

and other plants flourished over these tracts and accumulated vegetable matter sufficient to form thin seams of coal. These were subsequently overlaid in some cases by lake deposits, in which the remains of fishes were embedded; and these, in their turn, by other outbursts of igneous rock-matter and ashes. This portion of the Kilpatrick range accordingly reveals a geological structure similar to that of a more recent period shown in the bedded traps of Mull, enclosing coal and plant-remains of Middle Tertiary age.

NOTE.—Since the above was written, Mr. D. BELL, Secretary, has brought under the notice of the Society some plant-remains found embedded in the traps of the Lochwinnoch district, to the south-west of the locality above described. These were discovered in a bed of volcanic ash or mud, which occurs in the trap range to the north of Lochwinnoch; and though externally a good deal worn, and the structure not very well preserved, appear to belong to the genus *Lepidodendron*. The matrix in which they are found is quite similar in colour and composition to some of the interbedded ash or mud beds that lie amongst the traps of the Campsie hills.

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X.—On the POST-TERTIARY FOSSILIFEROUS BEDS OF SCOTLAND.  
By DAVID ROBERTSON, F.G.S., and Rev. H. W. CROSSKEY, F.G.S.

(Continued from page 45.)

XIII.—KILCHATTAN TILE-WORK, BUTE.

IN this series of papers on the Post-Tertiary Deposits, it has been our desire all along to confine our attention to their fossil remains, and to some facts connected with their inorganic contents, avoiding, as far as possible, the introduction of theoretical matter. This will account for our passing over unnoticed many topics of interest with regard to glacial phenomena.

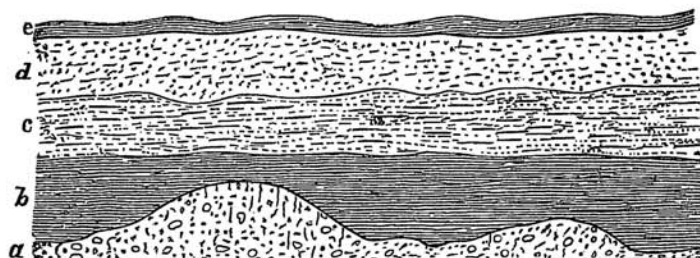
The section now under review has been described by several writers, particularly by Mr. Jamieson in his valuable paper "On the Last Geological Changes in Scotland,"\* and by Professor Geikie, in his well-known memoir on the "Phenomena of the Glacial Drift of Scotland," published in the Transactions of this Society.†

\* Quart. Jour. Geol. Soc., Vol. XXI.

† Vol. I., Part 2.—Mr J. Coultas has also, with much industry, made a large collection of shells from Kilchattan, which were exhibited at a meeting of the Natural History Society of Glasgow.

The deposit lies at the north-west side of Kilchattan Bay, beyond tide-mark, and dips seaward. Taking the beds in descending order, we find, as represented in the annexed cut:—

- I.—Peaty mould : about 1 foot.
- II.—Gravel : 3 to 5 feet.
- III.—Muddy sand : 4 to 6 feet.
- IV.—Grey laminated clay : 6 to 7 feet.
- V.—Reddish boulder clay : depth unknown.



Section showing position of shell-bearing clay at Kilchattan Tile-Work, Bute.

a, Boulder clay. b, Laminated clay. c, Sandy mud, with shells, &c. d, Gravelly mould. e, Peaty mould.

Passing over I. and II., it is in the stratum of muddy sand (III.) that the shells occur, and it is to be observed that they are more abundant therein towards the bottom than near the top. The proportion of sand in this layer is too great for tile-making, and it is therefore laid aside.

The prevailing shells of this deposit are *Tellina calcarea*, *Axinus flexuosus*, *Scrobicularia prismatica*, *Cyprina Islandica*, *Mya truncata*, and *Utriculus obtusus*. Most of these reach a size rather above the average of those met with in the Clyde beds generally. At the same time we remarked that, contrary to what is usually found, all these are abundant from the fry up to the adult forms, shewing, as regards this deposit, that the conditions for all stages of growth of these various species had been exceedingly favourable.

The majority of the *Myas* were found to have both valves preserved, together with remains of their siphons in position within the shells. This sandy material seems to be favourable for the preservation of this portion of the animal tissue. Siphons have been met with in the soft clay of other localities, but rarely.

Another point worthy of notice is that a number of the valves of *Mya truncata* have thick patches of the muddy sand in which they are imbedded indurated on their inner surface so firmly as not to be removed even by boiling water. Similar hard clays are

occasionally found in shells taken from other post-tertiary deposits. These patches generally do not extend over the whole interior of the shell, but are confined to a particular spot or region. Sometimes we have met with hard nodules of clay which, when broken, disclose a cluster of small shells embedded within, much like the well-known clay nodules enclosing shells or fish remains, in other formations.

These indurated patches of sand and clay within the shells, and those enclosing shells, as well as the clay nodules found in many of our brick clays, that have no apparent organic nucleus, have all, so far as we have examined, a strong calcareous base, while the clays in which they are embedded have none.

In this deposit many of the plates of *Echinus Dröbachiensis* are much corroded, as we find them in some other localities. We take this opportunity to remove a doubt we had regarding the identity of these eroded plates as referred to in a former paper, where a plate is given of the various forms.\* From the singular way in which the plates were corroded, leaving a regular pattern, we were led to think they might be plates of an undescribed species—an opinion shared by some carcinologists of the highest authority. Since that time, however, so many of these plates have come under our notice, that we have been able to trace the erosion from its first effect to the full formation of the pattern referred to, leaving no doubt that they are all the plates of one species, the *Echinus Dröbachiensis*.

The grey-coloured laminated clay (IV.) is formed into layers by thin bands of red sand, which are thicker and more distinct as they approach the bottom. Here the clay between them is again divided into exceedingly thin layers. No shells have been met with in this clay, and it has hitherto been considered azoic; but lately we examined a portion of it in which *Ostracoda*, *Foraminifera*, and one much-decayed fragment of an oval plate of an *Echinus* were obtained. Of *Ostracoda* there were three valves of one species, *Cytherura Sarsii*. Of *Foraminifera*, twelve specimens of *Nonionina depressula*, and three of *Polystomella striato-punctata* were obtained.

The piece of clay from which these were taken was somewhat less than 3 lbs. in weight, showing that it was not so destitute of life as had hitherto been supposed.

\* Transactions of this Society, Vol. III., p. 1.



It may be mentioned that a much larger portion from the same stratum had previously been examined by us, without finding a vestige of animal remains. This indicates how unsafe it may often be to pronounce such deposits unfossiliferous from one trial, inasmuch as the organisms may not be equally distributed through all parts of the same stratum. As this is a point of some interest, we shall endeavour to ascertain, when opportunity occurs, whether these organic remains are to be met with at any particular depth of the stratum in which they are found, or whether they are located promiscuously at different depths.

It is this clay only that is used for tile-making. When dry, it is of a lightish drab colour, and consists of

99½ per cent. fine mud,  
½ „ fine sand,

with occasionally small pebbles, less than the size of a common pea.

The boulder clay (V.) is, as has been stated, of a reddish colour, very uneven, at some places rising up in knolls so far through the grey clay as nearly to reach the muddy sand layer above. This clay, when dry, consists of

51 per cent. fine mud.  
28 „ fine and coarse sand.  
21 „ gravel.

The shell-bearing clay consists of

32 per cent. fine mud.  
68 „ fine sand.

#### LIST OF ANIMAL REMAINS FROM KILCHATTAN TILE-WORK.

##### PISCES.

A few small vertebræ. Not determined.

##### CONCHIFERA.

<i>Anomia ephippium</i> , Linn.	Moderately rare.
<i>Pecten Islandicus</i> , Müll.	Rare.
<i>Mytilus modiolus</i> , Linn.	Moderately rare ; mostly fry.
<i>Nucula tenuis</i> , Mont.	Rare.
<i>Leda pernula</i> , var.	
— <i>mucilenta</i> , Steenst.	Common.
— <i>pygmaea</i> , var.	
— <i>lenticula</i> , Möll.	
<i>Montacuta ferruginosa</i> , Mont.	This species is copied from Mr. Jamieson's list of the shells of Kilchattan.
<i>Axinus flexuosus</i> .	
— var. <i>Gouldii</i> .	Common and well grown ; many with the valves together.

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<i>Cardium edule</i> , Linn.	Rare ; half grown.
———— <i>echinatum</i> , Linn.	Rare ; fry.
<i>Cyprina Islandica</i> , Linn.	Common ; all sizes from the fry up to very large.
<i>Astarte compressa</i> , Mont.	Common.
<i>Tellina calcarea</i> , Chemn.	Common ; all stages of growth, but few marking beyond a medium size.
<i>Macra subtruncata</i> , Da Costa.	Rare.
<i>Scrobicularia prismatica</i> , Mont.	Moderately common. This species is rather rare in the west of Scotland as a post-tertiary shell.
<i>Mya truncata</i> , Linn.	Common ; all sizes.
<i>Saxicava rugosa</i> , Linn.	Rare.
<i>Pholas crispata</i> , Linn.	A fragment.

GASTEROPODA.

Chiton plate.	Too obscurely marked for determination
<i>Tectura verginea</i> , Müll.	Rare.
<i>Trochus cinerarius</i> , Linn.	Small, and much eroded.
———— <i>tumidus</i> , Mont.	Moderately common.
<i>Lacuna divaricata</i> , Fabr.	Moderately common ; small.
<i>Littorina littorea</i> , Linn.	Moderately rare.
———— <i>obtusata</i> , Linn.	Moderately rare.
———— <i>rudis</i> , Maton.	Rare.
<i>Rissoa parva</i> , Adams.	
———— var. <i>interrupta</i> .	Moderately common.
———— <i>striata</i> , Adams.	Moderately rare.
<i>Skenea planorbis</i> , Fabr.	Moderately common.
<i>Homalogyra atomus</i> , Phil.	Moderately common.
<i>Odostomia unidentata</i> , Mont.	Rare.
<i>Natica Grœnlandica</i> , Beck.	Moderately common.
———— <i>affinis</i> , Gmel.	Moderately common.
<i>Velutina lævigata</i> .	One fry ; Mr Coutts.
<i>Aporrhais pes-pellicani</i> , Linn.	Rare.
<i>Purpura lapillus</i> , Linn.	Rare.
<i>Buccinum undatum</i> , Linn.	Moderately rare.
<i>Trophon clathratus</i> , F. and H.	Rare.
———— <i>truncatus</i> , Ström.	Moderately rare.
<i>Fusus antiquus</i> , Linn.	Rare.
<i>Pleurotoma violacea</i> , Migh. and Ad.	Rare.
———— <i>turricula</i> , Mont.	Moderately rare.
———— <i>Trevelyana</i> , Turt.	Rare.
———— <i>pyramidalis</i> , Ström.	Rare.
<i>Utriculus obtusus</i> , Mont.	Common.
———— <i>hyalinus</i> , Turt.	Rare.

POLYZOA.

<i>Crisia eburnea</i> , Linn.	Rare ; one small branch.
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# CRUSTACEA.

Plates and claw.

Too fragmentary to determine.

# OSTRACODA.

Twenty-two Species.

# CIRRIPEDIA.

*Balanus porcatus*, Da Costa.

Common and large.

——— *crenatus*, Brug.

Moderately common ; rather small.

*Verruca Strömia*, Müll.

Rare.

# ANNELIDA.

*Serpula vermicularis*, Ellis.

# ECHINODERMATA.

*Ophiura albida*, Forbes.

Moderately common.

*Echinus sphæra*.

Plates and spines.

——— *Dröbachiensis*, Müll.

Plates and spines ; many of the plates much eroded ; similar to those met with in a post-tertiary deposit at Cumbrae, Buteshire, and other places. (See remarks at p. 130.)

*Amphidotus*, sp.

Spines and plates.

# FORAMINIFERA.

*Biloculina ringens*, Lamk.

Common.

——— *depressa*, D'Orb.

Rare.

*Quinqueloculina seminulum*, Linn.

Moderately common.

——— *subrotunda*, Mont.

Rare.

*Lituola scorpiurus*, Monfort.

Rare.

*Lagena levis*, Mont.

Rare ; deformed var.

——— *striata*, Mont.

Moderately common.

——— var. *apicula*.

Moderately rare.

——— *distoma*, P. & J.

Common.

——— *globosa*, Mont.

Moderately common.

——— *marginata*, Mont.

Moderately rare.

*Dentalina communis*, D'Orb.

Moderately rare ; very weak.

*Cristallaria rotulata*, Lamk.

Moderately common.

*Polymorphina lactea*, W. & J.

Moderately common.

——— var. *communis*.

Rare.

*Verneulina polystropha*, Reuss.

Moderately common.

*Bulimina pupoides*, D'Orb.

Rare.

*Cassidulina levigata*, D'Orb.

Rare.

*Truncatulina lobatula*, Walker.

Moderately rare.

*Rotalia Beccarii*, Linn.

Moderately rare ; very weak.

*Polystomella striato-punctata*, F. & M.

Moderately rare.

*Nonionina turgida*, Will.

Moderately common.

——— *depressula*, W. & J.

Moderately common.

# SPONGE.

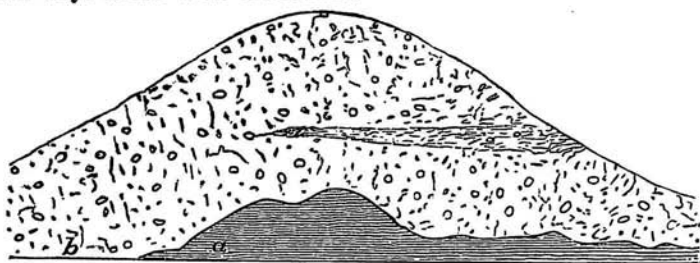
*Otiona celata*, Grant.

Moderately common.

XIV.—TANGY GLEN, NEAR CAMPBELTOWN.

The section now to be described\* occurs in what is called *Tangy Glen*, about six miles from Campbeltown, on the road to Tarbert. It is about three or four hundred yards up the little streamlet or "burn," at a point where it turns eastwards, and, as near as may be, 130 feet above the sea-level. Here the water has cut deeply into the bank, exposing a cliff of clay 55 feet above the level of the "burn," but this is only to the point where the face of the cliff begins, and we estimate that it rises 50 or 60 feet higher.

- This boulder clay is of the usual character, stiff, compact, and full of stones of various sizes, many of them distinctly striated. At one part a finer or more sandy bed, gradually thinning out, is intercalated in the clay, as shown in the annexed cut representing the section. Such lenticular beds are not uncommon in the boulder clays of the West of Scotland.



Scour of boulder clay, overlying denuded boss of laminated fossiliferous clay, Tangy Burn Campbeltown.

a, Laminated clay.

b, Boulder clay.

The chief interest of this section consists in the fact that, contrary to the usual position of the boulder clay in the West of Scotland, here it overlies shell-bearing clay. The latter is dark grey in colour, and contrasts strongly with the overlying boulder clay, which is of a full reddish brown. The two clays are equally distinct in composition. Thus :—

<i>Boulder Clay.</i>			<i>Shell-bearing Clay.</i>		
50	per cent.	fine mud.	80	per cent.	fine mud.
27	„	fine sand (21) and coarse sand (6).	14	„	fine sand.
23	„	gravel.	6	„	gravel.

The shell-bearing clay, as exposed in this section, is seen standing

\* First brought under our notice by Captain Kerr, formerly a member of this Society.



up in the boulder clay like a boss or knoll, and has doubtless been brought to this form by abrasion. At the greatest part visible it is 13 feet high, and it can be traced as it thins down along the edge of the streamlet for a distance of 60 or 70 yards. Its exact depth could not be ascertained, but as the rock is seen at a short distance on either hand, it is probably not more than a few feet deeper than what is exposed.

The fossils in this deposit are but thinly met with—molluscs, in particular are comparatively rare—*Leda pygmæa* being the prevailing shell, with an occasional *Leda pernula*, *Venus ovata*, and a few fragments of other species. These were submitted to Mr J. Gwyn Jeffreys, and at least two of them have proved to be of much interest—viz., *Pecten Grœnlandicus* and *Montacuta elevata*.

*Pecten Grœnlandicus* has been met with on the east coast, at Montrose, Errol, and Elie; but not before in the West of Scotland. It is remarkable that at Montrose it is only obtained at a great depth—seldom less than 30 or 40 feet; but at Elie it is met with only a few feet beneath the surface, and within reach of the tide; while at Tangy, as has been stated, it is 130 feet above the present sea-level.

*Montacuta elevata* is an Arctic species, and new to the glacial clays of Britain.

Ostracoda and Foraminifera are more numerous represented in this deposit, 18 species of the former and 23 of the latter having been obtained. It is to be remarked also regarding the Ostracoda, as we have already had occasion to do regarding the Mollusca, that they have much in common with those found in the clays on the east coast of Scotland, which are held to represent more strongly Arctic types than those generally found in the west. Amongst these are *Cytheropteron Montrosiense*, *Cytheropteron vespertilis*, and *Cytheropteron Sorbyana*. None of these has hitherto been met with in the clays of the West of Scotland, with the exception of one specimen of *C. Montrosiense*, which was found in the excavations for Messrs. Randolph & Elder's new dock near Govan.\* *C. vespertilis* and *C. Sorbyana* are common species in the clays of Norway.

\* This specimen was found, along with other Arctic marine shells, at a depth of 18 feet, in a lower bed of clay dipping away from the river. An upper bed, which dipped to the river, contained only more recent forms common to our raised beaches and present seas, such as *Pecten opercularis*, *Trochus umbilicatus*, &c. The operations at this dock having been suspended, the place soon filled with water, preventing further investigation for the time.



We may here allude to two deposits in the north of Ireland, which we have had an opportunity of visiting, under the guidance of Mr. S. A. Stuart of Belfast—viz., Knockburn, about a mile to the south of that town; and Woodburn, near Carrickfergus. In the clays of Knockburn we obtained *Cytheropteron Montrosiense*, and the same species in Woodburn, together with *C. vespertilis*.

We are doubtful as to the position of the clay in the latter section, it being overlaid by a bed of coarse gravel; but at Knockburn, which was best exposed at the time of our visit, the overlying bed seemed to be of a loose boulder clay. We reserve a fuller examination of these sections till a future opportunity.

In connection with these remarks on the Tangy deposit, we may also refer to the finding of a shell of Arctic type (*Leda arctica*) in the clays from a pit in Ayrshire—Lucknow Pit, Ardeer Iron-works—as recorded in the Society's Transactions, Vol. III. This shell has not been found elsewhere in the west of Scotland, but is moderately common in the clays of Elie, Fifeshire, and abounds in the clay at Moss Tile-Works, in Norway. It is also living in the northern seas.

Taken along with the well-known Kilmaurs and Croftamie beds, the deposit in Tangy Glen seems to be another well-marked instance of marine clay with Arctic shells underlying boulder clay; and we have no doubt, as there are now more workers in this field of research, that additional instances of the same kind will be disclosed.

We respectfully urge the members to lose no opportunity of obtaining information from borings or cuttings in these post-tertiary deposits, as until they are more thoroughly known at all depths over the whole country, no satisfactory conclusion can be arrived at regarding them.

#### LIST OF SPECIES FROM TANGY GLEN.

##### MOLLUSCA.

*Pecten Grœnlandicus*, Sow.

One fragment.

*Leda pygmœa*, Müntz.

— var. *Gouldii*.

Common and in good condition;  
mostly covered with ep.

*Leda pernula*, Müll.

Rare; mostly fragments, a few  
which were less or more water-  
worn.

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<i>Montacuta elevata</i> , Stimp.	One very young, with the valves together.
<i>Venus ovata</i> , Penn.	Rare in the glacial clays of Scotland.
<i>Corbula gibba</i> , Oliv.	One valve.

No univalves have been met with in this deposit; they are also rare in the clays on the east coast.

POLYZOA.

<i>Crisia eburnea</i> , Ellis.	Moderately common.
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CRUSTACEA.

<i>Verruca Strömia</i> , Müll.	A few plates.
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FORAMINIFERA.

<i>Cornuspira foliacea</i> , Phill.	One.
<i>Biloculina ringens</i> , Lamk.	Moderately common.
———— <i>elongata</i> , D'Orb.	Moderately common.
<i>Quinqueloculina seminulum</i> , Linn.	Moderately common.
———— <i>subrotunda</i> , Mont.	Moderately common.
<i>Lagena sulcata</i> , W. and J.	Two.
———— <i>lævis</i> , Mont.	Two.
———— <i>Jeffreysii</i> , Brady.	One.
———— <i>gracillima</i> , Seg.	Four.
———— <i>globosa</i> , Mont.	Two.
———— <i>marginata</i> , Mont.	One.
———— <i>squamosa</i> , Mont.	One.
<i>Vaginulina legumen</i> , Linn.	One ; large and fine.
<i>Polymorphina compressa</i> , D'Orb.	Common.
———— <i>lactea</i> , W. and J.	One.
———— var.	Two.
<i>Globigerina bulloides</i> , D'Orb.	Moderately common.
<i>Cassidulina lævigata</i> , D'Orb.	Moderately common.
<i>Discorbina globularis</i> , D'Orb.	One.
<i>Truncatulina lobatula</i> , Walker.	Four.
<i>Rotalia Beccarii</i> , Linn.	Three.
<i>Polystomella crispa</i> , Linn.	One.
———— <i>striato-punctata</i> , F. and M.	One.
<i>Nonionina depressula</i> , W. J.	Common.
———— <i>asterizans</i> , F. and M.	Two.