they have been determined. There are a few plants belonging to the list requiring special notice, as being rare and probably new forms. In the slaty-band, which appears to have been a stagnant pool, abundance of confervoid-looking plants are met with, consisting of clusters of long narrow tubes about the twentieth part of an inch in diameter, resembling our recent *Conjugatae*, but no appearance of joints or cell-divisions have been detected in the filaments. Also a plant resembling the genus *Chara*, which may probably be *Asterophyllites charaformis*. In this iron-stone other plant remains are abundant, especially *Lepidostrophi*, often measuring fully a foot in length. Some of these are found uncompressed, having a diameter of an inch and quarter. In clay shale above Shotts smithy-coal I find a reedy-looking plant, a specimen before me measures three feet in length, tapering, striated longitudinally, but without joints. In a micaceous sandy fire-clay above Drumgray coal, I find what appears to have been seed-vessels, and apparently of two different species; one measures $2\frac{1}{2}$ inches long by 1-10th broad, slightly dilated in the middle, the one end a little wider than the other. Another measures 3 inches long by 6-10ths wide, and of equal breadth throughout. These are all compressed, with a surface apparently smooth, their outline clearly defined, with no apparent fracture. *Asterophyllites foliosus* and *galioides*. *Calamites approximatus*, *C. cannaeformis*, *C. nodosus*. *Cardiocarpum*, one species. *Cyclopteris*, several species. *Halonina*, one species. *Lepidodendron dilatatum*, *L. elegans*, *L. gracile*, *L. Sternbergii*. *Lepidophyllum lanceolatum*. *Lepidostrobus ornatus*, *L. variabilis*. *Lycopodites*, one species. *Lyginodendron Landsburgii*. *Neuropteris*, several species. *Alethopteris lynchitica*. *Sigillaria oculata*, *L. organum*, *L. reniformis*, *L. Saullii*, *L. tessellata*. *Sphenopteris dilatata*, and a few more species, *Ulodendron Lindleyanum*, *L. majus* and *L. minus*. *Walchia*, one species. There are still a great many more species of plant remains which I have not been able to get named.

VIII.—THE POST-TERTIARY FOSSILIFEROUS BEDS OF SCOTLAND.

By Rev. HENRY W. CROSSKEY, F.G.S., and Mr. DAVID ROBERTSON.

(Continued from Vol. ii., page 282.—Read March 26, 1868.)

II.—CUMBRAE COLLEGE.

DURING the sinking of a water tank (1867), a bed of shell-bearing sand was exposed near the College, in the Isle of Cumbrae, which must be classed with the older Arctic deposits of the West of Scotland. We were kindly apprised of its existence by Mr. Levack, and found the depth of excavations reached to be 7 feet, with the following succession of deposits:—

Earth mould,	$1\frac{1}{2}$ feet.
Gravel,	4 feet.
Shell-bearing sand,	$1\frac{1}{2}$ feet (not pierced through).

The elevation (obligingly taken for us by Mr. James Brown, Engineer, Millport) is 32 feet 9 inches above high water level; and the bed occurs at a distance of about 200 yards from the shore, measuring from the high tide mark.

The excavation was made on the road side, a little north of the College gate, upon the flat of slightly elevated ground, on which the residence of the Hon. Mr. Boyle (termed the "Garrison") is built. On parts of this flat ground beds of Nullipore are met with, belonging to an old sea beach, and covered by a few inches of mould, which has the appearance of being a late addition for agricultural purposes. The Nullipore, however, is remarkable, since it is not now found in the adjoining bay.

The shell-bed reached during the workings, which we propose to term the Cumbrae College Deposit, is remarkable among the glacial beds of the Clyde district, through containing so large a proportion of sand. Taking $7\frac{1}{2}$ lbs. of the dried material, only ten ounces washed away through a sieve of 96 threads to the inch, leaving 6 lbs. 14 oz. residue. Of this residue, 1 lb. is composed of gravel and broken shells, retained in a sieve of $\frac{1}{8}$ in. mesh. The fragments of rock are sandstone, quartz, trap, and schist; the larger pieces being mostly water-worn, while the smaller are generally angular or partially rounded. Some of the smooth stones appear to have been fractured in two; and the fractured surface is entirely unworn.

An additional interest is given to this bed by the presence of plates of an *Echinus*, exhibiting very marked peculiarities which have not, so far as we are aware, been hitherto described. We first observed them (1867) in the glacial shell-deposits at Uddevalla in Sweden; and in the Post-Glacial beds at Aafos and Ommedalsstrand near Skien in Norway; and have subsequently found them in very considerable abundance in the Cumbrae Deposit.

Our first impression was, that the singular sculpturing of these plates might arise from erosion; and we still regard this as a possible explanation. At the Cumbrae College, where these peculiar plates occur in such great abundance, we have not yet found a spine or oval plate distinguishable from *E. Dröbachiensis*.

Further, although the plates in many cases seem entire, betraying no obvious marks of decay, they have a dull and lustreless surface.

On the other hand, the plates of *Echinus Dröbachiensis* in the

same bed are in great abundance, and quite entire. The uniformity of the pattern, moreover, in the new plates is so complete and persistent, that it scarcely appears possible to attribute it to any accidental wearing. Neither can we observe in any plate of *E. Dröbachiensis* any tendency to wear in the same way; or any approximate wearings leading up to the peculiar form.

On forwarding specimens to Prof. Sars at Christiania, that eminent naturalist refers them to an undescribed species.

The following is an extract from the letter with which he favoured us:—

“The state of the ambulacral pores leaves no doubt that these plates belong to an *Echinus*, but of what genus or species I cannot say.

I thought for a moment that they might belong to *E. Dröbachiensis*, Müller, since they have more than three pairs of ambulacral pores arranged in arches; and that the peculiar sculpturing might derive its existence from decay. But on examining an old half decayed specimen of that species, I could not discover anything resembling their sculpture.

I have also compared with them all the species of Norwegian *Echinus* which I possess, but find no agreement. I must therefore confess that they belong to an *Echinus* wholly unknown to me—the first example of a species from the Quaternary Period, not now living on our coasts.”

The following is a description of the plates :—

ECHINUS——— ? Plate I.

Interambulacral plates; furnished with a primary tubercle, which is embossed round with a five sided ridge. The plate on each side of the tubercle is crossed by from three to five ridges, arrow-shaped on the one side and straight and wavy on the other. Two or three of the cross ridges bear small tubercles.

Ambulacral plate; furnished on one end with a curved row of five pair of pores. About the middle of the plate five narrow ridges run down, and terminate on reaching the pores. On the other end, the plate is crossed by two or three arrow-shaped ridges. One or two tubercles occur on each plate. Surface of the plates dull and without lustre.

We subjoin a catalogue of all the species we have ourselves collected from the Cumbræ College Deposit :—¹

¹ We have to acknowledge, as in previous papers, the kind help of Mr. J. G. Jeffreys with the Mollusca, and Mr. H. B. Brady with the Foraminifera.

F. Bett. del. et lith.

POST-TERTIARY ECHINODERMATA
From the Cumbræ College Bed

CONCHIFERA.

<i>Anomia ephippium</i> , Linn.	Moderately rare ; small.
————— var. <i>aculeata</i> .	Rare; small.
<i>Pecten Islandicus</i> , Müller.	Fragments only. The rarity of this shell is noticeable in a Clyde bed; although probably dependent on merely local conditions of the sea bottom.
<i>Mytilus edulis</i> , Linn.	Moderately rare; some specimens greatly arched, the curve of the concave being more noticeable than that of the convex ridge.
———— <i>modiolus</i> , Linn.	Moderately common; large; some specimens measure $6\frac{1}{2}$ by $2\frac{1}{2}$ inches.
<i>Nucula tennis</i> , Montagu.	Rare; fry.
———— var. <i>expansa</i> .	————
<i>Leda pygmea</i> , Münster.	Moderately rare; small.
———— var. <i>gibbosa</i> .	Rare.
<i>Axinus flexuosus</i> , Montagu.	Rare.
<i>Cardium fasciatum</i> , Montagu.	Rare.
———— <i>Norvegicum</i> , Spengler.	Rare; moderately large.
<i>Cyprina Islandica</i> , Linn.	Common; large; valves united.
<i>Tellina calcarea</i> , Chemnitz.	Common; large; valves united.
<i>Mactra subtruncata</i> , Da Costa.	Rare; mature.
<i>Mya truncata</i> , Linn.	Moderately common.
<i>Saxicava rugosa</i> , Linn.	Rare; fry.
<i>Pholas crispata</i> , Linn.	A few large fragments; superior in size to any now living on the shores of Cumbræ.

GASTEROPODA.

<i>Chiton</i> , ———?	Rare eroded plates; species doubtful.
<i>Tectura virginea</i> , Müller.	Rather rare; moderate size.
<i>Puncturella Noachina</i> , Linn.	Common.
<i>Trochus helycinus</i> , Fabricius.	Rare; young.
———— <i>Grænländicus</i> , Chemn.	Rare fragment of large specimen.
<i>Lacuna divaricata</i> , Fabricius.	Moderately rare.
———— <i>puteolus</i> , Turton.	Rather rare; imperfect examples.

<i>Littorina obtusata</i> , Linn.	Moderately common.
———— <i>limata</i> , Loven.	Rare; young.
———— <i>littorea</i> , Linn.	Common and large.
<i>Rissoa striata</i> , Adams.	Rather rare.
———— <i>parva</i> , Da Costa,	
———— var. <i>interrupta</i> .	Rather rare.
<i>Skenea planorbis</i> , Fabricius.	Moderately common.
<i>Homalogyra atomus</i> , Philippi.	Rare.
<i>Natica affinis</i> , Gmelin.	Rather rare and rather small.
<i>Cerithium reticulatum</i> , Da Costa.	Rare; fry.
<i>Purpura lapillus</i> , Linn.	Rather rare; moderately large.
<i>Buccinum undatum</i> , Linn.	Moderately common.
<i>Trophon truncatus</i> , Ström.	Rather rare.
<i>Fusus antiquus</i> , Linn.	Rare.
<i>Pleurotoma turricula</i> , Montagu.	Moderately common.
———— <i>pyramidalis</i> , Ström.	Rare.
———— <i>violacea</i> , Migh. & Ad.	Rare.
<i>Utriculus obtusus</i> , Montagu.	Moderately rare.
———— <i>hyalinus</i> , Turton.	Rare; fry.

POLYZOA.

<i>Lepralia Peachii</i> , Johnston.	Rare.
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CRUSTACEA.

<i>Balanus porcatus</i> , Da Costa.	Moderately common.
———— <i>crenatus</i> , Brng.	Common.
<i>Verruca Strömia</i> , Müller.	Moderately rare.
<i>Pagurus Bernhardus</i> .	Rare. A claw.

ECHINODERMATA.

<i>Echinus Dröbachiensis</i> , Müller.	Common. A few were dug out whole, but fell asunder in the attempt the workmen made to clean them.
<i>Echinus</i> , sp. nov. ?	Plates common. See plate I.

FORAMINIFERA.

Quinqueloculina seminulum, Linn.

————— *subrotunda*, Mont.

Lagena sulcata. W. & J.

———— *lævis*, Montagu.

———— *striata*, Mont.

———— *globosa*, Mont.

———— *marginata*, Mont.

————— new variety.

Lituola ——— (undescribed form).

Dentalina communis, D'Orb.

(elongate attenuated var.)

Polymorphina communis, W. & J.

————— *compressa*, D'Orb.

Bulimina marginata, D'Orb.

Cassidulina crassa, D'Orb.

Truncatulina lobatula, Walker.

Nonionina asterizans.

III.—LOCH GILP.

The burn in the excavated banks of which the shell clay is found, begins in the marshy ground west of Baden farm head. A few years ago this burn was deepened, bringing into view, here and there, shell-bearing deposits variously overlaid by gravelly, peaty, and earthly matter, to the depth of 5 to 10 feet.

About 20 yards below the bridge, crossing the Crinan Road to Lochgilphead, there is a patch of shell clay exposed. None appears again for two or three hundred yards, when another patch is reached on the side of the same stream. It reappears at several other points, and may be traced for some distance above Baden farm.

Beneath the shell clay is the true boulder clay—hard, compact, and with the following characteristics :—

(1) It is tinged with the bluish hue of the surrounding trap rocks.

(2) It is exceedingly irregular in thickness, and curves violently within a few yards.

(3) The boulders are chiefly schist and greenstone, and very far travelled ; and finely striated, smoothed, and polished.

(4) It does not contain the slightest vestige of a shell.

This boulder clay rests upon greenstone rock, striated in horizontal or partly dipping grooves.

It is not succeeded by the usual laminated clay of the Clyde beds. A remarkable shell-bed rests immediately upon the boulder-clay.

The line of junction between the shell bed and boulder clay is sharp and well defined. There is no merging of the shell bed into boulder clay ; and no gradual transition. The separation is sharp, and in every way decisive.

Scarcely at any two places where the shells appear is the composition of the deposit alike. Some portions lose by washing about 10 per cent., and others about 60 per cent.

In some parts there is a thick blue clay ; in others, a mixture of clay and sand, varying from a sandy clay to a clayey sand.

On the north side of the burn, blue clay is overlaid with about a foot of gravelly clay, with boulders of various sizes thickly interspersed, not unlike a shore shingle. In this gravelly clay, *Mya truncata* is exceedingly plentiful in its natural boring position, with both valves united. The *Mya truncata* also occurs in the underlying blue clay more than a foot and a half lower down.

The burrow of this mollusc, however, never exceeds the half of that depth, and consequently the *Mya* of the upper bed could not have been contemporaneous with the *Mya* of the lower ; and we have the record of successive generations. This is a curious and interesting fact, illustrating the gradual nature of the elevatory movement during at least one part of the glacial epoch.

The fauna of the shell-bed is most abundant, but the grouping of the shells like the composition of the deposit, varies at different points. At one spot *Mya truncata* abound, the shells being thickly packed in a sandy matrix. At another, this shell is absent, and *Saxicava rugosa* stands in its natural position, and *Astarte borealis* is found with united valves. The smaller shells and even the Entomostraca equally vary in grouping at different points. We have in fact all those local varieties of *habitat* characterizing a sea-bottom. There is no sign of any confused sweeping of one part into another.

The occurrence of the shell-bed in patches may be due either to

the hummocky character of the surface of boulder clay, over which the shell-bearing deposit is spread, or to abrasion from above. Of the former, we have good illustrations in many of the brick fields near Paisley, where knolls of boulder clay rise up through the laminated clay, and at some places reach the surface. At West Barns brickfield, near Dunbar, the stratified clay rests on hummocks of sandy gravel. Of the process of abrasion from above, we have a good instance on the shore at high water mark, a little east of Helensburgh, where a patch of shell-bearing clay is lying in a rent or gully of boulder clay, and has been worn down to a level with the beach.

It has been already noted that *Mya Uddavallensis* occurs in its natural position. This shell may be collected in hundreds; and in many cases the syphon itself is preserved, although it rapidly decays on exposure to the air.

At one point the shell-bed dips under the stream; and it is exceedingly curious and instructive to see the bed of a fresh-water stream literally paved with the valves of *Mya*. This fact illustrates how marine and fresh water shells may have become mixed in past ages; and how shells of different epochs and implying entirely different climatic conditions may be found imbedded in the same strata.

At Lochgilp, in the present day, the remains of the existing animals of a fresh water burn are being mixed with the marine fauna of the glacial epoch.

Mya truncata occurs in every variety of form, leading up to *Mya Uddevallensis*, which is equally abundant. In fact, a series of specimens may be collected—some with the squat form and the deeply curved pallial line; others with the elongated form and the less deeply curved pallial line, characteristic of *M. Uddevallensis*, and others typical of the extremer types of both species. It is thus often difficult to tell to which so-called species a special specimen may belong.

A few boulders are scattered through the shell bed, but they are not, generally speaking, striated like those in the clay beneath, although grooved and polished specimens occasionally occur. The change is almost as great from striated to unstriated imbedded stones, as from the absence of a fauna to its abundant development.

The boulders in the shell bed are often covered with serpulæ, and evidently therefore must have been stationary during a certain

period, They are small in size compared with those in the clay beneath.

Above the shell bed in one locality is a patch of fine sand (2 to 3 ft.), destitute of organic remains ; and this is succeeded by a bed, of about the same depth, of ferruginous gravel.

The whole of these deposits, however, vary in thickness at different points in the section. In some places the sand thins out ; in others, the gravel disappears, and a mere bed of peaty or earthy matter is cast over the shells.

The section given by Mr. Geikie (Trans. Geol. Soc. of Glas., vol. i., p. 137), evidently refers to one spot immediately above the bridge. We subjoin a catalogue of all the species we have ourselves collected from the Lochgilp beds :—

VERTEBRATA.

Otolite of fish—species ? Rare.

CONCHIFERA.

<i>Anomia ephippium</i> , Linn.	Moderately common; small.
————— var. <i>aculeata</i> ,	Moderately rare; small.
————— var. <i>squamula</i> .	Moderately rare.
<i>Pecten Islandicus</i> , Müller.	Fragments only; moderately rare; some fragments belong to grown shells.
<i>Mytilus modiolus</i> , Linn.	Common at one or two points; large; much decomposed. Pearls common.
———— <i>edulis</i> , Linn.	Rare.
<i>Modiolaria discors</i> , Linn.	
————— var. <i>levigata</i> , Gray.	Rare; fry only.
<i>Nucula nucleus</i> , Linn.	Rather rare; full size.
———— <i>tenuis</i> , Montagu.	Rare; fry only.
<i>Leda pernula</i> , Müller.	Moderately common; an average size; valves united occasionally.
——— <i>pygmæa</i> , Münster,	Rare; young.
<i>Lepton nitidum</i> , Turton.	Rare.
<i>Montacuta elevata</i> , Stimpson.	Rare. Two valves only. This shell, identified by Mr. Jeffreys, is new to our glacial lists. It is distinguishable from <i>M. bidentata</i> ; and is not British.
<i>Axinus flexuosus</i> , Montagu.	

<i>Axinus flexuosus</i> , var. <i>Gouldii</i> .	Moderately common; full grown.
<i>Cardium echinatum</i> , Linn.	Rare; full size.
———— <i>fasciatum</i> , Montagu.	Moderately common; large size.
———— <i>edule</i> , Linn.	Rather rare.
<i>Cyprina Islandica</i> , Linn.	Rather rare; one large valve and several young.
<i>Astarte sulcata</i> , Da Costa.	Moderately common.
———— var. <i>elliptica</i> , Brown.	Full grown.
———— <i>compressa</i> , Montagu.	Moderately common.
———— <i>borealis</i> , Chemnitz.	Moderately rare; large and fine.
<i>Tellina calcarea</i> , Chemnitz.	Common and large. A characteristic species.
———— <i>fabula</i> , Gronovius.	Rare; young.
<i>Scrobicularia prismatica</i> , Montagu.	Rare.
———— <i>alba</i> , Wood.	Moderately common; moderate size.
<i>Mya truncata</i> , Linn.	Common at one point only, but there most abundant. It occurs in blue clay and in a gravelly layer above it. Every transitional form, from the extreme type of <i>M. truncata</i> , to the extreme type of the var. <i>Uddevallensis</i> , may be detected. In natural boring position.
—— var. <i>Uddevallensis</i> .	Common; and associated in every form of the variety with <i>M. truncata</i> . In natural boring position.
<i>Mya arenaria</i> , Linn.	Rare. One single valve only.
<i>Saxicava rugosa</i> , Linn.	Common; large; found imbedded in the bank in natural position.
<i>Saxicava rugosa</i> . Var. <i>arctica</i> .	
<i>Mya arctica</i> , Linn.	Common.
———— var. <i>precisa</i> .	Rare. One valve.

GASTEROPODA.

<i>Chiton ruber</i> , Linn.	Moderately rare.
—— <i>marmoreus</i> , Fabricius.	Common.
—— <i>cinereus</i> , Linn.	Rather rare.
<i>Halcion pellucidum</i> , Linn.	Rare. One only; large.
<i>Tectura virginea</i> , Müller.	Common. All stages of growth; large and characteristic.
<i>Puncturella Noachina</i> , Linn.	Common; large and characteristic.

<i>Trochus Grœnlandicus</i> , Chemnitz.	Moderately common.
—— <i>tumulus</i> , Chemnitz.	Moderately common; large.
—— <i>cinerarius</i> , Linn.	Moderately common; all stages of growth.
<i>Lacuna divaricata</i> , Fabricius.	Moderately rare. Generally small.
—— <i>pallidula</i> , Da Costa.	Rare; fry.
<i>Littorina littorea</i> , Linn.	Common; all stages of growth.
—— <i>obtusata</i> , Linn.	Moderately common.
—— <i>rudis</i> , Maton.	Rare.
—— <i>limata</i> , Löven.	Rare; young.
<i>Rissoa violacea</i> , Desmarests.	Rare.
—— <i>reticulata</i> , Adams.	Moderately rare.
—— <i>striata</i> , Adams.	Common.
—— <i>cancellata</i> , Da Costa.	Rare.
—— <i>striatula</i> , Jeffreys.	Rare.
—— <i>parva</i> , Da Costa.	
———— var. <i>interrupta</i> .	Common.
<i>Skenea planorbis</i> , Fabricius.	Moderately common.
<i>Homalogyra atomus</i> , Philippi.	Rare.
<i>Odostomia unidentata</i> , Montagu.	Common.
—— <i>spiralis</i> , Montagu.	Moderately rare.
—— <i>turrita</i> , Hanley.	Rather rare.
—— <i>pallida</i> , Montagu.	Rare.
—— <i>conoidea</i> , Brocchi.	Rare.
<i>Natica affinis</i> , Gmelin	Common; generally small.
<i>Cerithium reticulatum</i> , Da Costa.	Moderately common at one place only.
<i>Purpura lapillus</i> , Linn.	Rather rare.
<i>Buccinum undatum</i> , Linn.	Common; all stages of growth; the larger specimens however are broken.
<i>Trophon clathratus</i> , Linn.	Rather rare. Not so large as in Dalmeir and some other beds.
—— <i>truncatus</i> , Ström.	Common and large.
<i>Fusus antiquus</i> , Linn.	Rather rare; young only.
<i>Nassa incrassata</i> , Ström.	Moderately common; large, arctic form.
<i>Pleurotoma pyramidalis</i> , Ström.	Moderately rare.
———— <i>violacea</i> , Migh. & Ad.	Moderately rare.

<i>Cylichna alba</i> , Brown.	Moderately rare.
——— <i>obstricta</i> , Gould.	Rare.
<i>Utriculus obtusus</i> , Mont.	Rare.
<i>Actæon tornatilis</i> , Linn.	Rare.

POLYZOA.

<i>Membranipora Flemingii</i> , Busk.
<i>Lepralia Peachii</i> , Johnst.
<i>Lepralia concinna</i> , Busk.
<i>Crisia eburnea</i> , Linn.

CRUSTACEA.

<i>Verruca Strömia</i> , Müller.	Common.
<i>Balanus porcatus</i> , Da Costa.	Common.
——— <i>Hameri</i> .	Moderately rare; remarkably large and fine; one specimen could hardly be distinguished from the large examples common at Uddevalla, and was found entire.

(Entomostraca are also abundant, and will be subsequently catalogued.)

ANNELIDA.

<i>Serpula vermicularis</i> , Ellis.	Rather rather.
——— <i>triquetra</i> .	Common.

ECHINODERMATA.

<i>Echinus Dröbachiensis</i> , Müller.	Common.
——— <i>sphæra</i> , Müller.	Moderately rare.
<i>Sipunculus</i> — ?	Plasterwork and loophole.
<i>Dermal spines of Asteridæ.</i>	

FORAMINIFERA.

<i>Cornuspira foliacea</i> , Philippi.
<i>Biloculina ringens</i> , Lam.
——— <i>depressa</i> .
<i>Triloculina oblonga</i> , Montagu.
<i>Quinqueloculina seminulum</i> , Linn.

- Quinqueloculina subrotunda*, Montagu.
Lagena globosa, Montagu.
——— *semistriata* (apiculate var.) Will.
——— *sulcata*, W. & J.
——— *squamosa*, Montagu.
——— *striata*, Montagu.
——— *biconica*, Brady.
Lituola orata, Brady, M.S.
Polymorphina lactea, W. & J.
Globigerina bulloides, D'Orb.
Textularia sagittula, Defrance.
Bulimina marginata, D'Orb.
Discorbina rosacea, D'Orb.
Cassidulina levigata, D'Orb.
————— *crassa*, D'Orb.
Truncatulina lobatula, Walker.
Rotalia orbicularis, D'Orb.
Polystomella crispa, Linn.
——— — *striato-punctata*, F. & M.
Nonionina turgida, Will.

SPONGE.

Cliona celata, Grant.

Common.

IV.—BOULDER CLAY—CAITHNESS.

For the general description of the Caithness beds, we refer to the papers of Mr. Jamieson and Mr. Peach. The sections we examined were at Wick Harbour, Milton Burn, and Burn of Haster, which are near each other and evidently belong to the same horizon, so that they do not need separate lists.

The fossiliferous Boulder Clay is a hard and compact mass, with striated and polished boulders—in appearance, similar to that in the west of Scotland, in which we have failed as yet to detect fossils. It varies in depth from 4 to 25 feet, and is generally overlaid by shingly gravel, more or less thick, and in some places hummocky, which is succeeded by brown earth. The shells are

found thinly interspersed from top to bottom through the section, and are of a very water worn and fragmentary character. On some fragments of *Cyprina Islandica* Mr. Peach has observed glacial striæ. They appear very equally distributed, as if the whole mass had been mixed up and kneaded together. The shells can only be obtained with any degree of success on the face of weather beaten sections, and occur very sparingly.

12 lbs. of the dry clay lost 4 lbs. in washing through a sieve of 96 threads to the inch, leaving 8 lbs. residue; of which 2 lbs. was retained in a sieve of $\frac{1}{8}$ inch mesh, consisting of small stones more or less water worn, and some striated. The remaining 6 lbs. was chiefly sand.

We were not able to add any mollusca to the species, so laboriously collected by that able naturalist, Mr. C. Peach; but subjoin a list of Foraminifera, which contains some hitherto unnoted species, and is of considerable interest:—

FORAMINIFERA.

- Biloculina ringens*, Linn.
- Triloculina oblonga*, Montagu.
- Trochammina inflata*, Montagu.
- Lagena sulcata*, W. & J.
- *marginata*, Montagu.
- *globosa*, Montagu.
- *semi-striata*, Will.
- *squamosa*, Montagu.
- *costata*.
- *Jeffreysii*, Brady.
- Dentalina communis*, D'Orb.
- Cristellaria rotulata*, Lamk.
- Polymorphina lactea*, W. & J.
- var.
- *compressa*, D'Orb.
- Globigerina bulloides*, D'Orb.
- Textularia difformis*, D'Orb.
- Bulimina marginata*, D'Orb.

- Bulimina pupoides*, D'Orb.
Cassidulina lævigata, D'Orb.
Discorbina rosacea, D'Orb.
Planorbulina Mediterraneensis, D'Orb.
Pulvinulina Caracalla, Rœmer?
Rotalia Beccarii, Linn.

V.—LUCKNOW PIT, ARDEER IRON WORKS, AYRSHIRE.

Unfortunately we were not aware of the occurrence of a shell bed in the bore of this pit, until after it had been walled from the freestone to the surface with stone and lime, so that there was no opportunity of making a personal examination. We are, however, indebted to the kindness of Mr. Isaac Christie for a sketch of its character, which has been verified by the engineer; and for an opportunity of examining many of the shells which were discovered.

About 12 feet down through the sand, a bed of moss was passed through, $1\frac{1}{2}$ feet in thickness.

At a depth of 60 feet the shell beds were reached.

Mr. Liddell obligingly informs us that "the shells obtained during the sinking of our Lucknow pit, were found at a depth of about 10 fathoms from the surface, bedded in a blue loamy sand, or mud; this sand is about 6 feet thick, and lies immediately above the blue clay on the top of the freestone." Mr. Christie remarks that "the small shells were in thin beds—the large ones scattered about in the blue mud. There were six feet of blue clay below mud, and then rock."

The section therefore appears to have been the following:—

Sand, about.....	12 feet.
Moss, ,,	$1\frac{1}{2}$,,
Sand, ,,	$26\frac{1}{2}$,,
Shell "mud" or blue loamy sand,	6 ,,
"Blue clay,"	6 ,,
Sandstone rock.	

From the character of the shells and the description given, we have in the case of this pit, either a shell bed in which arctic and more temperate species are mixed together, as is the case in several Norwegian post-tertiary beds, or two shell beds, the one resting upon the other, were passed through.

The existence of a younger shell bed superimposed upon an elder, we shall have occasion to trace in subsequent divisions of this series of papers, and judging from the section exposed in the banks of the Irvine Water, the Lucknow pit furnishes a case in point.

Nine-tenths of the shells obligingly sent us by Mr. Christie are precisely similar to those which may be collected in a post-glacial bed in Irvine Water—mixed with these however, are several purely arctic species.

Mr. James Armstrong collected from the debris at the mouth of this pit one of the most remarkable glacial fossils, viz.,—a well preserved specimen of *Leda arctica*; and among Mr. Christie's specimens other arctic species occur.

The following is the list of shells which may be classed as glacial, since they are well known as such from other beds :—

<i>Leda arctica</i> — <i>Nucula Portlandica</i> , Hitchcock.	Two valves.
<i>Astarte borealis</i>	Two valves.
<i>Cyprina islandica</i>	Abundant.
<i>Tellina calcarea</i>	One valve.
<i>Natica clausa</i>	One.

The following, from the reasons given, cannot be safely classed as “glacial,” on the simple authority of this pit, although some of them are known as associates of glacial shells.

<i>Anomia ephippium</i>	3 Specimens.
<i>Ostrea edulis</i> (Large)	5 „
<i>Pecten opercularis</i>	1 „
<i>Cardium echinatum</i>	4 „
—— <i>Novegicum</i>	4 „
—— <i>edule</i>	1 „
<i>Venus fasciata</i>	2 „
—— <i>lincta</i>	1 „
—— <i>exoleta</i>	1 „
<i>Tapes pullastra</i>	1 „
—— <i>decussata</i>	1 „
<i>Lutraria elliptica</i> (Large)	1 „

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<i>Patella vulgata</i>	.	.	.	.	.	.	1 specimen.
<i>Trochus cinerarius</i>	'	.	.	.	.	.	4 „
—— <i>magus</i>	.	.	.	.	.	.	1 „
<i>Littorina obtusata</i>	.	.	.	.	.	.	1 „
—— <i>littorea</i>	.	.	.	.	.	.	6 „
<i>Turritella communis</i>	.	.	.	.	.	.	1 „
<i>Purpura lapillus</i>	.	.	.	.	.	.	1 „

The remarkable fact connected with this list, is the discovery of *Leda arctica*.

Leda arctica was first identified as a Scotch glacial fossil by Dr. Torrell, in the collection made by Rev. Dr. Brown of Edinburgh, at Elie. It has subsequently been found at Montrose, Errol, and other localities on the east coast of Scotland. At Errol, indeed, it is a characteristic shell, occurring, although in a very decayed state, in hundreds.

The Lucknow pit is the first fossil locality in which it has been discovered in the west of Scotland. Mr. Jeffreys informs us however, that he once dredged in the western waters a fossil valve.

The discovery of *Leda arctica* in the western beds is important for several reasons.

(1.) It affects the argument regarding the supposed colder and older character of the beds on the east.

(2.) The question arises, whether there is not an “upper and lower” among glacial sands and clays, equivalent to the upper and lower of many fossiliferous deposits.

Leda arctica is living within the Arctic Circle and on the East Coast of N. America; but is extinct in the British Seas and North Pacific.

It is a characteristic shell in the Leda clay of Montreal; and in the clay at Moss on the south of the Christiania Fjord. Its discovery as a Scotch fossil, both in the East and West, thus becomes a matter of peculiar interest.