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GIANTS AND PIGMIES:

(GEOLOGICAL.)

EARTH'S ORDER OF FORMATION AND LIFE,

AND

HARMONY OF THE TWO RECORDS.

REVISED AND CORRECTED, WITH SYNOPTICAL TABLE.

BY THE

REV. DAVID HONEYMAN, D. C. L.,

*F. S. A., F. R. S. C., F. S. Sc. (hon.) Lond., Honorary Member
of the Geologists' Association, London, &c.*

CURATOR OF THE PROVINCIAL MUSEUM,

AND

PROVINCIAL GEOLOGIST.

HALIFAX, NOVA SCOTIA:
Museum and Booksellers.
1887.

Dedicated

TO THE RIGHT HONORABLE SIR JOHN DOUGLAS
SUTHERLAND (THE MARQUIS OF LORNE,)

KNIGHT OF THE MOST ANCIENT AND MOST NOBLE ORDER OF THE THISTLE,
KNIGHT GRAND CROSS OF THE MOST DISTINGUISHED ORDER OF
ST. MICHAEL AND ST. GEORGE,

(LATE) GOVERNOR-GENERAL OF CANADA AND VICE-ADMIRAL OF
THE SAME, ETC., ETC.,

FOUNDER AND PATRON OF THE ROYAL SOCIETY OF CANADA.

BY HIS OBLIGED AND HUMBLE SERVANT,

THE AUTHOR.

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PREFACE.

THE articles contained in this volume originated with a suggestion made by the Rev. Robert Murray, Editor of the "Presbyterian Witness." It was expected at first, that the series would be confined to subjects in Provincial Geology. As we proceeded our scope expanded and developed, from Local to General. It became world-wide and led to the consideration of subjects of general and deepest interest. Our series commenced in the "P. W." of December 25, 1885, continued weekly in 1886, and ended in February 19, 1887. They are therefore 61 in number. The author has been solicited to publish them in a volume.

We are under great obligations to Mr. Murray for the interest he has taken in our articles, and the assistance given in the correction of the Press. Notes have been added and a Synoptical Table.

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GIANTS AND PIGMIES.

1. You seem to wish me to give your readers some account of certain giants that once lived in Cape Breton. Well, there have been giants in this Island, and pigmies too. I propose to tell you of both, setting the very great age of the latter over against the great size of the former. I shall give the latter the precedence. Those of which I shall write, lived, died, and were buried at Mira, near Louisbourg. Their remains which have come under my notice and occupy their place in our Provincial Museum, were collected by Mr. Hugh Fletcher, of the Geological Survey of Canada, and Rev. Mr. Sutherland of Gabarus. The rocks in which they are found are of the same age as the rocks which are found in Wales, called the "Upper Lingula Flags" Salter. Prof. Hall, who has examined the collection, agrees with this view of age. Trans. 1886-7. The "Lower Lingula Flags," are the sepulchres of what are *generally* believed to be the oldest inhabitants of our world. The name is well applied to our Cape Breton sepulchres. Mr. Sutherland's pigmies are *Lingulellae*. These are shells which have received names according to their form (Lat. *Lingua*, a tongue, *Lingula*, a little tongue, *Lingulella*, a very little tongue.) *Lingulidae* is a cosmopolitan family. It seems also to pervade time from "Primordial" to the present. In the Museum we have species belonging to different periods and countries. From the Indian Seas and the Fisheries Exhibition we have *Lingula anatina*.

Mr. Fletcher's pigmies are trilobites. These too are cosmopolitan. In geological formations from the "Primordial" to the "Coal Period," they are found throughout the world. Since the last period they have ceased to exist. If we had not the "testimony of the rocks" we would not have known that this *crustacean* family of "Giants and Pigmies" had ever

existed. The Mira species we know of are pigmies, their names are *Agnostus* and *Olenus (alatus)*. The two are associated in Mira as in Wales and Norway. Either when dead or living the Mira pigmies seem to have met with a disaster before burial. They are in fragments. They are so abundant as to form thin limestones. They must have swarmed in Mira waters, in the approximate beginning of life. Another name that has been given to this *Olenus* is *spherophthalmus alatus*. Besides being *alatus* (winged) it is *spher ophthalmus* (round eyed). With the aid of a magnifying glass we can see those round and compound eyes among the fragments, as well as the so-called wings.

In sunshine these little eyes are bright and brilliant like the eyes of a dragon fly. They tell us that the waters in which they lived were pellucid, and that the sun shone at Mira then, as I have seen it shine, when it rose above the waters of the Atlantic, while I was sitting at Louisbourg Point.

2. Nearly 25 years ago when I made my *debut* in Halifax as a lecturer on Geology, and had the Editor of the *Presbyterian Witness* as one of my hearers, I described the trilobites of Arisaig, N. S., with their brilliant eyes, now for the first time exposed to the light of the sun, which they had beheld ages ago. At the close of my lecture Mr. Mackay of Tilt Cove Copper Mine, Newfoundland, exhibited three "Giant" trilobites from Placentia Bay. These were Giants compared with the Arisaig trilobites, while the latter are much larger than the trilobites of Mira described in No. 1. One of the Newfoundland trilobites in our Museum measures 10x7 inches. This is about fifty times the size of the Cape Breton pigmies. These are known as *Paradoxides*—*paradoxus* signifies wonderful. They are of "Primordial age." Barrande, the great French Palaeontologist, so characterized the age of the *Paradoxides* of Bohemia. In Wales where the same *olenus* is found, *Paradoxides* also occurs in the "Lower lingula flags." This shows that the *Paradoxides* lived before *olenus*. The Newfoundland giant trilobites are to be regarded as older than the pigmies of Mira. They lived, died, and were buried before

the latter appeared in primeval waters. They—the very first of God's creatures—lived in the place now occupied by the Cambrian rocks of Placentia Bay. At Saint John, New Brunswick, similar giants have been disinterred by Mr. Matthew. He reports the discovery of *Paradoxides* as large as *Paradoxides davidis* of St. David's, Wales. Our Colonial waters were thus distinguished as a *habitat* of the first "*primordial*" creatures that lived in Earth's great waters.* Among the primordials of New Brunswick we find a pigmy to which you have been already introduced. Associated with the *Mira olenus*, we observed *agnostus*, so called on account of its singular character. The *genus* appears with *Paradoxides* as well as *olenus*. It survives the former, but disappears with the latter. In the "Silurian Period" the *Paradoxides* are not to be found. They only belong to the Upper Cambrian Period of Geological History.

3. With the Lower Silurian Period, Nova Scotia comes to the front. Another race of Giants appears in our waters. The new giants are trilobites which we have referred to the *genus asaphus* (signifying obscure). The individual of which we have a characteristic fragment in our Museum, by which we are enabled to judge of character, and dimension has been named *Asaphus ditmarsiae*. Its specific name (Ditmars) is familiar at Clementsport, Annapolis County.† The size of its caudal (tail) shield is 6x6 inches. This seems to indicate a trilobite much larger than the largest *paradoxides*. In the Trenton limestones of Ottawa giant trilobites are found in great numbers. In this period they culminated. They still appear in the subsequent Hudson Period, and then become extinct. Our giant(s) lived on the side of the Bay of Fundy, opposite the tombs of the Saint John primordial race. He seems to have met with a violent death before he was interred in the feruginous clays or iron deposit of Moose River. His remains

* Some will make exception in favour of *Eozoön*, No. 17.

† Prof. Hall is doubtful about this trilobite being an *Asaphus*, we therefore add (?)

have then been petrified and encased in magnetyte (magnetic, iron ore). With the culmination of this harmless race, there appears another race of giants of a widely different character (*cephalopoda*). The horse shoe crab of the seas of Maine and other seas may be compared to the former. The Giant Squid of Newfoundland (*Architeuthis harveii*) is representative of the latter. That the comparison is not unapt, I appeal first to testimony. Dana says in his Text Book : In Trenton Period "shells of cephalopods were especially common under the form of a straight or curved horn with transverse partitions." The straight ones were called *Orthoceras*, a straight horn,—one kind had a shell 12 or 15 feet long and nearly 1 foot in diameter. In the Museum there are two specimens of unusually large dimensions. The cephalopod that could carry this complete shell must have been of large and formidable proportions. The unhappy *Asaphus ditmarsiae*, *tyrannus*, or *gigas* in the clutch of the monster and being torn to pieces by his hawk's bill, was certainly to be pitied.

4. Approximately contemporaneous with the Giant trilobite of Moose River we have the *Lingule* of Nova Scotia. They are of larger size than the early Cape Bretoners, and of greater variety and beauty. Now is evidently their period of culmination, as subsequently, we have only one or two species, and these are of inferior size. They abounded at Arisaig on Northumberland Strait in the Co. of Antigonish, at Wentworth, Intercolonial Railway, in the Co. of Colchester and at Barney's River and Sutherland's River, Co. of Pictou. The sepulchres of these inhabitants of early Silurian Seas are to be found in the mountains and on the banks of the inland rivers as well as on the sea border. It is cause of astonishment to many—the finding of sea-shells inland and on the mountains. The geologist considers their occurrence in these diversified positions as a matter of course, and as convincing evidence that these places of sepulture were portions of the bottom of the seas in which the *lingula* or other marine inhabitants once lived. The *lingule* of Barney's River and Sutherland's River as well as

individuals at Arisaig, as they are disinterred, have a very singular appearance. They roll at our feet shaped like bullets or plums. They are mummies around which envelopes have been formed by the concretion of portions of their clayey sepulchres. These require only a gentle tap of the hammer to reveal the *lingula* of elegant form, black and pearly, often beautifully iridescent. Their first disclosure never fails to astonish. In the same cemeteries are trilobites of other *genera* *Phacops* and *Calymene*, bright eyed and rolled up like a hedgehog, or distended as overtaken by their last enemy. Associated are beautiful turbinated corals of the order *Actinozoa* (sea anemone) and species, *Petraia forresteri*, Salter, and corals and graptolites of the order *Hydrozoa* (hydra). The last are beautiful and slender *saw-like* forms which are peculiar to the Lower Silurian period with one or two exceptions, which occur in the Upper Silurian. Prof. James Hall also considers these to be of Lower Silurian age. Trans. I. N. S. 1886-7.

We are now ushered into the upper period. In Nova Scotia, Arisaig and the East River of Pictou are the principal cemeteries of the Upper Silurian inhabitants. The remains disinterred in these localities, but especially the former, show that now was the culmination of the Cephalopods in Nova Scotia as well as of its Silurian life. About 25 years ago I found at Springville, East River, the largest *orthoceras* yet found in Nova Scotia. This was exhibited at the London Exhibition of 1862, and left there. Although unusually large it was much inferior to the *orthoceras* of the Trenton limestone, and does not take the place of a giant. I have already named the Squid as a representative of this Family. I would now compare the *orthoceras* with the familiar *nautilus*. If the one were *coiled* it would closely resemble the other. At Arisaig the *ceras* (horn) presents a great variety of form. In addition to the plain *Orthoceras* we have *ornate* forms, large and small, and *Cyrtoceras*, *Omoceras*, *Ascoceras* and *Ammonoceras*. We have also trilobites, *Calymene* as in the previous period but larger in size, *Phacops* or *Dalmanites* and *Homalotus*, large and small, young and old, &c., of several species.

Here the remains of the several families are mixed up in wonderful confusion.

Victims, tyrants, small and great,
Partake the same repose,
And there in peace the fossils mix
Of those who once were foes.

5. Prof. Sedgwick, of Cambridge, named a Geological Formation with which his name is associated, Cambrian from Cumbria or Cambria in Wales. To the lower part of this Formation, the rocks of our Gold Fields belong (with the exception of the Granites) as first determined by Dr. Selwyn.* The Primordial or *Paraloxides* sepulchres of Newfoundland and New Brunswick belong to the upper part. Sir Roderick Murchison's name is familiar as the author of "Siluria" and the "Silurian System," so named by him after the "Silures" the ancient inhabitants of Wales. The rocks of Mira, Moose River, Wentworth, I. C. R., Barney's River, Sutherland's River, East River and Arisaig, to which attention has been directed in preceding No.'s belong to the "Silurian System."

The name of Hugh Miller the Cromarty mason and his "Old Red Sandstone" are household words. Few of the readers of the *Presbyterian Witness* are unfamiliar with the name. Those who have read the "Old Red Sandstone" are familiar with the names and appearance of the fishes: 1. *Coccosteus*. 2. *Pterichthys*. 3. *Cephalaspis*. 4. *Chirolepis*. 5. *Holoptychius*, &c., and the Crustacean *Seraphim*. The readers of his "Footprints of the Creator" are acquainted with the Fish, *Asterolepis* (of Stromness). Many of the fishes are almost "Pigmaean," some are of moderate size, others are large, gigantic, all are singular in appearance, and clad in coats of mail.

Our museum has scales of *Holoptychius* like "oyster-shells," once mistaken for such, from Dura den in Scotland

* We consider the granites to be of "Archæan Ages." No. 8. While we regard the Argillites and Quartzites of the Gold Fields as being of Lower Cambrian age, the Gold and its associate minerals, Arsenopyrite, &c., may be of Upper Cambrian or Lower Silurian ages, having been introduced subsequently while the rocks were being metamorphosed, and previous to the Lower Carboniferous Period. Vid. Trans. Institute of Natural Science 1886-7.

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(Nos. 1 and 2 above) are represented not from Scotland, but by specimens from an Old Red Sandstone Cemetery at Restigouche River, New Brunswick. These are from the collections of Mr. Ford presented by Dr. Selwyn, director of the Geological Survey of Canada. Giants of the Old Red Sandstone are the Crustacean Seraphim (so called) and the *Asterolepis*, of Stromness. The fragments of the Crustacean of Miller's collections in the hands of Agassiz arranged themselves into a giant-form somewhat resembling a lobster, $4\frac{1}{2}$ feet in length. Prof. Huxley has described and figured this giant and given it the name *Pterygotus anglicus*. The museum in Dundee has the greatest number of fragments, and a complete giant in a flagstone from Balruldery, Forfarshire. We have seen some large lobsters. One five feet in length from snout to tail would certainly astonish. A small specimen has been found at the Restigouche cemetery associated with the *Pterichthys*. It is to be remarked that the form of the Crustacean, and that of the fish have some resemblance. Both have wing-like (*Ptero*), paddles, projecting from either side of the head. The bodies of the *Pterichthys* without the paddles are puzzling to those who see them for the first time. Hugh Miller likened them to turtles. Gesner regarded the Restigouche ones as turtles. Until I saw the figures of *Pterichthys milleri*, Ag. in Miller's "Old Red Sandstone," I considered a small specimen that I found in the stone dyke around the "Standing Stones of Stennis" as a sort of a crab. I would observe that these "stones" are regarded as a Druidical Temple. They are at Loch Stennis in Orkney, not far from Stromness, *Vid.* Miller's "Old Red Sandstone." I visited the Orkneys and collected Old Red Sandstone Fishes at Stromness and Orphir in 1842.

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6. In the "Foot-prints of the Creator" Miller observes "*Gen. Asterolepis*." "It is from the star-like tubercles by which the cerebral plates were fretted that M. Eichwald bestowed on the creature its generic name. The fish was carnivorous in its habits. The size of the *Asterolepis* must, in the larger specimens, have been very great. This oldest of Scottish fishes—this earliest born of the Ganoids yet known—was at least as

bulky as a large porpoise. Thus in the not unimportant circumstance of size, instead of taking their places agreeably to the demands of the development hypothesis among the sprats, stickle backs, and minnows of their class, they took their place among its huge basking sharks, gigantic sturgeons and bulky sword fishes. They were giants, not dwarfs."

Fishes have been found in the Huron Shale of Canada, the upper member of the Devonian System in Ohio (Old Red Sandstone) "which are closely allied to *Coccosteus*, but very much larger, having a length of 15 or 18 feet, while *Coccosteus* was only as many inches in length. This has been named by Dr. Newberry, *Dinichthys*. He has given the name *Titanichthys* to another found by Mr. Terrell in the same shales, about two years since, which he describes as a Placoderm fish still more gigantic than the *Dinichthys*. The largest cranium of the latter is about 3 feet broad across the occiput while the former has a breadth of about 4 feet."

The Geological Formation that succeeds the Old Red Sandstone or Devonian is the Carboniferous or Coal-bearing. In this we recognize three divisions, lower and middle and upper, some style the whole as Permo-Carboniferous and others call the upper division Permian (Perm in Russia). In the Lower we have *Phillipsia*, the last of our trilobites. Antigonish and Hants limestones have furnished these. Prof. How found first the Hants specimens, and they have been called *Phillipsia Howi*. I found the Antigonish specimen. They are of small size. It is an interesting circumstance that Prof. How sent one of the first specimens to me at the Great London Exhibition of 1862. If I remember rightly Professor Phillips of Oxford was the first visitor to whom I showed it. He was agreeably surprised to find that his namesake existed in the Lower Carboniferous Limestone as in Great Britain. The finding of the same trilobite in the Ohio Lower Carboniferous Limestone, Antigonish, was a little singular. Sheriff Hill, of Antigonish, was my companion on the occasion. Looking at the limestones, observing their colour, fossils and relative position, I said to the Sheriff, I must find a *Phillipsia* here.

Before I left I found one—Prof. How's specimen, and this is in the Museum. One great reason of our success in finding certain creatures in certain rocks is we go expecting to find them. I could multiply examples. This is not "hap-hazard" work. Although *trilobites* disappear at this stage, *Cephalopods* still appear and continue onward. In the limestones of East River, Pictou, we find *Orthoceras* of small size.—In the corresponding limestones of Great Britain gigantic *Orthoceras* are found which have been described as "thick as a man's leg." Those that I have seen from the neighbourhood of Edinburgh are not much inferior in size to the Trenton Limestone Giants of No. 3. In our limestones of Windsor and Brookfield we find an advance among the Cephalopods, which we call *Nautilus*. Here we have two species. Mr. J. F. Falconer, of Acadia Mines, has presented to the Museum a beautiful specimen of the Brookfield limestone, which is used as a flux in reducing the iron ores of Londonderry. The specimen is portable, yet it contains the shells of twelve *Nautili*. This indicates clearly that this cephalopod abounded in Nova Scotia waters in the time that preceded the formation of our coal-beds. Their frequent appearance on the face of the deep, navigating the waters or basking in the warm sunshine tended to enliven the solitude that then prevailed.*

We have now the successors of the Old Red Sandstone Vertebrates of Restigouche, Fishes—in Nova Scotia. For a worthy successor of the *Asterolepis* we will have to go to Cape Breton, in our next.

7. In the Carboniferous limestones of Baddeck, Cape Breton, the remains of a giant were disinterred by the late Wm. Kidston and consigned to the late Wm. Barnes, mining engineer, who was engaged by the commissioners of the Nova Scotian Government to make a geological collection for the Exposition Universelle de Paris, 1867. The relic is now in our Museum, and is regarded as one of the interesting speci-

* The species are *Nautilus Avonensis*, Dawson, and *Nautilus Brookfieldi*, Honeyman. Trans. I. N. S. 1886-7.

mens in our collections. It was very much admired in Paris, as a unique fossil. Its name is *Gyracanthus magnificus*. It is so called as it is considered to be a fish spine of magnificent proportions, and having a gyratory sculpture. The class of fishes to which our monster belongs has as a representative the Port Jackson Shark of New South Wales. The *Spinax acanthius* or *Acanthias vulgaris*, spine dog-fish, is another representative. In a marine collection that I made at Moville, Ireland, when returning from the Fisheries Exhibition of London, I have what is considered to be a large spine which a fisherman gave me from a large dog fish, that he had just caught. The position it occupied was in front of the first dorsal fin. This spine is recurved and measures 2·4 inches. Our *Gyracanthus* is 32 inches in length. The butt end of the one is 3 of an inch across; of the other 2 inches. Our giant must have been from 14 to 20 feet in length—much larger than the largest *Cestracion phillipii* of New South Wales, of the Fisheries Exhibition. The finding of a mate would be a grand discovery; much more of his Old Red Sandstone ancestor. The distance between Badleck and Restigouche would be easily traversed by our Cape Bretoners. Horton Bluff on the south side of Mines Basin has produced beautiful "*Ichthyodorulites*—Fossil fish spears," as fossils of the *Acanthus* class are sometimes called. They are, however, much inferior in size to our *Gyracanthus magnificus*.

8. It seems now to be in the order of Nature for us to go to Wentworth, Intercolonial Railway. Having reached the station, we make a Geological and Topographical *reconnaissance*. We are on the north side of the Cobequid Mountains. To the south rises Folly Mountain formed of Crystalline Archæan (gr. Arche the Beginning) rocks. On the side of the mountain and in the middle of these rocks is the beautiful Folly Lake, with its diatomaceous deposit and fresh water sponges, discovered by A. H. McKay, F. S. Sc. London. Trans. I. N. S., 1884. On the south of these are the Upper Silurian metamorphic rocks with the Iron deposits of Londonderry Mines. At Wentworth we have the Lower Silurian with its *Pholidops cincinnatiensis*

Hall, *Lingula*, *Graptolites* (monoprionidean and diprionidean), *Trilobites*, and associates of No. 4, discovered by myself and assistant, Andrew Jack, in 1872.*

Turning to the west of the station we come to Purdy's Sandstone Quarry. In the flags we see a fern indicating vegetation. We observe rain-prints. Robinson Crusoe like, we see foot-prints in the sand (stone.) We look at them wonderingly. Some are deep but distinct,—here the sand has been soft. Others are not so deep, and surrounded with rain-prints. Yet others are more slight, but still distinct on sun-cracked sand. Similar appearances may now be observed around Truro, Kentville, &c., in the deposits of "marsh mud." The foot-steps are not pigmean. They are made by the feet of reptiles of considerable sizes. Similar foot-prints have been named *Sauropus* (lizard-foot) The print of a crocodile or alligator's foot might be so named, as they too are "Saurians" or of the lizard class. Farther west, at River Phillip, other flagstones were quarried on which were numerous Saurian foot-prints. Some of these were of monstrous size—the tracks of giants. In our Museum, in addition to the Wentworth foot-prints, we have two slabs from River Philip of a very interesting character. One has a double row of foot-prints with the trail of a tail intervening, showing that the animal was a lizard (?) The other has a print on a fern-frond, showing a fern as lying in its way when the Saurian was taking its walk.

At the time when these creatures lived and moved, the Cobequid range of mountains was a long island about 5 or 6 miles wide, having the seas of the Lower Carboniferous Period reaching to the vicinity of the site of the Iron Works on the south and to the sepulchres of the Silurian pigmies on the north. The coal of Cumberland and Pictou had then no existence, and Prince Edward Island was yet of the future.

9. My late friend, Prof. Jukes, in his introduction to a Geological paper, thus remarked, "Demosthenes, when asked what were the requisites for an orator, replied, Action! action!"

* Prof. Hall agrees with me on the question of Age (Hudson River or Cincinnati, U. S.).

action! So the requisites for a Geologist are—Travel! travel! travel! I dare say our readers are beginning already to consider that “travel” is a requisite for the Geologist, as I have in previous pages given them a little experience of this. We would now take them to Scotland—to the banks of the Findhorn and Clune Quarry, Morayshire, where we find Lady Gordon Cumming of Altyre at work, and Agassiz examining and naming fossil, Old Red Sandstone, fishes—about 1841. The chief of these are what he calls Placoids and Ganoids. The *Chirolepis cummingiae* is a prominent fish of the ganoids. They have been so called on account of the form of their shining bony scales. Their tails are formed like those of sharks or sturgeons, and are different from the tails of herrings or codfish. The colour of the scales is grey (silvery), brown or black according to the character of the deposit in which they are imbedded. The grey limestone bed of Clune Quarry has preserved their original silvery colour, giving them the appearance of fishes recently dead instead of ages long gone. Another characteristic of these ganoid fishes is that their teeth have a structure closely resembling that of the early amphibians (reptiles). From this we would go to the banks of the Rhine; to the coal fields of Saarbrueck, which have long been coveted by the French nation, and where at last they met with dire disasters in deadly encounter with the Germans in the Franco-German war. Here too are entombed ganoid fishes (*amblypterus*) in *sarcophagi* of ironstone. These ichthyolites when opened reveal the ganoids in a state of wonderful completeness, with brown colour.—Returning to our own neighbourhood, we have a place of ganoid sepulture, across the border in Albert County, New Brunswick. Here are fishes in considerable number. They are generally of small size. Occasionally, however, there are some, like “Saul among the people.” The small ones are known by the name of *palaeniscus*. Their size is from $2\frac{1}{2}$ to 3 inches in length. The larger ganoids measure about 9 inches. They are in the bituminous shales that accompany the mineral Albertite, and are consequently black and lustrous. Perfect specimens are not very common. They are more or less fragmentary. In Morrystown Township,

Antigonish County, scales of like colour occur in the bituminous shales. At Horton Bluff, Kings County, the black shales have also black ganoid scales. Here I found the right side of a lower jaw, $1\frac{1}{2}$ inch in length, with 4 conical teeth. Each of these rises, about the 20th of an inch, above the jaw. This is much larger than the jaw of a *palaeoniscus*. The Bony Pike, of the Canadian Lakes, of which we had several fine specimens at the Fisheries Exhibition, is a modern representative of the Ganoid Fishes.

10. In the year 1859 the late Dr. Forrester and I examined the marvellous section of the Carboniferous formation on the South Joggins Shore, Cumberland County. We admired its grandeur and phenomena of structure—with its remains of ancient vegetation, its coal seams and fossil trees, *Sigillaria*, *Lepidodendra*, *Calamodendra*, *Stigmaria* and *Culamites*—exposed in a beautiful and instructive manner by the action of the great tides of the Bay of Fundy. Certain coal looking beds were found to be composed of small mussels (*anthracosia*) and minute crustaceans (*leperditia*.) We proceeded to collect portable specimens from this interesting locality. In *Acadian Geology* we found an admirable and detailed account of the section. The occurrence of a reptile found by Lyell and Dawson in 1849 was regarded as of special interest, and reptilian remains were sought for. As we afterwards found we were on the wrong track and much below anything but foot-prints, the sepulchres being in newer *strata* or beds and not scattered around, but deposited in a sort of urns (*sigillaria*). On sitting down to rest on rocks at some distance apart, I observed lying before me a piece of black *leperditia* shale with something shining on its side. With the aid of my knife I exposed a large conical tooth of reptilian aspect. We then proceeded onward, and came to a point where we found the remains of a *Sigillaria* (tree) lying prostrate, having fallen from the cliff. In this I observed vegetable *debris* with a *carpolite*—fossil nut—what is called a *trigonocarpum*. I was satisfied with my success. I afterwards found that the tooth was of a ganoid fish, *Rhizodus*, and that the *Sigillaria* having the nut

was one of the group that contained the reptile referred to. So that both specimens are of unusual interest. The reptile was described by Professor Owen and named *Dendroserpentes* (tree reptile) *acadianum*. In the Museum we have a restoration of it by Waterhouse Hawkins,—the size of it is about 2 feet 9 inches. The largest amphibian of its form that we now have in Nova Scotia is the violet Salamander, whose length is 6 to 7 inches. The reptile seems to have been a lizard.

If you look into Lyell's Elements of Geology, Dawson's Acadian Geology and Dana's Manual and Text Book of Geology you will see erect columns, which represent trees in position, the greater part of them are *Sigillaria*; many of them may be sepulchres of reptiles. At the time when the creatures found their way into them, they seem to have been hollow.

Our *Rhizodus* tooth is conical, recurved, stout, its length is $1\frac{1}{2}$ inch, its root is $\frac{1}{2}$ inch wide. From this it has its name—*rhiza* a root and *odus* a tooth. The tooth of our Horton Bluff ganoid is pigmean compared with it. Its proportions approximate those of the great *Holoptychius* of the Scotch Old Red Sandstone and Carboniferous formations.

Prof. Marsh of Yale College found two large *vertebrae* at the Joggins, and published a description of them in 1862. In this he referred them to the *enaliosaurs* or sea-lizards, and named their original owner *Eosaurus*,—Dawn-lizard—*acadianus*. Thus Nova Scotia at this early period had the precursor of those great sea monsters which culminated at a later period, the Jurassic.

11. Before my first visit to the Joggins I had collected specimens on the north side of the Pictou coal field. At Deacon McKay's mine, New Glasgow, I found singular teeth in clay slate that had fallen from the roof of the mine. With the teeth were small spines and ganoid scales of various forms and sizes,—some of them large and beautiful. At Patrick's mine on the south-west side of the same coal field I found similar teeth, subsequently. From a mine next McKay's

I received from a miner another kind of a tooth. Of the first I collected about 30 of various sizes. These are shark's teeth—*hybodont*. They are called *Diplodus*—(double tooth). Each tooth is double. One single is upright, the other curves backward; a short cusp is between; the root is large. The teeth are lanceolate and crenulated; the largest tooth is formidable. When I showed it to Professor Phillips at the London Exhibition of 1862, he was astonished at its size and remarked that it was much larger than the tooth of the British *Diplodus*. Our sharks of the Coal Period must have been formidable. The ganoids, whose scales accompany the teeth, when once caught by the *Diplodus*, were doomed. The odd tooth is about $\frac{3}{4}$ of an inch in length; it is conical, recurved and striated.

In this field we have also an amphibian, a frog whose name is *Baphetes planiceps*. This was found by Sir J. William Dawson, and described in *Acadian Geology*. This frog was a giant when compared with the existing race of Nova Scotia frogs; it was even much larger than the frogs of the West Indies. The specimens of these in our Provincial Museum are certainly not pigmies, as they astonish visitors by their dimensions. The *Baphetes*, too, has teeth which could hold on to a *galaeoniscus*, although clad in ganoid coat of mail, tear it in pieces and make a meal of it. At the London Exhibition of 1862 there was a live frog exhibited in a block of English coal, and said to have been found in it. It was the subject of discussion in the newspapers. It died during the controversy. Visitors seeing our 30 feet Pictou coal column, expected to see the wonderful frog in it. If the *Baphetes* had been alive, and exhibited in our coal column it would have astonished and convinced the most incredulous "without controversy" as true and not false.

12. We would yet look at a few individuals which we have passed in our previous examinations.

There is the foot-print of a large *Sauropus*. This deep impression was found by J. M. Jones, F. L. S., in the Carboniferous formation of Parrsboro'. Then a plaster cast in the Webster collection of a row of foot-prints found by Mr. Harding at

Horton Bluff, and two kinds of foot-prints on clay slate, found by myself in the same locality, and next a large slab with foot-prints crossing and re-crossing from the quarry of the late R. N. B. McLelan in the carboniferous sandstone of Great River, south of the Londonderry Iron Mines.

Visiting Cape Breton, reptilian foot-prints are seen at the Sydney Coal Mines.

At the Schooner Pond we saw a Carboniferous giant whose name is *Haplophlebius*. It was exhibited at L'Exposition Universelle de Paris in 1867. This astonished geologists as much as did that of the other Cape Breton giant, *Gyracanthus magnificus*. Its specific name was *barnesii*, so named after his discoverer, Mr. Barnes, M. E. Since then he has received another specific name, *Longipennis*—*long winged*. What he is known by is a *long wing* having some resemblance to the wing of a Dragon-fly; this is 3 inches in length. It is extended on a piece of slate—on a part of it lies a fossil fern. The whole insect must have measured across the wings 6 or 7 inches. This was certainly a giant among insects. If it were as voracious as the dragon-fly, it must have inspired terror among his puny neighbours. This was not the first of this class of insects, if Geologists are correct in assigning a Devonian age to certain rocks associated with the Archaean and Primordial rocks of St. John, N. B., which contain plants, and were formerly regarded as Carboniferous. These rocks are found to contain, in like manner, wings of insects of much smaller dimensions. *Haplophlebius barnesii*, or *Longipennis*, Scudder is in the Provincial Museum.

13. We seem to have been altogether forgetful of our neighbour Island—Prince Edward's. Not so, for until now it has failed to put in an appearance. Prince Edward Island formation is post-Carboniferous, if we except its basal rocks, which may be Carboniferous or Permian—the age subsequent to the Carboniferous. *Vide Table*.

The chief formation of the Island is Triassic. Now that it has appeared, it comes to the front with a notable giant as its representative. Its name is *Bathygnathus*, so called on account

of the *depth of its jaw*. It is farther known as *Borealis*—northern. I believe its remains were found in New London. I have seen and examined them in the Museum of the American Academy of Natural Sciences, Philadelphia. The relic is its lower jaw and some of its formidable teeth. A very good picture of it by Leidy, with description, is in our Provincial Museum. It occupies a place among the Dinosaurs—the terrible saurians, or lizards. Other remains of this race are the tracks in the Connecticut sandstones in the Museum of the Boston Natural History Society. They were formerly considered to be the foot-prints of gigantic birds. From the now known characters of the Dinosaurs, which walked generally erect as bipeds, these tracks are believed to be reptilian—Dinosaurian.

We would now proceed to the South-west of England. (*Viñe Table at the end of the volume.*) Sailing up the Bristol Channel we come to the mouth of the river Severn and land on the western extremity of the Mendip Hills. We then proceed eastward along these hills until we reach the towns of Frome and Shepton-Mallet. The Mountain or Lower Carboniferous limestones largely enter into the constitution of the Hills associated with these. Succeeding, we have the Triassic and the Liassic formations, or Prince Edward Island formation and another succeeding it called the Liassic. Jurassic is another name given to it. Lias is equivalent to Layers (of rock). Jurassic is from the Juras (Alps) where it is largely developed. In the region we are now investigating there seems to be intermediate between the Lias proper and the Keuper division of the Triassic—a series called “Rhaetic.” A part of this is called the White Lias. On the Continent it is called *Infra-lias*. We now have established Geological relations between the “Old Country” and the “New.” Now for a search in the cemeteries. In the first layer of the Lower or Blue Lias, which comes next to the White Lias, there are no fossils; in the next bottom Blue beds, finely laminated, are (1) Insect-limestone, then marl; (2) Insect-limestone, marl; (3) Insect-limestone, three more thin layers, close grained; (4) Insect-limestone, marl; (5) Insect-limestone. This indicates insect life in great

abundance on the old Mendip Island and its Rhaetic shores—plenty of food for insect-eaters, *Coleoptera*—beetles, &c. What else have we here? A tiny tooth—not fish tooth, not reptile tooth—of a mammal—an insect-eater, a *microlestes*, a little thief—a pigmy mammal—one of the first of mammals. Here we have a molar tooth of *microlestes antiquus*. In 1847 several teeth of the same kind were found in a bone-deposit between the Keuper and Lias formations in Wurtemberg, Germany, by M. Plieninger of Stuttgart. Prof. Emmons also discovered another insect-eating mammal in North Carolina Triassic, U. S., a jaw-bone of *Dromatherium sylvestre*. Prof. Owen compares this animal with the *myrmecobius* of Australia. Near Shepton-Mallet, Mr. Moore, F. G. S., discovered a large reptile—*Scelidosaurus*—which lived during the Rhaetic Period, a giant Dinosaur akin to the Prince Edward Islander.

14.

"Whitby's nuns * * * * *
Told * * * * *
How, of thousand snakes, each one
Was changed into a coil of stone
When holy Hilda prayed;
Themselves, within their holy bound,
Their stony folds had often found."

—Scott.

Our guide, Mr. Moore, now shows us the so called "Petrified snakes" in their earliest sepulchre, not far above the "Insect limestone" of No. 13. Here we have *Ammonites planorbis*. We have seen nothing approaching to it among the Cephalopods since we were in Arisaig, Nova Scotia. Science has dispelled the legendary delusion, and proved that the Ammonite is the shell of a Cephalopod—like a nautilus. We soon find *Ammonites planorbis* "abundant," and associated with it *Pentacrinites*, stone-lilies, sometimes called "Saint Cuthbert's beads."

"On a rock, by Lindisfarne,
Saint Cuthbert sits, and toils to frame
The sea-born beads that bear his name,
Such tiles had Whitby's fishers told,
And said they might his shape behold,
And hear his anvil sound;
A deadened clang—a huge dim form
Seen but, and heard, when gathering storm
And night were closing round."

Although we have not previously alluded to the occurrence of *Crinoids* (like lilies), it is by no means their earliest appearance. In the Silurian of Arisaig they abound, and even in earlier periods. In periods later than the Silurian, *e. g.*, in the Mountain Limestone of Great Britain they are in very great abundance—giving character and beauty to many marbles.

Some of the most beautiful forms brought up from the depths of the sea by H. M. S. *Challenger* expedition and others, are the Crinoids. See the plates in publications of Expedition. Our guide introduces us also to the Foramenifer and the Saurian.

15. In my last I introduced the Ammonite. We found *Ammonites planorbis* at the Mendips and *Ammonites communis* and others in Poetry and Nature, at Whitby on the north-east coast of England and County of Yorkshire. This is the northern terminus of the Liassic formation in England. At Lyme Regis in the west of the south coast is the southern terminus. The Mendips are an intermediate locality. All along the line Ammonites may be collected. We now propose a trip along the south coast from Lyme Regis to Dover.

At our starting point we find abundance of Ammonites, similar to those of Whitby, the Mendips and other intermediate localities, especially in railway cuttings. When we reach Portland we come to a notable locality, a region of Giants. Here *Ammonites giganteus* abounds. Col. Akers (Major-General), R. E., tells me that when he was superintending the work of fortification there, he saw Ammonites disintombed, having a diameter of from 3 to 4 feet—being as large as a cart-wheel. In the Natural History Museum, South Kensington, in the Museum of Practical Geology, Jermyn street, and in the Museum of the Geological Society, London, magnificent specimens are readily seen. In our own Provincial Museum there is a young and portable specimen which is 1 foot in its greatest diameter and 2 feet 9 inches in circumference. The enormous size of these Cephalopods again reminds us of the great squids of Newfoundland. One of the latter, on its way to New York Aquarium, was examined by us some years ago on

board of the steamer *Cortes*. It nearly filled a molasses puncheon. An exquisite model of this monster was suspended overhead in the front of the United States Department, International Fisheries Exhibition. About the middle of the same department was another model of a kindred monster, the Octopus, with its writhing snake-like arms. It was impossible to look even at these without a shudder. Proceeding on our way we call a halt at Folkestone, at the Strait of Dover. Here in the Gault, Lower Cretaceous (chalk) formation, there is abundance of Ammonites. These are generally of small size—many are pigmean, literally the size of a pin head. We have worn for many years in our scarf-pin, an *Ammonites splendens* half an inch in diameter. In the so-called "Folkestone puddings" in our Museum are many of them. Modern representatives of small Cephalopods are the little *Spirula laevis* (shell) which we have collected on the shores of Sable Island, near the edge of the Gulf Stream, around the New Hebrides, and in the Indian Ocean. This is found in all the warmer seas. Associated with the Ammonites are the shells of other Cephalopods. These have names appropriate to their forms, *e. g.*, Scaphites (boat shaped), Hamites (hook), Bacculites (staff), Belemnites (dart). We will meet with similar forms of corresponding age in the sequel.

Walking towards Dover we come to Shakespeare's Cliff. Here we see an Ammonite, recently disintombed from the chalky cliffs by the action of the sea. We are sorry to leave it to the merciless destroyer. It would take a strong man to carry it. We are consoled, however, by finding specimens of other interesting remains of the Chalk Period. These are to be found in our Museum collections, side by side with a tolerably large *Ammonites nodosus*, which we purchased from a workman at the chalk-pits of Lewes.

16. In a farther search for Ammonites we cross the Strait of Dover, and proceed to Provence, the south-east department of France. We search the Liassic formation under the guidance of M. M. Lory and Hebert, members of the Société Géologique de France, and Professors of Geology in Grenoble

and the Sorbonne, Paris, respectively. We find this formation in the Basin of the Rhone between this river and the Var with many localities, having Ammonites with such distinguished names as Murchisoni and Parkinsoni, &c., and fascinating names as Calypso, Circe, Nilssoni, &c., with these are associated Bacculites and Belemnites. This formation enters very largely into the constitution of the several Alps, High, Low, Maritime, Jurassic and Khaetian. In the High Alps du Briançonnais, Lory gives as elevations of this formation, Mount Christoul, 8872 feet; Mount Joux, 8170 feet; Ponsonniere, 8310 feet; Chaberton, 10,148 feet. The Ammonites and their associates disinterred from these beds, unmistakably indicate that during the Liassic Period of the Earth's History the *strata* were in process of formation in the depths of the sea. When and how they came to occupy their present Alpine position we shall afterwards indicate.—We go to still loftier mountains, the Himalayas. In the high passes of these mountains at a height of 16,200 feet above the sea level, we are informed that Captain Alexander Gerard discovered Ammonites, similar to the Liassic species. This is 6,000 feet higher than the elevation of Mount Chaberton of the Alps.—Coming to our own Dominion we find among the Jurassic coal bearing rocks of the Queen Charlotte Islands in the Pacific, Ammonites collected by the late Mr. Richardson and Dr. G. M. Dawson of the Geological Survey. Associated with these are Scaphites, Hamites, Trilobites, Belemnites and Nautilus. These have been named and compared with the Cephalopods of the Alps by Mr. Whiteaves of the Geological Survey of Canada. They resemble in names and beauty of preservation the Lower Chalk Cephalopods of Folkestone (No. 15). Our Halifax volunteers during the expedition of 1885 collected, among other curiosities, some fine specimens of *Ammonites placenta* and *Bacculites ovatus*. Some of the Ammonites are of large size and great beauty, resplendent in pearly "sheen," like a polished Nautilus. The Bacculites are fragmentary, but have the same pearly lustre. This Cephalopod may be regarded as an uncoiled and straightened Ammonite—straight as a walking stick. All these, like their English, European and Asiatic congeners,

were tenants of the deep in the respective periods of Geological History to which they have been assigned. The localities where they are found were then, therefore, all *submarine*. The Rocky Mountain range is considered to have been then merely represented by a range of low islands extending through the wide waste of waters.

17. With the "Foramenifer," of the Lias formation, Mr. Moore introduces us to a very important sub-division of the Animal Kingdom. These rank among the lowest creatures; but although apparently structureless, many of them form tests (shells) which are remarkable on account of their beauty. These are often perforated by microscopic *foramens* (holes) by which the inmate had external communication. Many of the tests resemble the nautilus, whence they were once regarded as cephalopods; others have something the shape of coins. Some of them are small; others $\frac{1}{2}$ an inch or more in diameter. They are called *nummulina* or *nummulites* (*nummus*—a coin). Although our Liassic Zone is not regarded as the first of the appearance of foramenifers, it is yet remarkable on account of the large proportion which are identical with those now existing in all seas, according to the observations of H. M. S. *Challenger* and other expeditions. Prof. T. Rupert Jones now (since the death of Dr. Carpenter) the highest authority on Foramenifera, identified these Foramenifera for Mr. Moore. In his "Distribution of Foramenifera in Time," he shows that *sixteen* "recent" forms are found in the "Liassic." The largest of these are pigmean. Still it is maintained by Sir J. William Dawson, Dr. Carpenter and Prof. Jones, that the first and oldest of Foramenifera lived in the Archaean Period. Prof. Jones says of Eozoon (dawn animal): "In the 'Cambrian' of Bohemia and the 'Laurentian' of Canada we have Eozoon of as high structure as any of the hyaline (glassy) forms, in patches several square inches in size, forming together aggregations of considerable dimensions," This is certainly a giant among Foramenifers.

The great microscopist Ehrenberg first found *Foramenifera* in the Chalk of Meudon, south of Paris. Since then examina-

tions of the Chalk have revealed them to such an extent that it is considered as largely composed of the tests of these tiny creatures. The thought is overwhelming, that the Chalk Downs of England and France owe to these their very existence.

Sir C. Wyville Thompson, comparing the character of the Foramenifer deposits at the bottom of the ocean, brought up everywhere by the dredge, with that of the constitution of the Chalk, came to the conclusion that the present was in certain respects a continuation of the Tertiary—Chalk Period. In Prof. Jones' Tabular View of the Range of Foramenifera, in *Time*, we find that of 54 existing species there are 39 in the Cretaceous, 16 in the Liassic, 11 in the Triassic and 6 in the Carboniferous. Six species—*Fusulina*, *Dentalina*, *Nodosaria*, *Valvulina*, *Saccammina*—existing in the seas of the Carboniferous Period, still are found at the bottom of the ocean, presumably the tests of living Foramenifers. The longest direct line of descent—*Protozoan*, *Protoplasmic*.

18. I made an intimate acquaintance with the *Foramenifera* and other "subjects" of the Paris Basin in 1867, when I was Executive Commissioner of Nova Scotia, at L'Exposition Universelle. The Société Géologique de France, of which I was a member, had its *Reunion* for the year in and around Paris. We went, under the direction of Edouard de Verneuil, to Pont Ste. Maxence. In our examination of the Geology of the district, special attention was directed to the Nummulites. Here they are seen forming a conglomerate of considerable thickness. Their extension to the Alps was a subject of discussion as well as their place in the Paris Basin. I missed the meetings in Paris itself. Subsequently, however, I carried out the programme.—At Porte de Versailles I found the nummulites between the Great lower limestone (calcaire grossier inférieur) and the underlying clays. Among the specimens that I collected are two nummulites, having the interior filled entirely or partially with the green mineral glauconite. This is regarded as illustrating the mineralization of the *Eozoon Canadense*. Going to the south side of the Basin, I examined the geology of Meudon. Here was

Elhrenberg's Chalk with *foramenifera* and layers of flint with *echini* (sea urchins). Above the Chalk was the Limestone of Porte de Versailles. I had the remarkable good fortune of finding a grand slip, exposing a fine specimen of the great *Nautilus* of which I had found two fragments in the preceding locality. The entire *Nautilus danicus* is 2 feet 1 inch in circumference. This is about 3 inches larger than our largest *Nautilus pomilius* in the Museum. These with the associate *Echini* found in both localities with the mineral glauconite identified the two limestones. In the same limestones are abundance in species and numbers of a gasteropod *Cerithium* of small size—one species stands out from the rest as *Cerithium giganteum*. The nummulites at Meudon come between the Chalk and the Lower Limestone, and are therefore of Eocene age (dawn of the new). *Vide Table*.

Foramenifera—miliola—tiny in size, were found in the Gentilly Quarries, outside of Paris, forming limestone called *Calcaire miliolites*.

19. In addition to the Nummulites of the "Petra" of Pont Ste. Maxence, we have others at the base of the Glauconite or Calcaire inferieur of Porte de Versailles, or between it and a thick bed of clay. The very extensive excavation of this bed shows the extent of its use. Abundance of shark's teeth were found among the nummulites. At Meudon I also found nummulites of larger size than the preceding between the Chalk and the glauconites in a thin bed of marl. French geologists call these beds "*Nammulitque inferieur*" (lower). This implies a *superieur* (upper). These distinctions are important, as we shall see, when we come to "mountain elevation." In our Museum collection there are nummulites from Bracklesham, England, opposite the Isle of Wight. These seem to be contemporaries of our Paris nummulites, inferior or superior. England is their western limit of occurrence. From thence we would now follow them to their eastern limit. The Pyrenees between France and Spain have their nummuline peaks. In the Alps of Brianconnais and Savoy we have peaks of equal and greater altitude than those of the

Lias with Ammonites, noticed in No. 16. I translate Prof. Lory's description of these from Bulletin de la Société Géologique de France 1862. "The nummulite grits form a wild range, whose aspect is altogether peculiar. Of this the principal summits are, on the south of the valley of Maurienne, the Aiguilles d'Arves, 11,375 feet (3500 metres), the peaks of Goleon 11,144 feet, and of the Trois Eveches 10,140 feet. On the north the summits of the Grand Coin and the peak of Cheval Noir 9,201 feet (2830 metres), with which this nummulitic band terminates abruptly between Saint Jean de Belleville and the hill of the Madeleine."

At L. Exposition Universelle de Paris 1867, the special building in the Champ de Mars which contained the exhibits of the Compagnie Universelle de Canal Maritime de Suez was daily crowded with visitors. The extensive display, Geological and Palæontological, was to me peculiarly interesting. The chief collection included the following: 1. Nummulites and nummulitic limestone from the summit rocks and different parts of the chain Mokattam. 2. Nummulitic limestone with large nummulites from the mountains on the right side of the Nile, opposite Minieh. The Mokattam mountains begin near Cairo and extend to about 20 miles from the Isthmus of Suez. They attain to an elevation of about 800 feet above the Nile. The town of Minieh is about 190 miles south of Cairo.

Messrs. Bauerman and C. le Neve Foster in their Geological Reconnaissance made in Arabia Petrea in the spring of 1868 (Quarterly Journal of Geological Society) gives us the elevation of Mokattam and a section of a Quarry at the back of the tombs of the Caliphs behind Old Cairo, in which is "A bluish gray limestone with *Nautili* and large nummulites; this is 48 feet thick." This association of *Nautili* and nummulites reminds of the Calcaire grossier inferieur of Meudon and Porte de Versailles—the large nummulites, more especially the former. The Egyptian nummulites measure $2\frac{1}{4}$ inches in diameter—the nummulites of Meudon 1 inch, of Porte de Versailles $\frac{1}{2}$ an inch. They belong to separate species, and are known by different names.

At the Centennial Exhibition, Philadelphia, 1876, I received in exchange from the commissioner of the Egyptian Department, specimens of fossiliferous limestones having nummulites. Travellers have noticed the existence of nummulites in the stones of the Great Pyramid. It is supposed that these came from the quarries which produced our specimen. This illustrates the nummuline dominance in Egypt. Some years ago the Rev. J. Fraser Campbell, the missionary to India of the Canadian Presbyterian Church, presented to the Museum a magnificent *Clypeaster* from the vicinity of the Pyramids. In the Canal Company's collections were large petrified *oursins* (sea urchins) found at the Pyramids of Gizeh. In the *Calcaire grossier inferieur* of Porte de Versailles and Meudon I found abundance of the echini (sea urchins), *Pygostichus cuvieri* and *Echinolampus similus* associated with the Nautilus and Nummulites. These points of resemblance and difference are noteworthy.

20. We are still in Egypt. Its geology is of peculiar interest for other reasons than those adduced in our preceding No. 19. We will proceed to demonstrate why. Under the guidance of Dr. Compagny Fils, physician of the first Suez Canal Company, and with a good map of Egypt, published during the late Egyptian war, we shall proceed to investigate. We begin at the first cataract of the Nile. Here we have the famous quarries of Assouan, Syene, the Island of Philoe, with the Temple of Isis and the Isle of Elephantine. The familiar Syenite and Syenitic, rock appellatives, originate here. If the Canadian voyageurs of the late expedition had been Geologists, the rocks of and around the cataract would have forcibly reminded them of home.

Our "Archaean" granites, granitic Syenites and other Syenitic rocks correspond essentially with those of Egypt, as the Egyptian centennial specimens testify when compared with our collection from the "typical rocks" at Arisaig, or the corresponding rocks in the Cobequids or the mountains of Cape Breton. The term by which we indicate the age of our Syenites, &c., Archaean (*arché*, the beginning) is synonymous with the term Primitive used by our Egyptian director. The granites, &c.,

are represented in the Suez Canal collection. 1. By "a characteristic specimen composed of quartz, feldspar and mica, showing in a separate form the constituents of granite: from the left side of the Nile opposite the Isle of Philoe." Granites of Assouan and Philoe, red and grey, 7 specimens. In addition are pieces of Pompey's Pillar of the statue of Rhamses in the valley of Gessen (Goshen), of a monument of Persepolis, of the obelisk of Luxor now in the Place de la Concorde, Paris. 2. Amphibole (Hornblendic rock), from a bed of the first cataract which extends across the cataract from Assouan to the Isle of Philoe, 2 specimens of the Amphibole, which dips into the Nile at the entrance of the port of Assouan. 3. Porphyry, from the quarries of Assouan (Temple of Dendereh) and the bed of the first cataract. The extent of the quarries must be very great to have produced the building stones of the numerous and great buildings, the monoliths of the great monuments and the blocks for the colossal sculptures. The next geological formation to which our director introduces is the Cretaceous. He takes us to Mokattam which we have already signalized by its nummulites. He characterizes it as "calcaires crayeux." In it he finds a "fossil crab." The valley of Gessen (Goshen) is another locality where this formation is pointed out as chalk marl. It appears to coalesce with the succeeding, Eocene. Bauerman expresses the opinion that there is no marked division between the two. (Cretaceous and Eocene.)

A collection from Mount Lebanon in Palestine, presented to the Museum some years ago by Dr. McHattie, now of Antigua, points out this as also a locality. This collection consists of *crinidea* (St. Cuthbert's Beads) and numerous spines of the Echinus (sea urchin) *Cidaris olivæformis*, so called from the form of its spines, and a *Scaphite*. In our collections from the chalk of England, we have an allied cidaris with club-shaped spines approximating to olive-forms. The geological sequence here represented is certainly very irregular. The "Break in succession" is enormous. Between the Archæan and the Cretaceous, there should intervene, in order to complete the succession, all the formations that have been referred

to in the preceding Nos., as far at least as the Cretaceous of Folkestone. According to Companyo, with the exception of the Archaean and the Cretaceous, all the formations in Egypt are Cenozoic—new life.—I wish this to be borne in mind. *Vide Table.*

Bauerman's summary section is as follows:—1. Gneissic and granites, (Archaean). 2. Triassic rocks, (Palaeozoic). 3. Cretaceous (Mesozoic). 4. Eocene, (Cenozoic). 5. Miocene. 6. Gypsums and Conglomerates. 7. Raised beaches and miliolitic limestone. 8. Alluvium and desert drift. Volcanic rocks of two periods. This section fills up the "Break in succession" *partially* with *supposed Triassic*. *Vide Table.* Compare Hull's Palestine Series, No. 54.

21. The geology of Egypt, as illustrated by Companyo and Bauerman, seems to be beautifully and completely illustrative of the oldest written Geological Record extant, the Biblical. We demonstrate this. In Gen. chap. i., 1, 2, we have the "Archaean," or the granitic, syenitic, &c., the "Primitive" of Companyo. Verse 3 is "Pre-Cambrian," *preceding* the Trilobitic of Nos. 1 and 2 of this series of articles. Verse 9 introduces us to the Eocene Period, and other following verses to the subsequent formations up to the *Cene*,—the New. Between verses 3 and 9 we have the grand "*Break in succession*," of preceding No. 20. *Vide Table.* We have thus local geology for general—part for the whole. Still another aspect is this. It makes Egyptian Geology representative, as it seems to be, *Vide* coming Nos., of the geology of "*Orbis Veteribus Notus*,"—the world known to the Ancients. In the record we have at least time represented filling up the Geological Break, the so-called 'First' and 'Second' days. We are now called upon to make a few observations "On Time,"—which we would call "Divine measurement." The Record informs us that "in six days God made Heaven and Earth, the sea and all that in them is." The same Record tells us that they were all made in "One Day," Genesis chap. ii., verse 4: "In the day that the Lord God made the earth and heavens,"—literally, in Jehovah Elohim's day of making,

the Earth and Heavens. In Psal. xc., verse 4, Moses says, "For a thousand years in thy sight, like yesterday when it is past or a watch in the night,—or *vice versa*. *Anticipating cavilling*, the apostle Peter says, second Epistle, chap. iii., 8, "One day with the Lord as a thousand years, and a thousand years as one day." We might substitute a thousand thousand (1,000,000) or any number of years that the facts of Science may require. The sanctions of the Decalogue require definite measurement a week—seven days.

22. We resume our search for Nummulites, going eastward to India. In Scinde we find a range of mountains with Nummulites on their summits. At the close of the Scinde war, 1847, Capt. Vicary was sent by Sir Charles Napier to make a geological reconnaissance of the country. In this he made the interesting discovery that Nummulitic rocks constituted the summit ridge of the Hala range of mountains. This exalted position is about 1300 feet above the sea level. His investigations were communicated to the Geological Society by Sir Roderick I. Murchison. Also Persia, in the Western Himalayas (the region of Cashmère) at a height of 16,500 feet (Dana). Some of the nummulitic limestones of India make beautiful ornaments. A friend, Dr. Niven, formerly in the East India Company's service, gave me a beautiful specimen. It is a brownish marble; the nummulites are cut in every direction showing different phases of nummulitic structure. This is said to have come from Scinde.

Richthofen found the nummulitic formation in the Philippine Islands, Java and Luzon, and also in Japan. The seas of the nummulitic period thus extended from Java to the south of England. How and when these nummulites were brought into the elevated subaërial positions, where we now find them, will be a subject of enquiry in No. 27. We now revert to the "Saurians" of No. 14. The Saurians here, that come first in order, are En-alio-saurs (in sea lizards). These have already been noticed in No. 10, when we mentioned the Eosaurus (the dawn lizard) of Prof. Marsh. These monsters

now appear in unquestionable character and in formidable numbers. We single out representatives, the Ichthyosaurus (fish lizard) and Plesiosaurus (near the lizard). Of both we have associated in our Museum with Ammonites—so called “snake stones” and Encrinites—so called St. Cuthbert’s beads, vertebrae and teeth, which I purchased from a collector in Ipswich. The vertebrae of both are biconcave. The teeth of the Ichthyosaurs are short, stout, conical and striated; of the Plesiosaurs the teeth are large, long, conical and recurved. Of these each had a large number. The form of the Ichthyosaurus is Crocodilian, the head is large but the neck is short, and whale like flippers have the place of the feet of the latter. The body of the Plesiosaur resembles the other, only the neck is long—swan-like, the head is small—lizard-like. On the walls of our Museum are the splendid engravings of Hawkins’s “Great Sea Dragons.” These are of fossil skeletons of the British Museum and other collections. The almost complete Ichthyosaurus is about 30 feet in length. Their eyes were of great size—the strength and the form of their flippers rendered them agile and formidable. They must have been scourges of the seas of the period. The Plesiosaurs found in the same sepulchres must have been also formidable. They are supposed to have lived in estuaries or shallow waters. Their long necks which had 30 or 40 vertebrae with their lizard-like head would seem to have afforded facilities for securing food in air as well as water. We have seen restored Plesiosaurs having a Pterosaur or Pterodactyle caught in its flight vainly struggling to escape destruction. Some species of Plesiosaurs are from 20 to 30 feet long. Remains of more than 50 species of Enaliosaurs are found in the Jurassic rocks (Dana).

23. Whitby and Lyme Regis are noted as the sepulchres of Enaliosaurs. One remarkable fact in connection with their distribution is, their occurrence in the high latitudes. Sir Edward Belcher found vertebrae of Ichthyosaurus at Exmouth Island, lat. $77^{\circ} 12' N.$, long. $96^{\circ} W.$ Sir Leopold McClintock found them in Prince Patrick’s Island, lat. $76^{\circ} 90' N.$, long. $117^{\circ} 20' W.$, and also Ammonites. Capt. Sherard Osborne

also found broken vertebrae of an *Ichthyosaurus*, 150 feet up Rendezvous Hill, the N. W. extreme of Bathurst Island. Prof. Haughton observes in his appendix to McClintock's Narrative of the Lady Franklin Expedition, "But what are we to say as to the question of Temperature? It was certainly necessary for an ammonite to have a sea free from ice, on which to float and bask in the pale rays of the Arctic Sun; and therefore I claim a temperature for those seas at least similar to that which now prevails in the British Islands; and I may add that the ammonite from its habits was essentially dependent on the temperature of the air as well as that of the water."

I would now take you to a locality where there is a remarkable assemblage of these and other monsters which will yet claim our attention. If they were living we would rather not visit them, but as they are only lifelike, we can behold and admire them. I shall never forget the occasion of my first visit to this remarkable locality. In the memorable year 1862, I was invited to accompany the Geologist's Association in their visit to the Crystal Palace, Sydenham. After examining the wondrous structure and its contents, our party inspected its beautiful surroundings. Suddenly (to me) we came upon a bewildering spectacle—a geological—bewildering, because unnatural. Here we had a Carboniferous series, Limestones, Coal measures with coal seams, faults and usual phenomena above the London Tertiaries. I had scarcely discovered that the whole was artificial when I heard my name called by the President, Prof. Tennant, with the request that as the representative of Nova Scotia and the exhibitor of the great (Pictou) Coal Column, I should give a short lecture on the representation of a coal field before us. After this we were conducted to what is called the Island. Here was subject of greater marvel and astonishment. A menagerie of monsters. In this No. I will only give a list from proceedings of Geol. Assoc., London:

Labyrinthodon and *Dicynodon* of the Permian and Triassic Periods.

Ichthyosaurus, *Plesiosaurus*, *Teleosaurus* and *Pterodactyl* of the Triassic.

Megalosaurus of the Oolitic. (The preceding and this are comprehended in the Jurassic).

Iguanodons and Hyalosaurus of the Wealden.

Mososaurus of the Chalk Period.

Palaeotherium and Anoplotherium of the Tertiary.

Stag and Irish Elk Megatherium of the Quaternary Period.

These restorations which are well executed were done under the superintendence of Prof. Owen and Waterhouse Hawkins. The whole, geological and palaeontological, was an educational project of H. R. H. Prince Albert. Each and all of these Giants, not already noticed, will come under review at the proper periods in the sequel.

24. In 1883 we revisited this interesting spot and renewed our acquaintance with its inhabitants. We found the geological portion neglected, dilapidated and obscured. The haunt of mortars had become wild with overgrown vegetation, and therefore more natural. The lapse of twenty-one years had also told on the monsters, and they are therefore the worse of the wear. We would revert to them in their prime (in 1862). Then as now, the most prominent is the *Iguanodon Mantelli* (Owen). It is so called as its teeth very much resemble those of Iguana, a reptile now inhabiting the West Indies and Central America. In our Museum we have two stuffed specimens. The teeth of these have been compared with the beautiful figures of the teeth of the Iguanodon in Buckland's Bridgewater Treatise. The resemblance is sufficiently striking. The restored Iguanodon, in form, resembles iguana. Its proportions, however, are colossal. We have the ingenious and enthusiastic restorer—small in stature—on a ladder aloft on the monster's sides describing this and his other works with which he is surrounded. Like the Iguana; its back is bristly. The bristles are large and formidable as befitting the proportions of the giant. We suggest to Hawkins a ride on its back—a grin and a shake of the head. The President and I get a look into the inside. It is capacious. My friend informs me that after the work of restoration was completed, H. R. H. Prince Albert and a party of 18 or 19 dined in the interior and found sufficient accommodation. It

is named *mantelli*. In 1822, about 64 years ago, Mrs. Mantell found the first tooth imbedded in a mass of coarse conglomerate which had been brought as 'road metal' from one of the quarries of the Wealden formation of Tilgate Forest. Subsequently, other teeth and fragmentary remains were found. In 1834 Mr. Bensted found in the Kentish-rag quarries of the Lower Greensand formation of Maidstone, a connected series of bones of a young individual embedded in stone in a confused manner, flattened and distorted. We are sorry to say that subsequent discoveries have brought our *Iguanodon* into disrepute. In 1878 a remarkable discovery was made in Belgium of a deposit containing twenty-three huge *Iguanodons*. Three years were subsequently spent in extracting them and associate fishes, and reptiles. After seven years' labour two huge entire skeletons have been set up in the Court yard of the Museum at Brussels. One is the *Iguanodon Mantelli*, whose height is more than 10 feet,—its total length measured along the back is about 20 feet. In its erect position it occupies 12 feet horizontal space. Its companion is still larger. The *Iguanodon Bernissartensis* is about 15 feet in height,—measured along the back it is over 30 feet in length. In its erect position it covers nearly 24 feet of horizontal space. Thus after the space of more than 60 years the true character of these Wealden giants has been fully revealed. Its appearance, when erect, is Kangaroo-like.

At the Centennial Exhibition, Philadelphia, Mr. Hawkins erected a restoration of the *Hadrosaurus Foulkii*, whose remains had been found in the Cretaceous beds of New Jersey. This closely resembles the *Iguanodon*. It was about 28 feet in length. It was placed in the English Department, and towered over the passage between it and the Canadian Department. It was a reproduction of the restoration, with the original remains, which he had erected in the Museum of the American Academy of Natural Sciences, Philadelphia. America excels in Dinosaurs. Prof. Marsh is entitled to the honor of making known the largest number. More than thirty genera have been described.

25. The next of our Saurians in geological order are the winged Saurians (Pterosaurs or Pterodactyls). The Bat is a Pterodactyl, but not a Pterosaur. It is a mammal, while our present subjects are reptiles. Some of them are, in size, like common bats, pigmean. The restored ones on the Geological Island are eagle-like in their dimensions; the spread of their wings was probably 10 feet. They have heads, in some cases, *e. g.*, the *Crassirostris* equal to the length of the body. The mouth is armed with formidable teeth. In Kansas some have been found double the size of the largest European, 20 to 25 feet. Those on the Island perched upon a rocky projection with wings folded or partially expanded, were uncouth and monstrous. They were of Liassic and Cretaceous age. The next order of Saurians were of the Upper Chalk; they are named Mososaurs—Meuse—Saurians. They were so named, as the first one discovered was the *Mososaurus Hofmanni*. This was found at Maestricht, on the River Meuse in Belgium. The head, of which there is a beautiful figure in Buckland's Bridgewater Treatise, was there discovered. The cast of nearly an entire skull was presented to the British Museum by Cuvier, who published details of the animal in his great work, *Ossements Fossiles*. They were great snake like reptiles,—measuring from 15 to 75 feet in length. Their swimming appliances were four paddles. The head of the Belgian was about 4 feet in length. Hence their mouths were of enormous size. Their jaws were constructed something like those of the Boa Constrictor. They were thus enabled to swallow whole, animals of large size. The mouth was filled with formidable teeth. Some of these measure above the jaw an inch and two-tenths; with the root, two inches and eight-tenths, being shaped like the teeth of the Ichthyosaurus, but larger in size. The American rocks have furnished the largest of these and forty species. The question of the existence of Sea Serpents would have been readily solved in those days.

In 1862 a specimen was secured for the British Museum of unusual interest. One hundred pounds sterling was said to have been paid for it. It was a slab of limestone from Solenhofen with a very singular fossil. It had wing-feathers

and claws, and other parts like a bird, and a tail like a reptile, with two rows of feathers on opposite sides, coalescing at the end. It had not the rudder shaped bone—which is common to birds. Different opinions were entertained in reference to its character. Some considered it to be a reptile, having a very great affinity to a bird. Others supposed it to be a bird with reptilian characters. Professor Owen read a paper before the Royal Society, which settled the matter. It was demonstrated to be a bird, and the name *Archaeopteryx macrura* was given to it. The Professor's celebrated opponent was reported to hold a view different from that he entertained. A grand discussion was anticipated. The meeting was packed with expectants. The two principals agreed. The meeting was a quiet one. Many were disappointed. So my well informed friend told me.

Another specimen found in 1879 is now in the Berlin Museum. From this we find that this bird had from 10 to 12 teeth in the upper jaw and 3 or more in the lower jaw, as well as a long lizard like tail, observed in the first and three free digits in each *manus* armed with claws. The first of birds was certainly a remarkable form. We have had fishes with reptilian affinities and reptiles with bird affinities. It is but reasonable that we should have the *first bird* with something of the reptile. Among the grand discoveries of Prof. O. C. Marsh we have birds with teeth, and hence called *Odontornithes*. In his magnificent monograph on these, he gives a graphic description and beautiful restoration of the *Hesperornis regalis* $\frac{1}{2}$ size. This is a toothed bird of the Chalk (Cretaceous) Period, related to the great Northern Diver (Loon) or Penguin. An unusually large loon in the Museum is 37 inches along the back. Marsh's *Hesperornis regalis* is 54 inches. A Penguin in our collection is 22 inches in height. The *Hesperornis* is 38 inches. So that it surpasses both in size. It has 66 recurved teeth in the lower jaw and 28 in the upper. It was an aquatic bird, and is considered to be the immediate successor of the *Archaeopteryx*. Prof. Marsh observes: "Its nearest land of rest was a succession of low islands that mark the present position of the Rocky Mountains."

26. In and around the Paris Basin Sir Charles Lyell made a departure in geological nomenclature when he introduced the terms Eocene—dawn of the new ; Miocene—less new ; Pliocene—more new. These divisions were founded on the *more or less* proportion of fossils analogous and identical with shells now existing. These terms have been adopted, and are generally used in geology. French geologists, however, question “L’exactitude de ces lois,” and regard the division as purely nominal and equivalent to that which divides the Tertiary formations into inferior, middle and upper. We have used the Lyellian nomenclature occasionally in preceding Nos. As we are now farther to examine the Paris Basin, we give the above explanation, We may have occasion to use French divisions in preference, as we have already sometimes done. As we now intend to direct attention to the great physical changes which supervened. The nummulitic formations call for special consideration. We first, directed attention to their occurrence at Pont Ste. Maxence ; second, at the outside of Porte de Versailles, and third, at Meudon between the Chalk and the Lower Limestone. Higher in the Basin above what is called the “Sables de Beauchamp,” M. Hebert places another nummulitic formation which is called *superieur*, making the preceding *inferieur*. We would indicate the position of this upper nummulite zone. In No. 18 we had got as far up in the Paris Basin as the “Calcaire milliolites” of the Gentilly quarries. The next stage upward is “Sables de Beauchamp,” (the Sands of Beauchamp,) and then come the upper nummulites in question. We go to the “Gare du Nord,” the station of the Northern Railway by which on former occasions we went to Pont Ste. Maxence. We only take return tickets to the Herblay and Beauchamp Station. Reaching our destination we look around us and observe what seems to be a quarry some distance to the right—we walk to it and find it to be an old quarry. There is a bed of limtstone of some thickness and an accumulation of rubbish, largely sand. In this we find abundance of shells, *Cerithia* and *Melania* of certain species. This is the sand—Sables de Beauchamp—still it is not in position (*in situ*) and therefore not altogether satisfactory.

We observe another quarry in the middle of a field. We wend our way thither, and are much gratified with the spectacle of a fine exposure of rocks—the quarry men at work and everything fresh and clean. On the top, as at the other quarry, is a considerable thickness of soil above a bed of limestone and another solid stratum (bed) beneath. A thin bed of sand is observed between the two solid strata. We descend the quarry. With our pick we bring out the sand with its multitude of *Cerithia*, *Melania*, &c.,—all as fresh as if on the seashore. The underlying bed is found to be *gres*, of which the causeway stones of Paris are made. These are seen ready for the pavier at the top of the quarry. We consider that we have made two important discoveries, *sables* and *gres*. The nummulites are not found here associated with the Sables de Beauchamp. M. Hebert, however, reports sands as occurring elsewhere having the characteristic shells of these sands at Diablerets, Nice, Biarritz, &c., with overlying nummulites (*superieur*). We have thus indicated their position in the Paris Basin. These investigations were in themselves very interesting. They are of very great interest and importance in their relation to the formation of the mountain systems in which we have found the nummulites forming so prominent a part. The representative system is that of the Pyrenees.

It is subject of contention with geologists, whether the elevations took place *after* the formation of the lower or upper nummulitic deposits of the Paris Basin. We are disposed to agree with Elie de Beaumont, Hebert and others, in holding the latter view, and in considering the middle or upper Eocene to be the Period when the (nummulitic) Cretaceous and Jurassic formation of Europe, Africa and Asia attained to their lofty positions as well as humble, subaërial.

We regard this as *essentially the great mountain forming "Period of the Earth's history in both Eastern and Western Hemispheres,"* and regard the past as "Before the mountains were settled, before the hills were brought forth. While as yet He had not made the earth nor the fields (open places, *margin*) nor the highest part (chief part, *margin*) of the dust

of the world." Prov. viii. 25, 26. (Wisdom). Before the mountains were brought forth. Ps. xc. verse 7. (Moses). In like manner we view the Period of the Earth's History which we have reached, as that when God said, "Let the waters under the heaven be gathered together into one place, and let the dry appear." And God called the dry, Earth, and the gathering together of the waters called he Seas. Gen. i. 9, 10. (Moses). According to Elie de Beaumont, the principal chain of the Alps (and Himalayas) attained to their highest elevation somewhat later, *i. e.*, at the close of the Tertiary Period or Upper Miocene, or Quaternary (glacial).

27. We return to Egypt and look at the Cretaceo-nummulitic heights of Mokattam with new interest. We can now answer the question, "When were these elevated? In the Middle Eocene Period, according to Beaumont. How were they elevated? By the contraction of the Earth's crust consequent on the secular cooling of the globe. In preceding observations mention was made of an interesting collection of cretaceous fossils of Mount Lebanon, received from Dr. McHargie, formerly missionary at Damascus. No. 20. Since then we have found in *Nature*, April 22, 1886, "Across the Jordan," by Gottlieb Schumacher, C. E., reviewed. In this we find the Geology of the district compared with that of "Central France." The limestones are described as "Cretaceo-eocene" and "Cretaceo-nummulitic." *Vide Table*. The movement and denudation of the strata took place in the "Miocene epoch." The last observation differs from our own to the extent that the age of the "Sables de Fontainebleau" differs from that of the "Sables de Beauchamp." This difference will be better understood after the Geology of Montmartre in Paris is described in next No. In the same part of *Nature*, April, we have an account of a very interesting Paper by Starkie Gardner, read before the Geologists' Association, April 2. In Proceedings of the Geologists' Association, Vol. IX., No. 6. An inquiry as to the Geological period at which grasses first commenced to assume a preponderating position in vegetation. Their value and importance at the present day

was first sketched. The conclusion arrived at was that there was no great development of grasses until the close of the Eocene, while the Miocene beds all over Europe are crowded with them, page 574. This surely corresponds with the order of the Biblical Record, Gen. i., verses 11 and 12: Let the Earth bring forth grass, the herb yielding seed, &c. We are again in Paris. Its Eocene formation is now becoming familiar to us. We would now examine the high places of communism in the North of Paris—Buttes Montmartre, Buttes Chaumont and Pere la Chaise. Here we have, in the last, a Necropolis of the present; in the first a Necropolis of the past, and in the middle a place which was once notorious for its ugliness, with its excavations, the dens of robbers and haunts of vice. In Pere la Chaise lie entombed the mightiest and the lowliest of “la Belle France.” Montmartre is celebrated as the tomb of Earth’s earliest mammals. Buttes Chaumont is now remarkable for beauty and grandeur. Its heights and hollows, its grottoes low and lofty, the latter with their ceilings adorned with great stalactites and refreshed in summer heat with artificial waterfalls, its serpentine streams and tortuous pathways, contribute to form one of the most attractive resorts of pleasure-seekers and tourists. The same Geological formation, middle Eocene, nearly comprehends all the three. Pere la Chaise in its newly opened graves reveals beds of gypsum marls. The cliffs and rocks of Buttes Chaumont are formed largely of limestones with Calcaires de Brie. Gypseous marls, clays and gypsum constitute the heights of Montmartre capped with Sables de Fontainebleau of Lower Miocene age. Beaumont’s elevation of the Isle of Wight, Montmartre, &c., seems to correspond with that of Lebanon, according to Schumacher. The Isle of Wight, Montmartre and Lebanon would be simultaneously clothed with grass, &c., according to Starkie Gardner’s observations. We will have occasion to make further remarks on Eocene and Miocene vegetation, in the sequel.

28. We are at the foot of Montmartre—making a reconnaissance of it. It appears smooth, comparatively, all round.

No rocks appear outcropping. We must see them if they are to be found. In an obscure and *unsanitary* corner at its base, in the vicinity of old houses, we observe something like rocks, picking our steps we reach them. Our pick shows them to be gypsum,—true Plaster of Paris. This is perfectly satisfactory, we know our geological position, we are on the same horizon as we were in the vineyards of Herblay near Beauchamp. We are geologically *above* the Sables de Beauchamp, and the “upper Nummulites,” the Calcaire (limestone) de Saint Ouen, the marnes (marls) *with pholadomya ludensis*, and the Travertin de Champigny. Standing at the foot of Montmartre we stand geologically higher than if we stood on the lofty nummulitic Peaks of the Pyrenees, the Alps or the Himalayas (*Vide* preceding Nos.) We now climb the hill in search of other deposits overlying the gypsum. High up we find clay or marl exposed by a recent rainfall. In this we have a prize—a bed of pigmean oysters. These measure from $1\frac{1}{4}$ to $1\frac{1}{2}$ inches in width and $1\frac{1}{4}$ to $1\frac{3}{4}$ inches in height. They have unusually long bills, and hence are called *ostrea longirostris*. The stratum of clay is about 3 feet thick. We have missed what comes between this and the gypsum. The missing is well developed at Buttes Chaumont. It is called Calcaires de Brie Meulieres. This supplies the Bahrstones—millstones, so much prized by flour millers of Canada and elsewhere. These millstones are replete with *Charae*, aquatic plants which have all the simplicity of *algae*. They emit a fetid effluvium which is said to cause the malaria of the Campagna of Rome, where these plants abound. The Calcaires de Brie is “a fresh water formation.” Higher up the hill, above the oyster bed, we find a yellow marl which is full of the casts of *sea-shells* having *Cyrena convexa*, *Natica crassatina*. These with the oyster shell marls are “so-called” Sables de Fontainebleau. The gypsum which constitutes the principal rock of Montmartre is a hydrous sulphate of lime, *i. e.*, it contains a certain quantity of water. It can be scratched with the finger-nail. Its texture is crystalline lamillar, fibrous, granular, saccharoid, &c. Its colour is generally white—of this was made the original “plaster of Paris.”

Sometimes it is coloured with oxide of iron, which stains it yellow. The gypsum is sometimes mixed with lime, marl and clay. Ordinarily three beds of gypsum are distinguished separated from each other by white, yellow or greenish marls. The upper bed contains the greatest number of animal remains. A few fresh-water shells have been found in it, such as *Lymnaea*, *Planorbis*, *Cyclostoma*. It is most largely developed about Paris, Montmartre, Pantin, Ivry, and in the department of Seine and Marne and about Chateau-Thierry. Animal remains of course presuppose the existence of animals. When did these animals come into being? Our geology cannot fix a date; how long they lived and when they died are also uncertainties. Many of the animals were vegetarians. In the economy of nature the food supply generally anticipates the consumer. The written record of Creation reveals this arrangement. The Geological seems to indicate the same.

29. In our rambles around Paris we often looked at a lofty iron tower of considerable height, which we found out to be the celebrated Artesian well of Grenelle—from which is derived a very considerable part of the water supply of the city. The supply from ordinary sources being inadequate, M. Arago, the Astronomer and Geologist, in consultation with other Geologists, came to the conclusion that owing to the character of the Formations of the Paris Basin and their arrangement, a store of water might underlie the city at a great depth. They inferred the existence of the Lower Cretaceous Greensands under the Chalk. This outcropped at the edges of the Paris Basin underlying the Chalk at distances of 60 or 80 miles, e. g., in the Champagne district. It was supposed that if this should extend under Paris, the distant rainfalls might thereby be brought so as to be reached by the Artesian process of boring. He therefore urged the government to make the attempt. This was about the year 1834. The work was then commenced. Eight years were spent in boring; difficulties, discouragements and delays protracted the work. Arago's influence, nowever, prevailed. At length in 1841 this scientific auto da fé triumphed. At the depth of

1798 feet the Greensand (Lower Cretaceous) saturated with water was reached, the boring rods sunk a few rods, a shock was felt, accompanied by a whizzing sound. A jet of water spouted to the height of 118 feet, and discharged 600 gallons per minute. Subsequently a like well was made at Passy, having a depth of 1923 feet. It discharges 5,582,000 gallons a day. A plentiful supply of water, having a temperature of 82 Fahrenheit, from the Greensand of the basin, was thus secured. We now go to what is called the "London Basin." Formations co-temporary with those of Paris, constitute the rock system of this basin. The "London Clay" here chiefly occupies the place of the Clays, Limestones, Sands and *Gres* of the other basin to which attention has already been directed. It overlies the Chalk and Greensands in the same way. The latter occur at from 15 to 30 miles distance from London. The clays are therefore considered also to be of Eocene (dawn of the new) age. London has many Artesian wells, furnishing its chief water supply. I only specify two. One supplies the fountains of Trafalgar-square; another is in the Horticultural Gardens, South Kensington, supplying the Ponds and other requirements of the Great Exhibitions. The colossal statue of H. R. H. Prince Albert is near this well. These wells penetrate the London Clay: the underlying Chalk is "riddled" with them. As at Paris the Lower Cretaceous Greensand below chiefly supplies the water. The unsurpassed sewer system of the city is under great obligations to the London clay formation, and so is the underground (city) Railway.

The Island of Sheppey at the mouth of the Thames is formed of the London Clay. Although I have not had an opportunity of examining this locality it seems quite familiar to me, from conversations with my late lamented friend, Prof. Tennant, and the interesting *conversazioni* at Highgate in the great museum of the late Dr. Bowerbanks. Here were stored up a large and interesting collection of the fossil "Tropical fruits of Sheppey," which the Doctor delighted in describing to us, his interested listeners. These descriptions are recorded in his book "On the fossil fruits of the London Clay." The same clay has produced the remains of the *Coryphodon eocenus*

—a vegetarian, an eater of tropical fruits, his teeth tell us that this was his character. Owen says "He resembled the Tapir. In size the ancient British Tapiroid quadruped must have surpassed the largest Tapir of South America or Sumatra, by one-third. The remains of this Coryphodon were dredged up from the bottom of the sea between St. Osyth and Harwich on the Essex coast. There is no doubt as to the fossil having been originally imbedded in the Eocene tertiary formation of the Harwich coast." We will indicate his old sphere of action in another No. (36).

30. At the Fisheries Exhibition preparations were being made for an international *fete* in celebration of the "Silver Wedding of Her Majesty's eldest daughter, the Crown Princess of Germany." We then received an invitation from Sir James Maitland to visit his celebrated Howieton Fisheries near Stirling, Scotland. There was some difficulty in the way of deciding whether to remain at the Exhibition and witness the *fete*, or to take a pleasure trip to the "Land o' Cakes." I had been present at many great *fetes*, but I had not been in my native land for 17 years. I therefore accepted the Scottish Knight's kind invitation. Accordingly, at the appointed time, or rather before it, as it is my wont, I was at Euston Square Railway Station. Here were twenty gentlemen,—English, Scotch, Irish, Canadian, Australasian, American, French, Norwegian, Swedish. Two palace cars are engaged. The arrangements for our comfort and enjoyment provided by our noble host are princely, beginning, middle and end. I would here observe before starting that I have already gone along the road between London and Liverpool five times in daylight observing the geology with a good geological map: so that I can indicate the formations as they occur at any time—day or night. I would farther notice that in the Nos. proceeding as far as 18, we have been generally "ascending" as Geologists term it, going from the older to the newer. *Vide* Table. As we proceed from London to Liverpool we are "descending" or reversing the order. We start on the London Clay. At the Williston junction of the city and London and Liverpool railway we

come to the Chalk. We have light enough to see this. With moonlight we pass through the Cretaceous. Before reaching Rugby, of educational and ecclesiastical fame, we come to the Jurassic. The layers of rock distinctly show this. We have come to the Ammonites (snake stones) and Eocrinites (St. Cuthbert's Beads) of No. 14. An extensive museum collection presented by the late Mr. Wesley, marble worker, illustrates these formations. Farther on, we have Triassic, Permian and Carboniferous in varying order all the way to Liverpool. We now take a short sleep; at daybreak, we raise our blind and find that we are at Kendal. Our map informs us that we have passed the boundary of the formations on which we had entered before we went to sleep. We are now going through the Silurian and Cambrian formations of Westmoreland and Cumberland corresponding with Nos. 2, 1, 3, 4, and on "ascending" we pass through Carboniferous limestone, Permian and Triassic of the latter, and reach Carlisle. The New Red Sandstone or Triassic through which we have passed is remarkable for its Gypsums and Rocksalt. This led the earlier Geologists of Nova Scotia and Cape Breton into error by which they connected the Gypsums of Nova Scotia in all cases with its Triassic. Other Sandstones of the Carboniferous formation, especially in Cape Breton, in association with its Gypsums were thereby referred to the New Red Sandstone or Triassic. It was afterwards proved that our great beds of Gypsum in Nova Scotia and Cape Breton were of Lower Carboniferous age, and that only certain small quantities of Gypsum as at Blomidon and Five Islands were of Triassic age. We breakfast at Carlisle.

31. We leave Carlisle, cross the border, and are in Scotland. We recall to mind the first time when we crossed the border, in 1843. We were travelling to Carlisle in the old mail coach, and sitting beside the driver. Before crossing the line, he said to me, "You are in Scotland." Immediately after, "You are in England." Now, however, no one indicated the exact line. It would have been no easy matter to do so, as we could not even make out the names of the stations

as we passed. Gretna Green, we certainly noticed, celebrated for its runaway marriages. We stop at "Ecclefechen." We step out on the platform and stand on "Old Scotia" after an interval of 17 years. A thrill pervades our nervous system—magnetic. Ecclefechen is celebrated as the birthplace of, at least, one giant—in literature—Thomas Carlyle. We now career through Lockerbie, Moffat and Leadhills. The Geological Formation is Lower Silurian. Moffat rocks are known to us by their Graptolites. They resemble the Nova Scotian of Arisaig and Wentworth in the Cobequid Mountains (4, 8) at Isle Royal, Quebec, and the Utica Slates above the Trenton Limestone at Ottawa. We find this by comparing specimens from Moffat and all these localities, in our Museum. We cross the Clyde, not far from its source. We traverse Carboniferous Limestone and Coal-fields, and arrive at Stirling, the junction of the Carboniferous and old Red Sandstone. We intermit our Geology. Carriages are waiting us to take us to Howieton. We drive through Stirling amid no small excitement in the quiet old town. We pass through Bannockburn, noticing by the way the place where the binner of Bruce was stationed. We reach Howieton and receive a hearty welcome from Sir James Maitland. Each of us is accommodated with a bedroom. Shaking off the dust of our journey we meet in the drawing room, and are introduced to Lady Maitland and lady friends. A dejeuner is prepared for us on the lawn. We recline around and dispose of the feast. Sir James and the commandant of Stirling Castle, arrayed in a "garb of old Gaul," preceded us for the inspection of his long series of extensive artificial ponds for fish breeding. These are all connected. The first series contain young salmon and trout which have reached their third year. Here was a beautiful and interesting spectacle. The attendants were called with a supply of food. It was thrown into the pond. Before, not a fish was to be seen; now, all was life—the fishes leaping out of the water in all directions to catch the food ere it fell into the water. A scoop net was used to catch some of them. Such beauties in size and form! We went from pond to pond and at last reached the hatcheries at the foot of a hill from which flowed a beautiful cool stream

deeply shaded with the woods. This flowed into the troughs having their eggs, the overflow going to the ponds. After a thorough examination of the Fisheries we adjourned to a part where excavations were in progress in extension of the ponds. Here Lady Maitland and other ladies had a collation all ready for action. We were quickly seated and sumptuously treated. We afterwards took a parting look of the ponds. It was not a place to be hastily quitted. At night we were set down to a banquet where we feasted on viands and speeches until we separated for the night. I supplement, with the remarks made by J. Barker Duncan in a Paper read before the Scotch Fisheries Improvement Association in November, 1844, Howieton Fishery. "This Fishery belongs to Sir James Maitland, Stirling. It was commenced in 1873. From year to year it has extended and perfected, so as to have gained a world-wide reputation as a fish-breeding establishment. Upwards of ten millions of trout ova are now annually incubated at this fishery. Last season no less than 90,000 yearling trout were delivered from it to all parts of Great Britain and Ireland. Yearlings are recommended to its customers as the size for general purposes; they are strong enough to find their food, thus avoiding the principal cause of mortality among fry, starvation. Two-year-olds are recommended where coarse fish or large trout already exist in the water.—*Bulletin of the United States Fish Commission, 1885.* Two consignments of trout ova and one of salmon were also forwarded successfully to New Zealand. Lochleven trout is the specialty of the fishery. American brook trout and common trout are also extensively cultivated. Every twenty-four hours about one million gallons of water flow through the pond system which secures thorough aëration."

32. Still in Howieton. In the morning before breakfast we take a look at the Geology of the district. We go to the elevated ground. The botany is lovely. Rhododendra in greatest profusion, and full bloom all around; on the road side rocks are outcropping—they are crystalline rocks—trappean, volcanic. Other rocks are also seen—they are sandstones. Are they Carboniferous like these traversed to the East on our

way to Stirling? Our geological map, Murchison and Geikie's, inform us that they belong to division C. They are therefore Upper Old Red Sandstone, or Dura Den Yellow Sandstones, etc., of the Kingdom of Fife. They are therefore our "Native Rocks," and the Trappean correspond with those which furnished the Scotch Pebbles, plowed up in our fields, which we delighted in collecting in boyhood. It appears then, that the adaptation of Howieton to its Fisheries, is deprived largely from its intrusive—igneous—Dolerites. We are hailed by other members of our party, Dr. Day and others, who are collecting plants. After dejeuner, we mount carriages to visit Stirling Castle. We come to Bannockburn; we call a halt to examine a stone called the Bore-stone, which was pointed out to us on the preceding day, as where the Bruce stood on that memorable day, in the year 1314—569 years ago, when with 30,000 men he overthrew the host of Edward II., king of England, numbering 100,000, and secured Scotland's freedom. We stand on the stone and examine it. The stone is probably a slab of Old Red Sandstone. We did not chip a piece of it with our hammer—an act of self-denial. Not many of our party had sympathetic feelings. Amid excitement and cheering of boys, who enjoy and scramble for the *largesse* of pennies and half-pennies, we drive up the old town and enter Stirling Castle. Entering the square, we enquire for the commandant, Sir James Maitland's companion of the preceding day, who willingly takes us in charge. We have no difficulty with door-keepers—all is free. We are taken to the officers' mess room, at the top of the Castle, where the general visitors have no admission—we climb through a narrow way to the roof, and view the glorious panorama, a scene in extent of beauty and grandeur not to be surpassed. Of course, we examined the Palace and rooms; we have now no distinct recollection, as we were more impressed with the exterior than the interior. The only room which we can bring up before us, is the Douglas room, where the Douglas was murdered by the King, and where mementoes are sold to visitors, of which we purchased one. The only object of great interest in it to us, is John Knox's rude oaken pulpit, which we, of course, mounted, as we

had done when a student, another of his pulpits in our *alma mater*, St. Andrews. The Trappean eminence on which the Castle is built was not unnoticed. The rocks were inaccessible from where we stood. Its grotesque sculptures in bold relief on its walls in the square were subjects of remark, and made no favourable impression of the moral character of the age when the Castle was erected. The style of architecture is "Renaissance." The foundation rocks outcrop in the square. Having visited other places of interest connected with the Castle or otherwise, our party separated, some returning to London, others to Howieton. Having partaken of an early dinner,—some of us return to Stirling. We then proceeded to Glasgow and the mouth of the Clyde to visit our friends. A week later found us early in the morning at the border of the London Basin, the Chalk of the Williston Junction, and finally at Euston Square on the London Clay. When members of our party again met at the Exhibition all agreed in expressing greatest esteem for Sir James and Lady Maitland, and in admiration of the Howieton Fisheries. At the International Fisheries Exhibition in Edinburgh, in 1882, Sir James Maitland received a gold medal for fish culture apparatus, and a silver medal for live *salmonidæ*. The Société d'Acclimation, of Paris, also awarded him its gold medal. If our party were called upon to act as Jurors, we would certainly award them the highest honors.

33. In our last No. we gave due prominence to the "Bore-stone" of Bannoekburn. We are reminded of another remarkable stone, the Scotch "Stone of Destiny." When we visited Westminster Abbey our attention was directed to the "Coronation Throne." In it we observed this historical stone. King Edward the First, when he invaded Scotland, found it in the Abbey of Scone. It was then enshrined in a chair or throne, on which the Kings of the Scots were wont to be crowned. Its legend was, that it was the pillow on which Jacob reposed when he saw the vision of the angels ascending and descending the ladder, and that it was brought over by Scots, that daughter of Pharaoh from whom the Scots line of

monarchs was descended. It was regarded as the "palladium of Scotland." A prophetic couplet announced that wherever it might be placed there would the Scots be supreme.

"Ni fallat fatum Scoti, quocunque locatum
Invenient lapidem, regnare tenenter ibidem."

This prophecy seemed to have a fulfilment when the monarchs of the House of Stewart sat on it to be crowned in Westminster Abbey as monarchs of Great Britain. It is said to be a block of limestone. A chip with a hammer might reveal whether it is of Cretaceous-limestone of Bethel, or Carboniferous limestone of Scotland, or even Ireland, and effectually dispose of the legend of its history. It is not likely, however, that it will be subjected to this process. When we went to Scotland we descended in the London Clay, and reached the bottom of it when we arrived at Williston Junction, as if we had gone down the Artesian Well at the Fisheries Exhibition, and certainly much more easily, (as the latter mode of descent is of course impracticable) and we as certainly came up when we returned to London. We propose to make a similar descent and ascent to make you accustomed to such geological processes. Our next descent in the London Clay thus occurs: The Executive Committee, of the Fisheries Exhibition, have invited us to a pleasant excursion up the Thames, above Maidenhead, as far as Medmenham Abbey. They have invited Foreign and Colonial Commissioners, and others. At the time appointed, we assemble at the Paddington Station, of the Great Western Railway, on the London Clay. Thence we proceed by railway to the Taplow Station. Carriages are in waiting to take us to Maidenhead. I am accommodated with three others. One is a fellow-excursionist to Howieton, another is Lindley Sambourne, the "artist of *Punch*," the third is the pyrotechnist of the Crystal Palace, three very pleasant companions. We arrive at the Thames at Maidenhead, and have passed through (down) the London Clay and reach the Chalk. We are also in the neighborhood of Eton. We are to have a Reception at Maidenhead on our return. A steam-launch is waiting to receive us. It is gaily decorated with international flags flying

from stem to stern. The name of our boat is the *Beatrice*. A smaller launch accompanies to supply sufficient accommodation, and for other purposes, another *Beatrice*—a big and a little.

34. We sail up the Thames lock by lock, stage by stage, admiring the beautiful scenery on either side and before us. While we are in the locks, with the water rising to the level above, our attention is directed by Dr. Day and Mr. Ramsay of New South Wales, to beautiful specimens of fresh water sponges—*spongillae*—which they are collecting from the sides of the locks. We are interrupted in our admiration of the scenery by the invitation to luncheon. However, if we should miss any beautiful sight, we may make up for the loss on our return. We pass Cliveden, a residence of the Duke of Westminster, and at length reach Medmenham Abbey. Referring to Dickens' Dictionary of the Thames, we find that we are $60\frac{1}{2}$ miles from London by the river, or $10\frac{1}{2}$ miles from Maidenhead. We are in Buckinghamshire. The monks of Medmenham had for their motto, "*Fay ce que vouç. ras*," as it appears over a door way at the Abbey. A free translation of this is, Do-as-you-like. The accessibility of the Abbey, the loveliness of its surroundings, and its interesting historical associations, make this a favourite resort of tourists, pleasure seekers, excursionists and picnic parties. These appreciate the hospitable look of the motto, and accept of the gracious invitation to make themselves free and easy, probably more so than the ancient proprietors of the Abbey would have done. Our excursion party was certainly no exception. Except an ancient archway and a single pillar of the church there is little of the ancient abbey to be found in the present edifice. It stands in so beautiful position and commands such lovely views, that its present artificial appearance will be readily forgiven. On entering the Fisheries Exhibition a picture—an oil painting of considerable interest—attracts attention. The subject is the Monks of Medmenham fishing on the Abbey point. There are fine roach swims all the way up this reach. Returning we came to Cliveden. As the Duke of Westminster had kindly given us

permission to visit and view the mansion and grounds, we landed and availed ourselves of our privileges. Ascending the beautiful covert way, arched with trees, at the top we behold the extensive array of terraces and gardens. After a walk through the gardens and on the terraces, and a survey of the panorama of the Thames as far as Windsor Castle and beyond, we enter the mansion. Attention is directed to the splendid pavement of Staffordshire tiles in the entrance hall, Minton's present to the late Duchess of Sutherland in return for patronage and encouragement of the celebrated potteries. The library is inspected and art treasures admired, especially the ancestral and other family sculptures and paintings of historic interest. A number of aspirants ascend to the top. We are contented and satisfied with what we can see with less effort. A German professor and I direct our attention to the geology of the heights. Amid the profuse vegetation we observe a corner having an outcrop, showing Chalk with flints. We are in the Cretaceous formation underlying the London Clay and other beds. We reach the foot of the covert way on the side of the Thames and wait for the gathering of our party. His Grace apologizes for his absence, and regrets his inability to entertain us personally.

35. We have assembled once more. We are invited to partake of a little refreshment after our arduous work (?). Looking around to see that all is right, we observe first of all our gaily decorated big "Beatrice" ready for our embarkation—little "Beatrice" has mysteriously disappeared. Looking over our party, its numbers are diminished. Their presence seems to be required in advance. Certain knowing ones decline to answer inquiries. It appears that our movements have been watched from the opposite bank of the river. Two gentlemen appear and politely request us to arrange ourselves in a group beside our launch. Here we are English, Scotch, Irish, Russian, Austrian, French, German, Dutch, American, Australasian, Canadian, Swedish, Norwegian, Chinese and Japanese, &c. Being brought to order, a photographer points towards us his Camera. This over, we embark and make a

start—still a hindrance. The photographers having established themselves on the opposite side of the river, politely request that our launch lie across the river, which it nearly spans. Arranged, we are called to order. In an instant the picture is taken. Two beautiful photographs with the lovely scenery up the river, in the background. Precious mementoes of our pleasant excursion and international intercourse and companionship. We sail down the Thames admiring the ever interesting and changing scenery. The graceful swans and other aquatic birds engage our attention and the passing gondolas, boats and canoes with their pleasure-seeking or utilitarian parties. We pass through the lock obstructions, and at length reach Maidenhead. At Skindle's Hotel the Executive have provided a sumptuous dinner. We are introduced to the mayor of Maidenhead who appears in his robes to give us a welcome reception. We sit down to dinner—the mayor presiding. After the feast we have speeches. It is now dark—the shrubbery in the front of the hotel is lighted up with Chinese lanterns. Barges are moored in the river in front. Our companion, the pyrotechnist of the Crystal Palace, commences operations, and for more than half an hour he displays the wonders of his art illuminating the beautiful scenery of the Thames with unsurpassable brilliancy and splendour. Our delightful excursion terminates, we enter our carriages and return to the Taplow railway station; we “ascend” the London Clay and reach the Paddington station, and finally our home. It was pretty late or rather early, but then we have given a good account of ourselves. On the following morning we received in a befitting manner the condolence of our friends and colleagues, with regrets that we had had such bad weather, as it had rained steadily and heavily—in London.

HALIFAX, June 23rd, 1886.

I have just received a circular from the Geologists' Association, London, inviting me to an “Excursion to Pinner and Reckmansworth on Saturday afternoon, June 26.” Directions given: Leave Baker Street Station (Metropolitan Extension) by the 1.59 p. m. train, due at Pinner at 2.34. Time 35 minutes. Walking from Pinner to Reckmansworth along the line in course of construction there will be

found, first, London Clay; second, Woolwich and Reading Beds; third, Chalk. The second beds may or may not be wanting, elsewhere. As I am an Honorary Member (since 1862) I receive invitations to all excursions.

36. We propose to avail ourselves of another Fishery Exhibition Excursion in order to make a farther advance upward in our geology and at the same time to add a possible charm to details, which to some may be requisite. This excursion preceded the last in order of time. Geological sequence which we regard of first consequence, calls for this transposition. *Vide* Table. The invitation is to the Executive of the Fisheries Exhibition and Foreign and Colonial Commissioners from "A Committee of Norfolk and Norwich gentlemen interested in Inland Fisheries, for a day's excursion on part of the rivers and broads of Norfolk, W. Oldham Chambers, Secretary." According to directions we assemble at the Liverpool Street Railway Station at 7 a. m. As on previous excursions we start on the London Clay; proceeding onward we continue in the same formation until we reach Harwich. This is not the first time that we have gone thus far. In 1862 Professor Tennant and I visited Harwich, and then sailed up the harbour and river to Ipswich. A fossil turtle in our museum, dredged from the London Clay of Harwich Harbour, was then secured. This was one of a number which were offered for sale by a collector. Professor Tennant purchased a larger one. The largest specimens were too ponderous. My specimen is concretionary. They are found in stones which are dredged for the manufacture of Roman cement. Our concretion is perforated by the Mollusc *saxicava*, like many of the stones dredged in our own harbour and coast. This locality is remarkable as the habitat of the *Coryphodon eocen*, our first fruit-eating mammal of a previous note (29). In the proceedings of the Geologists' Association of London just received, our attention is directed by E. T. Newton to Croydon, on the south side of the London Clay. Our present position is on the north side. In this other locality in the estuarine beds a bone of *Coryphodon* was also found. In the search for other remains a

leg-bone of a large bird has been found (a tibio-tarsus). This, when perfect, is supposed to have been 23 inches in length. It has been compared with *Dinornis crassus*, one of the recent gigantic birds of New Zealand. Attention will be directed to our museum collection of these in a future number. It is also compared with another gigantic eocene bird, found and described by M. Hebert in 1855. It was found in the Eocene "plastic clay" of Meudon, and named *Gastornis parisiensis*. The Croydon bird has been called *Gastornis Klaasseni* in honor of its discoverer, Mr. Klaassen. They are supposed to have been wading and swimming birds. Dr. Victor Lemoine, from an examination of numerous remains, has been led to conclude—that *gastornis* probably attained to a height of eight feet. Sir Richard Owen has described three bird's remains of very great interest from the London Clay. The bird has been named *Argillornis* (clay bird) *longipennis* (long winged). It was a fish-eating (serrated or tooth-billed) bird larger than the Albatross.

37. Reaching Ipswich, we had reached what is called the Crag (Suffolk and Norfolk); the Pliocene, which lies above the London Clay. This is its proper geological position. Proceeding we *descend* into the London Clay, and then again into the Chalk. Advancing we approach Norwich, we then *ascend* from the Chalk into the Crag without meeting the London Clay. It is missing, making a "break in succession." We reach Norwich. Here we have a great accession to our numbers. The mayor of Norwich and other gentlemen who invited, gave us a hearty welcome. It is a gala day. Flags and Welcome to Norwich greet us. A special takes us to Wroxham. A luncheon is provided, of which we partake. We then go to the Bridge and River Bure, where a fleet of steam launches are in waiting. We embark. Ours is the *Caledonia*. The owners are with us, Messrs. Harvard & Son, of Norwich. The founder of Harvard College, Mass., was a relative. We are in the Bridge Broad. As we happen to be the farthest up in the river we are about the last in starting. The mayor's launch leads the way. Coming to Wroxham

Broad, where we have plenty of room, the *Caledonia* offers a tow-line to one, and then another; the last will be first. Mr. Towse, our leader, stands beside the engineer and stoker urging to increasing speed. The most noteworthy spot we come to is St. Benets' Abbey, situated on the left bank of the river, about 10 miles from our starting point: "Once upon a time, it must have been a mighty building, covering much ground, as its scattered ruins testify. Now nought reminds us of its founder, sensible King Canute, (*Vide* Canute and his courtiers on the seashore) but a fine archway with some contiguous walls, upon which a windmill has been erected, but which is now itself in ruins, and two massive parallel walls standing about 200 yards to the eastward; also there are two arched doorways and strong walls in the house by the river side whose cool recesses speak of ancient days," (C. Davies). This having been duly inspected we return in the same style as before. The mayor's launch only is beyond, and etiquette forbids; we slacken our speed. "It is somewhat difficult to analyse the charm which the "Broad" Districts of Norfolk and Suffolk has for those who have once made its acquaintance, in the only way in which an intimate knowledge of it can be gained. In a journey through it by rail, you see nothing but its flatness! walk along its roads you see the dullest side of it; but take to its water-highways, and the glamour of it steals over you, if you have aught of the love of nature, the angler, or the artist in you. One reason may be that the rivers are highways. From them you view things as from a different standpoint; along them flows a current of life differing from that on either rail or road. Houses are few and far between; within the circle of your sight there is neither house nor man visible. A grey church tower, a windmill, or the dark brown sail of a wherry in the distance breaks the sense of utter loneliness, but the scene is wild enough to enchain the imagination of many. Long miles of sinuous gleaming river, marshes gay with innumerable flowering plants, white sheets of water bordered with swaying reeds; yachts or wherries, boats, fish, fowl and rare birds and plants, and exquisite little bits to paint and sketch: these are the elements out of which a pleasant

holiday may be made. From Yarmouth, looking inland, three main water-highways radiate. The chief is the Yare, flowing from the westward; then comes the Bure, flowing from the north-westward, and having her large tributaries, the Ant and the Thurne, flowing from the northward. From the south-west come the clear waters of the Waveney. All these rivers are navigable for considerable distances, and on the Bure and its tributaries the greater number of the Broad's are situate. These Broad's are large shallow lakes connected with the rivers, and are most of them navigable. Flat marshes follow the lines of the rivers, and while higher and well wooded ground rises near the upper positions of the rivers, near the sea the country is perfectly flat, and vessels sailing on all three rivers are visible at the same time. There are no impediments to navigation of any consequence, so it may be imagined what a "happy hunting ground" this is to the boat-sailor, the naturalist and the angler. See Davis' Handbook of the Rivers and Broad's of Norfolk and Suffolk, with map presented to the Foreign and Colonial Commissioners of the great I. F. E. by the publisher.

38. The exit of these waters is at Yarmouth. At the distance of 20 miles by water there is an ebb and flow. This strange country is not beyond the possibility of a sudden visit from the sea. No! these light-coloured mounds in the distance are the sea banks of sand, only held together by scanty marram grasses. These sandhills form a very curious barrier between the salt and fresh water. Breaches have been made in them by the sea from time to time, notably in the winter of 1791 when a very high tide made several gaps, and threatened to overwhelm the marshes inland. The whole district is included in the "Crag formation" of Geology and Miocene and Pliocene (Lyell) which precede the Glacial. Its material is generally loose and incoherent. The want of solidity in its strata, which are sands and clays, accounts for the flatness which we have seen to be characteristic of the region. We shall have occasion, at the proper time, to return to these peculiar formations of Norfolk and Suffolk (45). At the close

of our delightful sail on the river Bure and its Broad's we find ourselves in Wroxham, and the closing scene of our visit. In the long and wide tent where we had our luncheon in the morning a sumptuous dinner covers the table. We take our seats in prescribed order. Our sail has prepared us to do justice to the viands. Fish (of the Broad's) have a prominent place in the Bill of Fare, as fishes have in all our I. F. E. dinners. The indefatigable and ingenious Secretary, W. Oldham Chambers, presents each guest with "a Bill of Fare" in the form of a Pike (fish) of the Broad's which we are to take to our homes as a souvenir of our visit. We eat and talk, having a member of the Executive on the right and a brother commissioner on the left. The talk all around makes as much noise as in a spinning mill. A select trio of gentlemen vocalists is provided to give relish to the entertainment. They certainly performed their part well. Godfrey's band or H. R. H. the Duke of Edinburgh's piper, however, would have commanded more attention. After dinner came a sufficient number of toasts and complimentary speeches. The hour of departure arrived. Our special train speeds on towards London, leaving our entertainers and others at Norwich and Ipswich. Amid all the stir we cannot help thinking about the Geology of the way, especially that of Ipswich, which as you know we have already visited under more favourable circumstances. Here the so called "Red-Crag" is found resting on the London Clay, being seen in interesting sections on the sea coast at Walton on Naze. Here the fossils of the formation are collected in abundance. These show that the formation is marine. The admirable museum at Ipswich is rich in these fossils. We secured a small collection of representatives; we specify the gasteropod *Fusus contrarius* (a reversed variety), found in the Mediterranean and on the coast of Spain (Woodward). In our Museum we have a considerable collection of the fossils of Walton on Naze, containing many *Fusus contrarius*—large and small—old and young, presented by the Prince of Mantua and Montferrat. Ipswich was the birthplace of Cardinal Wolsey. In the Challenger dredgings presented to the Museum by the late Sir C. Wyville Thomson,

we found a great many tiny shells of the shape of *Fusus contrarius*, a Pteropod, not Gasteropod. Arriving at London we reached our centre at an early hour—wearied, but highly gratified with the day's excursion.

39. From London we would go to China. Our Museum collections enable us to perform this feat. The contributor is Mr. John Graham, now of China, formerly of Halifax. We would examine them in geological order. We have first granites and coal. According to the analogy of Egyptian Geology we regard the granites as of Archaean age, and the coal as of doubtful age. Our first account of the granites received from Mr. Graham was rather startling. He informed us that there was a bridge in China having in its structure blocks of granite 75 feet in length. As he was informed that I was rather incredulous he had a photograph taken, which is now in the Museum; he also sent me specimens of granite. This bridge is certainly in analogy with the structures of Ancient Egypt. How the stones were brought into their present position is certainly a Chinese puzzle. Our other collections are from the Island of Formosa. They are fossils—one part of them are casts of shells in limestone. Their general aspect is that of the fossils of the "Calcaire grossier inferieur" of Paris. I regard them as of Eocene age. The occurrence of nummulites in the Philippines and Japan seems to harmonise with this view. The other fossils are *flora* and *mammalia* of presumably later ages, to which we will subsequently direct special attention. Having made these observations we return to Montmartre, Paris. In No. 29, I referred to the mammalian remains found in this locality. These were discovered, disinterred, examined and described by the "immortal Cuvier." The names of two are *Palaeotherium magnum* and *minus*. They have been noticed in the menagerie of the Sydenham Island. In Geological treatises they are often figured. A recent discovery, however, shows that *Palaeotherium magnum* is not altogether what it was supposed to be. According to the restoration it resembled a rhinoceros without a horn and as large as a horse. It was considered to

resemble the tapir. The short and stout neck was assigned to it on account of the vertebrae of the neck being compressed in the original skeleton. The discovery referred to was made in a plaster quarry at Vitry-sur-Seine. Here was found an almost entire skeleton embedded in gypsum and marl, which shows that the *Palaeotherium magnum*, instead of being bulky and massive, was a very slender animal, with an extremely graceful carriage, a neck longer than in the horse, and a general contour, much the same as that of the Llama. We quote the description from *Nature*, Feb. 12th, 1874. A picture illustrates the description: It had a height a little less than that of a middle-sized horse. Three toes are found on each of the feet; the head, much like that of the tapir, had probably the rudiment of a trunk: the former has a third trochanter. The dentary system is composed, in each jaw, of six incisors, two canines and fourteen molars, these latter corresponding with the same teeth in the rhinoceros. Like its congeners of which a dozen species are at present known, it was herbivorous, and without doubt lived in large herds. The specimen is in the Museum of Natural History, Paris.

40. Of the other mammals associated in life and death with the Palaeotheres, we notice the Anoplotheres, *commune* and *secundarium*. We give Owen's description of the first (3.) (This too is on the geological island) "It was 8 feet long including the tail or $4\frac{1}{2}$ feet without the tail. The body was about as long as that of a common ass, but less elevated above the ground, the withers being probably little more than 3 feet. The long and powerful tail must have formed the chief peculiarity in the living animal's outward form. This must have been of the same service to it in swimming as the tail of the otter. Its small, equable and well-opposed upper incisors would indicate that it cropped grass like a horse. This, one of the earliest hoofed quadrupeds introduced upon the surface of the earth, presents in comparison with living species, no indications of inferior or rudimental character in any known part of its organization. With regard to dentition it not only possessed incisors and canines in both jaws, but these teeth were so

equally developed that they form one unbroken series with the premolars and true molars, which character is now manifested only in the human species." (4). Another mammal found at Montmartre is the *Xiphiodoen gracile*. Its form was light and graceful, and somewhat resembled that of a stag. (5). Another is *Chaeropotamus Cuvieri*. This too is found at Montmartre. This quadruped must have resembled the Peccary of South America. It was the earliest form of the hog-tribe (Owen). In the "Formation of Anvergne" there have been found a great number of the bones of mammals. Among these have been recognized (6). *Cainothere*, (7). *Amphistragulus elegans*, *Pomel*, (8). *Microthere*, (9). *Hyaenodon*. In the Bassin de Mayence are recognized the mammals (10). *Hippotherium gracile*; allied to the horse, (11). *Acrotherium (rhinoceros incisivus)*. The two last localities, although at a distance from Paris, are geologically very near. Transferring them thus to Montmartre, they can all be accommodated between the gypsums and marls, and the oyster beds, &c., of the Sables de Fontaine bleau of the *summit*; as they do not range geologically higher than the Calcaires de Brie Meulieres (Burhstones) of Buttes Chaumont. This grand assemblage of mammals of various character and perfect organization constitutes, certainly, a mighty (Almighty) step in advance of preceding periods. The *Flora* and *Fauna* seem admirably to illustrate the written *Record*: "And God said, let the earth bring forth grass, the herb yielding seed after its kind and the fruit tree yielding fruit whose seed is in itself upon the earth, and it was so." Gen. i 11. "And God said, let the earth bring forth the living creature after his kind, Behemoth and creeping thing and beast of the earth after his kind, and it was so." Verses 24 and 25.

41. In a preceding No. (27) I referred to the Isle of Wight in connection with the elevation of Mount Lebanon and Montmartre. Its geology may also be correlated with that of the Paris and London Basins. Its formations are the Wealden, Cretaceous, lower and upper, Eocene, lower and upper. Osborne, the residence of Her Majesty the Queen, is on the Eocene formation. Having correlated the geology with that of

the Paris Basin, we propose now to correlate the Ancient Inhabitants. Sir Richard Owen will enable us to do so. We will inspect them in the order which he has given us: 1. *Macacus eocenus*. The remains of a monkey were found in a deposit of the Eocene Period at Kyson, England. This is allied to the Gibraltar monkey. 2. *Didelphis* (?), Colchester, Owen. 3. *Didelphis gypsorum*, Cuvier. Owen says, Cuvier demonstrated that there was entombed in the gypsum of Paris an animal (opossum) whose *genus* at the present day is confined to South America and the southern parts of North America. Well might Cuvier exclaim, when the delicate but clear lines of the parts he sought became manifest, "Que ces lineaments sont précieux!" How precious are these lineaments! 4. *Coryphodon eocenus* (*Coryphe*, a point; *odus*, a tooth). The remains of this pachyderm, as we have already noticed in a preceding No. (35) were found in the Eocene Clays of Harwich and Croydon. It is allied to the Tapir, "whose most common food is vegetable, and consists of wild fruits, buds and shoots. The abundance and variety of the fossil remains of fruits, most of them of a tropical character, which have been obtained from the same deposits of Eocene Clay (London Clay) as that which has yielded the remains of Coryphodon, indicate the extent and nature of those dark and dense primæval forests in which the Coryphodon obtained its subsistence." 5. *Lophiodon*. 6. *Lophiodon minimus*, Dwarf Lophiodon. This was found in the Eocene Clay of Bracklesham. In this clay were found the Nummulites already noticed (19). 7. *Palæotherium magnum*. This has already been noticed among the mammals of Montmartre and elsewhere. Teeth have also been found in the fresh water eocene marl at Seafeld in the Isle of Wight. 8. *Palæotherium medium*—middle sized. Remains of this Palæotherium, named *medium* by Cuvier, were found in Binstead, Isle of Wight. 9. *Palæotherium crassum*. This was found in the same locality. 10. *Palæotherium minus*. Of this elegant species the fresh water eocene deposits of the Isle of Wight have furnished several specimens, more entire and better preserved than those of the larger Palæotheres.

42. List of Eocene mammals continued. 11. *Chaeropotamus Cuvieri*. This member of the hog family was also found in the Isle of Wight as well as at Montmartre. 12. *Hyracotherium leporinum*. 13. *Hyracotherium cuniculus*. The first was found at Herne Bay. The form and structure of the molar teeth determine this interesting *genus* to belong to the same natural family of the hog-tribe as the *Chaeropotamus*. The second is from the Eocene Clay at Kyson. 14. *Anoplotherium commune*. This also existed in the eocene of the Isle of Wight as well as at Montmartre. 15. *Dichobune cervinum*. This, too, was found in the eocene marl of Binstead Isle of Wight. Cuvier considered that this mammal resembled the young musk-deer. The cotemporaneous existence of these mammals in Paris, the Isle of Wight and England (London Clay) seems to indicate that the Isle of Wight and England then were parts of the continent of Europe. The land mammals of England doubtless could roam at large over Europe, Africa and Asia. We have noticed representative land mammals of the so-called Eocene Period. We now come to look for sea mammals of the same period, which one record tells us did exist, as well as fowls, which we have already noticed. Gen. i., 20, 21, 22. We find the *Delphinidae*, *Dolphins*, *Porpoises*—of the Order *Cetacea*—Whales—occurring in the “Calcaire grossier” of the Department of Maine and Loire. Cuvier in his *Ossemens fossiles*, 1823, describes “Un Dauphin voisin de l’épaulard et de globiceps.” A Dolphin related to the *Phocena orca* (grampus) and the *Phocena melas* (black fish). Owen says that this Delphinus had 17 teeth in each alveolar series of the upper jaw. The *Phocena Orca* or *Gladiator*, exhibited in the Norwegian department of the Fisheries Exhibition was certainly a monster, and the Ca’ing whale or black fish is certainly not a pigmy. Schools of them are often seen in our own waters. The tail and flippers of one killed in Dublin Bay, N. S., are in our Museum. Each measures 3 feet. Of this the lower jaw has 10 teeth on either side. Cuvier’s whale seems to have been an approximate cotemporary with the *Coryphodon eocenius* of England, and the *Coryphodon eocenius* and the *Coryphodon oweni* of

France. With the last are associated the *Gastornis parisiensis*, Hebert "a gigantic bird whose proportions must have surpassed those of the ostrich." We wish the fact of the occurrence of the whale at this period to be particularly noted, as it may be referred to in a future No. (44.) Owen in his list mentions also the following whales: (2) *Balaenodon affinis*, (3) *Balaenodon definita*, (4) *Balaenodon emarginata*, (5) *Balaenodon gibbosa*, (6) *Balaenodon physaloides*. Most of these whales are found in the Miocene Crag of Suffolk and Norfolk, but there is little doubt that they were washed out of the underlying Eocene clay.—OWEN.

43. (1). We have found the "Sable de Fontainebleau" occupying the summit of Buttes Montmartre. (2). Elsewhere the "Calcaire de Beauce" rests immediately on the Sands of Fontainebleau. After the Limestone of Beauce, which is a fresh water formation, (3) are "clays with millstone or buhrstone" having *Chara medicaginula*. (4). Succeeding there is another limestone with *Helices*, snail shells—a lake-formed limestone. We now come to the "Upper Miocene." (5). The first bed of this period is a marine "Mollasse" near Utzigen, east of Berne, in Switzerland. In this are mixed teeth of fishes and bones of mammals such as Hyena, *Elephant* and Rhinoceros. These mammals of Switzerland send us back to Formosa—in China, where Hyenas, *Elephants* and Rhinoceros appear as contemporaries. Sir R. Owen tells us of their occurrence here. Mr. Graham's collections tell us a part of the same story. With the marine shells of Eocene (?) age, already noticed, we have fossil flora resembling *calamites*, but evidently different from those of the Carboniferous period. They are probably Eocene flora, pre-mammalian. Accompanying these, were (1) a part of the lower jaw of a Ruminant, having portions of two teeth. (2). A tooth of another mammal of large size. This is nearly entire. Wishing to have the opinion of Owen, as he had examined and described other mammal remains from Formosa, I sent them to the British Museum last winter. As Sir Richard Owen has retired from the Museum, Mr. Davies examined them and pronounced the jaw

to be "Bovine," ox-like, and the tooth to be that of an "Elephant species." The arrangement of the enamel ridges in the dentine resembles that of the teeth of the Indian Elephant generally, as we find by comparing with our specimens of Elephant teeth in the Museum. In the Quarterly Journal of the Geological Society, Vol. XXVI., No 3, is a paper "On Fossil remains of Mammals found in China." By Prof. Owen. The mammals described are from Formosa. They are (1). *Stegodon sinensis*. The author considers this Pachyderm to be allied to the mammoth. (2). *Stegodon orientalis* considered to be allied to the mastodon and elephant. (3). *Hyena sinensis*. (4). *Rhinoceros sinensis*. (5). *Tapirus sinensis*. (6). *Chalicotherium sinensis*. The *Chalicotherium sinense* is characterized by Dr. Falconer as "one of the most remarkable aberrant pachyderms that have been met with, closely allied to Anoplotherium, but yet having a closer affinity with Rhinoceros." Owen says "the extent of the range of Chalicotherium over the great division of dry land to which that form seems to have been restricted was considerable—from France to China. In tracing it in this direction the species appear to have lived on, nearer to the present period, as they were located eastward. Land at the eastern limits of the great European-Asiatic tract, and now forming China, may have been exempt or much longer exempt (since it became fit to be trod by Tapirs and Anoplotheroids) from those alternate elevations and depressions which have destroyed, modified or covered the western miocene land with deposits of pliocene or post-pliocene age." The fossils examined by Owen were found in Chinese drug shops. Fossils form part of the *materia medica* of the Chinese.

44. On our way from Formosa to France we take another look at Egypt. In the miocene (?) formation here, we have also mammal remains. Those that come under our notice are few in number, but they appear to be of a representative character. In the Suez Canal collections we find two, having a few mammalian fragments. The collection of M. A. Baudoin includes, (1). The jaw of a Hippopotamus. (2). The condyle of the

jaw of a Hippopotamus. (3). The tooth of a Hippopotamus. (4). The tooth of a young Hippopotamus. (5). The molar of a ruminant. (6). A vertebra. (7 and 8). Debris of different bones. In the collection of M. L. Degousee there are, (1) The fragment of the humerus of a ruminant, a species of goat. (2 and 3). Fragments of Hippopotamus. (4). Remains of a Camel. The last three were found at Chalouf by Dr. Terrier. Notes on these collections thus read: "Attention is directed to a group of fossil bones of large antediluvian animals collected on the plateau of Toussoum and on the bank of Chalouf el Terraba, the greater part undetermined. However, we distinguish an upper jaw with a tooth perfectly preserved, several portions of a sternum, a part d'omoplate, the head of a femur of the left side, upper parts of a tibia, the upper extremity of a humerus, vertebrae of different regions, a metatarsal bone and some fragments of ribs." "Hippopotamus is now confined to the rivers of the middle and south of Africa. It formerly found its way into Egypt by the Nile, but has long disappeared from that country." Cuv. and Lat.

We return to France. Geologists distinguish after the "Mollasse, a green calcareous grit and conglomerates, Marine de Suisse" of No. 43, "Mollasse de la Morée." (2). "Faluns (rocks abounding in shells) et Mollasse de Bordeaux et de Dax." (3). Falun de Touraine. There is nothing remarkable about the two first. The third commands attention by its remarkable group of mammals. These are, (1) Dinotherium. (2) Mastodon. (3) Rhinoceros. (4) Hippopotamus, land mammals, Walrus, Seal, Dolphins, Sea-Mammals and Sharks. Buckland gives us a picture of the lower jaw of *Dinotherium giganteum*. Its length with the tusk is $4\frac{1}{2}$ feet—the tusk is 1 foot 3 inches. He also pictures a lower and part of the upper jaw of *Dinotherium medium*. This lower jaw and tusk measures 3 feet; the tusk is less than a foot. The animal was elephantine, and probably had a proboscis. It differed from all the other elephantine animals in having the tusks in the lower jaws, bent abruptly downwards. Buckland gives a restoration of the *Dinotherium giganteum*. It resembles generally an elephant reclining beside a lake, with pond lilies

and other aquatic plants, its probable food. Associated with it, is the *mastodon*, another member of the same family. It is called *mastodon* on account of the nipple-shaped tubercles arranged in pairs on the crown of the molar teeth. The two incisors of the upper jaws formed long curved tusks as in the elephants. This seems to be the first appearance of this pachyderm. We shall again and again have occasion to refer to *mastodon* in the sequel. Hippopotamus is here met with as in Egypt, and of the same character, very similar to the sea-horse of the Upper Nile. These had the Rhinoceros as an associate similar to the *Rhinoceros africanus*. Europe and Africa seem to conform at this time in the character of its Pachyderms. The Walrus, Seal and Dolphin were European cotemporaries. The mode of occurrence of the Cetacea seems to be decidedly antagonistic to the "theory of Whale Evolution," which considers them to have been originally land mammals who took to the deep and underwent a process of devolution by which they were transformed, to their existing constitution. Prof. Flower of the British Museum is the chief advocate of this theory. He kindly invited me to his Lecture on this subject delivered in the Royal Institution during the Fisheries Exhibition. I must confess that I was taken by surprise, as the subject was altogether new to me and incomprehensible. We have indicated a great difficulty in the way of the acceptance of this theory, viz., the question of cotemporaneity, if not precedence, to the *Coryphodon eocenus*, *vide* No. 42 and the Biblical Record.

45. Geological sequence necessitates a return to Suffolk and Norfolk, to the crags of Pliocene age. *Vide* our trip to the Broads of Norfolk. (Nos. 36, 37, 38). At Southwold in Suffolk we have "mastodon in crag." This mastodon is a species *angustidens*; narrow toothed. It is a third less in size than the *mastodon giganteus* or *ohioticus*, and much lower in the legs. We will be able to judge of the dimensions of the one when we meet with the other on the west side of the Atlantic. (No. 54). We have already referred to the sea-shells of the Norwich Crag. Another striking character-

istic of the formation is its Coprolites, from which phosphatic fertilizers are manufactured. These are properly the fossil excrements of *carnicora*, Ichthyosauri, &c., and fossil bones of the same. From these were derived vertebrae of ichthyosauri described in a preceding No. (22). Shark's teeth abound, especially those of *Carcharodon megalodon*. Their name indicates their size—(shark-tooth—great tooth). A very singular fossil in the deposit is the *Cetiotolite*, the petrified ear-bone of a whale. The analysis of this fossil by Prof. Henslow led to the discovery of the phosphatic character of the so-called *Coprolites*. Thus originated the profitable industry of phosphate fertilizers—a valuable appliance for the agriculturist.

Crossing over to Antwerp, the capital of Belgium, we find the same formation, the Crag d'Anvers of the French geologists. Sections of this are not found, as in Suffolk, but excavations of a few feet in depth exhibit it in the city and environs. It is distinguished by the same sea-shells as the Crag of Suffolk, *e. g.*, *Fusus contrarius*, *Voluta lamberti*, &c. There is also the Norwich Crag, associated with that of Suffolk. French geologists correlate with the Crag of Norwich, the Calcaire de Grgenti: its thickness is from 200 to 300 metres. The shells are 70 per cent., recent shells, the most remarkable for size and abundance is *Pecten Jacobaeus*. Mountain elevation—System of the Alps. We translate, "The Alps are not the effect of one only, and unique elevation, but the work of several"—such as our own Cobequid Mountains, on a small scale. "It is believed that that which raised the Pyrenees and the Apennines has had an influence on the chain of the Alps in certain countries, as in Switzerland. But generally geologists distinguish only two principal elevatory movements, the one of which the direction is North 26° East, that of the Western Alps, the other which has formed the principal chain runs East 16° North, and extends without interruption to Valais in Austria. The elevation of the Western Alps appears to have been effected between the Miocene and Pliocene periods, while that of the principal chain might have been later, before the formation of the Quaternary, Post-Pliocene or Pleistocene, (Glacial)."

46. At Clacton in Suffolk, on the shore is a post-pliocene formation overlying the Crag. It is a "fresh-water deposit, containing shells and mammalian remains." This or a similar deposit may have produced an elephant's tooth which I purchased from a collector in Ipswich. This tooth is in a state of decay and with difficulty held together until it was saturated with gelatine. It is in the museum. "When Cuvier first announced the presence of remains of Elephants, Rhinoceroses and Hippopotamuses in the superficial unstratified deposits of continental Europe, he was reminded of the elephants that were introduced into Italy in the Roman wars and afterwards more abundantly, with the strange quadrupeds of conquered tropical countries, in the Roman triumphs and games of the amphitheatre." He therefore appealed with peculiar satisfaction to the discovery of similar fossils in the British Isles, to the origin of which the hypothesis of Roman or other foreign introduction within the historical period could not be made applicable. When Sir Hans Sloane disinterred an elephant's fossil tusk out of gravel, 11 feet below the surface in Gray's Inn Lane, and obtained molars from the county of Northampton, some considered them to have belonged to the identical elephant which Caesar was said to have brought over to England. Dr. Buckland observed that the remains of these Elephants are usually accompanied in England, as on the continent, by the bones of the Rhinoceros and Hippopotamus, animals which could never have been attached to Roman armies. The naturalists, Neville and Molineux, made known the existence of fossil molar teeth of elephants in the county of Cavan, Ireland, where the armies of Caesar never set foot. When the remains are compared with corresponding parts of the Indian and African elephants the dissimilarity is very obvious. Owen figures and compares the lower jaw of a young mammoth disinterred from a Pleistocene bed near Yarmouth in the county of Norfolk, with that of a young Asiatic elephant, clearly showing the difference. Woodward, in his *Geology of Norfolk*, supposes that upwards of 2000 grinders of the mammoth have been dredged up by the fishermen of Happisburg in the space of 13 years. The oyster-bed was discovered here in 1820, and

during the first twelve months, hundreds of the molar teeth of mammoths were landed in strange association with the edible mollusca. Remains of the mammoth are hardly less numerous in Suffolk, along the coast, and at Sutton. The village of Walton, near Harwich, is famous for the abundance of these fossils, which lie along the base of the sea-cliffs, mixed with bones of species of horse, ox and deer. A very distinctive feature of the *Elephas primigenius* (mammoth) is the tusks. These have an extensive double curvature. One of the finest tusks of a British mammoth was found at Ilford. It measured 12 feet 6 inches in length along the outward curvature. A tusk from a brick-field at Kingsland, of which there is a model in the museum of the Geological Society of London, measures 9 feet 10 inches along the outer curve. Another, from the drift near Happisburg, dredged up in 1826, measured nine feet six inches, and weighed ninety seven pounds. Others have been found weighing from one hundred to one hundred and sixty pounds each. The more bulky bones of Walton seem early to have attracted the attention of the curious. Lambard in his Dictionary says that "In Queen Elizabeth's time bones were found of a man, whose skull would contain five pecks, and one of his teeth as big as a man's fist, and weighed ten ounces." The remains of mammoths have everywhere been the prolific source of the traditions and histories of Giants and sometimes of Saints: Lucovius Vives relates that a molar tooth, bigger than a fist was shown to him as one of St. Christopher's teeth and was kept in a church that bears his name."—Owen's Fossil Mammals.

47. The remains of the great mammoth have been noticed as occurring in Europe and the British Isles, in superficial deposits to which have been given the names—Post-pliocene Pleistocene, Quaternary, Diluvium, &c. They are found in still greater abundance in the same formation in the higher latitudes of Europe, Asia and America, from the River Lena to Behring's Straits. They range from latitude, 40° to 70°. No authentic cases of remains have been found in tropical latitudes or in the southern hemisphere. Siberia seems to have been the

favourite haunt of these monsters, if we are to judge from their superabundant remains. Here their tusks are so abundant as to form "Ivory mines," seemingly, practically inexhaustible. Hedenstroem in his "Survey of the Laechow Islands on the north-eastern coast of Siberia, remarks that the first of these islands is little more than one mass of these bones; and that although the Siberian traders have been in the habit of bringing over large cargoes of tusks for upwards of sixty years, yet there appears to be no sensible diminution." "It is contended that the number of Elephants, now living on the globe is greatly inferior to the number of those whose bones are remaining in Siberia." Almost the whole of the ivory work made in Russia is from fossil ivory. It is also used in England. In consequence of its abundance it is much cheaper than the ivory of Africa and India. It becomes sooner yellow by the influence of the weather or heat, and is a little more brittle than the latter, and seems to be, in this respect, inferior. Tusks of Siberian ivory have been cited, as weighing two hundred pounds. Owen says that there is reason to believe that skeletons more or less entire have been recovered in Britain. That the animal—entire—has been found in Siberia, is a notable fact. The story of its discovery is as follows "Ossip Schumachoff, a Tungusian chief hunter and collector of fossil ivory who had migrated in 1799 to the peninsula of Tamust at the mouth of the River Lena, one day perceived amongst the blocks of ice, a shapeless mass not at all resembling the large pieces of floating wood which are commonly found there. To observe it nearer, he landed, climbed up a rock and examined this new object on all sides but without being able to discover what it was. The following year he perceived that the mass was more disengaged from the blocks of ice, and had two projecting parts, but was still unable to make out its nature. Towards the end of the following summer (1801) the entire side of the animal and one of his tusks, were quite free from the ice. On his return to the borders of Lake Gncoul, he communicated this extraordinary discovery to his wife and some of his friends; but the way in which they considered the matter filled him with grief. The old men related, on the occasion, their having heard their fathers

say, that a similiar monster had been formerly seen in the same peninsula, and that all the family of the person who discovered it died soon afterwards. The mammoth was, in consequence, unanimously considered as an augury of future calamity, and the Tungusian chief was so much alarmed, that he fell seriously ill ; but becoming convalescent, his first idea was the profit which he might obtain by selling the tusks of the animal, which were of extraordinary size and beauty. He ordered that the place where the mammoth was found, should be carefully concealed, and that strangers should, under different pretexts, be diverted from it, at the same time charging trustworthy people to watch that the treasure was not carried off. But the summer of 1802, which was less warm and more windy than common, caused the mammoth to remain buried in the ice, which had scarcely melted at all. At length, towards the end the fifth year, (1803), the ardent wishes of Schumachoff were happily gratified ; for the part of the ice between the earth and the mammoth melted more rapidly than the rest, the plane of its support became inclined, and the enormous mass fell by its own weight on a bank of sand. Of this, two Tungusians, who accompanied me were witnesses. In the month of March, 1804, Schumachoff came to his mammoth, and having cut off his tusks, he exchanged them with the merchant Bultanoff for goods of the value of fifty roubles, £8 stg. Schumachoff related the history of the discovery to Mr. Adams, Naturalist's Library, Mammalia, Vol. V., 1837, "Elephant of the Lena."

48. Two years afterwards or the seventh after the discovery of the mammoth, I (Mr. Adams) fortunately traversed these distant and desert regions, and I congratulate myself in being able to prove a fact which seems so improbable. I found the mammoth still in the same place but altogether mutilated. There was no obstacle to prevent approach to the carcase of the mammoth ; the proprietor who was my guide, was content with his profit from the tusks and the Jakutski of the neighbourhood had cut off the flesh with which they fed the dogs during the scarcity. Wild beasts, such as white bears, wolves, wolverines and foxes also fed upon it, and the traces of their footsteps

were seen around. The skeleton almost entirely cleared of flesh remained whole, with the exception of one fore-leg. [Note.—This has been restored in plaster of Paris from the other side.] The spine from the head to the *os coccygis*, [Note.—This is an error, as of the twenty-eight or thirty caudal vertebræ, only eight are remaining] One scapula, the basin and the three extremities, were still held together by ligaments and by parts of dry skin. The head was covered with a dry skin; one of the ears being well preserved, [Note.—The ears are not well preserved, but may perhaps have suffered in so long a carriage,] was furnished with a tuft of hair. All these parts have necessarily been injured in transporting them eleven thousand verts, (seven thousand three hundred and thirty miles.) Yet the eyes have been preserved, and the pupil of the left eye can still be perceived, [Note.—A dried substance is visible, but it is not certain whether it is the pupil of the eye,] the point of the lower lip has been gnawed, and the upper one having been destroyed the teeth could be perceived. The brain was still in the cranium, but appeared dried up. The parts least injured are one fore-foot and one hind-foot; they are covered with skin and have the sole still attached. According to the assertion of the Tungusian chief, the animal was so fat and well fed that its belly hung down below the joints of the knees. This mammoth was a male with a long mane on the neck, but without tail or proboscis, [Note.—The places of the insertion of the muscles of the proboscis are visible on the skull; it was probably devoured as well as the end of the tail.] The skin of which I possess three-fourths, is of a dark gray colour, covered with a reddish wool and black hairs. The dampness of the spot where the animal had lain so long, had in some degree destroyed the hair. The entire carcase, of which I collected the bones on the spot is nine feet four inches high, sixteen feet four inches long, from the point of the nose to the end of the tail without including the tusks which are a toise and a half (3 feet 6 inches) in length, (9 feet 6 inches measuring along the curve. The distance from the base of the root to the tusk to the point, is 3 feet 7 inches). The two together weighed three hundred and sixty pounds avoirdupois; the head alone without the tusks

weighs four hundred and fourteen pounds avoirdupois. The principal object of my care was to separate the bones, to arrange them, and put them up safely, which was done with particular attention. I had the satisfaction to find the others scapula, which had remained not far off. I next detached the skin of the side on which the animal had lain, which was well preserved. This skin was of such extraordinary weight that ten persons found great difficulty in transporting it to the shore. After this, I dug the ground in different places to ascertain whether any of its bones were buried, but principally to collect all the hair which the white bears, &c., had trod into the ground while devouring the flesh. Although this was difficult from the want of proper instruments, I succeeded in collecting more than thirty-six pounds of hair. In a few days the work was completed, and I found myself in possession of a treasure which amply recompensed me for the fatigues and dangers of the journey and the considerable expenses of the enterprise. The tusks were repurchased at Irkutsk and the whole transported to St. Petersburg. The skeleton is now mounted in the museum of the Petropolitan Academy. There is a good figure of it in the volume from which we have taken the description. Copies may be seen in Geological Text Books. There is a beautiful picture of it in our museum by Mr. Harris, R. A. C.

49. Mr. Adams gives the following information regarding the *situs* of the frozen mammoth: "The place where I found the mammoth is about 60 paces distant from the shore, and nearly 100 paces from the escarpment of the ice from which it had fallen. This escarpment occupies exactly the middle between the two points of the Peninsula. The escarpment of ice was thirty-five to forty toises high (240 feet), and according to the report of the Tungusians, the animal was, when they first saw it, seven toises (45 feet) below the surface of the ice." The skin being covered with thick hair induces Cuvier to consider "that it was the inhabitant of a cold region." Owen remarks: The molar teeth of the Elephants possess a highly complicated, and a very peculiar structure, and there are no other quadrupeds that derive so great a proportion of their food from the woody

fibre of the branches of trees. The elephants tear down and crunch the branches, the vertical enamel-plates of their huge grinders enabling them to pound the tough vegetable tissue and fit it for deglutition. Now, if we find in an extinct elephant the same principle of construction of the molar teeth, but with augmented complexity arising from a greater number of the triturating plates and a greater proportion of the dense enamel, the inference is plain that the ligneous fibre must have entered in a larger proportion into the food of such extinct species. This food could be had in sufficient quantity as high as the 60° latitude parallel. "In the extreme points of Lapland, in 70° north latitude, pines attain to the height of 60 feet," Lindley's Introduction to Botany. Lyell observes: "That as in our own times, the northern animals migrate, so the Siberian Elephant and Rhinoceros may have wandered towards the north in summer. In making such excursions during the heat of that brief season the mammoths would be arrested, when the Reindeer and Musk-ox would still proceed northward. In the drift and fresh water deposits and caves of what he calls, 'Newer Pliocene age,' Sir Richard Owen enumerates 27 land and 5 sea mammals in the one and 37 land mammals in the other (caves). Of these 16 land mammals are common to both. In the "alluvium," he finds, 20 land animals and 3 marine. Of these 11 land and 3 marine are in the post-pliocene. All these are British. Associated with the mammoths are such oriental mammals as Hippopotamus, Rhinoceros and Hyaena. We have already seen Rhinoceros and Hyaena in Formosa; Hippopotamus and Hyaena in Egypt, and Hyænodon, Hippopotamus and Rhinoceros in France as well as mastodon and mammoth. The same author gives mastodon *augustidens*, elephas *primigenius*, rhinoceros *tichorhinus*, in his Pliocene-Fluvio-marine crag, list of mammals. To this, however, he appends the note, "Probably from overlying Blue Clay" (Pleistocene).

50. We now take a closer look at the associates of the Elephant in Britain which Dean Buckland dissociates from the Roman Invasions as very unlikely followers of armies. The

first of these is the Rhinoceros. We would note localities where this pachyderm has been found. Owen informs us that the first notice of remains referable to the Rhinoceros occurs in a rare old tract: *Chartham News*, or a brief relation of some strange bones lately dug up in the grounds of Mr. John Somner of Canterbury, etc., printed for Garthwait in 1669. An upper molar of the remains described and speculated upon in this tract, belonged to *Rhinoceros tichorhinus* or the two horned Rhinoceros, the formation to which it belongs is "upper miocene," newer pliocene, or pleistocene (Synonyms). Other remains are a portion of the skull, also figured by Owen. They were found in the post-pliocene brick earth of Kent, Surrey and Essex which have yielded a rich harvest of great extinct pachyderms. Cuvier concludes from a certain peculiarity of structure that this Rhinoceros had more formidable nasal weapons than any of the known existing species, having two horns. Dr. Buckland had specimens of the skulls and other bones of the same species which were found on the banks of the Avon at Lawford near Rugby. The most complete skeletons have been found in caverns or cavernous fissures, *e. g.*, a cave near Weiksworth, Derbyshire, and the Cave, Kent's Hole, Torquay. Another species—*leptorhinus*, has been found at Clacton, Essex. The remains of this have been very abundant. There were discovered remains in the fresh water pliocene deposits, already noticed by John Brown, F. G. S. Owen farther observes: This peculiar form of Pachyderm appears to have been confined from its first introduction into our planet, to the same great natural division of the dry land—the Old World of the Geographers—to which the existing representatives of that form are still peculiar. The next of the associates of mammoth, which we would briefly notice is the Hippopotamus *major*. Remains of this pachyderm have been found in the same deposits that yielded the remains of Rhinoceros. They have been found in Walton, Essex, at Chartham, at Brentford, at Clacton, in the Kirkdale Cave and the Aire River, Lancashire. Fossil remains of *Hippopotamus major* have been found in considerable abundance in the fresh water formation that overlies the Norwich Crag on the eastern coast of Norfolk. Associated

with these we have another interesting pachyderm, the Fossil Horse, *Equus curvidens* (curved tooth). We have already noticed the Eocene Hippothere in Mayence, France. We shall again meet with *Equus curvidens* in the Western Hemisphere. A formidable enemy of the mammoth was the Great Cave Bear — *ursus spelaeus*. We know this monster particularly, as the Cave Bear of France. Of this there are *vertebrae* and other remains in our museum. These were a gift of my late lamented friend and confrere of the Société Geologique de France, the Marquis de Raincourt. Of that Cuvier says "The size of it must have equalled that of a large horse." It is considered to have surpassed in size all existing bears, even the Arctic or the great white bear, with the possible exception of the Grizzly Bear of America. *Felis Catus*, the ancestor of our domestic cat and *Mus musculus*, the mouse, which differs only from our common mouse by a slight superiority of size, were British contemporaries of the mammoth.

51. I have yet to direct attention to two worthy associates of the mammoth in Great Britain, known as *Cervus Elephas*, and *Megaceros Hibernicus*. The former known as the Red Deer, and the latter as the Great Irish Elk, make their appearance with the mammoth in the Newer Pliocene drift (Pleistocene) and fresh water deposits, and also in caves. The Red Deer survived the other two, and is to be found in the "Alluvium." Owen observes: "The chain of evidence of the existence of this species of deer in Britain, from the pliocene tertiary period to the present time, seems to be unbroken. This, at least, is certain that a deer, undistinguishable by the character of its enduring remains from *Cervus Elephas*, co-existed with the *Megaceros*, the spelaeon (cave) Hyaena, the *tichorhine* Rhinoceros and the Mammoth, and has survived as a species, those influences which appear to have caused the extinction of its gigantic associates." The late Dr. Warren, Curate of St. Paul's, Halifax, lent to the Museum a large and interesting fragment of an antler of this deer species, found at Brighton. Mrs. Warren afterwards kindly presented it as a memorial of her husband. It measures in length eighteen inches. Its circumference at

The insertion into the skull is eight inches. In other parts, seven, six, five inches. The lower branches are broken off; it terminates at the third. It has evidently been shed, not broken off. The menagerie of the Crystal Palace Island has a restoration. Its gigantic companion, *Megaceros Hibernicus*, is also restored in the same collection. See list in No. 23. In several museums of London, *e.g.*, Royal College of Surgeons, and Museum of Natural History, Kensington, and Museums of Dublin, etc., the Great Irish Elk is a prominent member. I had previously regarded our Moose as the largest of the Deer family. In presence of the skeleton of its extinct ancestor, it assumes moderate proportions. A skeleton figured by Owen, has height of 10 feet 4 inches. The span of its palmated antlers from the extreme tips is 8 feet. It is from these that he has his name *Megaceros*, and his surpassing height. Its height from the ground to the top of the longest dorsal spine is 6 feet. The corresponding height of the moose is about 5 feet, or 5 feet 6 inches. They seem to have abounded in Ireland. The first tolerably perfect skeleton was found in the Isle of Man, and was presented by the Duke of Athol to the Edinburgh Museum. Cuvier's figure in "Ossements Fossiles" is taken from an engraving of this skeleton furnished by Professor Jamieson. He named it *Cervus Megaceros*. The name *Megaceros Hibernicus*, originally applied by Dr. Carte, of Dublin, is regarded as the proper name. The shell-marl of Rathcannon has produced abundance of remains. They are found in bogs, but not in the peat itself. Owen says the following account of the situation of remains given by Mr. James Kelly, dated Downpatrick, Dec. 22nd., 1725, is most instructive and precise. "For the first three feet we met with a fuzzy kind of earth, that we call moss, proper to make turf for fuel; then we find a stratum of gravel about half a foot; under which, for about three feet more kindly moss, that would make a more excellent fuel; this is mixed with timber so rotten as to be easily cut with the spade, under this for a depth of three inches, we find leaves for the most part oaken that appear fair to the eye, but will not bear a touch. Under this is a stratum of blue clay, half a foot thick, fully mixed

with shells (*Lymnaea*), then appears the right marl, two or three feet deep; among this marl, and often at the bottom of it, are found great horns, which we call Elk-horns. We have also found shanks, and other bones of these beasts in the same place." Total depth of deposit is 10 or 11 feet.

52. Another gigantic monster of the Sydenham Island is the *Megatherium* (great beast). This is very conspicuous; he appears as making an effort to climb a tree. Possibly he has other intentions. His great size, weight and clumsiness, are not at all adapted for tree-climbing—yet a bear often performs the feat. The latter, however, has an adaptation of limb which has been denied to the *Megathere*. We will yet find out his probable object in taking his present position. Mr. Hawkins kindly takes us to see the skeletons of the giants in the museum of the Royal College of Surgeons. Having examined them with wonder and interest, he takes me to his workshop in a vault of the building. Here he is at work on the remains of another monster, a *Glyptodon*, attempting, from a confused pile of fragments, to restore the original. He shows me the teeth. They are exquisitely sculptured. From these the creature has received its name. We now examine an iron-frame work, which is partially covered on its top with a tessellated coat composed of the ornamented scutes, of which the pile is chiefly composed. It looks somewhat like the carapace of a tortoise. The enthusiast has a great work to accomplish in selecting the proper scute from the confusion of the pile to apply to its neighbor scute before the work can be perfected. Its feet are not in position, nor its wonderfully formed tail. This is solid and knobbed like an Indian war-club. The work was successfully completed. The *Glyptodon clavipes* (club-footed) is now one of the wonders of the great museum of the R. C. S., London. It measures about 9 feet in length. A picture of *Glyptodon* is in Dana's Text Book. The *Megatherium* and the *Glyptodon* are extinct animals of South America. Scutes of the latter were early found among the bones of the former, and gave rise to the belief, which Buckland and others entertained, that the *Megatherium* was protected by

a coat of armor like an armadillo. These, accordingly, enter among the illustrations of the *Megatherium* in the second volume of his Bridgewater Treatise. While the coat of the *Glyptodon* has some resemblance to that of the armadillo, it was rigid, and had not the pliability which the eleven bands (*undecemcinctus*) of the latter afforded. We have a specimen of the armadillo in the museum, which is certainly a pigmy compared with the *Glyptodon*. This, too, came from South America. At the Exposition Universelle de Paris, 1867, we saw in the department of Venezuela, Argentine Republic, a collection of remains of *Megatherium* and *Glyptodon*. They seemed to belong to several individuals of both. I attempted to secure some specimens. It was expected that they would be purchased by some of the great museums of the Continent. The Commissioner, like Mr. Hawkins, would not give me even a scute, lest it should be missed out of the restored carapace.

53. The *Megatherium* is considered to be allied to the sloth. It was a vegetarian. In Dana's Manual there is a figure of a skeleton in the British Museum. He gives its length as 18 feet. Buckland's *figure 1* is of "a nearly perfect skeleton in the museum at Madrid. His *figure 2* are the bones of a pelvis discovered near Buenos Ayres. This is in the museum of the Royal College of Surgeons. From these we find that the breadth of the pelvis was about 5 feet. The same was the breadth across the shoulders. Colossal strength is thus indicated as well as size. His tail is not simply an appendage. It is evidently intended for support. His fore feet are in length about two feet and a half each; they are provided with strong claws—four each. The "Island Megathere" has selected a tree, having (hypothetically) a plentiful supply of his favorite food. As it is high beyond his reach—it must be brought down. Having cleared away the soil from the roots of the tree, he is erecting himself. His hind legs and tail are now a tripod; he grasps the tree in his arms. It is moved backwards and forwards until its roots give way. It falls with a crash, the animal feasts while the foliage lasts. So it is supposed. When we first visited the British Museum

after our arrival in London in 1862, we, without loss of time, made our way to the upper galleries where the fossil mammals and other organic remains were to be found. One of the principal objects that arrested our attention, was the gigantic mastodon — *Mastodon ohioiticus* — the American Mastodon. Owen figures this as a representative mastodon, and the figure has been copied in all geological text-books (Dana, etc.,) which treat of mastodon. In connection he remarks: "The almost complete skeleton of the mastodon *giganteus* (*ohioticus*) so well known to the public as the "Missouri Leviathan," when exhibited, with a most grotesquely distorted and exaggerated collocation of the bones, in 1842 and 1843 in the Egyptian Hall, Piccadilly, but now mounted, in strict accordance with its natural proportions in the British Museum, has enabled me to present in the subjoined cut, as perfect a restoration of the mastodon as that of the mammoth (of St. Petersburg), given at the head of the preceding section." I regarded and examined this giant with much interest, as it reminded me of home and a race of giants that once lived in Cape Breton, of which a tooth in my collections were in the Exhibition at South Kensington, and photographs of a thigh bone preserved in the museum of the Mechanics Institute, Halifax. No. I.

We now return from our wanderings in Foreign Countries. We might have returned sooner if the requirements of Geology only had been consulted, but "Giants and Pigmies" have kept us abroad, and may again engage us in foreign travel. Prior to our departure, we had ascended geologically in Nova Scotia to the top of the Triassic Formation and Prince Edward Island Dinosaurian Period. See No. 13. Encountering a "break in succession." *Vid.* Table. Geological sequence sent us over to England, France, Egypt, and other foreign countries. We completed the succession when we reached the Glacial Period. No. 45. Then the geology of Nova Scotia is of surpassing interest, exceeding that of either England or France. *Vid.* Transactions of the Nova Scotia Institute of Natural Science, 1879 to 1887.

In connection with the geology of Egypt, and certain illustrative applications in Nos. 19, 20, 21, I would now briefly

refer to recent investigations in the "Geology of Palestine," recorded in a memoir on the Physical Geology and Geography of Arabia, Petraea, Palestine, and adjoining districts. By Edward Hull, F. R. S., (under the auspices of the Committee of the Palestine Exploration Fund, 1886). I arrange observations in the form of a section which can readily be compared with my own of the "Suez Canal" and Bauerman's of Nos. just referred to. My information is derived from a review of the above memoir in *Nature*, April 29th, 1886. (I was too late in receiving this at Halifax to give it with the others). Prof. Hull gives the information as follows: 1. Archæan, Crystalline Rocks; 2. Carboniferous; 3. Cretaceous; 4. Tertiary (Eocene, Miocene, Pliocene); 5. Post Tertiary (post pliocene). I would notice that the "break in succession" of our "Suez Canal," section is here partially filled by "Carboniferous." In Bauerman's section it was occupied by "Triassic." *Vid.* No. 20 and Table. It is probable that the two terms are applied to the same formation.

54. Geologists, however, are of opinion that the American Mastodon is of Post Glacial Age, that it was contemporary with the American Mammoth, both being of pleistocene age and of the Champlain Period. We have heretofore as a matter of course, referred our Cape Breton giant to this Period. On certain geological considerations we have been led to regard him as contemporary with the Europeans. No. 44. The only authentic remains that we have of these Cape Breton mastodons are in our Provincial Museum. These are a femur (thigh bone) and a molar tooth. The one was found about forty years ago at Middle River, about nine miles from its mouth. It was plowed up on the intervalle of Walker's farm. Its discovery caused considerable excitement. Admiral Dundonald and Dr. Gesner visited and explored the spot with the expectation of making farther discoveries of remains of the giant—without success. Fortunately the femur was deposited in the museum of the Halifax Mechanics' Institute, and is now a gem in our Provincial Museum. Its dimensions are: length, 3 feet 10

inches; breadth at the top, 1 foot 6 inches; girth in the middle, 1 foot 8 inches; above and below, 1 foot 11 inches; at the knee, 2 feet 1 inch. These proportions seem to indicate a mastodon equal in size to Dr. Warren's celebrated skeleton in Boston, which was found in a marsh near Newburgh, New York. This has a height of 11 feet, and a length to the base of the tail, 17 feet. I found in the Mechanics' Institute Museum tusks, which were supposed to be parts of the mastodon tusks. They are tusks of Walrus. If there existed any doubt regarding the identification of the femur as that of a Mastodon, the discovery of a mastodon grinder having characteristic "nipple ridges," seemed to dispose of the doubt. This tooth was found at Baddeck on the side of the Bras d'Or. The locality is about 9 miles distant from the former bed of the femur. From this, we infer the existence of, at least, two mastodons in Cape Breton; the owner of the tooth must have been of smaller size than the owner of the femur. The tooth resembles in size and form, teeth of the mastodon of the British Museum, and it is probable that the owner was of the same size. I compared them in 1862. Description: size of crown $4\frac{1}{2} \times 3$ inches; number of ridges with conical prominences more or less united in the transverse direction of the tooth, three. Thickness of enamel $\frac{3}{16}$ inch. It has two transverse fangs; at the back of the longest is a nerve hole, which is half an inch wide, and one inch and seven tenths deep. The shape of the crown is sub-rhomboidal; its four sides measure 12 inches. It was a fortunate thing that Dr. Kier, of Princetown, Prince Edward Island, secured the specimen and delivered it from the hands of those who did not appreciate its value. It is said to have been in good preservation when found, but the blacksmith's hammer and vice had broken a part of the end ridge, and much of the enamel had been broken off, only about one half now remains. The enamel is jet black on the outside, and white within. It seems to have been partially worn off the ridges during the life-time of the owner. Its bony part is perfectly sound. Dr. Kier kindly gave me the tooth. It is now in our Museum. How the Mastodons got into the Island of Cape Breton I cannot understand. The

Strait of Canso seems an insuperable obstacle in the way of their migration from the south. If Cape Breton was partially connected with the mainland, the difficulty would disappear. I have supposed that this was the case in the pliocene period, and that the Strait was opened by glacial action. The absence (?) of remains of Mastodon in Nova Scotia, has been credited to the glacial action in Nova Scotia, from which Cape Breton seems to have been largely exempt. The Mastodon has its specific name *ohioticus* as Ohio in the United States is regarded as the home of the species. The same friend gave me, along with the tooth of the Mastodon, the tooth of a horse, which has the appearance of a fossil. It resembles one of the teeth of the *Equus fossilis* or *curvidens*, which we find associated with the Mastodon and Mammoth in the *pliocene* and *pleistocene*.

55. The next mammal to which we would direct attention is marine. A whale, to which the name *Beluga* has been given. The species is doubtful. It is probably the same as *Vermontana* (of Vermont). The skeleton of which we have the greater part in our museum, was found at Jacquet River in the Bay Chaleur, New Brunswick, in a cutting of the Intercolonial Railway, when it was in course of construction. I subsequently visited the locality and found a bed of clay several feet below the surface, similar to the clay found in the vertebrae. In the bed I found abundance of shells, showing that the clay had been formed at the bottom of the sea, where the *Beluga* had been imbedded. The shells are identical with these, found in other cuttings of the I. C. R. in New Brunswick, and at the Levis Junction, also in the sands of Montreal, and other deposits of the Champlain (post glacial) period. It is interesting to observe that *Beluga* has been an inhabitant of the waters of the Gulf of St. Lawrence, from the time when our fossil *Beluga* lived to the present. I directed attention to this fact at the Fisheries Exhibition, and at Professor Flowers' lecture on the Evolution of the Whale at the Royal Institution, London. In our Canadian Department of the I. F. E., I exhibited characteristic parts of our fossil *Beluga* with associated fossils. In our collection we had a magnificent stuffed specimen

of the White Whale. "*Beluga delphinapterus*," from the Gulf of St. Lawrence, prepared by Mr. Gregory, of the Marine and Fishery Department, Quebec. Suspended over head in the United States Department, was a beautiful *papier marché* model of the same marine mammal, as natural as in life. Our museum collections show that Land and Marine mammals with fishes—"Giants and Pigmies" lived and died in the United States in these eventful times to which we have directed attention. Our collections from Suffolk—"Norwich Crag," etc., correspond in a striking manner with the phosphate beds of South Carolina, while the contents of both deposits are applied to the use of Agriculture. From the latter, we have large fragments of teeth (molars) of the mammoth, which has been named *Elephas Americanus*. These show proportions equal, at least, to those of the Lena mammoth—*Elephas primigenius*. There is also the fragment of the tooth of a mastodon, much larger than of our Cape Breton. It is probably equal in size to the tooth of the former proprietor of our femur. There is also a part of a tusk of an elephant of apparently small size. There is also the tooth of *Equus fossilis (curvidens)*. Other teeth there are, whose ownership we have been unable to determine. Mammals of the sea (whales) have left vertebrae about the same size as of our Beluga. One vertebra belonged to a whale of larger size. For this, and a large scapula of a mammal, I am indebted to Mr. Macpherson, ship-builder. This vertebra measures, length 7 inches, ends 7 x 6. It certainly represents a whale of large size, how large it may be difficult to estimate. There are other interesting relics of cetacea that call for notice. These are *cetiotolites*, or fossil ear bones of whales. I found one of these in a cargo at Cunard's, and directed attention to the fact in connection with their occurrence among the so-called coprolites of the Suffolk Crag, and Prof. Henslow's consequent discovery of the value of coprolites as material for the manufacture of Superphosphate of Lime as a fertilizer. Still other characteristic fossils are the teeth of *Carcharodon megalodon*, Shark's teeth of enormous size, and therefore so named. We have a good collection of shark's remains from the Phosphatic deposits of England, chiefly presented by the late Mr. H. Poole,

and others which I procured at Ipswich. Among these are teeth of *Carcharodon megalodon*. The largest is not larger than the medium size of the South Carolina collection. The largest of the English are 3 inches from end of root to apex; the American 5 inches. With the last we have associated teeth of smaller species—pigmæan teeth, not larger than the *tenth* of an inch. Large Shark's teeth are also found in calcareous deposits of Malta. Of these we have also specimens.

56. With the exception of a few of the largest *Carcharodon megalodon* (teeth), which were presented by Southern States friends, our collections were derived from cargoes, bound for England, the vessels having to come to Halifax for repairs. The first and best cargo was that of the barque Northumbrian, which was unloaded on Bennett's wharf, in order that the ship might be repaired. The cargo was in the rough, having been taken out of the sea and put on board by negroes. From the captain and mate I received the molars of mammoth and mastodon. Other specimens I collected by daily visits to the cargo on the wharf. I thereby got together a fairly representative collection. On one of my visits I was surprised by finding a flint spear head, of good shape, when looking for fossils. This had other evidence of having been associated with *Carcharodon megalodon* besides its position in the cargo and its coat of clay. The bases of *Balani* are firmly attached to both, showing that both had occupied a submarine position. I connected the two then, and they have continued so until the present. This conjunction was perplexing. The queries arose: When did the two become associated in the deposit? And by what means? The conclusion at which I arrived is this, that the spear head had been originally in a surface deposit which overlay the phosphatic bed, and that the sea had subsequently washed this with other contents of the superficial deposit among the fossils beneath. At the American Archæologist Convention, held during the Centennial Exhibition, Phila., 1876, I submitted the tooth and spear-head with my perplexities and conclusion. It was agreed that the conclusion at which I had arrived was the proper one. I have in my glacial investi-

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gations searched diligently for manufactured stone implements without success. In newer superficial deposits I find them often enough in Nova Scotia. They are often found in Indian graves, if we are to believe the old labels on museum specimens. We have a fine collection of arrow-heads made of jasper, quartz, and porphyrite, with abundance of beautiful chips presented by Mr. Anderson, of Lunenburg. These were found at Bockman's Beach in the same county, with needles, etc., made of native copper. The place was evidently an arrow-maker's camp. We have similar collections from Cornwallis and Antigonish. We certainly do not regard these as of very great antiquity, although prehistoric. Another interesting collection of stone arrow-heads and chips with a sharp and polished hornblende (jade like) chisel was presented by W. H. Reynolds from British Columbia. These are from a battle field of which the present races of Indians have no knowledge. They accompany human skulls, the most of which are too much decomposed for handling. Some large pieces, however, are in the collection, having many teeth in place. These certainly indicate comparatively recent age. All the arrow-heads of our collections resemble European implements of the stone age.

57. In the Reunion of the Société Géologique de France, 1867—at Pte. Ste. Maxence, already referred to, our director took out of a superficial deposit some pieces of flint, and compared them with wrought flints of Abbeville. This reminiscence brings up another of 1862. The discovery of flint implements at Abbeville, in France, and their bearing upon the Antiquity of Man, was a subject of much discussion with Geologists and Geological Societies. Some believed that they were of preadamian age; others post-adamic. Some even suggested the possibility of recent fabrication. In connection with the last supposition Prof. Tennant had just made a curious discovery. A certain character from Yorkshire commonly called Fossil Willie, and Flint Jack, frequented his shop with specimens for disposal. On one occasion he introduced me to him. Some of his specimens were flint arrow-heads. Our friend Tennant was a very shrewd man. Something or other caused him to

make the curt remark—you made these. Jack was caught and had to confess that he did make them. For a consideration he showed the Professor how he made them. His tool was what was called a "gate-hasp." The specimens made were taken by the professor to a collector of stone implements—he was in rapture at the sight of the arrow-heads, could tell all about them, assigning them even to the proper period. He was shocked when informed that they were only a day or two old. Subsequently Jack made a full confession, which was published in a pamphlet. From this it appeared that for a number of years he had manufactured and sold flint implements to museums and collectors in Great Britain and Ireland. In regard to fossils he said that he found it easier to make them than to find them. He was thus paid for his impositions. After his confession his former purchasers in many cases paid him to distinguish the fictitious from the genuine. He also sold as very rare and valuable ammonites—snake-stones, (so-called) with snakes' heads—fabricated. After his confession and exhibitions of handicraft, Prof. Tennant paid him to attend a meeting of the Geologists' association, when he showed his skill in making to order, arrow-heads of as good forms as those of the "stone age." The Prof. himself seemed to regard the Abbeville specimens as of the same character as flint Jack's productions, Prof. Prestwich first brought under notice the flint implements, discovered by M. Boucher de Perthes, at Abbeville, in the Diluvium of the Somme, and Sir Charles Lyell was his associate in the advocacy of their preadamite character, and their consequent evidence of the "Antiquity of Man." Prestwich and Lyell, from an examination of the deposits in which the flint implements were found, and their relations to the under lying chalk, deduced certain conclusions in reference to the character and age of the deposits which would refer the implements and their makers to newer Miocene, or older Pliocene periods. Mr. Taylor, F. G. S., made subsequent, more elaborate, and exhaustive examinations of the same region with the aid of the Engineer-in-Chief of the Northern Railway and his staff, which led him to conclusions altogether at variance with those of Prestwich and Lyell. These appear

in the Quarterly Journal of the Geological Society This shows at least that the views maintained by Sir Charles Lyell in reference to the "Antiquity of Man," are not unquestioned. The character of the deposits, in short, of "superficial deposits" in general, often renders exact and unquestionable observation very difficult. It was suggested by Dr. Falconer that as the ups and downs, and violent changes in countries, which had complicated superficial geology had not extended to the regions of the Nile and Ganges, we might expect that investigation in the latter may afford more satisfactory data for reliable conclusions. In a late number of "Nature" we find discoveries made on the Nile very much akin to our own Nova Scotian.

58. We now come to examine another race of Giants, which has become extinct in comparatively recent times. In the Ashmolean Museum, Oxford, "among the remnants of Tradescant's collections still preserved, there are the bill and foot of the Dodo—*Didus ineptus*, Linn., a bird no longer in existence. It was first seen by the Dutch, when they landed on L'isle de France, at that time uninhabited, immediately after the discovery of a passage to the East Indies by the Cape of Good Hope. It was of large size and singular form, its wings short like those of the ostrich, and wholly incapable of sustaining its heavy body, even for a short flight. "The death of a species," says Lyell, "is so remarkable an event in Natural History that it deserves commemoration." The remains of the last specimen of Dodo which had been permitted to rot in the Ashmolean Museum, were cast away by the consent of the vice-chancellor and other curators assembled on the 8th day of January, 1775. A painting now in the British Museum was made from the living, by George Edwards, who lived between 1698 and 1773.

A traveller from Australia brought to England a piece of bone of doubtful character. It might be supposed to have belonged to a mammal of bovine character. It was taken to the celebrated comparative Anatomist of the Museum of the Royal College of Surgeons, Prof. Owen. He recognized it as the bone of a bird of gigantic proportions. Bones were found

in New Zealand (whence the specimen came) of the same character as the fragment. These, when put together, revealed the skeleton of an ostrich like bird of the proportions supposed. To this was given the name *Dinornis giganteus*. Of this we saw a fine specimen in the New Zealand court of the Centennial Exhibition.

As we would expect, Sir Julius Haast of the Museum of Canterbury, Christ Church, the Commissioner of New Zealand, had a fine display of skeletons at the Colonial and Indian Exhibition, and also the egg of a moa, the last of the giants. The first skeleton with the specimen bone is now in the museum of the Royal College of Surgeons. Other museums on both sides of the Atlantic have been enriched by the generosity of Sir Julius. Our own museum has the greater part of a skeleton of *Dinornis giganteus*, and an almost whole skeleton of *Dinornis cassuarius*, the smallest of the giants, with leg bones of *Dinornis elephantopus*, *Dinornis didiformis*, *Dinornis rheides*. The race became extinct at no distant time. They were probably destroyed by the Maories.

At the Paris Exhibition, 1867, there were exhibited in the Venezuela department of the Argentine Republic two eggs (shells) of the gigantic *Aepyornis* of Madagascar. Each was over a foot in diameter. Plaster casts of similar eggs are to be seen in the Natural History Museum, South Kensington. The eggs of the *Aepyornis* would not be pigmacan beside the Roc's egg of Sinbad's Adventures in the "Thousand and One Nights," of the Arabian Story Teller.

59. The earliest authentic record we have of the existence of giants of the human race, is the Biblical. In Genesis, chapter vi., verse 4, we read: "The Nephilim were in the earth in those days," that is in the post-glacial and pre-diluvian period. In the post-diluvial we have other Nephilim. We read in Numbers, chapter xiii., verse 32, of "men of stature," verse 33. The Nephilim, sons of 'anak, of the Nephilim. In Deut., chapter ii., verse 10, we have "the Emim, a people great and many, and tall as the 'anakim." Verses 20, 21, "The Zamzummin, a people great and many, and tall as the 'anakim."

In Deut. 2: 11, we have "Og, king of Bashan, of the remnant of the Rephaim." Some old authors have connected the last with the Titans of Greek and Roman mythology. The pre-diluvial Nephilim may have frequented the caves of Europe in which the last of the mammoths are found, and they may have been the "mound-builders" of America. We are farther informed that "there are none of the 'anakim left only in Gaza, Gath, Ashdod," of Philistia. From Gath stalks forth Goliath, the champion of the army of the Philistines. He is the first whose height is given, six cubits and a span, *i. e.*, about 9 feet 9 inches. He had two sons and a brother, who were also "men of stature." In later history we notice other giants. Pliny says: "The tallest man that hath been seen in our days was one named Gabara who, in the days of Claudius the late Emperor, was brought out of Arabia. He was 9 feet 9 inches." Josephus mentions a Jew Eleazar whom the Emperor Vitellius sent to Rome. He was 10 feet 2 inches. Becanus saw a man nearly 10 feet in height. In the reign of James the First, there was a man named John Middleton, who was over 9 feet high. Dr. Plot, in his History of Staffordshire, tells of a man whose height was 9 feet 3 inches. His hand from the *carpus* to the end of the middle finger was 17 inches in length, and the breadth of his palms $8\frac{1}{2}$ inches. At l'Exposition de Paris, 1867, we saw Chang, the Chinese giant, walking about in the Champ de Mars. He towered head and shoulders above the surrounding multitude. Many others might be named. We would end the list with the stalwart Cape Bretoner, Angus McAskill, whose height is said to have been 7 feet 9 inches, and his strength very great. One of his feats caused decrepitude and a premature end.

FICTION.

60. The term Giant is of Greek origin. In the mythology of Greece and Rome we read of the Titans (Rephaim?) making war with the Gods, suffering defeat and condign punishment. Their relations, the gigantes (giants) incensed thereat, in turn made war with Jupiter in order to dethrone him. In alarm he called the other gods to his assistance. The giants in their

warfare hurled rocks of vast magnitude; some of these fell into the sea and became islands; others falling on the land became huge mountains. They attempted to scale the heaven by piling Mount Ossa on Mount Pelion. The gods were frightened. Some of them fled to Egypt and assumed the shapes of animals. Jupiter, by the advice of Minerva, summoned Hercules to his aid. He then hurled at them his thunderbolts. Hercules rendered effective assistance with his club. The giants were defeated. Some were crushed under mountains, others were buried in the sea.

TANGIER GIANT.

In Tangier town as I've been tauld,
There lived intil the time of auld,
A giant stout and big,
The stateliest and the dourest carl,
That e'er on this side of the warl,
Has wallop'd bane or leg.

His horse was a mammoth. On this he careered up and down the earth. Riding toward the North Pole he stuck fast in the Arctic ice, and so ended his career.

MORAL.

From this dour giant you may see,
How little mighty limb and thle,
The human race bestead.
A wee bit man wi' muckle sense,
Is better than a carl immense,
Wi' nonsense in his head.

St. Mary's College, St. Andrews, Scotland, 1835. } By Wm. Tennant, (late)
Prof. of Oriental Languages,
author of "Anster Fair," and
other Poems.

FICTION.

61. To find the *proper* Pigmy we must again have recourse to Greek mythology. This tells us of their existence, their country, their habits, occupations, and disasters. We are informed by some that the *Pygmaioi* were a nation of dwarfs in the extreme parts of India. Others affirm that they lived

in Ethiopia. Some say that they were no more than one foot high, and that they built their houses with egg shells. Aristotle says that they lived in holes under the earth, and that they came out in the harvest time with hatchets to cut the grain, as if it were a forest. They rode on goats and lambs of proportionable stature, to make war upon certain birds, called cranes (Gr. *Geranoi*), which came yearly from Scythia to plunder them. The latter were originally governed by *Geranà*, a princess who was changed into a crane, for boasting that she was fairer than Juno. The battles of the "Pigmies and Cranes" were disastrous to the former. The Pigmies were exterminated. These wars are pictorially represented on ancient vases, and they are often referred to by classical writers. Thus Homer, in his *Iliad*, Book III., lines 3, 4, 5, 6, compares the mustering of the Greeks to battle against Troy :

* * * * *

" As when the Cranes
Fleeing the wintery storms, send forth on high,
Their dissonant clamours, while o'er the ocean stream,
They steer their course and on their pinions bear,
Battle and death to the Pigmaean race.—*Derby's Translation.*

MORAL.

" Pigmies are pigmies still, though perched on Alps,
And pyramids are pyramids in vales."—*Pope.*

SYNOPTICAL TABLE

OF

GEOLOGICAL FORMATIONS,

TO ILLUSTRATE

"GIANTS AND PIGMIES."

SPECIAL.		GENERAL.		SPECIAL.
<i>Nova Scotia and New Brunswick.</i>				<i>Egypt. Palestine. Bible.</i>
15. Recent.		15. Recent.		15. Recent. }
14. Champlain.		14. Champlain. }	<i>Pleis-</i>	14. Diluvial. }
13. Glacial.		13. Glacial. }	<i>tocene.</i>	13. * * * }
Break in succession.		12. Pliocene.	<i>Descending</i>	12. Pliocene. }
		11. Miocene.		11. Miocene. }
		10. Eocene.		10. Eocene. }
		9. Cretaceous.		9. Cretaceous }
7. Triassic.		8. Jurassic.		Triassic (<i>Egypt</i>)
6. Permian ?		7. Triassic.		(Bauerman.)
5. Carboniferous.		6. Permian.		Carboniferous
4. Old Red Sandstone		5. Carboniferous		(<i>Palest.</i>)
or		4. Old Red Sandstone		(<i>Hull.</i>)
Devonian.		or		"Nature."
3. Silurian.		Devonian.		
2. Cambrian.		3. Silurian.		
1. Archaean.		2. Cambrian.		
		1. Archaean.		
				1. Archaean.