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THE

CANADIAN

NATURALIST AND GEOLOGIST.

VOL. VIII. APRIL, 1863. No. 2.

ART. VI.—*The Air-Breathers of the Coal Period in Nova Scotia;* by J. W. DAWSON, LL.D., F.R.S., &c.

(*Continued from page* 12.)

IV.—DENDRERPETON ACADIANUM.

Plate III.

The geology of Nova Scotia is largely indebted to Sir Charles Lyell. Though much had previously been done by others, his personal explorations in 1842, and his paper on the gypsiferous formation, published in the following year, first gave form and shape to some of the more difficult features of the geology of the country, and brought it into relation with that of other parts of the world. In geological investigation, as in many other things, patient plodding may accumulate large stores of fact, but the magic wand of genius is required to bring out the true value and significance of these stores of knowledge. It is scarcely too much to say that the explorations of a few weeks, and subsequent study of the subject by Sir Charles, with the impulse and guidance given to the labors of others, did as much for Nova Scotia, as might have been effected by years of laborious work under less competent heads.

Sir Charles naturally continued to take an interest in the geology of Nova Scotia, and to entertain a desire to explore more fully some of those magnificent coast sections which he had but hastily examined; and when, in 1851, he had occasion to revisit the United States, he made an appointment with the writer of these pages to

spend a few days in renewed explorations of the cliffs of the South Joggins. The object specially in view was the thorough examination of the beds of the true coal measures, with reference to their contained fossils, and the conditions of accumulation of the coal; and the results were given to the world in a joint paper on "The remains of a reptile and a land-shell discovered in the interior of an erect tree in the coal measures of Nova Scotia," and in the writer's paper on the "Coal Measures of the South Joggins;"* while other important investigations grew out of the following up of these researches, and much matter in relation to the vegetable fossils still remains to be worked up. It is with the more striking fact of the discovery of the remains of a reptile in the coal measures that we have now to do.

The South Joggins Section is, among other things, remarkable for the number of beds which contain remains of erect trees imbedded *in situ:* these trees are for the most part Sigillariæ, varying in diameter from six inches to five feet. They have grown in underclays and wet soils, similar to those in which the coal was accumulated; and these having been submerged or buried by mud carried down by inundations, the trees, killed by the accumulations around their stems, have decayed, and their tops being broken off at the level of the mud or sand, the cylindrical cavities, left open by the disappearance of the wood, and preserved in their form by the greater durability of the bark, have been filled with sand and clay. This, now hardened into stone, constitutes pillar-like casts of the trees, which may often be seen exposed in the cliffs, and which, as these waste away, fall upon the beach. The sandstones enveloping these pillared trunks of the ancient Sigillariæ of the coal, are laminated or bedded, and the laminæ, when exposed, split apart with the weather, so that the trees themselves become split across; this being often aided by the arrangement of the matter within the trunks, in layers more or less corresponding to those without. Thus one of these fossil trees usually falls to the beach in a series of discs, somewhat resembling the grindstones which are extensively manufactured on the coast. The surfaces of these fragments often exhibit remains of plants which have been washed into the hollow trunks and have been imbedded there; and in our explorations of the shore, we always carefully scrutinized such specimens, both with the view of observ-

* Journal of the Geological Society of London; Vols. ix and x; and Acadian Geology.

ing whether they retained the superficial markings of Sigillariæ, and with reference to the fossils contained in them. It was while examining a pile of these "fossil grindstones," that we were surprised by finding on one of them what seemed to be fragments of bone. On careful search other bones appeared, and they had the aspect, not of remains of fishes, of which many species are found fossil in these coal measures, but rather of limb-bones of a quadruped. The fallen pieces of the tree were carefully taken up, and other bones disengaged, and at length a jaw with teeth made its appearance. We felt quite confident, from the first, that these bones were reptilian; and the whole, being carefully packed and labelled, were taken by Sir Charles to the United States, and submitted to Prof. J. Wyman of Cambridge; who recognized their reptilian character, and prepared descriptive notes of the principal bones, which appeared to have belonged to two species. He also observed among the fragments an object of different character, apparently a shell; which was recognized by Dr. Gould of Boston, and subsequently by Mr. Deshayes, as probably a land-snail, and has since been named *Pupa vetusta*.

The specimens were subsequently taken to London and re-examined by Prof. Owen, who confirmed Wyman's inferences, added other characters to the description, and named the larger and better preserved species *Dendrerpeton Acadianum*, in allusion to its discovery in the interior of a tree, and to its native country of Acadia or Nova Scotia. With the aid of Plate III, I shall now endeavour to describe this species as fully as the materials at my command will allow, and shall then make some remarks on its affinities, habitat, and mode of life. It is necessary to state in explanation of the fragmentary character of the remains represented in the plate, that in the decay of the animals imbedded in the erect trees at the Joggins, their skeletons have become disarticulated, and the portions scattered, either by falling into the interstices of the vegetable fragments in the bottom of the hollow trunks, or by the water, with which these may have sometimes been partly filled. We thus can obtain only separate bones; and though all of these are no doubt present in each case, it is impossible in breaking up the hard matrix to recover more than a small proportion of them. For this reason I have been obliged to have recourse, not merely to the original specimen whose discovery is noticed above, but to three others subsequently obtained by me; all however belonging, on the evidence of the teeth and more important bones, to one.

species, and all being nearly, though not absolutely, of the same size. It is also proper to state that in the case of the original specimen, and another still more perfect one, both of which are now in London, I have been able to refer only to the published plates, and to add to these from parts of two additional individuals still in my own collection.

In form, *Dendrerpeton Acadianum* was probably lizard-like; with a broad flat head, short stout limbs and an elongated tail; and having its skin, and more particularly that of the belly, protected by small bony plates closely overlapping each other. It may have attained the length of two feet. The form of the head is not unlike that of *Baphetes*, but longer in proportion; and much resembles that of the labyrinthodont reptiles of the Trias (Fig. 1). The bones of the skull are sculptured as in *Baphetes*, but in a smaller pattern (Figs. 8, 9). The nostrils are small, and near the muzzle: the orbits are circular, and separated by a space of more than their own diameter. In the upper jaw there is a series of conical teeth on the maxillary and intermaxillary bones (Figs. 5, 15). Those on the intermaxillaries are much larger than the others, and have the aspect of tusks or canines (Figs. 3, 13). Within this outer series of teeth, and implanted apparently in palatal bones, as in *Archegosaurus Decheni*, there is a second series of teeth, closely placed, or with intervals equal to the diameter of one tooth. These inner teeth are longer than the others, implanted in shallow sockets, to which they are anchylosed, and have the dentine plicated, except toward the point (Figs. 2, 4, 6, 7, 17). A third group of teeth, blunt at the points, largely hollow in the interior, and with the dentine quite simple, appears in detached bones, which may represent the vomer (Fig. 12). Only a part of this formidable armature of teeth appears in the skull represented in Fig. 1, as the bones of the roof of the mouth have been removed, adhering to the opposite side of the matrix; but the fact of the occurrence of two sets of teeth was ascertained by Prof Wyman, from the original specimens, and is manifest in the fragment represented in Fig. 17; while the other teeth, supposed to be vomerine, appear in fragments which must, from their size and collocation, have belonged to *Dendrerpeton*. It will be observed that all these teeth are anchylosed to the bone; and while those of the vomer are thinly walled and simple, those on the maxillaries and intermaxillaries are plicated toward the base only, while the inner series of palatal teeth are plicated more than half way up. In

the lower jaw there was a uniform series of conical teeth, not perceptibly enlarged toward the front; at least this is the case in the only specimen at present in my collection (Fig. 16); which is however merely an imperfect cast in hard sandstone.

The scapular and sternal bones seem to have been well developed and strong, but only portions of them are known (Fig. 25.) The fore limb of the adult animal, including the toes, must have been four or five inches in length, and is of massive proportions. The bones were hollow, and in the case of the phalanges the bony walls were thin, so that they are often found crushed flat. The humerus however was a strong bone, with thick walls and a cancellated structure toward its extremities; still even these have sometimes yielded to the great pressure to which they have been subjected. Fig. 26 shows the humerus of the original specimen of the species, and Fig. 10 exhibits a series of sections of a similar bone, probably the humerus of a smaller individual. The cavity of the interior of the limb-bones is usually filled with calc-spar stained with organic matter, but showing no structure; and the inner side of the bony wall is smooth, without any indication of cartilaginous matter lining it.

The vertebræ, in the external aspect of their bodies, remind one of those of fishes, expanding toward the extremities, and being deeply hollowed by conical cavities, which appear even to meet in the centre. There is however a large and flattened neural spine. The vertebræ are usually much crushed, and it is almost impossible to disengage them from the stone. Fig. 21 exhibits the usual form, and Fig. 22 another; which, in its long neural and hæmal spines, reminds us of the caudal vertebræ of those batrachians and reptiles which have tails flattened for swimming, and probably indicates that this was the case with *Dendrerpeton*. Fig. 23 is a transverse section of a somewhat crushed vertebra, showing its ossified centrum and neural spine, and also the microscopic structure of the bone. The ribs are long and curved, with an expanded head, near to which they are solid, but become hollow towards the middle; and the distal extremities are flattened and thin walled. The posterior limb seems to have been not larger than the anterior, perhaps smaller. The bones represented in Fig. 27, which I refer to this member, probably belonged to a somewhat smaller individual than that to which the humerus in Fig. 26 belonged. The tibia is much flattened at the extremity, as in some labyrinthodonts, and the foot must have been broad, and probably suited for

swimming or walking on soft mud, or both. That the hind limb was adapted for walking is shown, not merely by the form of the bones, but also by that of the pelvis, the best preserved specimen of which is represented in Fig. 28; but an iliac limb of still larger size is figured in the Journal of the Geological Society, Vol. IX.

The external scales are thin, oblique-rhomboidal or elongated-oval, marked with slight concentric lines, but otherwise smooth, and having a thickened ridge or margin; in which they resemble those of *Archegosaurus*, and also those of *Pholidogaster pisciformis*, recently described by Huxley from the Edinburgh coal-field,—an animal which indeed appears in most respects to have a close affinity with *Dendrerpeton*. The microscopic structure of the scales is quite similar to that of the other bones, and different from that of the scales of ganoid fishes, the shape of the cells being batrachian as in Fig. 11. Figs. 18 and 19 exhibit different forms of the scales.

With respect to the affinities of the creature, I think it is obvious that it presents some points of resemblance, on the one hand to *Archegosaurus*, and on the other, to *Labyrinthodon;* and that it has the same singular mixture of ichthyic, batrachian, and reptilian characters which distinguish these ancient animals, and which give them the appearance of prototypes of the reptilian class. Professor Owen regards *Archegosaurus* as the type of the order *Ganocephala*, which he characterizes as having the head protected by sculptured and polished ganoid plates, no occipital condyles, teeth with converging folds of cement at their basal half, the notochord persistent, the ribs short and straight, the limbs natatory and small; and holds that *Dendrerpeton* approaches more nearly to this order than to the *Labyrinthodonts*. But at the time when this opinion was expressed, he was not fully aware of the development of the limbs and ribs, and of the ossified condition of the vertebræ; characters which, with the form of the skull, the arrangement of the teeth, and the probable possession of occipital condyles, appear to determine the scale in favour of the *Labyrinthodonts*. At the same time it must be admitted that *Dendrerpeton* is far removed from the typical genus *Labyrinthodon*, and that in the characters in which it differs, it leans toward *Archegosaurus;* closely resembling in thisits contemporary *Pholidogaster pisciformis* already referred to.

This ancient inhabitant of the coal swamps of Nova Scotia, was, in short, as we often find to be the case with the earliest

forms of life, the possessor of powers and structures not usually, in the modern world, combined in a single species. It was certainly not a fish, yet its bony scales, and the form of its vertebræ, and of its teeth, might, in the absence of other evidence, cause it to be mistaken for one. We call it a batrachian, yet its dentition, the sculpturing of the bones of its skull, which were certainly no more external plates than the similar bones of a crocodile, its ribs, and the structure of its limbs, remind us of the higher reptiles; and we do not know that it ever possessed gills, or passed through a larval or fish-like condition. Still, in a great many important characters, its structures are undoubtedly batrachian. It stands, in short, in the same position with the *Lepidodendra* and *Sigillariæ* under whose shade it crept, which though placed by palæo-botanists in alliance with certain modern groups of plants, manifestly differed from these in many of their characters, and occupied a different position in nature. In the coal period, the distinctions of physical and vital conditions were not well defined—dry land and water, terrestrial and aquatic plants and animals, and lower and higher forms of animal and vegetable life, are consequently not easily separated from each other. This is no doubt a state of things characteristic of the earlier stages of the earth's history, yet not necessarily so; for there are some reasons, derived from fossil plants, for believing that in the preceding Devonian period there was less of this, and consequently that there may then have been a higher and more varied animal life than in the coal period.* Even in the modern world also, we still find local cases of this early union of dissimilar conditions. It is in the swamps of Africa, at one time dry, at another inundated, that such intermediate forms as *Lepidosiren* occur, to baffle the classificatory powers of naturalists; and it is in the stagnant unaerated waters, half swamp, half lake or river, and unfit for ordinary fishes, that the semi-reptilian *Amia* and *Lepidosteus* still keep up the characters of their palæozoic predecessors.

The dentition of *Dendrerpeton* shows it to have been carnivorous in a high degree. It may have captured fishes and smaller reptiles, either on land or in water, and very probably fed on dead carcases as well. If, as seems likely, the footprints referred to in a previous section belong to *Dendrerpeton*, it must have frequented the shores, either in search of garbage, or on its way to

* See the author's paper on Devonian plants, Journal of the Geological Society, Vol. xviii, p. 328.

and from the waters. The occurrence of its remains in the stumps of Sigillaria, with land-snails and millipedes, shows also that it crept in the shade of the woods in search of food; and under the head of coprolitic matter, in a subsequent section, I shall show that remains of excrementitious substances, probably of this species, contain fragments, attributable to smaller reptiles, and other animals of the land.

All the bones of *Dendrerpeton* hitherto found, as well as those of the smaller reptilian species hereafter described, have been obtained from the interior of erect Sigillariæ, and all of these in one of the many beds, which, at the Joggins, contain such remains. The thick cellular inner bark of Sigillaria was very perishable; the slender woody axis was somewhat more durable; but near the surface of the stem, in large trunks, there was a layer of elongated cells, or bast tissue, of considerable durability, and the outer bark was exceedingly dense and indestructible.* Hence an erect tree, partly imbedded in sediment, and subjected to the influence of the weather, became a hollow shell of bark; in the bottom of which lay the decaying remains of the woody axis, and shreds of the fibrous bark. In ordinary circumstances such hollow stems would be almost immediately filled with silt and sand, deposited in the numerous inundations and subsidences of the coal swamps. Where however they remained open for a considerable time, they would constitute a series of pitfalls, into which animals walking on the surface might be precipitated; and being probably often partly covered by remains of prostrate trunks, or by vegetation growing around their mouths, they would be places of retreat and abode for land-snails and such creatures. When the surface was again inundated or submerged, all such animals, with the remains of those which had fallen into the deeper pits, would be imbedded in the sediment which would then fill up the holes. These seem to have been the precise conditions of the bed which has afforded all these remains. I may add that I believe all the trees, four or five in number, which have become exposed in this bed since its discovery, have been ransacked for such remains; and that while all have afforded some reward for the labour, some have been far more rich than others in their contents. It is also to be observed that owing to the mode of accumulation of the mass filling the trees, the bones are usually

* See a paper by the author, on the structures of coal; Journal of the Geological Society, Vol. xv; also supplement to Acadian Geology.

found scattered in every position, and those of different species intermingled; and that being often much more friable than the matrix, much labour is required for their development; while after all has been done, the result is a congeries of fragments like that presented by Plate III. The two specimens which displayed the largest number of bones in juxtaposition, are one of *Dendrerpeton Acadianum*, and one of *Hylonomus Lyelli*, both presented by me to the geological Society of London, and now in its collection; but of which I shall endeavour to obtain accurate representations for this memoir.

In order more fully to illustrate the mode of occurence of these remains, I quote the following notice of my last explorations in the bed containing them, from the Journal of the Geological Society of London, for 1861:

"In the bed which has hitherto alone afforded reptilian remains in its erect trees, two additional examples of these were exposed. One was on the beach, and in part removed by the sea. The other was in the cliff, but so far disengaged that a miner succeeded in bringing it down for me. In the first, comparatively little was found. It afforded only a few shells of *Pupa vetusta*, and scattered bones of a full-grown individual of *Dendrerpeton Acadianum*.

"The second tree was more richly stored; and, being *in situ*, was very instructive as to the mode of occurence of the remains. Like all the other trees in which reptilian bones have been found, it sprang immediately from the surface of the six-inch coal in Group XV. of my section*; which is also Coal No. 15 of Sir W. E. Logan's section†. Its diameter at the base was two feet, and its height six feet, above which, however, an appearance of additional height was given by the usual funnel-shaped sinking of the overlying beds toward the cavity of the trunk. The bark is well preserved in the state of bituminous coal, and presents externally a longitudinally wrinkled surface, without ribs or leaf-scars; but within, on the 'ligneous' surface, or that of the inner bark, there are broad flat ribs, and transversely elongated scars. The appearances are precisely those which might be expected on an old trunk of my *Sigillaria Brownii*; to which species this tree may have very well belonged.‡

* Quart. Journ. Geol. Soc. Vol. ix. p. 58, and Vol. x. p. 20.

† Reports of Geol. Survey of Canada, 1845.

‡ Quart. Journ. Geol. Soc. Vol. xvii. p. 523.

"The contents of the trunk correspond with those of others previously found. At the bottom is the usual layer of mineral charcoal, consisting of the fallen wood and bark of the tree itself. Above this, about two feet of its height are filled with a confused mass of vegetable fragments, consisting of *Cordaites*, *Lepidodendron*, *Ulodendron*, *Lepidostrobus*, *Calamites*, *Trigonocarpum*, stipes and fronds of ferns, and mineral charcoal; the whole imbedded in a sandy paste blackened by coaly matter. In, and at the top of this mass occur the animal remains. The remainder of the trunk is occupied with grey and buff sandstone, containing a few fragments of plants, but no remains of animals.

"Portions of six reptilian skeletons were obtained from this trunk. The most important of these is a large and nearly complete skeleton of *Dendrerpeton Acadianum*.* Another specimen found in this trunk is a jaw of an animal about the size of *Dendrerpeton Acadianum*, but with fewer and larger teeth.† The remaining skeletons were imperfect, and belonged to a small individual of *Dendrerpeton Acadianum*, two of *Hylonomus Lyelli*, and one of *Hylonomus Wymani*. The dislocated condition of these and other skeletons is probably due to the circumstance that, when they were introduced, the matter filling the trunk was a loose mass of fragments, into the crevices of which the bones dropped, on decay of the soft parts. Most of the skeletons lie at the sides of the trunk, as if the animals had before death crept close to the walls of their prison. At the time when the reptiles were introduced, the hollow trunk must have been a pit four feet in depth. A number of specimens of *Pupa vetusta* and *Xylobius Sigillariæ* were found, but nothing throwing further light on these species.

"The beds on a level with the top of this erect tree are arenaceous sandstones, with numerous erect *Calamites*. I searched the surfaces of these beds in vain for bones or footprints of the reptiles which must have traversed them, and which, but for the hollow erect trees, would apparently have left no trace of their existence. On a surface of similar character, sixty feet higher, and separated by three coals, with their accompaniments, and a very thick compact sandstone, I observed a series of footprints, which may be those of *Dendrerpeton* or *Hylonomus*."

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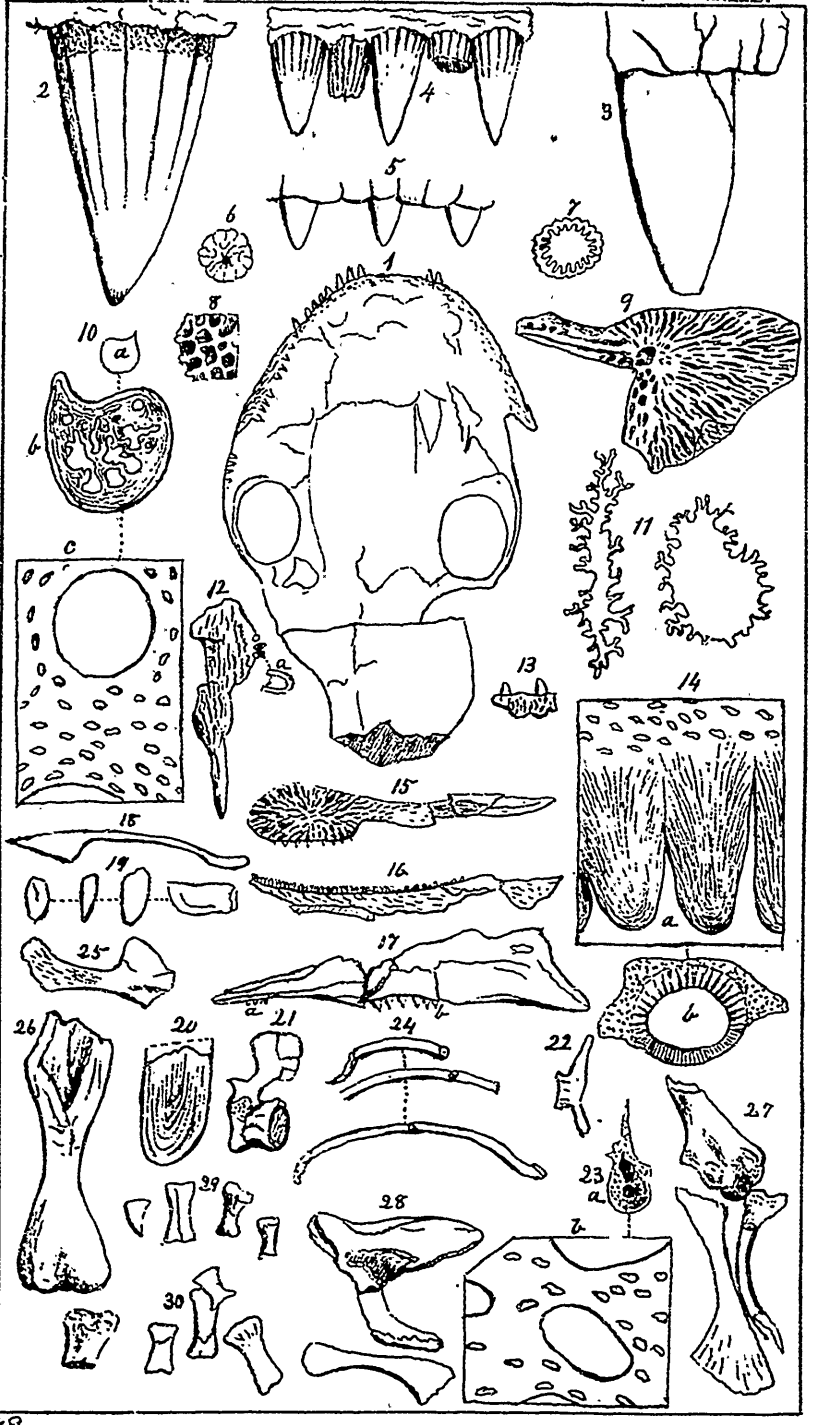
* Now in the collection of the Geological Society of London. Fig. 1, represents the skull of this specimen.

† Since named and described by Prof. Owen as *Hylerpeton Dawsoni*.



DENDRERPETON ACADIANUM. *Owen.*

EXPLANATION OF PLATE I.

Footprints of Reptiles, &c.

Fig. 1.—Footprints discovered by Sir W. E. Logan, in the Lower Carboniferous beds of Horton Bluff, in 1841; reduced to one-fourth of the natural size. (1a) one of the impressions, natural size.

" 2.—Footprints discovered by Dr. Harding, in the Lower Carboniferous beds of Parrsboro'; one-fourth of the natural size. (2a) Prints of fore and hind foot, natural size. This figure is from a rubbing kindly taken for me by Prof. How, of Windsor.

" 3.—Footprints from the Coal Measures of the South Joggins; one-fourth natural size. (3 a) One of the impressions, natural size.

" 4.—Smaller footprints from the South Joggins; one-fourth of natural size.

" 5.—Skin of a reptile, found with remains of a small *Dendrerpeton*, in an erect tree at the Joggins. (a) Scaly portions; (b) Traces of hind leg? and small scales. (c) (d) Portions magnified, showing scales.

EXPLANATION OF PLATE III.

Dendrerpeton Acadianum.

Fig. 1.—Skull seen from below.

" 2.—Inner tooth, magnified; from the jaw, Fig. 17.

" 3.—Tooth of intermaxillary, magnified; from the bone in Fig. 13.

" 4.—Series of inner teeth, less magnified.

" 5.—Series of outer teeth of maxillary bone, Fig. 15, magnified.

" 6, 7.—Sections of inner teeth.

" 8.—Portion of bone of skull, outer surface, twice the natural size.

" 9.—Super-temporal bone, twice the natural size.

" 10.—Cross section of humerus; (a) natural size; (b) magnified; (c) portion more highly magnified, showing canals and bone cells.

" 11.—Bone cells, highly magnified.

" 12.—Vomer? with teeth; (a) tooth magnified.

" 13.—Intermaxillary with teeth.

" 14.—Section of teeth of intermaxillary; (b) magnified; (a) portion highly magnified.

" 15.—Maxillary bone with teeth.

" 16.—Mandible with teeth.

" 17.—Fragment of skull, with (a) outer teeth of maxillary; (b) inner palatal teeth.

" 18.—Cross section of a scale, magnified.

Fig. 19.—Outlines of scales, natural size.
" 20.—Scale, twice natural size.
" 21.—Vertebra.
" 22.—Caudal vertebra.
" 23.—Vertebra broken across, showing neural and central cavities; (a) natural size; (b) section of a portion magnified, showing canals and bone cells.
" 24.—Fragments of ribs.
" 25.—Scapular bone.
" 26.—Humerus, crushed at the proximal end, with fragments of the radius.
" 27.—Fragments of femur, tibia, and fibula.
" 28.—Remains of pelvis.
" 29.—Bones of the foot.
" 30.—Group of bones of the foot, *in situ*.
All the above are of the natural size, unless otherwise stated.

ART. VII.—*Notes on Diatomaceæ from the St. John River*; by PROF. L. W. BAILEY, of the University of New Brunswick.

(*Communicated by the Natural History Society of New Brunswick.*)

For the benefit of those especially interested in such pursuits, I have prepared the following lists of the species which I have, so far, observed as occurring in the waters of this Province. Further study will no doubt add greatly to the number of species.

The first list which I have to present is that of a number of forms obtained from a very interesting gathering, kindly sent me by Mr. G. F. Matthew, a member of the Society, with the request, that I would report any results which might occur to me. The examination has been to me one of much pleasure, and has developed facts of importance in regard to the distribution of the species it contains. Although I give the list so far as now completed, I hope to be able, at some future period, to dwell at more length upon the subject, and at the same time to present a variety of other interesting matter from various parts of the province.

List of Diatomaceæ from Harris' Cove, Kennebeckasis R., N. B.

Doryphora Boeckii.
" *amphiceros.*
Navicula maculata, Bail.
" *ovalis.*
" *viridis.*
" *rhynchocephala.*
Navicula pusilla?
" *permagna.*
" *firma.*
Pinularia major.
" *Couperi?*
" *mesolepta.*

Pleurosigma strigilis.
" *intermedium.*
" *Spencerii*
Nitzschia scalaris.
" *dubia.*
" *sigmoidea.*
Tryblionella gracilis.
" *scutell.*
" *punctata.*
Epithemia turgida.
" *musculus.*
" *granulata.*
" *gibba.*
Campylodiscus Argus.
Surirella biseriata.
" *circumsuta.*
" *splendida.*
" *linearis.*
" *ovata.*
" *limosa.*
Amphiprora alata.
Coscinodiscus minor.
" *cingulatus ?*
" *radiatus.*
Coscinodiscus eccentricus.
" ———
Eupodiscus radiatus ?
Biddulphia turgida.
Cocconema lanceolata.
Gomphonema geminatum.
" *acuminatum.*
Striatella unipunctata.
Orthosira orichalcea.
Melosira Borrei i.
Podosira hormoides.
Achnanthes.
Synedra undulata.
" *radians.*
Cymbella cuspidata.
Mastogloia.
Podosphenia.
Stauroneis gracilis.
" *salina.*
Triciratium.
Amphora ovalis.
Eunotia Arcus.
Cyclotella Kützingiana.
Himantidium.

From this one locality therefore may be procured as many as thirty distinct genera, and not less than sixty species. Long before receiving the above gathering, I had considered it probable that an examination of the aquatic flora in the lower portion of the St. John River would yield interesting results, from the very unusual connexion between that stream and the ocean. As will be seen by an examination of the above list, this conjecture has been verified, the gathering containing a curious mixture of fresh-water, marine, and brackish-water species. It will be an interesting point to determine how far up this influence of the salt water, may extend; marine species being in many cases found many miles above the faintest suspicion of salt-water.

If, as is generally supposed, the three great parallel sheets of water, which cross the southern central portion of the Province, viz, the Kennebecasis, Long Reach, and Grand Lake, are really the remains of three or more great central lakes left by the rising of the land above the ocean, and connected with each other and the sea by the breaking away of the rocky barriers at their south-west extremities, we would expect to find some remains of marine vegetation among the marls and alluvial clays which line their

banks. The subject is one of much interest, and one to which I shall continue to devote myself as opportunities offer.

As far as I am aware the above list is the only one yet published concerning the microscopic organisms of this Province: indeed I think it doubtful whether any one has hitherto even examined our microscopic flora. The list is at present an imperfect one, and will be undoubtedly increased by farther observation.

It may, however be taken as a very fair list of the characteristic diatomaceous forms from the lower St. John. I have not yet had the opportunity to make examinations of gatherings from other portions of the stream. A few forms however, collected, from the surface of stranded ice during the opening of the river last Spring, may be interesting, and are given below. The number of all of these were very great; comparatively few different species were detected. They were as follows:

Organisms observed in melting ice of St. John River.

Fragilaria capucina.
Tabellaria flocculosa.
Cymbella Helvetica.
Odontidium mesodon.
Eunotia monodon.
" *Arcus.*
Cocconema lanceolatum.
Nitzschia Amphioxys.
Surirella
Gomphonema geminatum.
" *accuminatum.*
Synedra Ulna.
Pinnularia mesolepta.

The following forms, including Desmids, Diatoms, and Infusoria, were found in a small pond upon the summit of the hill back of the University buildings, at Fredericton.

Euastrum.
Micrasterias crenata.
" *denticulata.*
= *Rota.*
Didymocladon.
Closterium.
Meridion circulare.
Volvox globater.

I had hoped in the present article to bring before the Society the economic importance of these microscopic organisms, and more especially the assistance they will eventually afford in the determination of the age of many geological deposits from which all traces of organic life have disappeared. This is a particularly interesting subject, and one on which I hope to bring forward some new facts. As the discussion however is necessarily a lengthened one, and as the time at my disposal is now too limited to do the subject full justice, I must beg leave to postpone the remainder to some future period. I shall then attempt to discuss this.

important question, and at the same time to report the examination of other localities from various parts of the Province. In conclusion, I will only say, that specimens of algæ, especially of lighter kinds from the shores of the Bay of Fundy, or Gulf of St. Lawrence, would be highly prized by me, if any members have the means of obtaining them, and could not fail to furnish much that would be new and interesting in the study of our Microscopic Flora.

Note.—Harris' Cove is about thirteen miles from the outlet of Kennebeckasis Bay, and three miles from its head. As the streams which enter this arm of the lake at the mouth of the Saint John River, are all of small size, the salt water which flows inward at flood-tide over the Falls, or rapids connecting it with the harbour, has free access to the locality where those organisms were obtained.

The water is not so brackish however, as to prevent the growth of Potamogeton perfoliatus, Potamogeton pectinatus, Nuphar lutea, confervæ and other aquatic plants; which by their luxuriant growth choke the shallow waters of this and other coves in Kennebeckasis Bay, and are frequently uncovered during the low stage of the river, at midsummer. During the freshets of early spring the salt water is for a time completely excluded by the floods poured into this lake-like expansion of the river, by the main St. John.

ART. VIII.—*Description of a new Trilobite from the Quebec group;* by T. DEVINE, F.R.G.S., C. L. Dept. Quebec.*

OLENUS ? LOGANI. (N. sp.)

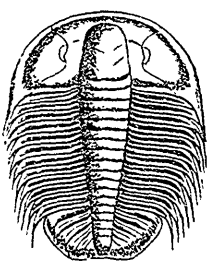


Fig. I.

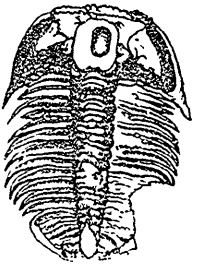


Fig. II.

Fig. I.—*O. Logani.* The anterior point of glabella in this figure is slightly too narrow.

Fig. II.—An imperfect specimen shewing the hypostoma in place.

The general form is oval.

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* NOTE.—By E. Billings. Mr. Devine having lately discovered several nearly perfect trilobites in the limestone at Point Lévis, has kindly

HEAD—exclusive of spines, semi-circular, more than twice as wide as long; truncate in front, and prominently convex in the middle, with a narrow equal border one half a line in width, extended at the posterior angles with the free cheeks into moderate diverging spines; posterior margin marked by a shallow furrow, reaching from the glabella outward to the free cheeks; eyes not large, smooth, and equi-distant from the front and posterior margins, and about one line from the glabella; the ocular ridge prominent, extending from the eye obliquely forward to the glabella, meeting the latter at about one line from the front thereof; facial suture running obliquely from the eye, and cutting the front and posterior margins far outward. The free cheeks are not quite so smooth as the central lobe of head, but no radiation or other marking is visible.

GLABELLA—bell-shaped; width less than one third of the entire head; broadly rounded in front, reaching nearly to the

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consented to allow me to publish a note on them in this place. The species is unquestionably congeneric with those which I have called *Dikelocephalus Belli* and *D. Oweni* from the same locality. My references were founded on fragments of the head, consisting of detached glabellæ, but the aspect presented by these new specimens, (which exhibit all the parts) is that of the genus *Olenus*. As the structure of the underside of the head is unknown, it cannot yet be positively decided that this species truly belongs to that genus, but it is the best reference that can at present be made, and was Mr. Devine's first conclusion. There are two points of difference that are worthy of notice. In *Olenus* (at least in all the 21 species figured by Angelin), the facial sutures run from the eyes either nearly straightforwards, or turn a little inwards. In this species they curve outwards. This is their course in *Dikelocephalus*. The eyes also in *Olenus* are, in general much more distant from the sides of the glabella than they are in this species. Should the underside of the head of the Swedish species of *Olenus* and of *O. Logani* turn out to be the same in structure, then no one would hesitate to place them all in the same genus. In *Dikelocephalus Oweni* the head is composed of three pieces only: 1.—The glabella with the fixed cheeks. 2.—The hypostoma. 3.—The two movable cheeks which are united together by a band extending across the front margin on the underside of the head. I think it will turn out that *O. Logani* is of the same structure.

Angelin has described the Swedish species of *Olenus* under eight subgenera and Mr. Devine's species might form the type of a ninth, differing as much from them, as they do from each other. His discovery is an important addition to our knowledge, as we now know (from entire specimens) that the genus *Dikelocephalus*, so characteristic of the base of the palæozoic rocks of America, is closely allied to the genus *Olenus*.

front margin ; straight sides converging a little anteriorly, convex towards the front ; depressed convex at the neck lobe ; neck furrow well defined, extending across, and directed obliquely forward at each side—two oblique glabellar furrows at each side in front of the latter, making an angle anteriorly of about 45° with the axis ; the furrows are well marked interiorly but very obscure at the sides, and are separated by about one half the width of the glabella, forming three lateral lobes of nearly equal size, each larger than the neck lobe. In some specimens there are three glabellar furrows on each side, the front one making a greater angle anteriorly with the axis than either of the others.

Pleuræ—twelve ; moderately convex outward from the axal furrow, each marked by an equal deep groove to the tips, which are of a horny aspect, recurved and extended into long spines ; sides parallel as far back as the eighth segment, then gradually converging to the pygidium.

Axis—convex, gradually tapering to the extremity of the tail, about two thirds of the width of the pleuræ anteriorly—less at the pygidium ; twelve body rings, and five or six caudal joints ; the body rings notched above posteriorly and slightly swelled at the axal furrows.

Pygidium—entire ; semi-circular ; truncate behind ; lateral lobes depressed convex, on a level with the pleuræ ; four broad ribs on each side of the middle lobe recurved towards the extremities ; margin smooth, and entire anterior angles moderately rounded.

Dimensions of largest specimen.

Entire length	16 lines.
Length of head	5 "
" of thorax	8 "
Axis of tail	3 "
Width at base of head	11 "
" at eighth segment	10 "
" at front of pygidium	8 "
" of axis at same place	1½ "
Length of glabella	4 "
Width at neck lobe	3⅓ "
" at front of glabella	2½ "
" between the eyes	4 "
" of margin in front of glabella	0½ "
" of border	0½ "

Locality, Point Levis.—Band of limestone, A3, referred to in Sir W. E. Logan's "Remarks on the Fauna of the Quebec group of Rocks and the Primordial Zone of Canada," addressed to Mr. J. Barrande, dated Montreal, 31st Dec. 1860, and printed in the Canadian Naturalist and Geologist of that year.

I have in the mean time referred this species to *Olenus*, although at one time inclined to refer it to *Conocephalites*, (Sub-genus). Should it be found necessary to institute an intermediate generic form, whatever place Naturalists may assign it in the animal kingdom, I propose that it be named *Loganellus Quebecensis*.

Dedicated to Sir W. E. Logan, F. R. S. &c., &c.,
Director of the Canadian Geological Survey.

Art. IX.—*On the Land and Fresh-water Mollusca of Lower Canada;* by J. F. Whiteaves, F.G.S., &c.

(Read before the Natural History Society of Montreal.)

Part II.—List of Species Inhabiting Lower Canada.

The writer of this list wishes to acknowledge his obligations to many of the most eminent United States conchologists for practical suggestions and assistance. Mr. Temple Prime has kindly indentified the Cycladidæ; The writer is also indebted to Messrs. Bland, Binney, J. G. Anthony, I. Lea, A. D. Brown, Tryon, and others, for critical advice and sympathy.

In the nomenclature of the Unionidæ, the names given by Rafinesque have been retained; these having priority. The writer has been unable to see why Lamarck's short, insufficient diagnoses of species in this difficult family, should be preferred to the exclusion of the earlier descriptions of the author of "the Bivalve Shells of the Ohio River."

As the Lower Canadian Cycladidæ seem very little understood, Mr. Prime's careful descriptions of these somewhat intricate shells have, with his consent, been added; together with wood-cuts, taken from original drawings.

Note.—The following abbreviations have been made use of in citing the authority for each species in Lower Canada: —R. B. (R. Bell): W. D. (W. D'Urban): E. B. (E. Billings): R. J. F. (R. J. Fowler): J. F. W. (J. F. Whiteaves): W. C. (W. Couper) M. de V. (M. de Villeneuve).

LAMELLIBRANCHIATA.

UNIONIDÆ.

Unio radiatus, Lamarck. Abundant in the rivers and lakes of Canada East. The U. siliquoideus is often taken for this shell.

Unio siliquoideus, Barnes. Equally common with the above. For details of difference between the former species and this, see Conrad's Monograph of the genus Unio. As many able conchologists deny that this is the Unio luteolus of Lamarck, I have preferred keeping the name given to the species by Barnes.

Unio Canadensis, Lea. St. Helen's Island, Montreal; apparently very rare. Some rayed specimens of a Unio which I took at Quebec may be a dwarf form of this species. A single dead *typical* specimen on the beach of the Island of Orleans: J. F. W.

Unio cardium, Rafinesque. (U. ventricosus, Barnes.) St. Lawrence; very fine near Quebec. Unio subovatus, Lea, appears to be the male of this species; and U. occidens, Lea, a variety of the female.

Unio complanatus, Solander. By far the commonest Unio in the district; living (according to Mr. Bell) as far down the St. Lawrence as Berthier below Quebec.

Unio dilatatus, Rafinesque. (U. gibbosus, Barnes.) Widely distributed in the St. Lawrence and its tributaries, but scarce. Some varieties closely resemble the last species.

Unio rectus, Lamarck. St. Lawrence at Quebec and Montreal, but somewhat rare.

Unio alasmodontinus, Barnes, (U. pressus, Lea.) Rare: L'Assomption river: M. de V. River St. Pierre, and Lachine canal near Montreal: R. J. F. Rideau canal near Ottawa city: E. B.

Unio alatus, Say. Ottawa river, near Ottawa: mouth of River Rouge: R. B.

Unio olivarius, Rafinesque. (U. ellipsis, Lea, *fide* J.G. Anthony.) St. Lawrence at Quebec and Montreal; fine and not infrequent at Quebec.

Margaritana margaritifera, Linn. (Alasmodon arcuatus, Barnes.) Very large and fine in the St. Charles river near Quebec: J. F.W. Green and Rimouski rivers; both of the Matapedia lakes; Lake St. John: R. B.

Margaritana costata, Rafinesque. (Alasmodon rugosa, Barnes.) Sparingly in the St. Lawrence about Montreal. Yamaska river near St. Hyacinthe: J. F. W.

Margaritana marginata, Say. With the foregoing, but not very common.

Margaritana undulata, Say. Common in the St. Lawrence down to Quebec; at which latter place it is very abundant, and often beautifully coloured.

Anodonta cataracta, Say. (A. fluviatilis, Lea.) Lake Calvaire, near Quebec: abundant in small creeks near the St. Charles river at Quebec: J. F. W. Large and plentiful at Brome Lake in the Eastern Townships: R. J. F. Probably common in suitable places throughout the district.

Anodonta Lewisii, Lea. Lachine canal near Montreal. R. J. F.

Anodonta Benedictensis, Lea. Mississquoi bay, Lake Champlain.

Anodonta implicata, Say. Fine in the St. Lawrence near Quebec: J. F. W. Berthier: R. B.

Anodonta Ferussaciana, Lea. Creek at L'Orignal: R. B. Fine in old stone quarries near the Mile-end toll-gate, Montreal.

Anodonta undulata, Say. St. Charles river about three miles from Quebec.

Anodonta edentula, Say. Lake Matapedia: R. B. Brome Lake in the Eastern Townships: R. J. F. I consider this species, and perhaps even the next, as identical with A. undulata, Say.

Anodonta subcylindracea, Lea. Lachine Canal: R. J. F. St. Lawrence at Quebec. J. F. W.

Anodonta Footiana, Lea. Sixteen Island, Eagle Nest, and Bevan's lakes. W. D.

Anodonta modesta? Lea. A few specimens which appear to me to agree with Mr. Lea's figures and description of this species, were taken by Mr. Bell from Lake St. John.

CYCLADIDÆ.

The genus Cyclas was proposed by Bruguière in the year 1792; but Scopoli's genus Sphœrium bears date 1777; and consequently has priority, as has been shown by Dr. Gray. See Mr. Temple Prime's elaborate monograph of the North and South American species in this genus, published in the "Proceedings of the Academy of Natural Sciences of Philadelphia" for December, 1861.

Sphœrium sulcatum, Lamarck. (Cyclas similis, Say.) Metis lakes, and a small lake six miles S.W. of Metis: R. B. Common

in the St. Lawrence at Montreal; and probably widely diffused throughout the province.

Sphærium solidulum, Prime. Creek at L'Orignal: R. B. It will probably be detected in Canada East, as it has been taken so near the border.

Sphærium striatinum, Lamarck. (Cyclas edentula, Say.) Lachine Canal, near Montreal: R. J. F. St. Lawrence and St. Charles rivers near Quebec, abundant: J. F. W.

Sphærium rhomboideum, Say, (sp.). Gregarious, but very local. Old quarries near the Mile-end toll-gate, Montreal, but apparently confined to a very limited space there. R. J. F., and J. F. W.

Sphærium occidentale, Prime. Swamps on an island near Lachine: R. J. F.

Sphærium transversum, Say, (sp.). Lachine Canal near Montreal: R. J. F. St Lawrence near Quebec: J. F. W.

Sphærium securis, Prime. Old stone quarries filled with water, near the Mile-end toll-gate, Montreal: R. J. F. and J. F. W. Lachine: R. J. F.

Pisidium Virginicum, Brongniart. (Cyclas dubia, Say.) St. Lawrence and St. Charles rivers at Quebec: J. F. W. Montreal, in the St. Lawrence, and the Lachine canal. Probably common in all the large tributaries of the St. Lawrence.

Pisidium altile, Anthony. Fine in the ponds near the Mile-end, Montreal: R. J. F., and J. F. W. A smaller, more compressed variety abounds in the St. Charles River near Quebec; J. F. W. It is the P. compressum of Prime; but Mr Anthony's name seems to have priority.

Pisidium abditum, Haldeman. A very common species in Lower Canada. I cite four localities where I have taken it, as examples. Swamps in woods near the St. Charles river, Quebec: trenches in fields near the Beauport road: marshy ground on the Plains of Abraham,—both near Quebec. Brook near river St. Pierre, Montreal.

GASTEROPODA,—PECTINIBRANCHIATA.

VIVIPARIDÆ.

Paludina decisa, Say. Common throughout the district. Reversed varieties occasionally occur in the St. Lawrence, about Montreal.

Valvata tricarinata, Say. Also abundant. At Quebec the species generally occurs large, with the carinæ sometimes almost obsolete.

Valvata sincera, Say. Marl lake, Anticosti: R. B.

Valvata humeralis, Say. This species, so closely allied to the depressed form of the V. piscinalis of Europe, has been taken by Mr. Bell at the following localities: Matanne; small lake at the head of Awaganasees brook, and Little Lake Matapedia.

Amnicola porata, Say. Lake Calvaire, near Quebec: J. F. W. Little Lake Matapedia: R. B. Near Montreal: R. J. F.

Amnicola tenuipes, Haldeman. St. Lawrence, near Quebec: burrowing in the sand between tide-marks: J. F. W.

MELANIADÆ.

Melania subularis, Lea. (M. acuta, Lea.) St. Lawrence at Montreal.

Melania Niagarensis, Lea. St. Lawrence, from Quebec to Montreal. At Quebec I obtained only the pale yellowish, unbanded variety.

GASTEROPODA,—PULMONIBRANCHIATA.

LIMNÆIDÆ.

Limnœa stagnalis, Linnæus. (L. jugularis, Say.) Common at Montreal in the St. Lawrence, but rare at Quebec. Metis lakes, and lakes on the Rimouski river: R. B. Probably of wide distribution in Canada East.

Limnœa megasoma, Say. Very fine at Nuns' Island, near Montreal: M. de V., and R. J. F. Hawkesbury village: R. B.

Limnœa ampla, Mighels. This fine species was first detected in Lower Canada by R. J. F. at Brome Lake.

Limnœa decollata, Mighels. Great Lake Matapedia, and Rimouski village: R. B.

Limnœa columella, Say. St. Lawrence at Quebec, adhering to stones at low water-mark: J. F. W. The var. macrostoma occurs with the type.

Limnœa reflexa, Say. Upper Metis Lake: R. B. Near Grenville village: W. D.

Limnœa umbrosa, Say. Point Levis: J. F. W. Montreal

Mountain: St. Anne: creek about two miles below Chat river: Metis and Restigouche rivers: R. B.

Limnœa elodes, Say. (L. palustris? Linn.) Common everywhere throughout the district. Haldeman in his monograph considers it the L. fragilis of Linnæus. In Europe L. fragilis is considered a variety of L. stagnalis, Linn., and the L. elodes of Say as probably identical with the L. palustris.

Limnœa catascopium, Say. A common species. As unpublished localities, I may cite the St. Charles river near Quebec, and Cap Rouge in the same neighborhood. Dr. Lewis of Mohawk (N.Y.) considers it a variety of the preceding shell.

Limnœa solida, Lea. (L. apicina, Lea: *fide* Haldeman.) Profusely abundant everywhere about the St. Lawrence at Quebec. Metis, Rimouski, and White rivers: R. B.

Limnœa caperata, Say. Widely distributed. Abundant with Succinea ovalis, Say, on the banks of the St. Charles river, near Quebec. Limnæa umbilicata, Adams: is generally considered a variety of this species.

Limnœa humilis, Say. (L. modicellus, Say.) Green Island village: Rimouski: St. Anne: R. B. Lake Calvaire near Quebec: and ponds near the Mile-end toll-gate, Montreal: J. F. W. L. parva, Lea, is supposed by Haldeman to be the young of this species.

Limnœa desidiosa, Say, (L. acuta and L. Philadelphica, Lea: *fide* Haldeman.) Upper Lake Metis: Marl lake, Anticosti: (the var. acuta): R. B.

Limnœa pallida, Adams. Great Lake Matapedia: Cape Chat: R. B.

Limnœa alternata (or a new species). Point Levis: R. B. A species which I am unacquainted with.

Limnœa exigua, Lea: (young). In a small lake near Hamilton's farm: W. D.

Limnœa galbanus, Say. Abundant in shell-marl from the bottom of Eagle's Nest lake: W. D.

Physa heterostropha, Say. Common everywhere throughout the district.

Physa ancillaria, Say. St. Charles river near Quebec: J. F. W. near Montreal: R. J. F. Rimouski village: R. B. Doubtful if distinct from the preceding.

Physa marginata, Lea. (not of Say.) Near Rimouski village. Probably a variety of P. heterostropha.

Physa hypnorum, Linn. (P. elongata, Say.) Abundant about Quebec and Montreal. Green Island: Metis: St. Anne: R. B.

Physa aurea, Lea. Several localities in the county of Rimouski: R. B. Near Quebec: J. F. W.

Physa elliptica, Lea. Small lake one mile west of the Indian village in Arundel: W. D.

Planorbis macrostomus, nobis. (see description, and Figure 12.) Ponds near the Mile-end toll-gate, Montreal: R. J. F., and J. F. W.

Planorbis trivolvis, Say. Common throughout the district. Planorbis corpulentus of Say appears to be a variety of this species.

Planorbis lentus, Say. Less frequent than the above. St. Lawrence at Montreal. An almost hyaline variety occurs with the normal form.

Planorbis bicarinatus, Say. Abundant apparently all through the province. Extremely large at Brome Lake, R. J. F. At Quebec a variety with transverse wrinkles, and the upper carina almost obsolete (P. megastoma? De. Kay.) is more abundant than the type.

Planorbis campanulatus, Say. Near Quebec: J. F. W.: Fine at Brome Lake: common in the Richelieu River at St. Johns: St. Helen's Island, Montreal: R. J. F. Near Grenville, and in numerous lakes throughout that district. W. D.

Planorbis exacutus, Say. Scarce: swamps near the City mills, Montreal: R. J. F.

Planorbis deflectus, Say. Near Quebec: J. F. W. Great Lake Matapedia: R. B. Sixteen-Island and Sugar-bush lakes: W. D.

Planorbis parvus, Say. Widely distributed, and plentiful throughout the district.

Planorbulina armigera, Say. (sp.) Trenches in fields near the Beauport road, Quebec: J. F. W., and W. Couper: Nuns' Island, Montreal: R. J. F. Ponds on the top of Montreal Mountain: R. B.

Ancylus fuscus? Adams. Ponds near the Mile-end toll-gate, Montreal: R. J. F., and J. F. W.

Ancylus rivularis? Say. St. Lawrence, at Quebec and Montreal: St. Charles river near Quebec. Not having access to Haldeman's monograph of this genus, I am uncertain about these two species. The last may be *A.* parallelus, Haldeman.

GASTEROPODA,—PULMONIBRANCHIATA.

HELICIDÆ.

Tebennephorus Carolinensis, Bose. Point Levis, large and fine: probably common in wooded districts.

Limax campestris? Gould. Abundant under stones in fields: also in woods.

Vitrina limpida, Gould. (=V. pellucida;) Montreal Mountain, abundant: R. J. F., and J. F. W. Rivière du Loup: R. B. and J. F. W. Trois Pistoles: St. Anne: Restigouche river, ten miles above its junction with the Matapedia: R. B.

Succinea obliqua, Say. Abundant everywhere, but generally in dryer situations than most North American Succineas.

Succinea ovalis, Gould. Banks of the St. Charles river near Quebec: J. F. W. Metis, Matanne, and St. Anne: R. B.

Succinea avara, Say. Island of Orleans; J. F. W.

Succinea vermeta, Say. Mouth of the Magdalen and Restigouche rivers: R. B. As many conchologists consider this a distinct species from the preceding, in deference to their opinion I keep them separate.

Helix albolabris, Say. Fine and frequent throughout the district: Mr. Bell appears, however, not to have met with it in the county of Gaspé.

Helix dentifera, Binney. St. Lambert, Montreal: near Brome Lake: R. J. F. Apparently very rare in Lower Canada.

Helix exoleta, Binney. About the Montmorenci river, near the falls: W. C., and J. F. W. Wentworth, Montcalm and Harrington: W. D.

Helix Sayii, Binney. Widely diffused, but scarce: Island of Orleans, near Quebec: W. C., and J. F. W. Montreal Mountain: near Brome lake: R J. F. Restigouche river, about five miles above the mouth of the Matapedia: R. B. Near Doran's lake, Grenville: W. D.

Helix hortensis, Muller. Brandy Pots and Hare Island: extending from Metis to Gaspé bay. R. B.

Helix tridentata, Say. Montreal Mountain, but very rare.

Helix monodon, Racket. Abundant throughout the district, in suitable situations. In Lower Canada the typical form is abundant but the varieties (?) H. fraterna, Say; and H. Leaii, Ward; have not occurred to me in Lower Canada.

Helix multidentata, Binney. In 1861 I found one living specimen of this species on the Island of Orleans, and not noticing the teeth, took it for H. capsella of Gould. I am indebted to Mr. Bland for the correction of this error.

Helix lineata, Say. A species widely distributed throughout the district, but not abundant.

Helix labyrinthica, Say. The same remarks will apply to this species as to the above. Island of Orleans, Montmorenci falls, etc.

Helix alternata, Say. Very abundant everywhere in Lower Canada.

Helix striatella, Anthony. In different situations to the above, but equally common.

Helix rufescens, Muller. Living in abundance at Quebec on that part of the Plains of Abraham known as the Cove fields. J. F. W.

Helix (*Zonites*) *cellaria*, Muller. Dead shells of this species have been taken by Mr. Fowler near gardens in Craig Street, Montreal.

Helix pulchella, Mull. Abundant throughout the province.

Helix concava, Say. Not very common, but apparently with a wide range.

Helix electrina, Gould. Near Brome Lake in the Eastern Townships: R. J. F.

Helix arborea, Say. One of the commonest of the Canadian land-snails.

Helix indentata, Say. Montreal Mountain R. J. F.

Helix asterisca, Morse. Valley of the Marsouin river; R. B.

Helix chersina, Say. (= H. fulva? Mull.) Common in damp situations.

Bulimus lubricus, Mull. Rivière du Loup; Trois Pistoles: Metis lakes, and along the Restigouche: R. B. Montreal Mountain: R. J. F., and J. F. W.

Bulimus harpa, Say. Montreal Mountain: R. J. F., and J. F. W. Rivière du Loup: J. F. W. Metis: mouth of Magdalen river, and very abundant in the Marsouin valley: R. B.

Bulimus marginatus, Say. (Pupa fallax, Say.) Sugar Bush Lake, and near Gate Lake: W. D.

Pupa armifera, Say. Plains of Abraham, Quebec: W. C. and J. F. W.

Pupa contracta, Say. Island of Orleans: J. F. W.

Vertigo simplex, Gould. Rivière du Loup : J. F. W. Valley of the Marsouin : along the Restigouche and at Metis : R. B.

Vertigo Gouldii, Binney. Island of Orleans, and Rivière du Loup : J. F. W. Sixteen-Island lake. W. D. Montreal Mountain : R. J. F.

Vertigo ovata? Say. Montreal mountain : R. J. F., and J. F. W. The only specimen taken was not quite adult, but appeared to belong to this species.

Carychium exiguum, Say. Sixteen-Island lake, one specimen : W. D.

DESCRIPTIONS OF NEW, OR IMPERFECTLY KNOWN SPECIES.

SPHŒRIUM.

(Section A. Species with Rounded but not Protuberant Beaks.)

Figure 1.

Sphærium sulcatum, Lamarck.

Animal white ; tubes, a light orange color.

Shell transversally oval, nearly equilateral, light in texture for its size ; posterior margin somewhat more pointed : anterior rounded ; base slightly curved ; valves convex ; beaks full raised above the outline of the shell ; posterior portion a little longer ; sulcations coarse, regular ; epidermis dark chestnut brown ; interior light blue ; hinge margin narrow, nearly a straight line ; cardinal teeth small, indistinct, situated somewhat towards the anterior side, double in both valves, and so placed as to assume the shape of the letter V reversed ; lateral teeth on a line with the primary teeth, large, strong and prominent.

Long. 11–16 ; lat. 71–61 ; diam. 5-16 inches.

The young is more equilateral than the adult, and more compressed ; it presents the shape of a quadrilateral, and is of a light lemon colour : the striations are as heavy as those of the mature shell. The hinge-margin is generally straight, but, in specimens from Alabama, Pennsylvania, and Rhode Island it is slightly curved.

Figure 2.

Sphœrium solidulum, Prime.

Animal not observed.

Shell transversely inequilateral, elongated, slightly convex; beaks full, not very prominent; anterior margin rounded; posterior drawn out to an angle; base slightly curved: epidermis variable, dark chestnut or brownish yellow, with sometimes a yellow zone on the basal margin; sulcations coarse, irregular; interior dark blue; hinge margin considerably curved; cardinal teeth double, in the shape of the letter V reversed; lateral teeth large; the anterior placed at an angle with the margin; the posterior more on a continuation of the curve.

Long. 9–16; lat. 7–16; diam. 5–16 inches.

Differs from the preceding species in being less elongated, more inequilateral, less convex; the hinge margin is more curved, and the shell is more solid than in the S. sulcatum. Having unfortunately mislaid my only specimen from L'Orignal, the figure is taken from a fine large specimen from the Little Miami river, at Waynesville, Ohio. Canadian specimens will probably be smaller, and with their distinctive characters less strongly marked.

Figure 3.

Sphœrium striatinum, Lamarck.

Animal white; tubes light reddish yellow.

Shell slight, transversely elongated, somewhat compressed, inequilateral; anterior margin rounded, posterior distended, inferior rounded; beaks full, not much raised; sulcations irregular, at times so light as hardly to be seen with the naked eye, thus giving the shell a lustrous appearance; colour varying from a light greenish-yellow to a darker shade; valves slight; interior blue; hinge margin

slightly curved: cardinal teeth double, very small, of the same size; lateral teeth larger, not very prominent.

Long. 7–16; lat. 5-16; diameter 4–46 inches.

Compared to the Sphœrium solidulum, this species is smaller, more inequilateral, less tumid, more compressed, less solid, less heavily sulcated, and its posterior extremity is more distended.

A very common species in the rivers of Lower Canada; but appears to have been generally overlooked.

Figure 4.

Sphœrium rhomboideum, Say. (sp.)

Animal; white? syphons reddish-yellow.

Shell sub-globular, rhombic, orbicular, equilateral; anterior margin truncated; posterior slightly angular; basal nearly straight; beaks full, but not prominent; valves slight, convex towards the beaks, gradually decreasing in fullness towards the margins; interior blue; sulcations very delicate; epidermis olive-green, often with a straw coloured zone on the margins; young shell more compressed than the adult; hinge margin nearly straight; cardinal teeth rudimentary; lateral teeth distinct, somewhat acute, not elongated.

Long. 8–16; lat. 6–16; diam. 5–16 inches.

A very local, but gregarious species.

Figure 5.

Sphœrium occidentale, Prime.

Animal not observed.

Shell oval, small, pellucid, fragile, equilateral, margins rounded; valves slight, rather convex; beaks full, rounded, not much raised; sulcations very fine, hardly visible; epidermis horn coloured; cardinal teeth very diminutive, lateral teeth more distinct.

Long. 5-16; lat. 4-16; diam. 3-16 inches.

This species is remarkable for its completely oval shape, which renders it quite distinct from all others. Apparently rather rare in Lower Canada.

(Section B.—Species with Protuberant, or Calyculate Beaks.)

Figure 6.

Sphœrium transversum, Say. sp.

Animal white, syphonal tubes pink, foot white.

Shell transversely oblong, elongated, sub-inequilateral, translucent; anterior side narrow; anterior margin rounded, posterior margin sub-truncate, basal very much curved; beaks placed somewhat on the anterior side, large, calyculate, very much raised above the outline of the shell; striæ very delicate; epidermis greenish-yellow (generally whitish in Canadian specimens), of a darker shade at times in the region of the beaks; valves slight; interior bluish; hinge-margin very nearly straight, narrow; cardinal teeth compressed, in the shape of the letter V reversed, and very much expanded; lateral teeth slightly elongated.

Long. 10-16; lat. 7-16; diam. 4-16 inches.

This large and delicate species is remarkable for its very transverse shape and for the narrowness of the anterior extremity as compared to the posterior.

Figure 7.

Sphœrium securis, Prime.

Animal pinkish; syphons of the same colour.

Shell rhombic-orbicular, ventricose, sub-equilateral, both sides nearly of the same length; anterior margin a little curved; posterior margin abrupt, forming an obtuse angle with the hinge margin; basal margin much longer than the superior margin, rounded;

beaks large, calyculate, slightly inclined towards the anterior, very approximate at apex: valves slight, very convex, especially in the region of the umbones; striæ delicate, regular, hardly perceptible; epidermis glossy in some cases, very variable in colour, but generally of a greenish-horn tint; at times of a brilliant yellow or straw colour (in Canadian specimens often translucent glossy white): hinge-margin curved, narrow; cardinal teeth very small, united at base; lateral teeth slight elongated; very narrow.

Long. 6-16; lat. 5-16; diam. 4-16. inches.

Unlike any other Canadian species.

The descriptions of the Lower Canadian species of Sphœrium have been taken from Mr. Prime's able monograph. The ensuing descriptions are original, except in the case of Limnæa ampla.

PISIDIUM.

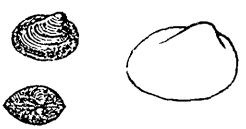

Figure 8.

Pisidium Virginicum, Brongniart.

Shell ovate, elliptical, oblique; strongly concentrically sulcate; "beaks placed much nearer one end;" slightly elevated, rounded, with a decided inclination to the anterior portion of the shell Posterior end elongated, rounded; anterior portion truncate; ventral margin convex. Easily distinguished from all the Lower Canadian Pisidia by its large size, strong concentric sulcations, and general outline.

Figure 9.

Pisidium altile, Anthony.

Shell sub-triangular, very tumid (except in the variety *compressum*, which may prove a distinct species), especially in the region

of the beaks: generally much broader from the umbo to the ventral margin, than in the opposite direction: beaks elongated into an obtuse point: anterior portion shortly rounded, but not truncate; posterior end forming a rounded, slightly pointed angle with the very convex ventral margin. Surface very finely striated.

Figure 10.

Pisidium abditum, Haldeman.

Shell ovate, orbicular, not very inequilateral; ventricose; beaks prominent, rounded: general outline very variable, sometimes very oblique; in others the umbones almost central, the general form being nearly circular, but elongated and very bluntly pointed posteriorly: surface striated, the striæ stronger than in the preceding species.

LIMNÆIDÆ.

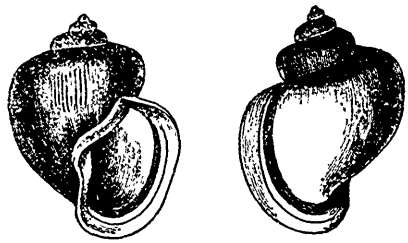

Figure 11.

Limnæa ampla, Mighels.

"L. [testa] amplâ, subovata; anfractibus quinque, convexis, superné geniculatis; suturâ valde impressâ; spira brevi; apertura latâ; umbilico profundo (?); columella valde plicata."

I have copied the original diagnosis of this very characteristic species from the proceedings of the Boston Society of Natural History for June 21st, 1843.

Dr. Mighel's description agrees with our Lower Canadian specimens in nearly every respect; but the Brome Lake specimens

are imperforate, or very nearly so. The species is easily known by its large and wide body-whorl, which is decidedly angulated towards the sutures. The spire varies in length, but is seldom more than half as high as the last volution.

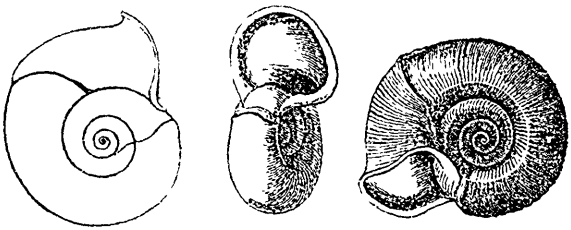

Figure 12.

Planorbis macrostomus, nobis.

Shell in many points closely resembling Planorbis lentus, Say: of which it may perhaps be only a variety. It is much larger, higher, and has deeper costæ; its lines of growth are very prominently marked: the upper angle of the whorls as shown in the mouth, is more prominent. Lip *widely expanded*, and *reflected*, covered with a white enamel. In this latter character it differs from all the North American species of Planorbis. It is a species nearly allied to Planorbis lentus and P. trivolvis; but apparently distinct from both.

ART. X.—*On the Antiquity of Man; a Review of 'Lyell' and 'Wilson.'* *

Questions of human origins have always been popular, and have been agitated in all sorts of forms. Next to the dread question of the unknown future, the long buried past is one of the most attractive subjects of inquiry; and while the faith of the Christian rests for both on the statements of Holy Scripture, the imagination of the poetical or the superstitious, and the reason of the philosopher or the sceptic have found ample scope for exercise. In our day, geological investigation on the one hand, and antiquarian and

* "The Geological Evidences of the Antiquity of Man with remarks on theories of the origin of species by variation," by Sir CHARLES LYELL, F.R.S., 8vo. pp. 520, illustrated. London, John Murray. Montreal, Dawson, Bros.

"Pre-historic Man.—Researches into the origin of Civilization in the Old and New World," by DANIEL WILSON, LL.D., Prof. of History in University College, Toronto, 2 vols. 8vo. pp. 488-499, illustrated. London, MacMillan & Co. Montreal, Dawson, Bros.

philological research on the other, have given an exact and scientific character to such researches, which, without detracting from their interest, has fitted them to attract a more sustained and systematic attention; hence the appearance of such works as those above named. One of these works is the summing up of the geological evidence in relation to the origin of man, by one of our greatest masters of inductive reasoning. The other is the effort of a skilful antiquarian and ethnologist to apply to the explanation of the primitive conditions of the old world, the facts derived from the study of the more recent primitive state of the western hemisphere. Both books are very valuable. Their methods are quite different, and their results as well; and it may be truly said that the geologist might have profited by the labours of the western antiquarian, had he known of them in time; and that the antiquarian might have found some new problems to solve, and difficulties to remove, had he read the work of the geologist. For this, among other reasons, it may be well to consider them together. It will be necessary for us in doing this to summarize the numerous and varied facts adduced, and the reasonings therefrom, and we shall follow the order employed by Sir C. Lyell, bringing in Dr. Wilson's antiquarian lore to our aid as we proceed.

The great question to be noticed in this review is that of the connection of human with geological history. How far back in that almost boundless antiquity disclosed by the geologist has man extended? At what precise point of the geological scale was he introduced on the mundane stage, and what his surroundings and condition in his earlier stages? In answer to these questions, negative geological evidence, and some positive considerations testify, without a dissenting voice, that man is very modern. All the evidences of his existence have until the last few years belonged exclusively to the Recent or latest period of the geological chronology. Certain late observations would, however, indicate that man may have existed in the latter part of the Post-pliocene period, and may have been contemporary with some animals now extinct. Still the evidences of this, as well as its true signifiance, are involved in much doubt; partly because many of the facts relied on are open to objection, partly because of the constant accession of new items of information, and partly because the age of the animals, whose remains are found with those of man, and the time required by the physical changes involved, are not certain.

To these questions Sir Charles addresses himself, with all his vast knowledge of facts relating to tertiary geology, and his great power of generalisation; and he has, for the first time, enabled those not in the centre of the discussions which have for a few years been carried on upon this subject, to form a definite judgment on the geological evidence of the antiquity of our species.

As a necessary preliminary, Sir Charles inquires as to the *recent* remains of man, including those which are pre-historic in the sense of antedating secular history, but which do not go back to the period of the extinct mammalia. He refers in the first place to the detailed researches of the Danish antiquaries, respecting certain remains in heaps of oyster-shells, found on the Danish coast, (which appear to be precisely similar to those heaps accumulated by the American Indians on our coasts from Prince Edward Island to Georgia); and respecting similar remains found in peat bogs in that country. These remains show three distinct stages of unrecorded human history in Denmark:—1st. A *stone period*, when the inhabitants were small sized men, brachykephalous or short headed men, like the modern Lapps, using stone implements, and subsisting by hunting. Then the country, or a considerable part of it was covered by forests of Scotch fir (*Pinus Sylvestris*). 2nd. A *bronze period*, in which implements of bronze as well as of stone were used, and the skulls of the people were larger and longer than in the previous period; while the country seems to have been covered with forests of oak (*Quercus robur*). 3rd. An *iron period*, which lasted to the historic times, and in which beech forests replaced those of oak. All of these remains are geologically recent; and except the changes in the forests, and of some indigenous animals in consequence, and probably a slight elevation of some parts of Denmark, no material changes in organic or inorganic nature have occurred.

The Danish antiquaries have attempted to calculate the age of the oldest of these deposits, by considerations based on the growth of peat, and the succession of trees; but these calculations are obviously unreliable. The first forest of pines would, when it attained maturity, naturally be destroyed, as usually happens in America, by forest conflagrations. It might perish in this way in a single summer. The second growth which succeeded, would in America be birch, poplar, and similar trees, which would form a new and tall forest in half a century; and in two or three centuries would probably be succeeded by a second permanent forest,

which in the present case seems to have been of oak.* This would be of longer continuance, and would, independently of human agency, only be replaced by beech, if, in the course of ages, the latter tree proved itself more suitable to the soil, climate, and other conditions. Both oak and beech are of slow extension, their seeds not being carried by the winds, and only to a limited degree by birds. On the other hand the rechanges of forests cannot have been absolute or universal. There must have been oak and beech groves even in the pine woods; and the growing and increasing beech woods would be contemporary with the older and decaying oak forest, as this last would probably perish not by fire, but by decay, and by the competition of the beeches. In like manner the growth of peat is very variable even in the same locality. It goes on very rapidly when moisture and other conditions are favourable, and especially when it is aided by wind-falls, drift-wood, or beaver-dams, impeding drainage and contributing to the accumulation of vegetable matter. It is retarded and finally terminated by the rise of the surface above the drainage level, by the clearing of the country, or by the establishment of natural or artificial drainage. On the one hand all the changes observed in Denmark may have taken place within a minimum time of two thousand years. On the other hand no one can affirm that either of the three successive forests may not have flourished for that length of time. A chronology measured by years, and based on such data, is evidently worthless.

Possibly a more accurate measurement of time might be deduced from the introduction of bronze and iron. If the former was, as many antiquarians suppose, a local discovery, and not introduced from abroad, it can give no measurement of time whatever; since, as the facts so clearly detailed by Dr. Wilson show, while a bronze age existed in Peru, it was the copper age in the Mississippi valley, and the stone age elsewhere; these conditions might have co-existed for any length of time, and could give no indication of relative dates. On the other hand the iron introduced by European commerce spread at once over the continent, and came into use in the most remote tribes, and its introduction into America clearly marks an historical epoch.

* The details of this process, as it occurs in America, will be found noticed in a paper by the writer in the Edin. Phil. Journal for 1847. Such changes are constantly in progress in the American forests.

With regard to bronze in Europe, we must bear in mind that tin was to be procured only in England and Spain, and in the latter in very small quantity: the mines of Saxony do not seem to have been known till the middle ages. We must further consider that tin ore is a substance not metallic in appearance, and little likely to attract the attention of savages; and that, as we gather from a hint of Pliny, it was probably first observed, in the west at least, as stream tin, in the Spanish gold washings. Lastly, when we place in connection with these considerations, the fact that in the earliest times of which we have certain knowledge, the tin trade of Spain and England was monopolized by the Phœnicians, there seems to be a strong probability that the extension of the trade of this nation to the western Mediterranean, really inaugurated the bronze period. The only valid argument against this, is the fact that moulds and other indications of native bronze casting have been found in Switzerland, Denmark, and elsewhere; but these show nothing more than that the natives could re-cast bronze articles, just as the American Indians can forge fish-hooks and knives out of nails and iron hoops. Other considerations might be adduced in proof of this view, but the limits of our article will not permit us to refer to them. The important questions still remain: when was this trade commenced, and how rapidly did it extend itself from the sea-coast across Europe. The British tin trade must have been in existence in the time of Herodotus, though his notion of the locality was not more definite than that it was in the extremity of the earth. The Phœnician settlements in the western Mediterranean must have existed as early as the time of Solomon, when "Ships of Tarshish" was the general designation of sea-going ships for long voyages. How long previously these colonies existed we do not know; but considering the great scarcity and value of tin in those very ancient times, we may infer that perhaps only the Spanish, and not the British deposits were known thus early; or that the Phœnicians had only indirect access to the latter. Perhaps we may fix the time when these traders were able to supply the nations of Europe with abundance of bronze in exchange for their products, at, say 1000 to 1200 B.C., as the earliest probable period; and probably from one to two centuries would be a sufficient allowance for the complete penetration of the trade throughout Europe; but of course wars or migrations might retard or accelerate the process; and there may have been isolated spots in which a partial stone period extended

up to those comparatively modern times, when first the Greek trade, and afterward the entire overthrow of the Carthaginian power by the Romans, terminated forever the age of bronze, and substituted the age of iron. This would leave, according to our ordinary chronologies, at least ten or fifteen centuries for the post-diluvian stone period; a time quite sufficient, in our view, for all that part of it represented by such remains as those of the Danish coast, and the still more remarkable platform habitations, whose remains have been found in the Swiss lakes, and which belong properly to the *recent* period of geology. In connection with this we would advise the reader to study the many converging lines of evidence derived from history, from monuments, and from language, which Dr. Wilson shows, in his concluding chapter, to point to the comparatively recent origin of at least post-diluvian man. Let it be observed, also, that the attempts of Bunsen and others to deduce an extraordinarily long chronology from Egyptian monuments, and from the diversity of languages, have signally failed; and that the observations made by Mr. Horner in the Nile alluvious are admitted to be open to too many doubts to be relied on.*

Before leaving the recent period, it is deserving of note that Sir C. Lyell shows on the best evidence, that in Scotland, since the building of the Wall of Antoninus, an elevation of from twenty-five to twenty-seven feet has occurred both on the eastern and western coast, and consequently that the raised sea bottoms containing canoes, &c., in the valley of the Clyde, supposed by some to be of extremely ancient date, were actually under water in the time of the Romans; a fact of which, but for their occupation of the country, we should have been ignorant.

From the Recent period we pass, under the guidance of Sir Charles, to the Post-pliocene, geologicaly distinguished from the Recent by the fact that its deposits contain the bones of many great extinct quadrupeds; as for instance the mammoth, *Elephas primigenius*, the wooly rhinoceros, *R. tichorhinus*, and others, heretofore, (but it would seem on insufficient evidence,) supposed to have disappeared before the advent of man. The evidence now

* The chronology deduced from the Delta of the Tinière, which would give to the stone period an antiquity of 5000 to 7000 years, appears to us to be similarly defective; and the data assigned to human remains in the valleys of the Mississippi and Ohio, and the old reefs of Florida still more so.

adduced that primeval man was really contemporary with these creatures is manifold, and apparently conclusive, and in the work before us is carefully sifted and weighed in all its bearings, much being rejected as inapplicable or uncertain. The evidences relied on are chiefly the following:

1. Human remains found with those of extinct animals in caves in Belgium, in England, and elsewhere, in circumstances which preclude the probability of their mixture by interments or other modern causes.

2. The finding of flint implements associated with bones of extinct animals in the valley of the Somme, and elsewhere.

3. A supposed sepulchral cave of this period discovered in the south of France. In addition to these there are many minor facts tending to the same conclusion, but with less distinctness.

It is impossible to give extracts which will convey any adequate idea of the facts adduced from the above sources, but the following paragraphs may serve as examples of some of them. They relate to evidence that man was contemporary with extinct animals, afforded by caverns near Liege, explored by Dr. Schmerling, and to the similar evidence obtained in the cave of Brixham in England.

"The rock in which the Liége caverns occur belongs generally to the Carboniferous or Mountain limestone, in some few cases only, to the older Devonian formation. Whenever the work of destruction has not gone too far, magnificent sections, sometimes 200 and 300 feet in height, are exposed to view. They confirm Schmerling's doctrine, that most of the materials, organic and inorganic, now filling the caverns, have been washed into them through narrow vertical or oblique fissures, the upper extremities of which are choked up with soil and gravel, and would scarcely ever be discoverable at the surface, especially in so wooded a country. Among the sections obtained by quarrying, one of the finest which I saw was in the beautiful valley of Fond du Forêt, above Chaudefontaine, not far from the village of Magnée; where one of the rents communicating with the surface has been filled up to the brim with rounded and half-rounded stones, angular pieces of limestone and shale, besides sand and mud, together with bones, chiefly of the cave-bear. Connected with this main duct, which is from one to two feet in width, are several minor ones, each from one to three inches wide, also extending to the upper country or table-land, and choked up with similar materials.

They are inclined at angles of 30° and 40°, their walls being generally coated with stalactite, pieces of which have here and there been broken off and mingled with the contents of the rents, thus helping to explain why we so often meet with detached pieces of that substance in the mud and breccia of the Belgian caves. It is not easy to conceive that a solid horizontal floor of hard stalagmite should, after its formation, be broken up by running water; but when the walls of steep and tortuous rents, serving as feeders to the principal fissures, and to inferior vaults and galleries, are encrusted with stalagmite, some of the incrustation may readily be torn up when heavy fragments of rock are hurried by a flood through passages inclined at angles of 30° or 40°.

"The decay and decomposition of the fossil bones seem to have been arrested in most of the caves by a constant supply of water charged with carbonate of lime, which dripped from the roofs while the caves were becoming gradually filled up. By similar agency the mud, sand, and pebbles were usually consolidated.

"The following explanation of this phenomenon has been suggested by the eminent chemist Liebig. On the surface of Franconia, where the limestone abounds in caverns, is a fertile soil in which vegetable matter is continually decaying. This mould or humus, being acted on by moisture and air, evolves carbonic acid, which is dissolved by rain. The rain-water, thus impregnated, permeates the porous limestone, dissolves a portion of it; and afterwards, when the excess of carbonic acid evaporates in the caverns, parts with the calcareous matter and forms stalactite. So long as water flows, even occasionally, through a suite of caverns no layer of pure stalagmite can be produced; hence the formation of such a layer, is generally an event posterior in date to the cessation of the old system of drainage; an event which might be brought about by an earthquake causing new fissures, or by the river wearing its way down to a lower level, and thenceforth running in a new channel.

"In all the subterranean cavities, more than forty in number, explored by Schmerling, he only observed one cave, namely that of Chokier, where there were two regular layers of stalagmite, divided by fossiliferous cave-mud. In this instance, we may suppose that the stream, after flowing for a long period at one level, cut its way down to an inferior suite of caverns, and, flowing through them for centuries, choked them up with debris; after which it rose once more to its original higher level: just as in

the Mountain limestone district of Yorkshire some rivers, habitually absorbed by a "swallow hole," are occasionally unable to discharge all their water through it; in which case they rise and rush through a higher subterranean passage, which was at some former period in the regular line of drainage, as is often attested by the fluviatile gravel still contained in it.

"There are now in the basin of the Meuse, not far from Liége, several examples of engulfed brooks and rivers: some of them, like that of St. Hadelin, east of Chaudefontaine, which reappears after an underground course of a mile or two; others, like the Vesdre, which is lost near Goffontaine, and after a time re-emerges; some, again, like the torrent near Magnée, which, after entering a cave, never again comes to the day. In the season of floods such streams are turbid at their entrance, but clear as a mountain-spring where they issue again; so that they must be slowly filling up cavities in the interior with mud, sand, pebbles, snail-shells, and the bones of animals which may be carried away during floods.

"The manner in which some of the large thigh and shank bones of the rhinoceros and other pachyderms are rounded, while some of the smaller bones of the same creatures, and of the hyæna, bear, and horse, are reduced to pebbles, shows that they were often transported for some distance in the channels of torrents, before they found a resting-place.

"When we desire to reason or speculate on the probable antiquity of human bones found fossil in such situations as the caverns near Liége, there are two classes of evidence to which we may appeal for our guidance. First, considerations of the time required to allow of many species of carnivorous and herbivorous animals, which flourished in the cave period, becoming first scarce, and then so entirely extinct as we have seen that they had become before the era of the Danish peat and Swiss lake dwellings: secondly, the great number of centuries necessary for the conversion of the physical geography of the Liége district from its ancient to its present configuration; so many old underground channels, through which brooks and rivers flowed in the cave period, being now laid dry and choked up.

"The great alterations which have taken place in the shape of the valley of the Meuse and some of its tributaries, are often demonstrated by the abrupt manner in which the mouths of fossiliferous caverns open in the face of perpendicular precipices,

200 feet or more in height above the present streams. There appears also, in many cases, to be such a correspondence in the openings of caverns on opposite sides of some of the valleys, both large and small, as to incline one to suspect that they originally belonged to a series of tunnels and galleries, which were continuous before the present system of drainage came into play, or before the existing valleys were scooped out. Other signs of subsequent fluctuations are afforded by gravel containing elephants' bones at slight elevations above the Meuse and several of its tributaries. The loess also, in the suburbs and neighbourhood of Liége, occurring at various heights in patches lying at between 20 and 200 feet above the river, cannot be explained without supposing the filling up and re-excavation of the valleys at a period posterior to the washing in of the animal remains into most of the old caverns. It may be objected that according to the present rate of change, no lapse of ages would suffice to bring about such revolutions in physical geography as we are here contemplating. This may be true. It is more than probable that the rate of change was once far more active than it is now. Some of the nearest volcanoes, namely, those of the Lower Eifel about sixty miles to the eastward, seem to have been in eruption in post-pliocene times, and may perhaps have been connected and coeval with repeated risings or sinkings of the land in the basin of the Meuse. It might be said, with equal truth, that according to the present course of events, no series of ages would suffice to reproduce such an assemblage of cones and craters as those of the Eifel (near Andernach for example); and yet some of them may be of sufficiently modern date to belong to the era when man was contemporary with the mammoth and rhinoceros in the basin of the Meuse.

"But although we may be unable to estimate the minimum of time required for the changes in physical geography above alluded to, we cannot fail to perceive that the duration of the period must have been very protracted, and that other ages of comparative inaction may have followed, separating the post-pliocene from the historical periods, and constituting an interval no less indefinite in its duration."

* * * * * * * * * *

"As the osseous and other contents of Kent's Hole had, by repeated diggings, been thrown into much confusion, it was thought desirable in 1858, when the entrance of a new and intact

bone-cave was discovered at Brixham, three or four miles west of Torquay, to have a thorough and systematic examination made of it. The Royal Society made two grants towards defraying the expenses,* and a committee of geologists was charged with the investigations, among whom Mr. Prestwich and Dr. Falconer took an active part, visiting Torquay while the excavations were in progress under the superintendence of Mr. Pengelly. The last-mentioned geologist had the kindness to conduct me through the subterranean galleries after they had been cleared out in 1859; and I saw, in company with Dr. Falconer, the numerous fossils which had been taken from the subterranean fissures and tunnels, all labelled and numbered, with references to a journal kept during the progress of the work, and in which the geological position of every specimen was recorded with scrupulous care.

"The discovery of the existence of this suite of caverns near the sea at Brixham was made accidentally, by the roof of one of them falling in. None of the five external openings now exposed to view in steep cliffs or the sloping side of a valley, were visible before the breccia and earthy matter which blocked them up were removed during the late exploration. According to a ground-plan drawn up by Professor Ramsay, it appears that some of the passages which run nearly north and south are fissures connected with the vertical dislocation of the rocks, while another set, running nearly east and west, are tunnels, which have the appearance of having been to a great extent hollowed out by the action of running water. The central or main entrance, leading to what is called the reindeer gallery, because a perfect antler of that animal was found sticking in the stalagmitic floor, is ninety-five feet above the level of the sea, being also about sixty above the bottom of the adjoining valley. The united length of the five galleries which were cleared out amounted to several hundred feet. Their width never exceeded eight feet. They were sometimes filled up to the roof with gravel, bones, and mud; but occasionally there was a considerable space between the roof and floor. The latter, in the case of the fissure-caves, was covered with stalagmite, but in the tunnels it was usually free from any such incrustation. The following was the general succession of the deposits forming the contents of the underground passages and channels:—

* When these grants failed, Miss Burdett-Coutts, then residing at Torquay, liberally supplied the funds for completing the work.

"1st. At the top, a layer of stalagmite, varying in thickness from one to fifteen inches, which sometimes contained bones, such as the reindeer's horn, already mentioned, and an entire humerus of the cave-bear.

"2ndly. Next below, loam or bone-earth, of an ochreous-red colour, from one foot to fifteen feet in thickness.

"3rdly. At the bottom of all, gravel with many rounded pebbles in it, probed in some places to the depth of twenty feet without being pierced through, and as it was barren of fossils, left for the most part unremoved.

"The mammalia obtained from the bone-earth consisted of *Elephas primigenius*, or mammoth; *Rhinoceros tichorhinus*; *Ursus spelæus*; *Hyæna spelæa*; *Felis spelæa*, or the cave-lion; *Cervus tarandus*, or the reindeer; a species of horse, ox, and several rodents, and others not yet determined.

"No human bones were obtained anywhere during these excavations, but many flint knives, chiefly from the lowest part of the bone-earth; and one of the most perfect lay at the depth of thirteen feet from the surface, and was covered with bone-earth of that thickness. From a similar position was taken one of those siliceous nuclei, or cores, from which flint flakes had been struck off on every side. Neglecting the less perfect specimens, some of which were met with even in the lowest gravel, about fifteen knives, recognized by the most experienced antiquaries as artificially formed, were taken from the bone-earth, and usually from near the bottom. Such knives, considered apart from the associated mammalia, afford in themselves no safe criterion of antiquity, as they might belong to any part of the age of stone, similar tools being sometimes met with in tumuli posterior in date to the era of the introduction of bronze. But the anteriority of those at Brixham to the extinct animals is demonstrated not only by the occurrence at one point in overlying stalagmite, of the bone of a cave-bear, but also by the discovery at the same level in the bone-earth, and in close proximity to a very perfect flint tool, of the entire left hind-leg of a cave-bear. This specimen, which was shown me by Dr. Falconer and Mr. Pengelly, was exhumed from the earthy deposit in the reinder gallery, near its junction with the flint-knife gallery, at the distance of about sixty-five feet from the main entrance. The mass of earth containing it was removed entire, and the matrix cleared away carefully by Dr. Falconer, in the presence of Mr. Pengelly. Every bone was in its natural

place, the femur, tibia, fibula, ankle-bone, or astragalus, all in juxta position. Even the patella or detached bone of the knee-pan was searched for, and not in vain. Here, therefore, we have evidence of an entire limb not having been washed in a fossil state out of an older alluvium, and then swept afterwards into a cave, so as to be mingled with flint implements, but having been introduced when clothed with its flesh, or at least when it had the separate bones bound together by their natural ligaments, and in that state buried in mud.

"If they were not all of contemporary date, it is clear from this case, and from the humerus of the *Ursus spelæus*, before cited as found in a floor of stalagmite, that the bear lived after the flint tools were manufactured, or in other words, that man in this district preceded the cave-bear."

Multitudes of questions arise out of these observations, and many of them will probably long remain unanswered; but we may in the remainder of this article, profitably restrict ourselves to three of them:

1. What style of men were these contemporaries of the mammoth, as compared with those who now walk the earth?

2. How great is their antiquity?

3. What bearing have the conclusions which we must form on these points, on the facts known to us on other evidence than that of geology, as to the origin and early history of man?

The writer of these pages, on a former occasion, ventured to predict that if any osseous remains of antediluvian man should be discovered, they would probably present characters so different from those of modern races that they might be regarded as belonging to a distinct species.* With perhaps one exception, this anticipation has not yet been realized. The skull from the cave of Engis, in Belgium, supposed to be the oldest known, is in the judgment of Prof. Huxley, not by any means abnormal, but on the contrary, not unlike some European skulls. Another skull, that of Neanderthal, not found with remains of extinct animals, and therefore of uncertain geological antiquity, has however excited more attention than the Engis skull. Its pre-historic antiquity has been assumed by many writers, and its low forehead, prominent superciliary ridges, and general flatness, giving a more ape-like air than those of the heads of any modern tribes, together

* Archaia p. 237.

with the great stoutness and strong muscular impressions of the bones found with it, have been regarded as confirmatory evidence of this supposition. It is quite certain however that the characters for which this skeleton is eminent, are found, though perhaps in a less degree, in the rude tribes of America and Australia. It is also doubtful whether this skeleton really indicates a race at all. It may have belonged to one of those wild men, half crazed, half idiotic, cruel and strong, who are always more or less to be found living on the out-kirts of barbarous tribes, and who now and then appear in civilized communities, to be consigned perhaps to the penitentiary or to the gallows, when their murderous propensities manifest themselves. Still, as we shall show under our third head, this Neanderthal man is nearer in some respects to our historical idea of antediluvian man than any other of these very ancient examples; though, as Lyell properly suggests, there is no absolutely valid reason for assuming that he may not even have belonged to the same nation with the Engis man; since nearly as great differences are found in the skulls of individual members of some unmixed savage races.

One remarkable conclusion however deducible from the answer to this our first question, must not be omitted. Of all the criteria for the distinction of races of men, the skull is probably the most certain, and as any one may perceive, who reads Dr. Wilson's book, it affords in really reliable hands, the best possible evidence of distinctness or of unity, except where great mixtures have occurred. Now man is one of the most variable animals; and yet it would seem that, since the post-pliocene period, he has changed so little that the skulls of these post-pliocene men fall within the limits of modern varieties; and this, while so great changes have occurred that multitudes of mammals once his contemporaries have utterly perished. Now if these men are so ancient as many geologists would assume, nay if they are even 6000 years old, surely the human race is very permanent, and Prof. Huxley may well say that "the comparatively large cranial capacity of the Neanderthal skull, overlaid though it may be with pithecoid bony walls, and the completely human proportions of the accompanying limb-bones, together with the very fair development of the Engis skull, clearly indicate that the first traces of the primordial stock whence man proceeded, need no longer be sought by those who entertain any form of the doctrine of development, in the newest tertiaries; but that they may be looked for in an epoch more dis-

tant from the age of the *Elephas primigenius* than that is from us." They may, in short, spare themselves the trouble of looking for any such transition from apes to men in any period; for this great lapse of time renders the species practically permanent; more especially when we bear in mind that of the numerous species whose remains are found with those of these ancient men, some have continued unchanged up to our time, and the rest have become extinct, while not one can be proved to have been transmuted into another species.

Sir Charles devotes no less than five concluding chapters to this doctrine of transmutation, as held by Darwin and others. He does not commit himself to it, but wishes to give it due consideration, as a possible hypothesis, which may at least lead to great truths. We are not disposed to give it quite so high a position. Mr. Darwin's book impressed us with the conviction that his hypothesis really explains nothing not otherwise explicable, and requires many assumptions difficult of belief; while the whole argument in its favour is essentially of the nature of reasoning in a circle. The point to be proved is, that variations arising from external influences and "natural selection" may produce specific diversity. Now in order to begin our proof of this, we require at least one species, with all its powers and properties, to commence with. This being granted, we proceed to show that it may vary into several races, and that these races, if isolated, may be kept distinct and perpetuated. We further proceed to show that these races differ so much, that if wild, and not tampered with, we might suppose them originally distinct. So far all goes well with our demonstration; but we find that many of the differences of these races are of the nature of mere monstrosities, like the six fingers of some men, which, as far as they go, would exclude the individuals having them, not only from their species, but from their order or class. Further, we find that the differences which do resemble those of species, have not, when tried by the severe test of crossing, that fixity which appertains to true specific differences; so that with due care all our races can be proved to belong to but one species. Thus our whole argument falls to the ground; unless we are content quietly to assume the thing to be proved, and to say, that after showing that some species are very variable, we have established a certain probability that they may overpass the specific limits; though the fact that with all this variability, no species has been known practically to overpass these limits;

should logically bring us to the opposite conclusion; viz., that the laborious investigations of Mr. Darwin have more than ever established the fixity of species, though they have shown reason to believe that many so-called species are mere varieties.

Applying this to man, and even admitting, what Sir Charles Lyell very properly declines to admit, that the differences between men and apes are in all respects, only differences of degree, and further admitting with Prof. Huxley, that the difference between the size of the brain in the highest and lowest races of men is greater than the differences between the latter and the highest apes, nothing would be proved towards the doctrine of transmutation; for all these variations might occur without the ape ever overleaping the dividing line between it and the man; and the one fact to be proved is that this overleap is possible.

Perhaps this question as to man and apes, which some recent transmutationists have started, is one of the most damaging aspects of the doctrine, since it show sbetter than other cases the essential absurdity of supposing the higher nature to be evolved out of the lower; and thus startles the common sense of ordinary readers, who might detect little that is unreasonable in the transmutation of an oyster into a cockle, or even of a pigeon into a partridge; more especially if the reader or auditor is enabled to perceive the resemblance of type between these creatures, without receiving the further culture necessary to appreciate specific and generic difference, and thus is made ready to believe that similarity of type means something more than similar plan of construction. It is very curious too to observe, that while these theorists seize on occasional instances of degraded individuals in man as evidence of *atavism* reverting to a simian ancestry, they are blind to the similar explanation which those who hold an opposite view may give to the cases of superior minds appearing in low races, in which the transmutationists can see nothing but spontaneous elevation. It is also deserving of a passing remark that while, as Dr. Gray shows, the doctrine of transmutation is not subversive of all natural theology, that is, so long as transmutationists admit the presiding agency of a spiritual Supreme Being, the application of such views to the human species, attacks leading doctrines of that biblical Christianity which is practically of so much higher importance to man than mere natural theology.

Still some of our modern naturalists follow with as much per-

tinacity these transmutation hypotheses, as did the old alchemists their attempts to transmute chemical species into each other. Perhaps the comparison is hardly fair to the older school of speculators, for chemical species or elements tend by their combination to form new substances, which animal and vegetable species do not; and by so much the balance of antecedent probability was on the side of the alchemists, as compared with the transmutationists, though their methods and doctrines were very similar. We may, however, at least hope that, like the researches of the alchemists, those of their successors may develop new and important truths. Leaving then this much vexed topic, let us proceed to our second inquiry, as to the actual antiquity of these primitive men.

This antiquity is of course to be measured by the geological scale of time, whose periods are marked not by years or centuries, but by the extinction of successive faunas and floras, and the progress of physical changes. With respect to the first of these marks of time, we confess that we have not regarded the observations of Boucher de Perthes and others, as free from the suspicion that accidental mixtures of human and fossil bones, or other causes not taken into the account, may have vitiated their conclusions; and this suspicion still applies to some of the cases cited by Sir C. Lyell, as more or less certain proofs. After reading the statements of the present volume, we think the Belgian and Brixham caves may be taken as good evidence of the probable contemporaneousness of man with the *Elephas primigenius*, *Rhinoceros tichorhinus*, *Ursus spelœus*, and their contemporaries; or rather as evidence that man was beginning to appear in Western Europe before those animals had finally disappeared. In consequence of some flaws in the evidence, as it appears to a reader at a distance, we cannot as yet so implicitly receive the evidence of the Somme flint weapons. The cave of Aurignac described by M. Lartet, and in which seventeen human skeletons were found buried, apparently in a sitting posture, cannot be relied on, owing to the late period at which it was explored. We are sorry to doubt this unique instance of antediluvian sepulchral rites, but all the appearances *actually seen** by M. Lartet are better explicable on the supposition that a cave, once tenanted by the cave

* We refer to Mr. Lartet's account of his discovery in the Natural History Review, as well as the more concise statement given in the book before us.

bear and hyæna, had been partially emptied of its contents by some primitive tribe, who had broken up the bones of the extinct animals, not for their marrow, but to make tools and ornaments of them, and had subsequently used the cave as a place of burial, and the ground in front of it for "feasts for the dead." If the bones are still so perfect as M. Lartet asserts, they must have been quite sound when first disturbed at the early historical time in which the cave may have been ransacked. Further, the skeleton of *Ursus spelæus* found in the interior, was below the place of deposit of the human skeletons; and we can suppose it to have been contemporaneous, only by the unlikely theory that the earth containing this skeleton was placed in the cave by the aboriginal people.*

We give the above leading cases as examples of the rest which are cited, and all of which may in like manner be divided into those which afford probable, though not absolutely certain evidence of post-pliocene man, and those which are liable to too grave suspicion to be accepted as evidence. It may be said that we should be more ready to believe, and less critical, but it is not the wont of geologists to be so, when new facts and conclusions are promulgated; and the present case involves too important consequences, both in relation to history, and to the credibility of geological proof in general, to escape the most searching criticism. Geologists must beware lest their science, at the point where it comes into contact with other lines of investigation, and where its own peculiar methods are most liable to err, should be found wanting, and its reliability fall into discredit.

But when did the fossil mammals named above, really become extinct. As a preliminary to our answer to this question, we may state that in Western Europe, in the post-pliocene period of geologists, these animals were contemporary with many still extant, some of them in Europe, others elsewhere. Pictet even maintains that all, or nearly all of our modern European mammals co-existed with these animals in the post-pliocene period, and that consequently there has since that time been a progressive diminution of species down to the present day. The mammoth, *Elephas primigenius*, existed, or perhaps began to exist at a still more ancient

* It is certainly very curious that the objects and arrangements of these caves and other ancient European depositories, are so thoroughly American, even to the round stone hammers, whose use is so oddly misinterpreted by the Danish antiquaries.

period,—the newer pliocene; when it was contemporary with *Elephas meridionalis* and other animals of an older fauna. It continued to survive until the introduction of the modern mammals, and then became extinct along with *Rhinoceros tichorhinus* and several other species, which, however, may have been of younger date than itself. With these species lived the *Megaceros Hibernicus*, or great Irish stag, which lasted longer, but perished before the dawn of history. With them also lived the *Bos primigenius*, or gigantic wild ox, the aurochs, the musk-ox, and the rein-deer. The first of these existed wild until the time of Cæsar; the second is still preserved in a forest in Lithuania; the third exists now in Arctic America, and the fourth still remains in Lapland. With them also co-existed the wolf, the fox, the hare, the stag, and other creatures still living in western Europe.

That these creatures have been disappearing at different times seems certain; some may have been exterminated by man, but the greater part must have perished from other causes. They may have gone *seriatim*, or in considerable numbers at or near the same time; and there seems some reason to believe in a considerable and rapid decadence at the end of the post-pliocene and beginning of the recent period. One cause which may be assigned is change of climate. The climate of Europe in the time of the mammoth was very cold, as indicated by the evidence of glaciers, and other forms of ice action, and by the presence of the musk ox. No doubt the extinction of this creature, and of the mammoth and tichorhine rhinoceros as well, would follow from the amelioration in this respect as the recent period approached. This change of climate depended on geographical changes, modifying the distribution of land and water, and the direction of ocean currents. A subsidence in central America or in Florida, might restore the climate of the mammoth by altering the course of the gulf stream; and an elevation of land in these regions may have introduced the climate of the recent period. There is abundant evidence that much subsidence and elevation did occur while these changes in organic life were in progress; and these may, more directly, by the submergence or elevation of large areas in Europe itself, have tended to extinguish species, or introduce them from other regions. All these points being granted, and abundant evidence of them will be found given by Sir C. Lyell, it remains to ask, can we convert the period required for these changes into solar years? There is but one way of doing this in consistency with the principles of modern geology, and this is to ascertain

how long a time would be occupied by agencies now in operation in effecting the changes of elevation, subsidence, erosion and deposit, observed. Reasoning on this principle, it is plain that a vast lapse of time will be required, and that we may place the earliest men and the latest mammoths at an almost incredible distance before the oldest historical monuments of the human race.

But can we assume any given rate for such changes? Not certainly till all the causes which may have influenced them can be ascertained and weighed. We have only recently learned that Scotland has risen twenty-five feet in 1700 years; but we do not know that this elevation has been uniform and continuous. There is another older sea-level at forty-four feet above the present coast; and there is a still higher sea-level 524 feet above the sea, which certainly goes back to the time of the mammoth. Now we may calculate that if an elevation of twenty-five feet requires 1700 years, an elevation of 500 feet will require twenty times that length of time; but if we should find on further investigation that ten of the twenty-five feet were raised in the first century of the seventeen, and that the rate had gradually decreased, our calculation must be quite different, and even then might be altogether incorrect, since there may have been periods of rest or of subsidence; so that "such estimates must be considered in the present state of science as tentative and conjectural."

Again, at the rate in which the Somme, the St. Lawrence and the Mississippi now cut their channels and deposit alluvium, we can calculate that several tens of thousands of years must have elapsed since the mammoth roamed on their banks; and we have been accustomed to rest on these calculations as close approximations to the truth: but Sir Charles Lyell has, in his present work, introduced a new and disturbing element, in the strong probability which he establishes that the cold of the glacial period extended to a later time than we have hitherto supposed. If, when the gravels of the Somme were deposited, the climate was of a sub-arctic character, we have to add to modern grading causes the influence of frost, greater volume of water, spring freshets, and ice-jams, and the whole calculation of time must be revised. So, if it can be proved that when the St. Lawrence began to cut the ravine of Niagara, in the post-pliocene or newer pliocene period, there were great glaciers in the basin of Lake Superior, all our calculations of time would be completely set at nought.

Such are the difficulties which beset the attempt to turn the monumental chronology of geology into years of solar time. The

monuments are of undeniable authenticity, and their teachings are most valuable, but they are inscribed with no record of human years, and we think geologists may wisely leave this matter where the Duke of Argyle, in his address to the Royal Society, lately placed it, as a doubtful point, in so far as geological evidence is concerned, whether the mammoth lived later than we have hitherto supposed, or man lived earlier. Still, as we have already stated, those geologists who hold that we must reason inflexibly on rates of change indicated by modern causes, will necessarily, on the evidence as it now stands, maintain that the human race, though recent geologically, is of very great antiquity historically.

We must now shortly consider our third question, as to the bearing of these facts and doctrines on our received views of human chronology, derived from the Holy Scriptures and the concurrent testimony of ancient monumental and traditional history. It is certain that many good and well-meaning people will, in this respect, view these late revelations of geology with alarm; while those self-complacent neophytes in biblical learning who array themselves in the cast-off garments of defeated sceptics, and when treated with the contempt which they deserve, bemoan themselves as the persecuted representatives of free thought, will rejoice over the powerful allies theyhave acquired. Both parties may however find themselves mistaken. The truth will in the end, vindicate itself; and it will be found that the results of such careful scrutiny of nature as that to which naturalists now devote themselves, are not destined to rob our race either of its high and noble descent, or its glorious prospects. In the mean time those who are the true friends of revealed truth will rejoice to give free scope to legitimate scientific investigation, trusting that every new difficulty will disappear with increasing light.

The Biblical chronology, though it allows an unlimited time for the pre-human periods of the earth's history, fixes the human period within narrow limits,though it does this not by absolute statement of figures,but rather by inference from chronological lists, with respect to the computation of which there may be and has been some difference, especially in the antediluvian period. Allowing large latitude for these differences, we have say 2000 to 3000 years for the human antediluvian period, corresponding, it is to be supposed, to the later post-pliocene of geologists. In this period men may have extended themselves over most of the old continent; and it has been calculated that they may have been nearly as numerous as at present, but this is probably an exaggeration.

They had, locally at least, domesticated animals; they had discovered the use of the metals, and invented many useful arts, though there must have been a vast, scattered, barbarous, population. They had split into two distinct races; some portions of which at least, had sunk to a state presumably lower than that of any modern tribe, since these latter are all amenable to the influences of civilization and Christianity, while the former seem to have been hopelessly depraved and degenerate. At the same time they had much energy for aggression and violence; and it would seem that these giants of the olden time were in process of extinguishing all of the civilization of the period when they were overwhelmed with the deluge. This is described in terms which may indicate a great subsidence, of which the Noachian deluge was the culminating point, in so far as western Asia was concerned. The subsidence, unless wholly miraculous, may have commenced at least at the beginning of the 120 years of Noah's public life, and possibly much earlier, and the re-elevation may have occupied many centuries, and may not have left the distribution of land and water, and consequently climate, in the same state as before. At a very early period of this subsidence, if there were men in Europe, they would be perfectly isolated from the original seats of population in Asia, and so would the land animals, their contemporaries. There is farther, nothing in the Mosaic account to prevent us from supposing that the existence of many species was terminated by this great catastrophe.* These are some of the conditions of the biblical deluge, which we might much further illustrate, were this a proper place for doing so, but those stated will suffice to show precisely in what points the new doctrines of geologists in regard to the antiquity of man, appear to conflict with this old narrative.

When we carefully consider the geological facts, in so far as they have been ascertained, it seems to us that the discrepancy may be stated thus. Reasoning on the geological doctrine that all things are to be explained by modern causes, and insisting on a rigid application of that doctrine, we must infer that the date of the introduction of man was "many ten thousands of years" ago. Adopting the biblical theory, so to speak, that a great subsidence, of which modern history affords no example, has occurred within the human period, we might adopt a very much shorter

* See Archaia, pp. 216 et seq. and pp. 238 et seq. King's Geology and Religion, "Deluge."

chronology. It would seem at present that the facts can be explained on either view; and that the possibility of reconciling these views must depend on the greater or less evidence which geologists may find of more rapid changes than they have heretofore supposed within the human period. Our own impression, derived from a careful study of all the facts so well stated by Sir C. Lyell, is that the tendency will be in this direction, that the apparent antiquity of the comparatively insignificant deposits containing remains of man and his works will be reduced, and that a more complete harmony than heretofore between the earliest literary monuments of the human race and geological chronology will result. At present the whole inquiry is making rapid progress, and the time may perhaps be not far distant when its difficulties will receive some such solution. In the meantime both of the writers whose works are noticed in this article, deserves careful study, and will be found to contribute much toward the solution of these great questions. J. W. D.

ART. XI.—*On the remains of the Fossil Elephant found in Canada;* by E. BILLINGS, F.G.S.

(Read before the Natural History Society of Montreal, 23rd Feb., 1863.)

The remains of the Elephant, now in the Provincial Geological Museum, were found in 1852, at Burlington Heights, near Hamilton, at the western extremity of Lake Ontario, about forty feet beneath the surface, and sixty feet above the level of the lake. The workmen engaged in making an excavation on the line of the Great Western Railway, first cut through thirty feet of stratified gravel, composed of small pebbles of limestone, and so strongly cemented that it could only be removed by blasting. Below this gravel, there was met with a deposit of coarse sand; and in this the bones were discovered. The geological age of this deposit is not yet determined with certainty; but is supposed to be that of the well-known lake-ridges and terraces, which were apparently formed just after the close of the upper drift period; and either while the waters of the lake stood at a higher level than they do at present, or perhaps while the basin of the lake formed an arm of the sea.

The following are descriptions of the more important bones found at this locality.

EUELEPHAS JACKSONI. (Briggs & Foster.)

The most perfect specimen consists of the right ramus and the symphysis of a lower jaw, holding a molar tooth in a good state of preservation. The condyle is broken off at the neck, and the angle and wall of the alveolus on the inner face of the jaw are removed, so that on the outside, the lower posterior edge, and on the inside, three fourths of the whole surface of the molar are exposed. The notch between the neck of the condyle and the coronoid is deepened by a fracture.

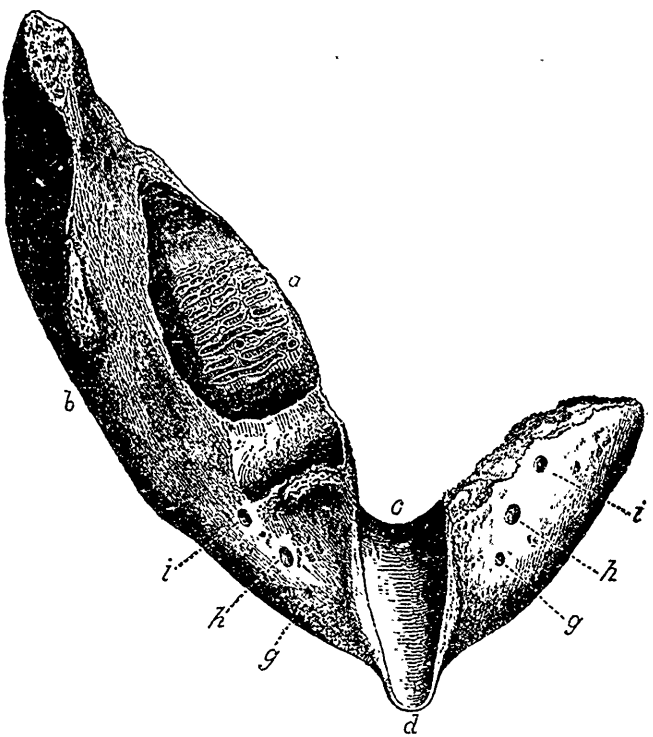

Fig. 1.—EUELEPHAS JACKSONI, (Briggs & Foster,) Right ramus and symphysis with a molar in place.

As nearly as can be ascertained, the length of the jaw, when both rami were in connection, measured along the median line through the symphysis, from the extreme point of the mandible to a plane erected perpendicularly behind the ascending rami, was twenty-three inches. The greatest width across the two rami, from outside to outside, at about four inches in advance of

the posterior edges, is twenty-two inches. Length in a straight line, from the posterior side of the neck of the condyle obliquely downwards and forwards to the point of the mandible, twenty-eight inches; from the same point in the neck of the condyle to the anterior margin of the alveolus, twenty inches; from the anterior edge of the coronoid to the anterior margin of the alveolus, eight and three-fourths inches. Height of the ascending ramus, seventeen inches; of the coronoid, twelve inches; of the jaw at the anterior margin of the alveolus, eight and three-fourths

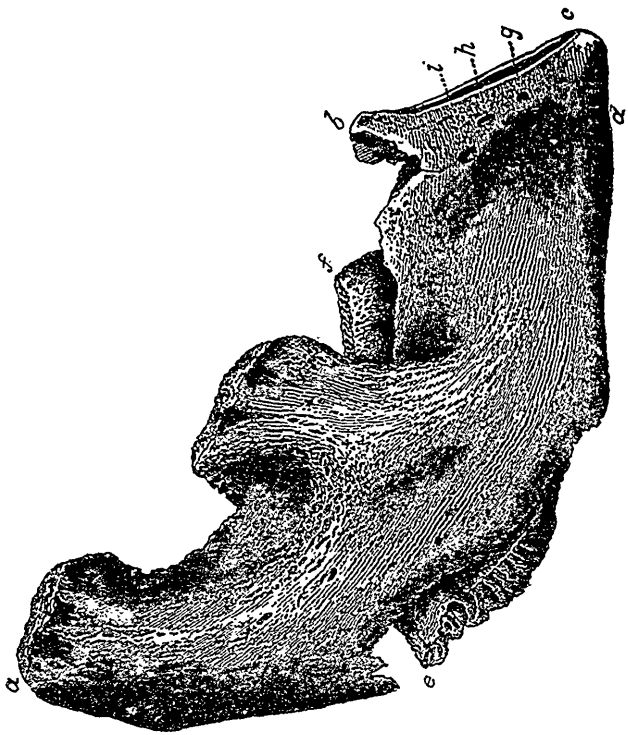

Fig. 2.—Side view of Fig. 1. This figure having been engraved from a photograph does not give the true proportions. Owing to the great convexity of the object the front *d b* is diminished by the strong perspective.

inches. There are three pairs of mental foramina. The first or anterior foramen on the right side is three and a half inches; the second, four and a-half; and the third, five and a quarter inches, above the base of the jaw. On the left side

the height of the first is three and a-half, of the second five, and of the third five and a-half inches. The distance through the symphysis, in a straight line between the two foramina of the first pair is five inches; of the second pair, six and a quarter; and of the third pair, nine and a quarter inches. The thickness of the jaw (including the molar) at the anterior edge of the coronoid is eight inches.

The form of the symphysis differs from that of *E. primigenius* as figured by Cuvier, Owen and others. On the underside the

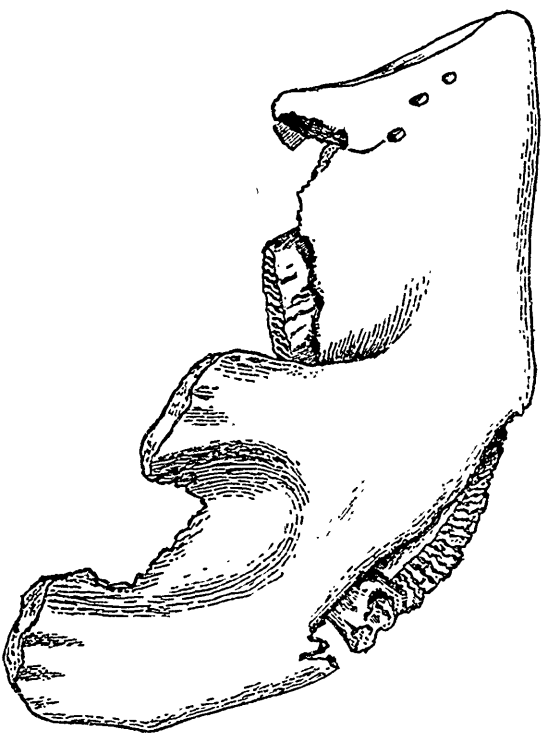

Fig. 3.—Outlines of Fig. 2, giving the proportions more nearly.

length along the median line (*c.* to *d.*, fig. 1) is five and a-half inches, including the mandible, which latter is one and a-half inch in length. The most elevated point of the symphysis, is at two and a-half inches in advance of a line erected perpendicularly from the posterior margin, or nearly half way between *c* and *d*. The height of this point is three and three-fourths inches above the

lower surface of the jaw. The bottom of the symphysial gutter inclines forwards and downwards with a straight slope at an angle of about 40° with the plane of the under-surface; but backwards the descent is depressed convex and at an angle of 60°. with the same plane. There is a strong rounded elevated margin on each side, which is about three-fourths of an inch in height and width at three inches from the point of the mandible, but becomes narrower and less prominent both above and below. It (the gutter) is rounded in the bottom; and its width at one inch above the most elevated point of the symphysis is two and one-eighth inches. In front of this point it narrows to three-fourths of an inch at the point of the mandible, where it is also very shallow. Owing to the great height of the jaw, the gutter, on a front

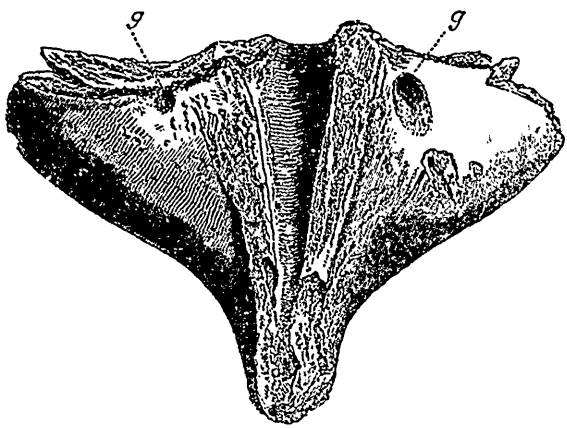

Fig. 4.—Upper side of a symphysis with the elevated margins of the gutter broken away, *g*, *g*, the anterior foramina.

view, makes a deep notch between the upper halves of the two rami, having a nearly vertical wall on each side. The depth of this notch is five inches, and its width at the top is two and three-fourths inches. Behind the notch, the inner surfaces of the two rami appear to form two nearly vertical parallel planes, for a distance of about nine inches, separated from each other by a space of between two and three-fourths and three inches. They then diverge from each other with an obtusely rounded curve.

The molar tooth is in a fine state of preservation, and well exposed to view. Its length along the crown is eleven inches; but owing to the manner in which the plates diverge from each other towards the lower side or base, the extreme length, at about two

inches below the plane of the crown, is thirteen and one half inches. The greatest width of the crown is at the third plate, where it is three and one fourth inches. It becomes slightly narrower backwards. At two inches below the plane of the crown the width is three inches and seven-eights. There are twenty-six plates, including two incomplete ones at the posterior extremity. The nine anterior plates have been brought into view, and the next two are partially exposed. The nine worn plates occupy a length of four inches, giving an average of a little less than half an inch for each. From the manner in which the plates diverge below the crown, the average width at half the depth of the tooth, as exhibited by the ridges on the side is a little more than half an inch. The

Fig. 5.—View of the left side of Fig. 4.

enamel plates are thin and not crimped, and both the dentine and the cement are worn out to the depth of one or two lines below them. The height of the tooth at the mid-length is about seven one half inches. In front of it there is an empty fang-pit, four inches in depth, separated from the main body of the alveolus by a thick transverse wall. The tooth is gently curved sideways, having the concave curve outside. The last or posterior plate consists of only three digitations. The next in front of it, of six and the third of seven.

The next specimen to be described is a symphysis (Fig. 4 & 5), evidently belonging to a much larger animal. The length along the median line on the under surface is six one-fourth inches including the mandible, which is two and one-fourth inches in

length and is still not complete; the point having been broken away. The height from the under surface, to the most elevated point in the bottom of the gutter, is four and three-fourths inches. The slope of the bottom of the gutter forwards and downwards forms an angle of 40°, with the plane of the under surface precisely as in the other specimen. But the slope backwards differs in being about 80° instead of 60°. The greatest width of the gutter is one and three-fourths inches. It is bordered on each side by the remains of what was evidently an elevated margin similar to that of the other specimen. The two anterior foramina remain; their height above the plane of the under side of the jaw is five inches distance between them three and three-fourths inches. The greatest width across the broken larger end of this bone is about nine and a-half inches.

Calling the first specimen described No. 1, and the latter No. 2, the difference in their proportions may be thus tabulated in decimal parts of an inch.

	No. 1	No. 2
	Inch.	Inch.
Length of underside of symphysis along the median line including mandible,.....	5.50	6.25
Length of mandible,.....	1.50	2.25
Length exclusive of mandible,.....	4.00	4.00
Most elevated point of the bottom of the gutter,.	3.75	4.75
Greatest width of the gutter,.....	2.12	1.75
Height of anterior mental foramina,.....	3.50	5.00
Distance between them,.....	5.00	3.75

The most important differences between the two specimens, so far as they can be compared, are, that in No. 2, the symphysis is nearly one third higher, or thicker, in the vertical direction, and has a more abrupt slope posteriorly; the gutter is one fourth narrower; and the mental foramina more elevated above the base and not so far apart.

These two specimens, at first sight, appeared to me to belong to two distinct species, and as such I described them at the time, the abstract of this paper was read before the Natural History Society. But on further study I found that if the whole of the elevated margin of the symphysial gutter of No. 1 were broken away (as it is in No. 2,) the slope of the front part of the symphysis, forwards, would be precisely the same in both, (i. e. 40°) when seen on a side view, as in fig. 5. This would greatly diminish the difference in the aspect of the two specimens. There would yet remain, the greater vertical height of the symphysis

of No. 2, and the more nearly perpendicular descent backwards I do not feel myself competent to say whether or not these last mentioned characters are of specific importance in the mammalia.

Other Bones.

Along with the above were found :—

1. A fragment of a very large tusk, evidently a portion near the base. It is four and a-half feet in length, seven and a-half inches in diameter at the larger, and five and a-half inches at the smaller extremity. It is curved to a radius of about four feet.

2. Part of another tusk a little over five feet in length. It is rather more strongly curved than the other. Its diameter at the larger extremity is four and a-half inches, and at the smaller three and a-half inches. A portion of it appears to be that part which was inserted into the alveolus as it is hollow to the depth of about three inches. It shews the double curvature characteristic of the tusks of the European Mammoth.

3. Portions of two scapulæ and several fragments of other bones, all, from their size, apparently belonging to the same species.

The jaw No. 1, and the smaller tusk were described by T. Cottle, of Woodstock, Canada West, in the Annals of Natural History [2] vol. 10, p. 395, 1852. See also Am. Jour. Sci. [2] vol. 15, p. 282. He was the first to announce the discovery of mammoth remains in Canada. All the bones now in the Provincial museum were presented by the late R. Benedict, Esq., who was, at the time of their discovery, the Chief Engineer of the Great Western Railway.

Remarks on the Species.

The remains, upon which the species *Euelephas Jacksoni* was proposed, were collected in Jackson County. Ohio, in 1838, by C. Briggs and J. W. Foster; then engaged along with Mr. Mather, in the geological survey of that State. The following is Mr. Briggs, account of the discovery :

"About two years ago, some bones, so large as to attract the attention of the inhabitants, became exposed in the bank of one of the branches of Salt Creek, in the northwest part of Jackson County. They were dug out by individuals in the vicinity; from whom we obtained a tooth, a part of the lower jaw, and some ribs.

"In the examinations at this place, during the past season, it was concluded to make further explorations, not only with the hope of finding other bones, but with a view of ascertaining the situation and the nature

of the materials in which they were found. The explorations were successful. There were found some mutilated and decaying fragments of the skull, two grinders, two patellæ, seven or eight ribs, as many vertebræ, and a tusk. Most of these are nearly perfect except the bones of the head. The tusk, though it retained its natural shape as it lay in the ground, yet, being very frail, it was necessary to saw it into four pieces, in order to remove it.

"The following are the dimensions of the tusks, taken before it was removed from the place in which it was found:

Length on the outer curve	10 feet	9 inches.	
" " inner curve	8 "	9	"
Circumference at base	1 "	9	"
" 2 feet from base	1 "	10	"
" 4 feet from base	1 "	11	"
" 7½ feet from base	1 "	7½	"

"This tusk weighed, when taken from the earth, 180 lbs. The weight of the largest tooth is 8¼ lbs. These bones were dug from the bank of a creek, near the water, where they were found under a superincumbent mass of stratified material fifteen to eighteen feet in thickness." (See the 1st Ann. Rep. Geol. Sec. Ohio, p. 97, 1838.)

In November, 1838, there was published in the Am. Jour. of Sci., vol. 34, p. 362-3, a letter, apparently written by one of the discoverers of the remains in question, in which the difference between the form of the jaw and that of *E. primigenius* was pointed out and illustrated by two figures. His remarks are, in substance, that the jaw of *E. Jacksoni* "converges more," or is not so broadly rounded in front, and that the symphysial canal is much narrower than in *E. primigenius*. The figures, it is evident, were only intended for a mere diagramatic illustration, and are therefore not very neatly executed. But taken together with the letter, they constitute a very important contribution to science, as they afford the first proof ever published, that there is in America a fossil elephant different from the European and Siberian *E. primigenius*.

In the original figure of the jaw of *E. Jacksoni*, above alluded to, the form of the symphysis and gutter agrees so nearly with that of the corresponding parts of our specimens that no specific differences can be perceived. The molar teeth, represented in their place in the jaw, do not appear to be correctly drawn, as they differ from each other in their proportions and in the number of plates. On the same page, however, there is a figure of the crown of one of the molars, and in the 36th volume of the Journal, p. 190, Mr. Foster gives another and a better one, of the same

tooth; but he does not state on what scale it is drawn. The length of this latter figure is three and a half inches and one and a half in width. Assuming this to be half the natural size, the length would be seven inches and the width three. There appear to be fifteen plates, including four at one end which are represented by irregular rows of digitations, more or less worn. This would give an average of a little less than half an inch to each plate, thus agreeing exactly with the Canadian molar.

The tusk described by Mr. Briggs differs from our specimens in being less curved; but this is a character upon which a great deal of reliance cannot be placed. The tusks of all the species of elephants vary to a considerable extent, not only in the amount of their curvature but in their size. Three tusks have been lately procured from the Youcon river, in Arctic America, by B. R. Ross, Esq. Two of these are curved, but the third is nearly straight, The characters of the molars seem to be more permanent.

At Zanesville, in Ohio, there was found, in 1852, the skeleton of an enormous elephant, having the tusks and the four molar preserved.

These were described by Prof. J. Wyman, in the Proceedings of the American Association, published in 1857.

"The following are the dimensions of the right and left upper molars in inches:—

	Right.	Left.
Greatest length	14¼	13½
Greatest height when resting on the ground.	10½	11
Length of grinding surface	8¾	9
Breadth of " "	4¼	4¼
Whole number of plates	29	30
Plates of grinding surface	18	18

The dimensions of the molars of the lower jaw are as follows:

	Right.	Left.
Whole length	14½	15
Length of grinding surface	9	8¾
Breadth " "	3¾	3½
Whole number of plates	24	25
Plates of grinding surface	17	17

Comparing the average width of the plates of the grinding or worn surfaces of the above four molars with that of the Canadian specimen, and also with that of *E. Jacksoni*, as figured by Foster

(assuming that his figure is half the natural size), the following are the results in decimal parts of an inch:

	Average Width.
Right upper (Wyman)	·49
Left upper "	·50
Right lower "	·53
Left lower "	·52
Right upper (Foster)	·46
Right lower (Billings)	·44
The first thirteen plates of the same at two inches below worn surface	·51

In the Zanesville molars, there were eighteen plates in the upper, and seventeen in the lower, brought into view. Consequently the average width of the plates, on the worn surface, is greater than it would be if only nine plates had been brought out to view by wear, as in our specimen.

According to the views of Mr. Foster, as given in the Proc. Am. Assoc. above cited, the remains of the Ohio elephants were found in a deposit accumulated just after the close of the northern drift period, and while the river terraces were in process of formation. The individual, to which the four molars described by Prof. Wyman belonged, was discovered in an ancient shore of the Muskingum River, in what he, Mr. Foster, calls valley drift, being composed of loam sand and gravel filling up the original valley of the stream that had been excavated out of the palæozoic rocks. This valley drift holds large blocks of rock; evidently transported, but derived from the neighboring carboniferous and Devonian formations, over which the river flows. These blocks were most probably floated, not by icebergs, but by river ice, at a time when a somewhat colder climate prevailed in the Western States. Some of these blocks were found, immediately above the stratum of sand holding the elephant's bones. I believe this valley drift to be of the same geological age as the formation of sand gravel at Hamilton in which our specimens were found. On comparing all the evidence—namely, the figures and descriptions published by Briggs and Foster, the measurements of the teeth given by Prof. Wyman, the proximity of the localities and the probable identity in geological age of the valley drift and lake terraces,—I think it almost certain that the four elephants above noticed are all of the same species, *E. Jacksoni*.

I have no means, except the figures published by different

authors of comparing *E. Jacksoni* with *E. primigenius*. Dr. H. Falconer in an article, (extraordinary for the amount of valuable instruction it contains) published in the Natural History Review for January, 1863, points out that the American molars, referred to *E. primigenius*, differ from those of the European form of that species, in having the plates more numerous in proportion to the length of the teeth. He also says (p. 67 Op. cit.) that the figure of the lower jaw of *E. Jacksoni*, above mentioned, indicates a different species. But he was evidently not aware that the molars in question and the jaw belong to the same. Our specimens set that question at rest. The figures 4 and 5 Pl. 11, Cuvier's Ossimens Fossiles represent two lower jaws of *E. primigenius*. Fig. 4 is one-eighth of the natural size, and shews a symphysial canal 8 lines wide, giving $5\frac{1}{3}$ inches for the width of it in the original. That of Fig. 5 had a canal 4 inches wide. The width of the same organ in our two specimens of *E. Jacksoni* is $2\frac{1}{8}$ and $1\frac{3}{4}$ inches respectively. This difference is so great that, could we compare entire animals or skeletons of both species we would, in all probability, find corresponding differences throughout their whole frame. The difference in the molar teeth is not so great, but still it is such that it gives, as Dr. Falconer says, "a certain amount of distinctive physiognomy." By itself it would not, perhaps, amount to much; but when taken in connection with the difference in the form of the symphysis it becomes important.

It seems quite certain that there are several species of American fossil elephants, but the question, how many? remains yet to be decided.

The following have been indicated, but much yet remains to be done before the Synonymy can be clearly settled.

1 *E. primigenius*, (Blumenbach).
2 *E. Jacksoni*, (Briggs & Foster) 1838.
3 *E. Rupertianus*, (Sir J. Richardson) 1852.
4 *E. Americanus*, (Leidy) 1853.
5 *E. Columbi*, (Falconer) 1857.
6 *E. Imperator*, (Leidy) 1858.
7 *E. Texanus*, (Blake? or Owen) 1858.

The last three are clearly distinct from *E. Jacksoni*, but are they distinct from each other? I have seen no description of *E. Americanus*. Dr. Falconer says that Sir J. Richardson has withdrawn *E. Rupertianus* from the list, having become aware by his own researches that it is not separable from *E. primigenius*.

Should it be admitted that *E. Jacksoni* is distinct from *E. primigenius*, then, we have no proof whatever that this latter species ever lived so far south in America as the United states and Canada. A large proportion of the remains, found in these two countries, which have been heretofore referred to *E. primigenius*, most probably belong to *E. Jacksoni*.

No Remains of Man Found.

No remains of man, or of his works, have been found in the formation which holds the bones of the Elephant in Canada. In allusion to the absence of human bones in the ancient river drift of Europe, I may mention, that for the last fifteen years, I have been in the habit of examining the bottom of the Ottawa and other Canadian rivers every season, at the time of the lowest water, in search of fossils; and that, although I have seen the bones of almost all the species of land animals now living in the country, associated with innumerable works of man, I never yet found a human skull in any of these streams. I speak of the skull, because it is possible that some of the small bones may have been those of the human frame, and not recognized as such by me. But, as man is the only animal who removes the dead of his own species from the water, and buries them on shore, thousands of years may elapse without a single skeleton being imbedded in a fluviatile formation; and yet the same formation may be full of the traces of his existence, associated with abundant remains of contemporary animals.

Art. XII.—*Remarks on the Genus* Lutra, *and on the Species inhabiting North America;* by George Barnston, Esq.

(Presented to the Natural History Society.)

The purpose of this paper is to introduce to the notice of naturalists a rare variety, in all probability, I may say, a distinct species of otter, yet undescribed by zoologists, and smaller than the common otter of Canada. Experienced Indian hunters know it as a different animal, applying to it the name of the pulling-down otter. In the Ojibiway tongue this term is *Pinaikiwawkeek*, or *Pinahaikiwawkeek*, which I have followed in adopting for it the specific name of *Destructor*.

A few prefatory remarks on the number of the species of the

genus *Lutra* generally may not be uninteresting.* The materials within my reach do not allow me to enter into many particulars; but I can touch upon the names of six or seven species mentioned by travellers as occurring in different quarters of the globe. Following such information we find otters of different kinds on the four great continents.

First, we have the *Lutra vulgaris* of Great Britain and Europe; with what is considered a dark or black variety of the same on the sea coasts. This is called *L. Roensis* by Ogilby, who deemed it distinct, and who had it from the shores of Antrim in the north of Ireland.

India has its otter in the *Lutra Nair*, the Nir Nayie, which in some parts of that country is domesticated, and rendered very serviceable by being taught to drive fish, and even take them in the water and bring them on shore for the fishermen. No doubt the Nir Nayie brings the fish ashore for his own use; but the fisherman interferes, the rights of the biped coming before those of the quadruped. The Juhl Margur of the Mahrattas is perhaps only a variety of the Nir Nayie. It is a little larger, and differs in wanting the white spot over the eyes, and in having a white upper lip. It may be found however, upon a full anatomical comparison, that these two otters are of distinct species.

The Javanese Simung is a species of otter to which Horsfield, so well known as an ornithologist, gave the name of *Lutra leptonyx*, or fine-clawed otter. Opinions vary as to whether this may not be similar to, or a variety of the otter to which I have next to advert; but the wide separation of the two countries by ocean, and the almost total if not entire difference of their mammals in other genera, would favor the opinion that their otters are distinct also.

The *Lutra Capensis* was constituted a genus by Lesson, under the name *Aonyx*, as wanting claws, a peculiarity pertaining to some specimens had from the Cape, but which has not been determined as in all instances constant. It would appear that such

* Audubon gives a list of 11 species enumerated by authors, viz:—"Europe, 1; Island of Trinidad, 1; Guyana, 1; Brazil, 1; Kamschatka, 1; Para, 1; Malay, 1; Pondichiery, 1; The Cape of Good Hope, 1; and North America, 2." Pennant seems to have considered the North American and Kamschatka Otter as the same, and the names Guyana, Trinidan, Brazil, appear merely local, not distinctive, in the absence of specific characters, which I regret I cannot here obtain.

a character would require a number of specimens in proof, ere naturalists could admit it as always existing and permanent, so as to entitle it to generic pre-eminence. It is possible there may result a solution of these difficulties in the determination of two distinct species of otter on the southern portion of the African continent.

The *Lutra Brasiliensis* of Ray is the *lobo du rio* of the Portuguese and Brasilian colonists. This appellation of River Wolf is given to it, we may conclude, from the barking noise it makes, and from its gregarious habits. These otters keep together in bands, but have no resemblance to the wolf. Azara's name is *Nutria*, and it is a well marked species, smaller than our Canadian otter, of a yellow colour, and destitute of the glandular apparatus round the nostrils; which is the only portion of the nose wanting hair. In our North American otters a large space on the nose is bare. As might be implied from its gregarious habits, the Brasilian otter has a social disposition. They fish in company in the rivers of Paraguay and Brazil, and many females rear their young together in one locality.

Lutra Californica is a species established by Mr. J. E. Gray of the British Museum, on the strength of its differing from the Canadian Otter, in having but little hair on the feet between the pads of the toes, and less on the palms and soles generally. Besides this, the length of the naked portion of the nose is shorter than its breadth, and shews not anteriorly or posteriorly the acute points encroaching upon the upper lip and forehead. These marks, especially the latter, are quite observable in the case of the Canadensis, and probably are the consequences of a difference in the nasal bones. Zoologists therefore have been induced to follow Gray, and adopt the species. Indeed the separation of California from the rest of our continent by the high lands of Mexico, with their characteristic Fauna and Flora, on the east, the sandy deserts and the Elk and Humboldt mountains, on the north east, and the gigantic southern limbs of the Cascade range, on the north, renders it probable that this otter, is distinct. When a number of the skulls and skeletons of each shall have been collected, a close comparison will decide the matter.

Eastern North America, which is so highly favored in the possession of magnificent rivers and lakes, filled at times to overflow by a thousand tributary streams and mountain torrents, might well

be supposed to abound in otters, and such is really the case, where civilization with its attendant population has not thinned their numbers, or entirely rooted them out. In flat level districts, where streams are numerous, and well provided with boulders and rolled rocks, localities to which otters appear partial, as affording secluded and safe retreats, an able Indian hunter has been known to kill forty or fifty in the course of a winter and spring. The *Lutra Canadensis*, which affords this sport, is found across the whole of the continent, and the animal differs little on the western slope from what he is found to be on the eastern side. From recollection I am disposed to think that on the waters of the south branch of the Columbia, and the rivers lying between that and the Pacific, its fur, like the coat of the beaver, is lighter colored than in the colder regions.

In winter, otters, like seals, are fond of coming upon the ice, but always in the vicinity of open water, into which they can easily plunge on the slightest alarm. In the spring they extend their walks, and disport themselves on the ice, especially after a light fall of snow. On these occasions they frequently fall by the hunter's gun. When greater excursions are made, as in crossing through woods from one stream to another, or traversing large lakes to reach open currents, otters seem to glide along, as it were, in their course, and this is done by repeated jerks forward. In deep snow scarcely any traces are left of the feet, the weight of the body following erasing the impression. The appearance afterwards is exactly as if a heavy cylinder, the size of a stove-pipe had been moved along by some invisible power. These long journeys are made principally in the earliest warm days, when otters begin to change their winter haunts, and seek for mates. At this period hunting is followed up with the greatest success. The Indian is constantly on the look-out for these animals, when they leave their holes to pass through points of woods and over frozen lakes, in search of their companions, and of other quarters where fish begin to collect. In deep snow the difficulty of overtaking them is lessened by using the snow-shoe, and when a frozen lake occurs, where the crust is hard or the ice bare, the snow-shoe is dispensed with, and the animal soon overtaken, if there be no open water at hand. The mode of progression of the otter by jerks, or a repeated succession of forward impulses, is occasioned by the shortness of its legs, and the compact firmness of its hind joints, best adapted for swimming. In fact they do swim on the

surface of soft snow, their smooth fur opposing no obstacle to their advance, but rather aiding them on declivities, where their pace becomes accelerated. A hunter needs to be quick when an otter is shot in or near to the water. The moment it is dead it sinks like a seal; and if not badly wounded it escapes without difficulty unless seized immediately.

The female otters are smaller than the males. March and April is the season of gestation, and in August the young are active and able to provide for themselves. In northern latitudes the season of pairing may be a little later. Their principal food is fish, but they eat also mollusks and crustacea; unios and crawfish abound in some streams, and afford them much sustenance. At fishing stations they are particularly troublesome, and very expert in eluding the snares devised to catch or entrap them. They destroy many more fish than they eat, preferring always the head, and often leaving the rest untouched. When the nets are watched, during the day, they make their visits in the darkness of the night and retire unperceived to holes in the bank, under the roots of trees and similar places, where they remain in comparative safety. When there is a scarcity of fish and otters are numerous, their depredations are very damaging.

If trouble be taken with the otter to tame it, it becomes a very interesting pet. There is something mischievously amiable about a pup otter. Restless and wary he gets into every hole and corner, his tone of voice is agreeable, and the soft glossiness of his black coat would induce any one to pat or caress him. I kept one for some time, and it afforded great amusement. When taken to the borders of the river, it would seek a pool or eddy of considerable depth, where it would commence diving, bringing generally from the bottom some species of small mollusk. Shells of the cyclas genus were very abundant there. These it would crunch and eat, one at a time, holding the nose and mouth out of the water the body being apparently almost in an upright position. As soon as one was finished, it would dive again without delay to the bottom, returning to the surface as soon as another cyclas had been got, never seeming to tire of the amusement. This hard exercise appeared to occasion no fatigue; and as a hearty breakfast of fish had been had before hand on shore, the entertainment no doubt was equivalent to a dessert and a bath.

With harder shells an otter has greater difficulty; with an anodonta or unio he seeks some rock shelving into the stream, or a flat-

tish stone or rolled boulder just appearing above water, or but slightly covered; here he makes his repast, breaking the shell and, eating its contents. In navigating rivers with boats or canoes, rocks and flat stones, on or near the surface, may be frequently observed with collections of open and shattered shells upon them; indicating the spot to which an otter had resorted for the purpose of dining, a board where he could best get over the troublesome process of getting into the dish. These dinner-tables of the otter are worthy of the conchologist's regard, as likely to furnish occasionally a rare bivalve.

The remarks just made, although drawn from observation of the habits of *Lutra Canadensis*, are applicable, I daresay, in a great measure, to the other otters; and we now arrive at the more particular consideration of the *Lutra destructor*. I purpose to show that there exists throughout a great portion of the British territory in North America, if not farther south, a smaller species of otter, well known to the aboriginal Ojibways and the Crees, as the *Pinaikiwawkeek*, the breaker of beaver-houses and dams. He closely resembles the larger otter in dentition, color, and shape, but is of more slender structure, and possesses marked differences in the proportions of the cranial bones. He has besides distinct habits, and modes of life, especially in his search for sustenance, which I think altogether entitle us to consider him as specifically separated from the *Lutra Canadensis*.

Through the kindness of Professor Baird, of the Smithsonian Institution, I have been favored with drawings of the skulls of the English otter, *Lutra vulgaris*, and of *Lutra destructor*, the latter taken from a specimen sent by me to the Institution about eighteen months ago. A comparison of these shows differences so striking, that we cannot entertain an idea of their belonging to the same species, and we are thus left to the investigation of the points of variance between the *L. destructor* and our own otter, *L. Canadensis*.

The *Pinaikiwawkeek* or pulling-down otter, attains the length of from thirty-six to forty inches, about the size of the smallest females of the *Lutra Canadensis*, but nearly a foot shorter than the largest males. From many measurements of two specimens of the two species, of nearly equal size, it will be perceived how closely in some respects they resemble each other, yet in other particulars how they unaccountably disagree. This disagreement in the measurements before skinning, as shown in the accompanying table, is per-

haps more strikingly illustrated by an examination of the skulls; and accords with remarks I have heard made by Indians of the appearances by which they distinguish the one otter from the other. In the *L. destructor* the bones of the skeleton and the cranium are less massive. The length of the skulls being nearly alike (as in the two specimens taken for exemplification), there is found in the *L. destructor* a less breadth in the post-orbital process of the frontal; and the whole of the nasal bones are narrower and weaker. The outer measurement of the cavity of the brain approaches the oval, being convex in all aspects, and it exceeds the half of the total length of the skull from occiput to incisors, by nearly one-fourth of an inch; whereas the enclosing shell or covering of the brain in the *L. Canadensis* is almost exactly half the length of the whole skull. It is also nearly flat on the top, presenting no rounded surface except close to the occiput: this feature also prevails, although to a less extent, laterally, and there is a more sudden and decided narrowing of the cavity anteriorly, so that the general outline approximates less to ovaliform, and more to the shape of a truncated cone.

On the lateral view, with the lower jaws taken off, the skull of the *L. destructor* exhibits somewhat of an arched appearance; the molar and facial bones are narrower, and the zygomatic arch rises to about half the height of the skull. In the *L. Canadensis*, on the same lateral aspect, the planes of the head are straighter, the facial bone deeper and broader, and the zygomatic arch rises only to a paralled line of two-fifths of the depth of the skull. Here I may observe that the smallness of the bones of the face in the *L. destructor*, coincides with the remark I have heard made by a hunter, that the eyes of the *Pinaikiwawkeek* were closer to the end of the snout than in the common otter.

These differences, drawn from measurement and osteological characters, would not have determined me to have reckoned these two otters different species, (although deviations of less note have often served for specific separations,) but the account given by Indians of their *Pinaikiwawkeek*, not only to myself, but to others, tend to impress upon me the conviction that in it we have a different animal from the common otter of America. That the beaver, in spite of his size and strength, at times falls a prey to the otter is certain. In 1823, I accompanied a few Churchill Crees, in order to be present at the taking of a beaver-lodge. After breaking through about three to four feet of frozen mud with their

ice chisels, they found the lodge empty. The lodge being large, I was able to descend into it, and crawl about on all-fours. At the door, situated opposite the middle of the little shoal-lake in which the beavers had built, I found vestiges of old cut willows

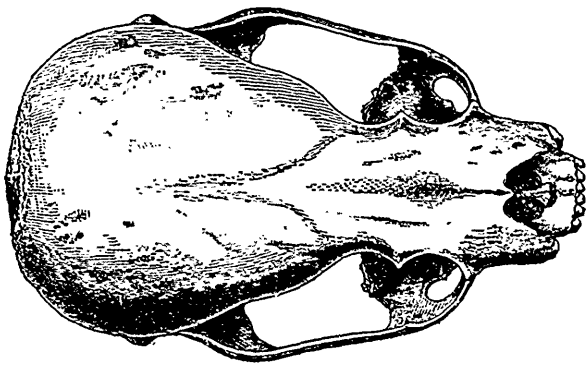

Figure 1.

L. destructor; top view of skull three-fourths natural size.

scarcely thicker than the fingers. The door had been under water, but the floor rose towards the centre of the house, so that it must have been partially dry in summer. The ice was at its upper surface higher than the opening or door towards the lake,

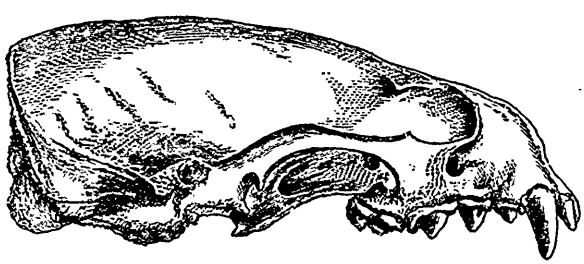

Figure 2.

L. destructor; side view of skull three-fourths natural size.

but the water having either retired or been drawn off, it was hollow beneath; and although the situation was shoal, a beaver nevertheless could have crept under. I was much interested about the structure of the lodge, and especially with one or two niches in the wall, a little above the level of the floor, which I looked

upon as seats, or places of retirement, if at any time the rising of the water should overflow the basement. Some such provision for accidents was without doubt had in view in the construction of these lowly arched niches, which certainly afforded more room

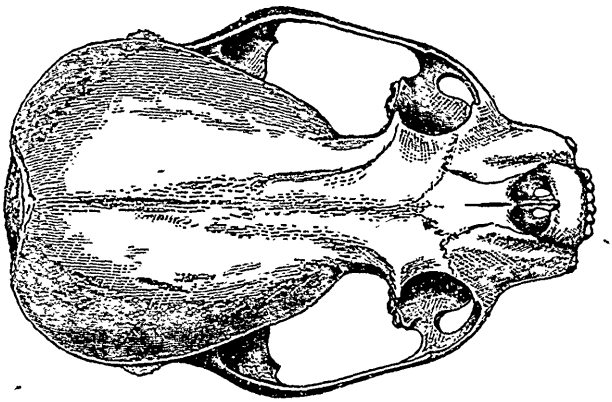

Figure 4.

L. Canadensis; top view of skull three-fourths natural size.

to the family. Being scarcely acquainted with the Cree language at that period, I could not interrogate the hunters closely; but after they had surveyed the surrounding locality, and examined the

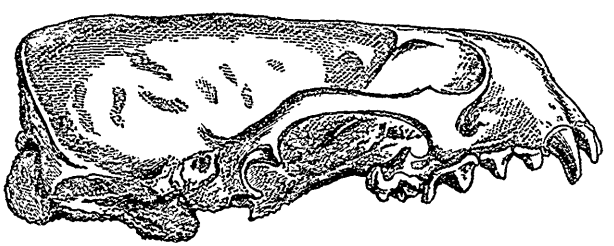

Figure 5.

L. Canadensis; side view of skull three-fourths natural size.

lodge, they gave it as their opinion that an otter had been there to spoil their sport and destroy the beaver.

In 1835 I first began to make particular enquiry regarding the destruction of beaver by otters. This was on the Albany river, and the Indian interrogated was an elderly man, not one of the best of characters, but he had always been most friendly to me, and

was most shrewd and intelligent. He was deemed a conjuror by his tribe, and bore that name at our establishment amongst the

Figure 3.

L. destructor; lower jaw three-fourths natural size.

servants. I was told by him that it was the small otter, which he styled *Pinaikiwawkeek*, that killed the beavers, by breaking down their dams and getting into their houses; or so disturbing them as

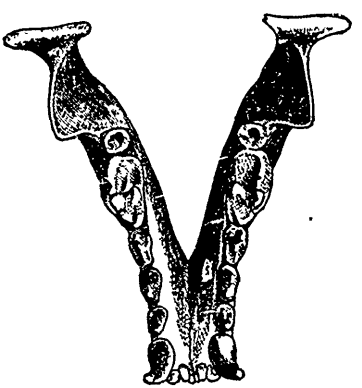

Figure 6.

L. Canadensis; lower jaw three-fourths natural size.

to take them at disadvantage abroad, devouring the young, and all he could succeed in mastering. Had this animal been the young of the Canadian otter, it would have been named *Neekeekous*, *i. e.* the diminutive affix would have been used with *Neekeek*.

From that period I have always thought we had two species of otter. I was informed at the same time that the *Pinaikiwawkeek* did not consort with the *Neekeek* but that the two were at enmity with each other, and fought when they met. It can scarcely be imagined that this very unamiable disposition, and the destructive habit of destroying the beaver, with the fatigue necessarily attendant upon such a pursuit, could be possessed by a mere variety of the *Neekeek* or common otter, while the same inclinations were not ascribed to every individual of the species. Neither can it be supposed that the young and smaller individuals of a species would follow an occupation requiring apparently a greater amount of intelligence and skill, if not of strength, while the older and stronger members of the same family left it off, or generally declined it. This would be contrary to nature, as displayed in the order of carnivorous animals. It may be also observed that had the two animals been the same, the remark could never be made by Indians that they were obnoxious to each other, and did not commingle or associate together.

Judging from the skull of the *L. destructor*, its greater comparative fulness or roundness of outline, indicating a greater amount of brain anteriorly, and a development of higher instincts,—any one might infer it to be a creature endowed with more sagacity than the common otter; and we find accordingly that, besides the usual fishing occupations, it resorts to war upon the industrious and harmless beaver, and brings into the field a degree of design, contrivance, and perseverance, not belonging apparently to either the *Lutra Canadensis*, or any other of the genus. Not to be tedious, I shall only add, that the information of the Albany and Weenusk Conjuror has been confirmed by many hunters on the shore of Lake Superior, who never saw the Albany river, and who never moved to any great distance from the great lake; and also by communications from a gentleman, who had similar statements from Indians on the shores of Hudson's Bay.

Agassiz says in his very useful work on classification "that "Species in a natural genus should not present any structural "differences, but only such as present the most special relations "of their representatives to the surrounding world, and to each "other. Genera, in one word, are natural groups of a peculiar "kind, and their *special* distinction rests upon the ultimate details "of their structure." I believe there is exhibited in the skull of the

L. destructor a *special* distinction resting on the *ultimate* details of its structure; a speciality is also displayed in relation to the outward world, by the breaking of beaver-works, and preying upon that animal. Another speciality is its non-association with, or enmity towards the other otter. Its isolated mode of life may be deemed a third; and its allowed inferior size a fourth speciality, apart from structural details.

A sufficient amount of data and information has been adduced, I think, to authorize the introduction of the *L. destructor* as another and distinct species of otter, inhabiting in small numbers the region of North-eastern America. If the grounds appear too slight for the substantiating specific impress, I hope that, in course of time, further inquiry and better examination by practical zoologists will decide the point, as well as add to our stock of zoological knowledge.

Differences in Measurement of Two Otters.	Lutra destructor 28th Dec., 1861.	Lutra Canadensis January, 1862.
	Inches.	Inches.
Total length from point of nose to end of tail	36.20	38.25
Length from " " to root "	23.25	24.00
Height of hairy portion of upper lip	.62	.65
Breadth from angle to angle of mouth beneath, across the lower lip from jaw to jaw	2.00	2.20
Breadth of expanded forepaw	2.60	2.75
Breadth of hind sole at callosities	1.75	2.00
Breadth of expanded hind foot, from point of the first toe to point of the fifth	3.25	3.50
Breadth of muzzle behind the nose	1.75	1.90
" from point of one eye to point of the other	1.60	2.00
" of head at opening of the ear	3.25	3.75
Circumference of head at the ear	8.12	9.25
" " " at the eyes	6.12	6.50
" " neck at three inches from the ear	9.50	10.50
" " body at shoulder	13.00	14.00
Length of head from occiput to point of nose	4.75	4.75
" from eye to the nostril	1.00	1.10
" " " to point of snout	1.50	1.60
" " " to entering angle of bare portion of nose on forehead	1.12	1.25
Circumference from point of snout to auditory opening	3.60	3.90

NOTE.—The wood-cuts illustrating this article were drawn on the blocks by Mr. H. S. Smith and engraved by Mr. J. H. Walker.

Addendum to Dr. Dawson's article on Air-Breathers of the Coal Period.

Through the kindness of the Council of the Geological Society of London, the fine skeleton of *Dendrerpeton Acadianum*, sent by me to the Society in 1861, has been returned for my inspection in the preparation of this article.

I am now able to state, in addition to the facts already published, that the large furrowed teeth of the inner series were not placed in the palatal bones, but on the maxillaries and intermaxillaries, the outer series of smaller and simple teeth being borne on the outer margin of these bones. The arrangement was thus somewhat similar to that in *Lepidosteus*. Immediately within the large teeth were the vomerine series, which were very numerous and irregularly placed, but small, with the exception of a few in front. They extended backward in two lines along both sides of the palate, in this also resembling some ganoid fishes.

In this specimen, the lower jaw, remaining in place under the skull, is seen to contain, especially toward the front, long furrowed teeth like those of the upper jaw, implanted in round sockets on the broad upper surface of the mandible, with others more simple and of smaller size.

By carefully removing the stone, I have uncovered the occipital condyles, which are double and square in outline, much like those of *Labyrinthodon*, and not dissimilar from those of *Sieboldia* and *Menobranchus*.

Near the skull, the scales of the throat remain in their natural position, and are seen to be densely imbricated, and arranged in curved rows, diverging from the mesial line. The scales of the abdomen are of larger size, and are scattered over the stone. Those of the throat are of a narrow ovate form, those of the abdomen wider, and some of them tending to rhomboidal in outline.

Twenty-four vertebræ, in all, are seen in the specimen. Of these thirteen occur in continuous series, and appear to be lumbar. They are of small size, relatively to the dimensions of the head and limbs, and indicate a weak and flexible back. Other vertebræ, not in regular series, are dorsal, and have strong transverse processes with oblique articulating surfaces. A few are perhaps cervical and caudal. The bodies of the vertebræ have continuous bony walls, but thinner than in specimens of larger size.

One half of the pelvis is well preserved, and shows a broad

ileum, and strong ischiac and pubic bones. There are also broad scapular, and probably sternal bones, but crushed and imperfect. Few of the ribs remain, and these apparently only the smaller ones, as compared with other skeletons of which I have portions.

Several of the bones of the limbs remain in sufficiently good preservation to allow of measurement of their size. I am thus enabled to give the following dimensions of parts of the animal.

Total length of skull,.....	$2\frac{9}{12}$ inches.
" breadth " at the orbits,*.....	2 "
Length of humerus,.....	$1\frac{4}{12}$ "
" " ulna,.....	1 "
" " femur,.....	1 "
" " rib,.....	$\frac{9}{12}$ "
" " eleven vertebræ in series,.....	$2\frac{3}{12}$ "

It would seem from these dimensions that the head was broad, and the trunk slender; the anterior limb, including the foot half as long again as the head, and the posterior limb rather smaller or shorter than the anterior. It would thus appear that while the general form of the body was not unlike that of *Menobranchus*, the limbs were much larger, and must have carried the trunk without allowing any part of it to touch the ground, as would also seem to have been the case from the footprints found in the coal-formation beds, and the size and form of the toes of which make it likely that they belonged to this animal.

The limb-bones, though thin-walled and often crushed, evidently had broad articulating surfaces; and in the base of the fore-limbs particularly, were large and strong in proportion to the dimensions of the head and vertebral column.

The large size of the fore-limb I suppose to have been related to a habit of walking or standing in shallow water, with the snout in the air, in the manner of newts, and the more rapid movements of the creature were probably performed by the tail. It is interesting to observe that in *Hylonomus* the proportions of the limbs were reversed—the hind limbs being much larger than the fore limbs.

From the relative dimensions of the bones, as compared with those of other specimens in my possession, I presume that this individual was three-fourths grown, and I doubt if its total length much exceeded one foot.

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* Perhaps increased by flattening.