GASTEROPODA.

Dentalium priscum, *Goldf.*	Grey marine shale,	Inkerman
Loxonema scalaroidea, *Phill.*	Do.	do.
Macrocheilus imbricatus, *Sow.*	Do.	do.
Murchisonia striatula, *De Kon.*	Do.	Govan pits.
Naticopsis Omaliana, *De Kon.*	Do.	Dalry pits.
Eulima Phillipsiana, *De Kon.*	Do.	do.
Pleurotomaria granulata, *De Kon.*	Do.	Inkerman pits.

GASTEROPODA (NUCLEOBRANCHIATA).

Bellerophon decussatus, *Flem.*	Grey marine shale;	Dalry pits.
——— Dumontii, *D'Orb.*	Do.	Inkerman pits.
——— Urii, *Flem.*	Do.	do.

CEPHALOPODA.

Nautilus tetragonus, *Phill.*	Do.	do.
Orthoceras attenuatum, *Flem.*	Do.	do.
Goniatites, *sp. ?*	Govan ironstone;	Dalry pits.

PISCES.

Rhizodus Hibberti, *Ag.*	Teeth and portions of jaws, do.

NOTE.—The foregoing list embraces all the organisms that I know to have been found in the Possil and Govan coal and ironstone series, but I have hopes of the list being extended, when a more exhaustive search is made amongst the various beds passed through in the sinking of new pits, or amongst the waste shale heaps at the pit mouths, which is the only opportunity we have of obtaining fossils from this group of strata.

XIX. *Notes on the* OCCURRENCE OF SEEDS OF FRESHWATER PLANTS AND ARCTIC SHELLS, *along with the remains of* THE MAMMOTH AND REINDEER, *in beds under the* BOULDER-CLAY *at* KILMAURS. By Messrs. JOHN YOUNG *and* ROBERT CRAIG.

(Read April 1, 1869.)

THE remarks which we have to bring before the Society this evening are upon certain organisms recently found in strata that underlies the Boulder-clay at Kilmaurs, near to Kilmarnock. Ever since the discovery, in the year 1816, of the remains of the Mammoth, *Elephas primigenius*, and the Reindeer, *Cervus tarandus*, at the Woodhill quarry, Kilmaurs, these beds and their remains have

attracted the attention of nearly every writer on Scottish post-tertiary geology. Since the period of the first discovery, some nine or ten tusks and a portion of a molar tooth had been found, along with horns of the Reindeer. Two of the tusks and the horns of the Reindeer are preserved in the Hunterian Museum, University of Glasgow. These remains were at one time referred to the Till or drift. Mr. A. Geikie says,[1] "It is singular that in this little Ayrshire valley, within the compass of a few yards, there should occur a greater number of mammalian remains than have been obtained from the drift of all the rest of Scotland; and that among these there should be well-preserved relics of the only two mammals which have yet been ascertained, beyond a doubt, to have inhabited Scotland during the drift period."

Dr. James Bryce,[2] a few years ago, however, having become satisfied of the unfossiliferous nature of this deposit as it exists in the West of Scotland, made an examination of the Kilmaurs beds; and from information obtained from parties who had formerly worked in the old quarry, and from a new section of its face opened up for him, was at last able to show clearly that the remains of the Mammoth and the Reindeer were not found in the Boulder-clay, but in certain thin beds underlying the Till, superimposed upon the carboniferous strata of the Woodhill quarry. The following is the section of the quarry given by Dr. Bryce in his paper, showing the thickness and nature of the beds, as seen in ascending series :—

"1.—Carboniferous sandstone, terminating upwards in beds of sandy-clay resembling a fire-clay.

2.—Hard gravel, with a little clay and small bits of round, smooth stones, most of them quartz and trap, but all free from striation. There are also many white and grey spots, and small decomposing lumps of sandstone and limestone, often with an unctuous feel, as if containing steatite. The mass has something of the look of an artificial cement—a resemblance noted by all the men who speak of it as if 'run together.' Thickness—2 feet.

3.—A fine dark-blue clay, with occasionally small bits of

[1] Glacial Drift of Scotland. Trans. Geol. Soc. of Glas., Vol. I., Part II. 1863, p. 71.

[2] On the Occurrence of Beds in the West of Scotland beneath the Boulder Clay. By James Bryce, M.A., LL.D., F.G.S. Quart. Journ. Geol. Soc. Vol. XXI. 1865; p. 213.

quartz and other pebbles, extremely distinct in character. Thickness—9 inches.

4.—Sand, irregular in structure; very fine in places, and again coarse, approaching gravel, very like river-sand. 6 to 18 inches.

5. — Boulder-clay of reddish-brown colour, very tough and unworkable, full of large boulders and smaller stones, mostly smooth, polished, and striated; bits of coal-shale covered with striations, not crushed. 16 feet.

6.—Upper drifts, with stones, but much more open in texture, no striations. 20 feet.

7.—Subsoil and surface soil."

The important point which Dr. Bryce established by opening up the face of the quarry, was, that there lay under the Boulder-clay certain strata dissimilar in character from the Till; and that it was in these beds that the organisms were reported as having been found in former years. On this occasion no remains were found, but any disappointment that may have been felt on this score, was, we think, fully compensated by establishing the relation of these beds to the overlying Boulder-clay of the district. Besides the mammalian remains found in the Woodhill quarry, specimens of various genera of marine shells were reported as having occurred in the same beds, but unfortunately, as none of them were ever correctly identified, no satisfactory opinion could afterwards be formed either as to their true character, or whether the shells lay in the same bed with the tusks and horns, or in the bed above. From Dr. Bryce's paper, we learn that he is inclined to place the shells in the sand-bed, No. 4 of his section, and the mammalian remains in bed No. 3. He says, "Now all the men who had been connected with the quarry at any of the times when fossils were found, agreed in placing them below the 'hard and tough Till,' which was never known by them to contain anything but large and small stones, and in referring them to the two beds below it, the sand and clay over the gravel—that is, the beds Nos. 3 and 4. Of these, the sand-bed No. 4 was stated to be most irregular in its development, occurring rather in 'nests' than as a continuous bed under the Till throughout the whole extent of the workings. This bed, indeed, even through the limited extent to which I traced it in searching for shells, varied much: it seemed thinning out southwards, while northwards it increased in thick-

ness from 6 to 18 inches. This bed was the chief repository of the shells, the clay below it that of the Elephant-remains; between them, and partly imbedded in the clay, the horn of the Reindeer, with a portion of the skull attached, was found, further forward in the cutting, and later than the Elephants' bones, but the geological horizon was exactly the same."

After bringing forth some other evidence against the idea of these beds belonging to the Boulder-clay period, Dr. Bryce concludes his paper by saying,—"The abundance of Mammoth remains suggests a correspondence with the Cromer forest-bed of the Norfolk coast, the chief repository of the remains of this species, though they occur also rarely in beds above the Boulder-clay. It is not meant, however, that our deposit is not a member of the Glacial series, for the Boulder-clay merely marks the climax reached by refrigerating causes which had long operated. It is only intended in the meantime to indicate an analogy: the facts do not warrant an attempt at classification. Another analogy with the English series is presented by the estuarine character of the Kilmaurs deposit. The beds of sand, sandy-gravel, and clay underneath the Till, have all the characters of such a deposit, or one formed near a river-mouth on the sea-shore. This opinion, formed on the first inspection of the section, was afterwards confirmed by chemical examination of the sand, in which a small quantity of common salt was detected. The Woodhill quarry is 90 feet above the level of the sea, and five miles distant from it in a direct line."

We have quoted these passages from Dr. Bryce's interesting paper to show the conclusions at which he had arrived, and the amount of evidence that we possessed regarding these beds and their fossils, previous to the discoveries which we have now to bring before you. These consist, in the first case, of the remains of the seeds of freshwater plants and insects, found along with the tusks of the Mammoth, and horns of the Reindeer, in bed No. 3 of Dr. Bryce's section; and in the second case, of the remains of certain species of arctic shells, etc., found in the recent sinking of one or two pits for coal at Kilmaurs; the shells being found in the sand-bed No. 4, under the Boulder-clay.

In the year 1829, on the 4th of Dec., a tusk of the Mammoth, and a pair of horns of the Reindeer, were found in the Woodhill quarry. These specimens were presented to the Hunterian Museum by Thomas Fulton, Esq., at that time proprietor of Greenhill, the

property on which the quarry is situated.[1] The card attached to these remains states that they were found at a depth of 34 feet from the surface, imbedded in diluvium or Till; but there is no mention of any shells having been found along with them. Fortunately, a portion of the sandy-clay in which some of the smaller fragments of the horns of the Reindeer were imbedded, was also sent to the Museum, and the clay was not all cleaned away from the cracks and crevices in the tusk. Recently it occurred to us, that if a bit of this clay was carefully washed it might be got to tell its story, like other clays in our neighbourhood, both glacial and carboniferous. A small piece about the size of a duck egg was, therefore, allowed to dissolve in water. After a while, we found numerous brown organisms floating on the surface.—These proved to be the seed-cases of several species of freshwater plants. The material, on being washed free of the brown clay, was carefully dried, and, on being searched, it yielded upwards of 300 seed-cases, and seeds of plants, the most abundant of which being a species of *Potamogeton* and *Ranunculus*, along with a few seeds of *Hippuris*. Altogether, some five or six species of seeds were found, one or two of which have not yet been determined.

To satisfy ourselves that the horns and the tusk came out of the same bed, we washed some of the sandy-clay picked out from the crevices in the tusk, and found more of the same species of seeds; also the wing-case and thorax of a small beetle. A careful search failed to reveal any other organisms, either freshwater or marine. We were satisfied that the deposit in which the tusk

[1] NOTE.—All the tusks of the Mammoth and horns of the Reindeer seem to have been found at the old Woodhill quarry, which has been abandoned for many years, owing to the great expense of removing the rapidly increasing thickness of surface drift and Boulder-clay lying over the sandstone rock.

There is, however, a little obscurity regarding the exact locality of one of the two tusks in the Hunterian Museum. The old card attached to the specimen has the following written upon it—"Tusk of the Fossil Elephant found in diluvium in the neighbourhood of Kilmarnock. Presented by Thomas Morton, Esq., Kilmarnock." As Kilmaurs is in the neighbourhood of Kilmarnock, we can only reasonably infer that it is one of the nine tusks said to have been found in the Woodhill quarry. The ivory in this tusk is wonderfully well-preserved, a portion of the larger end being sawn off, evidently for the purpose of being used in the manufacture of some article. The following are its present dimensions:—Length, 26½ inches; curve of tusk in the same length, 3 inches; circumference, large end, 11¾ inches—smaller end, 8¼ inches. The ivory in the tusk presented by Mr. Fulton is very much decayed, its dimensions are as follows:—Length, 32 inches; curve, 3¼ inches; circumference, large end, 12¾ inches—small end, 11½ inches. The Reindeer horns found along with this tusk have been broken into a number of pieces. The longest portion when put together measures 33 inches in length, and its circumference, one inch above the burr, 5 inches. The horns have evidently belonged to a large and well-grown animal. There is also a toe-bone of apparently the same deer in the collection.

and the horns were imbedded was of freshwater origin, and quite distinct from that said to contain the marine shells.

The recent discovery of other marine shells in the Kilmaurs beds is due to our having lately been at Kilmarnock; and while there we learned that in a new pit (No. 9, Woodhill, Kilmaurs), shells had been found by the pit-sinkers. On hastening to the spot we found that the sand-bed in which the shells were discovered had been covered up by the later materials brought out of the pit, so that none were now to be obtained, and the pit was so closely boarded down its sides that none of the sand could be picked out from the seams. We were, however, fortunate in obtaining from Mr. Yates, Jun., the manager of the pit, all the examples of the shells which he still retained in his possession. These he has kindly presented to the Hunterian Museum, to be placed alongside the other Kilmaurs organisms. Other shells went into the hands of various parties about Kilmarnock, which we were unable to trace. The shells presented by Mr Yates consist of the following species :—

Natica Grœnlandica, two small specimens.
N. clausa ? fragment of large shell.
Littorina littorea ? fragment of pillar lip.
Cyprina Islandica, nine fragments.
Astarte sulcata, two perfect valves, four fragments.
A. compressa, three perfect valves, two fragments.
Tellina calcarea, three fragments.
Leda oblonga, four fragments.
Pecten Islandicus, three fragments.
Balanus porcatus ? two fragments.

This new pit in which the above shells were obtained is about one half mile distant from the old Woodhill quarry, where the shells were formerly found. The sand-bed in which they occur is of a light reddish-brown colour, exactly like the sea-sand on the neighbouring Ayrshire coast. It lies under 50 feet of surface drift and Boulder-clay. Mr. Yates states that the surface beds in the pit are as follows :—

Surface drift and Boulder-clay, 50 feet.
Sand-bed containing arctic marine shells, 1 foot 3 inches.
Sandy peaty-clay, about 1 foot.
Coarse gravelly sand, 1 foot 6 inches.
Carboniferous strata.

It will be perceived that this section agrees very closely with that of the Woodhill quarry, as stated by Dr Bryce; and in all the other pits and bores previously put down in this district, we have learned that wherever the surface beds under the Boulder-clay have escaped denudation, their character and relation to each other is always as distinct as in the foregoing sections quoted. The bed of "sandy peaty-clay" has been noticed in several of the other pits and bores, but none of it has been searched for organisms. We are satisfied, however, that it is the same as bed No. 3 at Woodhill quarry, yielding the seeds of the freshwater plants; and from the character which the borers and pit-sinkers give it, it is evident that this deposit is mixed up with a considerable amount of vegetable matter at several places in the district.

In a new pit at present being put down at Woodhill, Kilmaurs, by Mr. Yates, about 250 yards south-east from No. 9 pit, where the above-mentioned shells were found, the sand-bed was 5 feet in thickness. Mr. Yates has kindly furnished the following section of the surface beds:—

Surface drift and Boulder-clay, 42 feet.
Sand-bed, 5 feet.
Clay-shale forming the roof of the "Major-Coal."

In this pit the gravel-bed and peaty-clay were off. Mr. Yates informed us that the only trace of the peaty-bed that existed, was near the bottom of the sand-bed, where it became blacker and softer, but there was no clay. In No. 9 pit, the workmen stated that shells were common in the sand-bed. In this pit, however, none were observed; but in the washing of a small quantity of the sand, after it had been taken out of the pit, by Mr. David Robertson and ourselves, the following organisms were found:—*Astarte compressa*, fragment of one valve; *Leda pygmæa*, fragments of the hinge portion of the shell, *Polystomella striato-punctata*, *P. arctica*, *Biloculina elongata*, *Lagena marginata*, var. *L. sulcata*, *Cythere concinna*, and *Cytheridea punctillata*. A few seeds of *Potamogeton*, *Ranunculus*, etc., were also obtained, which show that the peaty-bed, mentioned by Mr. Yates, is not entirely awanting at the bottom of the sand-bed, as indicated by the seeds of these freshwater plants. Their occurrence, in the same washings, along with the marine organisms, can in this case be easily explained by the fact

that the bed of sand had lain for some weeks at the pit mouth ere any of it had been collected by us, and during that time the various portions of the bed had got mixed together. The finding of the above organisms in this new pit clearly establishes the relation of the sand and peaty-bed with that of the other pits and the quarry, but they do not seem to be equally distributed in these beds over the district.

We have taken considerable pains in tracing, from bores and pit sections, the extent of these beds under the Boulder-clay of the Kilmaurs district, and we find that they are of a very irregular character. At old Woodhill quarry, and No. 9 pit, we have seen that all the beds were on; at the present sandstone quarry, and in other pits and bores the beds are off, the overlying Boulder-clay resting at these latter points directly upon the carboniferous strata, without any intervening sand or gravel beds. Another interesting fact which we have obtained information about goes to prove that the lower gravel and sandy-clay beds, Nos. 2 and 3 of Dr Bryce's section, had suffered denudation over certain tracts in the above district, before the bed of sea-sand with the marine shells was deposited.

This sand-bed is extremely variable in the district. In pursuing our investigations regarding it, we were much indebted to A. Finnie, Esq., coal master, Kilmarnock, for kindly furnishing sections of the surface strata in pits wrought by him on the lands of Annandale, Kilmarnock. These pits lie from one half mile to a mile south, and south-west from Woodhill. In some of them the sand-bed was found from twenty to thirty feet in thickness, while in others it was entirely absent, the Boulder-clay being found resting on the coal strata. Mr. Gilmour, underground manager of one of the pits at Crosshouse, informed us, that in one of the pits put down some thirty years ago, shells were got in sinking through this sand, but no record was ever made of their discovery at this point.

The following statement, furnished by the sections in nine of Mr. Finnie's pits, shows where the sand-bed and peat-bed is off or on, also the great thickness of the surface drift and Boulder-clay in several of the pits :—

No. 1.	Surface drift, and Boulder-clay, sand, and peaty-clay. *Shells found here.*		
No. 2.	Do.	do.	84 feet; sand-bed, 30 feet.
No. 3.	Do.	do.	86 feet.
No. 4.	Do.	do.	80 feet; sand-bed, 15 feet.
No. 5.	Do.	do.	sand-bed, 20 feet.
No. 6.	Do.	do.	60 feet; sand-bed, 10 feet.
No. 7.	Do.	do.	40 feet; sand-bed, 4½ feet; peaty-clay and gravel.
No. 8.	Do.	do.	
No. 9.	Do.	do.	60 feet; sand-bed, 20 feet.

In two of the pits we were unable to get the exact thickness of the surface drift and Boulder-clay. Mr. Finnie informed us that in No. 3 pit there were found at the bottom of the Boulder-clay, and resting on the carboniferous sandstone, a great number of large water-worn stones with gravel. These stones, he stated, had all the appearance of having formed part of an old river bottom. He had noticed the same phenomenon at the bottom of the Boulder-clay in some of the other pits, and had come to the conclusion that they lay in the course of some old pre-glacial river that once existed in that district.

The upper surface drifts, composed of comparatively loose gravels and sands, are of considerable thickness, and have evidently been formed out of a rewash of the various materials composing the Boulder-clay, which is seen to have suffered extensive denudation at many places in the Kilmaurs district ere these sands and gravels were deposited. In no instance have we found any evidence of stratified beds of gravel or sand in the Boulder-clay of the Carmel valley, which might in any way be held to favour the opinion that the bed of peaty sand, in which the seeds and mammalian remains were found, as well as the sand-bed with arctic marine shells, were of inter-glacial origin. A bed of stony clay, reported in one or two bores, as lying beneath the sand and gravel beds, is seen in Mr. Yates' new pit to be a very light-coloured, rotted carboniferous shale, with hard nodules, forming the roof of the "major coal." The whole of the evidence which we have obtained points rather to the Carmel, being a pre-glacial valley, in which we had two sets of strata laid down ere the Boulder-clay of the district was deposited over them. The beds of gravel and sandy peaty-clay, containing the seeds of the freshwater plants and mammalian remains, Nos. 2 and 3 of Dr. Bryce's section, we consider as either of lacustrine

or estuarine origin. The bed of sand with arctic marine shells, which overlies those beds, clearly shows that the district was depressed under sea-level before it was deposited, and we have further evidence that in the interval these freshwater beds had suffered denudation over certain tracts, the bed of marine sand being found resting on the carboniferous strata. The next part of the evidence obtained from the pits and bores show that both the freshwater and marine beds had suffered denudation at other points in the district before the deposition of the Boulder-clay.

In bringing these remarks to a close, we have only to observe that the evidence gained by our recent discoveries, beyond what was formerly known, tends to establish in a clear manner the existence of two sets of strata of different origin and age under the Boulder-clay of the Carmel valley at Kilmaurs—the lower being of freshwater origin; the upper, an arctic marine deposit. Without giving a decided expression as to the particular age of either deposit, we are, however, inclined to view them as pre-glacial remnants of the oldest post-tertiary beds yet discovered in the west of Scotland, and from the character of the organisms, marking, as it were, the dawn of the glacial period in this country.

NOTE. — Since this paper was read, there has appeared a paper by Mr. W. Boyd Dawkins,[1] in which he places, to our surprise, the remains of the Mammoth and Reindeer found at Kilmaurs in his post-glacial series, or in beds more recent than the Boulder-clay period; while at the same time, from the reference he makes to the papers of Dr. Bryce, he was fully aware that these remains were found in strata that underlie the Boulder-clay of that district. Mr. Dawkins, while speaking of the Mammoth, states (p. 208) that it was found "in a deposit of sand and clay which has been proved by Dr. Bryce to underlie the Till. Antlers of Reindeer have also been obtained from the same stratum and are now deposited in the Hunterian Museum, Glasgow." After making this statement, we can hardly conceive what motive could have induced Mr. Dawkins to place them in his post-glacial series, except it be that he does not admit either the Mammoth or Reindeer into his British pre-glacial series.

[1] On the Distribution of the British Post-glacial Mammals. By W. Boyd Dawkins, Esq., M.A., F.R.S., F.G.S. Quart. Jour. Geol. Soc., vol. xxv., No. 98, May 1, 1869, p. 192.

Mr. Dawkins gives a list of pre-glacial mammals (page 210), and says:—"To this list Dr. Falconer would add the Mammoth; but a careful investigation into the evidence which was supposed to establish its pre-glacial age has convinced me that the inference is faulty." Surely Mr. Dawkins, in making this statement, either overlooks the evidence afforded by the Kilmaurs specimens, or does not understand the character and true geological position of the Boulder-clay of Scotland, when he refers remains found under that deposit to a post-glacial period. We think that if we look at all the recorded instances of the occurrence of the Mammoth and Reindeer in Scotland, we will find that in the majority of cases they either have been found in beds under the Boulder-clay, or in that deposit itself. Those found in the Boulder-clay may have been derived from the denudation of pre-glacial beds, and in the one or two instances where the Mammoth has been found in beds more recent than the Till, they still may have been washed out of earlier deposits. The Reindeer in Scotland has had a longer life-range than the Mammoth, having existed down to historic times.

Bearing upon the pre-glacial age of the Reindeer in Scotland, we would notice here a portion of the right antler of a Reindeer found in the Boulder-clay at Raes Gill, Carluke, Lanarkshire. This specimen bears evident marks of transportation, its burr, brow-tyne, and other extremities being worn and rounded; and the whole surface has a smooth, polished, ice-scratched appearance, exactly like what we meet with amongst the ice-worn stones of the Till.

This interesting relic was found by the workmen while they were removing the Boulder-clay from the surface of the Raes Gill ironstones, the Till being several yards in thickness at the spot where it was found. It has been in the possession of Mr. William Grossart, surgeon, one of the Society's corresponding members for twenty years, and was lately presented by him to the Hunterian Museum. Independently of the ice-worn appearance of the horn, Mr. Grossart was not likely to mistake the nature of the deposit in which it was found, as from an earlier period he had been collecting the fossils of that district.

There is one other statement in Mr. Dawkins' paper to which we wish to take exception. At page 208, he says:—"The remarkable fact that these two animals—viz., the Mammoth and

Reindeer—were derived from beds underneath the Till does not imply that Scotland has been submerged since they lived in that country, for it is very probable, as Mr. Geikie has shown,[1] that the Till in some places is the result of the melting of land-ice, and not of icebergs floating on the sea." This statement is now entirely negatived by the discovery of arctic marine shells in the sand-bed overlying that containing the mammalian remains at Kilmaurs. Besides, we think there is plenty of evidence, other than palæontological, to prove that the low-lying districts of Scotland were depressed under the level of the sea to a period as late as the formation of the arctic shell-beds of the Firth of Clyde, and, more recent, raised beach shell-beds, both of which are clearly seen to overlie the Till at various heights above the present sea-level. Such being the case, we think it is clear that the land has suffered a long submergence under the sea, since the Mammoth and Reindeer existed in the pre-glacial valley of the Carmel at Kilmaurs.

XX. *The* Post-Tertiary Fossiliferous Beds of Scotland. By Rev. Henry W. Crosskey, F.G.S., and Mr. David Robertson, F.G.S.

(Continued from Part I., page 129.)

VI.—EAST TARBERT—LOCH FYNE.

On the north side of Tarbert Loch, at the north-east corner, where the bay bends southwards, a small stream, called the Black burn, comes down and cuts into a bed of clay containing arctic shells, which can be traced from 12 to 15 feet above high-water mark.

The shell bearing bed, which is of a light grey colour, lies at an incline of 1 foot in 10, and is overlaid by 5 or 6 feet of brown stony mould, which appears to have been washed down from the hill side. In washing through a sieve of 96 meshes to the inch, 100 parts of the dry material lost 30; while 10 parts of the residue were retained in a sieve of $\frac{1}{8}$-inch mesh, and consisted of coarse

[1] Trans. Geol. Soc., Glasgow, Vol. I., Part II., p. 70; Quart. Journ. Geol. Soc., Vol. xxi., p. 213.