not always possible to make these determinations with such accuracy, that further discoveries will not show the necessity of some modification. Were the descriptions of the genera and species of the Lamelli branchiate, shells of the Palæozoic rocks, left until the hinge and teeth, the pallial and muscular impressions, could be determined, comparatively few would be described.

In the first volume of the Palæontology of New York several new genera were proposed, and among them the genus Tellinomya, which is the subject of the present notice. This genus was constituted to include several species, supposed to be related to each other from external characters. These characters were suggestive of *Tellina* and of *Mya*, and the name adopted accordingly.

In the specimens known to me at that time there were no visible teeth or crenulations in the hinge line, and this fact was stated in the description. Subsequently I obtained some specimens which suggested other relations than those indicated by the generic name. No opportunity has occurred of correcting the original description, while in the meantime the species have been referred by Palæontologists to other genera, and in some instances to those of very different character.*

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* M. d'Orbigny refers the species of Tellinomya described in the first volume of the Palæontology of New York to the genus Lyonsia of Turton, a modern shell belonging to a very different family; and to add still more

More recently the extensive collections of the Canada Geological Survey have furnished some beautiful examples, showing in a most perfect manner the structure of the hinge, and the muscular impressions of several species of this genus.

In the meantime, a specimen taken to London by Sir William E. Logan has been noticed as a new genus by Mr. Salter, under the name of Ctenodonta.

The shell upon which Mr. Salter founded this genus is a species of *Tellinomya*, closely allied to the *T. nasuta* of the Trenton limestone. Mr. Woodward, in his "Treatise," places the genus Ctenodonta as synonymous with Isoarca of Munster; while, according to Pictet, it would be placed under the genus Nucula.

The character of the hinge of *Tellinomya nasuta*, and of *T. dubia*, represented in the accompanying figures, show that it bears a close relation to *nucula*, and that it is identical with Ctenodonta.

The shells referable to this type have not the ventricose character, large and often sub-spiral beaks, of *Isoarca;* nor is the beak uniformly anterior, as in that genus. The species of Tellinomya, so far as known, are never cancellated, or otherwise ornamented, beyond the ordinary concentric lines of growth.

Having had an opportunity of examining the hinge, and the internal characters of at least six species, the following characters are deduced therefrom:

TELLINOMYA.

GENERIC CHARACTERS.—Shell, equivalve, equilateral or subequilateral, closed, smooth or marked by lines of growth; ligament, external; hinge line, curved, sometimes sub-angular, with a continuous series of small curved transverse teeth, which diminish from the extremities to the beak, beneath which they are much smaller; muscular impressions, double, two anterior and two posterior, one large and strongly impressed, the other smaller, lying above and

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to the confusion, the same author has placed the species of Modiolopsis also under the genus Lyonsia. In this reference he has been followed by *one* American author.

I may mention here that the collections of the Canada Survey furnish some beautiful exhibitions of the hinge of Modiolopsis, which I hope to have the privilege of illustrating at no distant period.

M. d'Orbigny places *Nucula levata* under the genus Leda, while he leaves the *N. donaciformis* under *Nucula*. Both these shells belong to the genus Tellinomya.

between the larger one and the hinge line; pallial impression, simple.

In the larger species known the hinge line is only slightly arcuate, while among the other species we find many variations

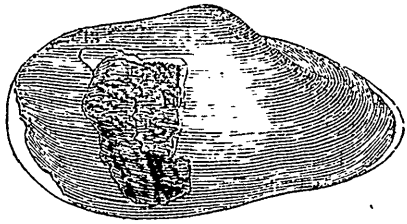

Fig. 1.

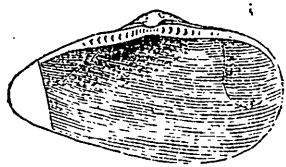

Fig. 2.

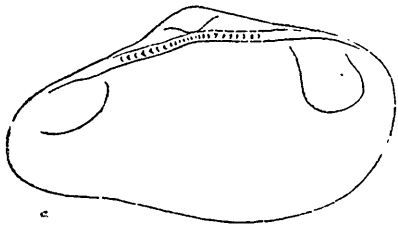

Fig. 3.

Fig. 4.

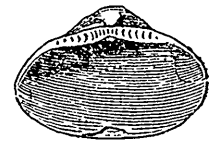

Fig. 5.

Fig. 6.

Fig. 7.

Figs. 1, 2, 3.—*Tellinomya nasuta.*
Figs. 4 and 5.—*Tellinomya dubia.*
Figs. 6 and 7.—*Tellinomya cuneata.**

in the curvature, and it sometimes becomes distinctly angular, as in *T. cuneata.* In some species the teeth on either side of the beak curve outwards from it, and in others inwards towards the

* The specimens above figured were collected at Pauquette's Rapids, on the Ottawa River, in beds lying at the junction of the Trenton and Black River limestones. E. B.

beak on both sides. The teeth are often very minute immediately beneath the beaks. The shells of this genus vary from elliptical to ovate and sub-triangular forms, many of them being contracted on the posterior side; they are usually of moderate thickness, though one species is very thick and strong. Some of the species have a distinctly impressed lunule. The lesser muscular impression is often a small pit placed directly beneath the hinge line and between it and the large muscular impression.

The beaks are usually of medium size, pointed, rarely ventricose, approximate or in contact, never subspiral.

The relations of this shell are among the Arcadæ, and approximate to the Nuculæ in their general characters, and to which genus they have usually been referred. They differ from that genus, however, in the absence of the ligamentary pit beneath the beak, and in the presence of an external ligament and double muscular impressions.

It is probable that most of the Palæozoic species referred to the genus *Nucula* belong to Tellinomya, except those of the genus *Nuculites* of Conrad, Cucullella of McCoy, which is distinguished by the presence of a septum in the anterior part of each valve. The place of Tellinomya may be regarded as between Nucula and Nuculites. In external characters it may prove difficult to separate Tellinomya from Nuculites, but the presence of the septum affords nearly the same degree of difference as that between Cucullella and Arca.

The species of the genus Cucullella of McCoy are cited from Upper Ludlow rocks; and the species of the genus Nuculites of Conrad are, with one exception,* from the Hamilton group, or rocks of the same age. We may therefore infer, with some reason, that the shells having crenulate hinge lines, with the internal septum, occur in rocks of later date, or, in other words, that they do not begin their existence before the Upper Silurian or perhaps the Devonian period, while the Tellinomyæ occur among the earliest forms of lamellibranchiate shells.

For the purpose of comparison with Tellinomya, and as exhibiting in some degree similar characters with that genus, as well as to show the marked identity of description in these two genera, I give below the generic characters of *Nuculites* and *Cucullella*, from the descriptions respectively of M. Conrad and Professor McCoy:

* This exception has been found to be destitute of teeth in the hinge.

Genus Nuculites.—Conrad, 1841, Geological Report of New York, page 49.

"Equivalved; hinge, with cardinal teeth, as in Nucula, but apparently uninterrupted beneath the apex; an interior rib like that of Solecurtus, but narrower, extends from the apex, either direct or slightly oblique, towards the base, never passing much beyond the middle of the valve."

"These shells have much the exterior aspect of Nucula, but the deep sinus in casts of some of the species, left by the interior rib, constitutes about the same amount of difference between the two genera as between *Solen* and *Solecurtus*, especially, as I believe to be the case, that the series of cardinal teeth is uninterrupted by a fosset, which in Nucula is a prominent character. This genus, so constituted, is restricted to the Silurian, and perhaps to the Carboniferous system."

Genus Cucullella.—McCoy, Ann. Nat. Hist., 2d series, vol. vii., p. 50. British Pal. Fossils, p. 283, 1855.

"Generic Characters.—Sub-rhomboidal, inequilateral, subequivalve; margin, even; hinge line, entirely crenulated; muscular impressions, two, with a simple pallial scar between them; a strong internal septum extends from before the beaks to the posterior margin of the adductor muscle, forming a deep slit in the casts; surface, generally smooth, or nearly so."

"These Palæozoic shells have been confounded with *Nucula*, (Sow., Phil., &c.,) from which they differ in the absence of the ligamentary pit in the hinge, and in the anterior internal septum; they have also been confounded with *Cucullea*, from which they differ in wanting the hood-like plate of the posterior adductor, and having the septum in the anterior end; and with *Clidophorus*, (Geol. Surv. of Great Britain,) from which they differ in having the hinge crenulated as in *Arca*."

The genus *Lyrodesma* of Conrad was constituted to receive a small shell which occurs in the shales of the Hudson River group, and which, but for certain restrictions in the generic description, might include those here referred to Tellinomya.

Lyrodesma.—Conrad.

Generic Characters.—"Equivalved, inequilateral; hinge line, with eight diverging prominent cardinal teeth, transversely striated."

Mr. Conrad remarks that he "was fortunate enough to obtain two fine casts of this bivalve, with the teeth remarkably well represented." The figure given by Mr. Conrad, to illustrate this fossil, shows the hinge line with a continuous series of eight teeth. The typical species is *L. plana.* I have referred to this genus a small shell from the Utica slate, which is nearly equilateral, with equally rounded extremities, and a few distinct teeth on each side of the beak. This shell, *L. pulchella*, does not differ from Tellinomya, to which it must be referred.

The shells of the genus Tellinomya are shown to differ from Nucula, Isoarca, Nuculites, and Cucullella.

In addition to the species described under this genus in the first volume of the Palæontology of New York, may be added *T.* (*Nucula*) *levata*, *T.* (*Nucula*) *donaciformis*, *T.* (*lyrodesma*) *pulchella;* and also the following species, described by Professor Phillips: (Memoirs Geological Survey of Great Britain, vol. 2.) *Tellinomya* (*Nucula*) *coarctata*, *T.* (*Nucula*) *deltoidea*, *T.* (*Nucula*) *lingualis*, *T.* (*Nucula*) *rhomboidea.*

ARTICLE LVI.—*On American Geological History:*—Address before the American Association for the Advancement of Science, August, 1855, by JAMES D. DANA.*

In selecting a topic for this occasion, I have not been without perplexity. Before an Association for the Advancement of Science,—science in its wide range,—a discourse on the progress of science in America for the past year would seem legitimate. Yet it is a fact that the original memoirs in most departments, published within that period, would make a very meagre list. Moreover, it is too much to expect of any one to roam over others territories, lest he ignorantly gather for you noxious weeds. I have, therefore, chosen to confine myself to a single topic, that of Geology; and I propose, instead of simply reviewing recent geological papers, to restrict myself to some of the general conclusions that flow from the researches of American geologists, and the bearing of the facts or conclusions on geological science. I shall touch briefly on the several topics, as it is a subject that would more easily be brought into the compass of six hours than one. In drawing conclusions among conflicting opinions, or on

* Silliman's American Journal of Science, November, 1856.

points where no opinion has been expressed, I shall endeavor to treat the subject and the views of others in all fairness, and shall be satisfied if those who differ from me shall acknowledge that I have honestly sought the truth.

In the first place, we should have a clear apprehension of the intent or aim of Geological Science. It has been often said, that Geology is a *history*, the records of which are written in the rocks: and such is its highest department. But is this clearly appreciated? If so, why do we find text-books, even the one highest in authority in the English language, written back end foremost,—like a History of England commencing with the reign of Victoria. In history, the phases of every age are deeply rooted in the preceding, and intimately dependent on the whole past. There is a literal unfolding of events as time moves on, and this is eminently true of Geology.

Geology is not simply the science of rocks, for rocks are but incidents in the earth's history, and may or may not have been the same in distant places. It has its more exalted end,—even the study of the progress of life from its earliest dawn to the appearance of man; and instead of saying that fossils are of use to determine rocks, we should rather say that the rocks are of use for the display of the succession of fossils. Both statements are correct; but the latter is the fundamental truth in the science.

From the progress of life, geological time derives its division into Ages, as has been so beautifully exhibited by Agassiz. The successive phases in the progress of life are the great steps in the earth's history. What if in one country the rocks make a consecutive series without any marked interruption between two of these great ages, while there is a break or convenient starting point in another; does this alter the actuality of the ages? It is only like a book without chapters in one case, and with arbitrary sections in another. Again, what if the events characteristic of an age—that is, in Geology, the races of plants or animals—appear to some extent in the preceding and following ages, so that they thus blend with one another? It is but an illustration of the principle just stated, that *time is one*. Ages have their progressive development, flowing partly out of earlier time, and casting their lights and shadows into the far future. We distinguish the ages by the culmination of their grand characteristics, as we would mark a wave by its crest.

Divisions of time *subordinate* to the great ages will necessarily depend on revolutions in the earth's surface, marked by abrupt transitions, either in the organic remains of the region, or in the succession of rocks. Such divisions are not universal. Each continent has its own periods and epochs, and the Geologists of New York and the other States have wisely recognized this fact, disregarding European *stages* or subdivisions. This is as true a principle for the Cretaceous and Tertiory, as for the Silurian and Devonian. The usurpation of Cromwell made an epoch in English annals; not in the French or Chinese. We should study most carefully the records, before admitting that any physical event in America was contemporaneous with a similar one in Europe. The unity in geological history is in the progress of life and in the great physical causes of change, not in the succession of rocks.

The geological ages, as laid down by Agassiz, are the following:—I. The AGE OF FISHES, including the Silurian and Devonian; II. The AGE OF REPTILES, embracing from the Carboniferous through the Cretaceous; III. The AGE OF MAMMALS, the Tertiary and Post-tertiary; IV. The AGE OF MAN, or the recent era; *fishes* being regarded as the highest and characteristic race of the first age, *reptiles* of the second, and *mammals* of the third.

More recent researches abroad, and also the investigations of Prof. Hall in this country, have shown that the supposed fish remains of the Silurian are probably fragments of Crustacea, if we except those of certain beds near the top of the Silurian; and hence the *Age of Fishes* properly begins with the Devonian. What then is the Silurian? It is pre-eminently the AGE OF MOLLUSKS.

Unlike the other two Invertebrate sub-kingdoms, the *Radiate* and *Articulate*, which also appear in the earliest fossiliferous beds, the *Molluscan* sub-kingdom is brought out in all its grander divisions. There is not simply the type, but the type analysed or unfolded into its several departments, from the Brachiopods and Bryozoa up to the highest group of all, the Cephalopods. And among these Cephalopods, although they may have been inferior in grade to some of later periods, there were species of gigantic size, the shell reaching a length of ten or twelve feet. The Silurian is therefore most appropriately styled the *Molluscan Age.*

The Palæozoic Trilobites belong to the lower tribe of Crustacea, and Crustacea rank low among Articulates. Moreover, Crustacea (and the Articulata in general) did not reach their fullest development until the Human Era.

The Radiata were well represented in the Silurian periods; but, while inferior to the Mollusca as a sub-kingdom, only corals and crinoids, the lower fixed or vegetative species, with rare exceptions, occur in the Silurian of Molluscan Age.

The Articulata and Radiata thus begin early, but with only the lower forms in each, and neither is a leading class in any age.

Viewing the history, then *zoölogically*, the ages are, the Age of Mollusks, of Fishes, of Reptiles, of Mammals, of Man.

We may now change the point of view to the Vegetable Kingdom. The ages thence indicated would be three:—

I. The *Age of Algæ*, or marine plants, corresponding to the Silurian and Devonian.

II. The *Age of Acrogens*, or flowerless trees, that is, the Lepidodendra, Sigillariæ, and Calamites,—corresponding to the Coal Period and Permian; a name first proposed by Brongniart, and which may still be retained, as it is far from certain that the Sigillariæ and Calamites are most nearly related to the Coniferæ.

III. The *Age of Angiosperms*, or our common trees, like the Oak, Elm, &c., beginning with the Tertiary.

The interval between the second and third of these ages is occupied mainly by Coniferæ, the Pine tribe, and Cycadeæ, the true Gymnosperms, species of which were abundant in the Coal Period, and have continued common ever since. The Coniferæ, in the simplicity of their flowers and their naked seed, are next akin to the Acrogens or flowerless trees. Although in the main a flowerless vegetation, for the few supposed remains of flowers observed abroad have been recently referred to undeveloped leaf-buds, it appears probable from the observations of Dr. Newberry, that there were some true flowers over the Ohio prairies,—apparently monocotyledonous, and related to the Lily tribe. But no traces of Palms or monocotyledonous trees have been found in the coal fields of this country.

Combining the results from the animal and vegetable kingdoms, we should introduce the Age of Acrogens, for the Coal Period and Permian, between the Age of Fishes and Age of

Reptiles,—a space in time zoölogically occupied by the overlapping of these two ages.*

The order then reads, the Age of Mollusks, of Fishes, of Acrogens or Coal plants, of Reptiles, of Mammals, of Man.

The limits of these ages are as distinct as history admits of; their blendings where they join, and the incipient appearance of a type before the age it afterwards characterizes fully opens, are in accordance with principles already explained.

The reality of progress from lower to higher forms is not more strongly marked in these names, properly applied, than in the rocks. If, hereafter, mammals, reptiles, or fishes, are found a little lower than now known, it will be changing but a sentence in the history,—not the grand idea which pervades it.

A theory lately broached by one whose recent death has caused universal grief to science, supposes that the Reptilian was an age of diminished life, between the two extremes in time, the Palæozoic and Mammalian Ages. But, in fact, two grand divisions of animals, the Molluscan and Reptilian, at this time reach their climax and begin their decline, and this is the earliest instance of the highest culmination of a grand zoölogical type.

Preceding the Silurian or Molluscan Age, there is the Azoic Age, or *age without animal life.* It was so named by Murchison and De Verneuil; and was first recognized in its full importance, and formally announced in this country, in the Geological Report of Messrs. Foster and Whitney, although previously admitted in an indefinite way by most Geologists.†

It embraces all the lowest rocks up to the Silurian, for much of the lowest granite cannot be excluded.

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* This Age would perhaps be more correctly styled the *Age of Conifers*, as Conifers, a higher group than Acrogens, were among the earliest of all land plants, occuring in the upper Devonian as well as Carboniferous; and the ages in other cases are named from the superior group of species. Yet as the Acrogens were especially characteristic of the era, and the Conifers have their fullest development in the present age, the name above given seems to be preferable, unless it prove true that the Sigillariæ and Calamites are actually related to the Coniferæ as urged by Brongniart. *Zoologically*, the age has some title to the name, *Age of Amphibians.* But before it closed, true reptiles had appeared. It is a significant fact that the Amphibians in some cases appear to have approached true reptiles, as much as some of the genera of Acrogens the Conifers. An interesting example of this, from the coal formation of Ohio, has recently been mentioned by Dr. J. Wyman, (Tenth Meeting Amer. Assoc. at Albany.)

† Report on the Geology of the Lake Superior Land District, by J. W. Foster and J. D. Whitney, U. S. Geologists; Part II, The Iron Regions, together with General Geology. Senate Executive Document, No. 4, Special Session, March, 1851. Ordered to be printed, March 13, 1851. 406 pp. 8vo, with many plates, and a large geological map and section.

The actual absence of animal life in the so-called Azoic Age in this country is rendered highly probable, as Foster and Whitney show, by the fact that many of the rocks are slates and sandstones, like fossiliferous Silurian rocks, and yet have no fossils; and moreover, the beds on this continent were uplifted and folded, and to a great extent crystallized on a vast scale, before the first Silurian layers were deposited. A grand revolution is here indicated, apparently the closing event of the early physical history of the globe.*

(*To be continued.*)

* Foster and Whitney observe, (loc. cit. pp. 7, 26, 132,) that at Chippewa Island (in the Menomonee River, near 45½° N., 88° W.,) the Potsdam sandstone lies on the up turned Azoic slates. At White Rapids, lower down the stream, the same sandstone rests on the tilted edges of the Azoic quartz rock. Near Presqu'Isle (not far from 46° 30'—46° 35' N, 87° 33' W.,) a similar contact of the nearly horizontal Potsdam and the vertical quartz rock is seen.

The Azoic of this continent was well studied and defined at a still earlier date by the distinguished geologist of Canada, Sir William E. Logan. In his Annual Report for 1846 1847, and that for 1848, he points out several examples of the Silurian covering the contorted Azoic, and his subsequent surveys have added to the facts of this kind. They occur north of the Lakes Huron and Superior, and along and to the north of the Saint Lawrence. Moreover, in the vicinity of the lakes just mentioned, he found the Azoic divided into two unconformable groups, a *lower*, since called by him the *Laurentian*, and an upper, the *Huronian*; the former consisting of granite, syenite, gneiss, hornblende rock, hypersthene rock, crystalline limestones, &c., the latter of diorite, slates, white and red sandstones, conglomerates, limestones, the whole much intersected by trap and metalliferous veins containing native copper, &c., and having a thickness in some places, probably of 9,000 to 12,000 feet.

Sections representing the nearly horizontal Lower Silurian overlying the Azoic, as observed by him in the vicinity of the St. Lawrence north-east of Lake Champlain, are figured in the Quarterly Journal of the Geological Society of London, for 1852, pp. 203 and 206.

In the progress of the Geological Survey of New York, commencing in 1836, the fact that the crystalline rocks of Northern New York were older than the Silurian was early shown, but good sections illustrating the superpositions of the two were not given.

At the meeting of the American Association at Cincinnati in 1851, when Foster and Whitney first presented their views on the Azoic, Prof Mather stated that he had traced the continuation of the system nearly to the sources of the Mississippi and on the waters of the St. Peters,—a region since reported on by Dr. D. D. Owen, (Geol. Survey of Wisconsin, Iowa and Minnesota, 4to, 1852); Dr. H. King contributed observations on the Azoic or iron mountain region of Missouri, (p. 191, Amer. Assoc. Rep. 1851,) indicating the inferiority in position of these rocks to the Silurian, as had been urged by Messrs. Foster and Whitney from the investigations by Mr. Mersch under their direction; and Dr. Engelmann described related rocks in Arkansas between Little Rock and the Hot Springs.

Professors W. B. and H. D. Rogers refer to Azoic Rocks as found in the Appalachians; but no instances of the superposition of the lowest Silurian in those regions on other *non-conformable* beds have yet been published; and it is a question whether the metamorphic rocks are all related to those of New England in age, or partly of this era of metamorphism and partly Azoic.