

how masses of that rock, the smallest of which is about 370 yards in diameter,¹ masses, of which one has been traced to a depth of 500 yards, could remain throughout in a practically uniform glassy condition.

P.S.—This paper was written before the publication of the notice of the late Professor Lewis' work (p. 366). On a few points, as will have been seen, I differ from its author, but need only refer to the following. Two are inaccuracies: on p. 367, line 6, for "original" read "unpublished," and line 13 for "three" read "two." There was no manuscript of Section III, unless a few references could be thus called. A third is an error (p. 368): the largest inclusion in plate i is said to consist of rather decomposed compact serpentinized olivines and pyroxenes. This reads to me rather like nonsense, and I do not make the statement. I assert the fragment to be "a rather decomposed compact serpentinous rock." I now believe it is identical with some of the fragments described above. In regard to the "Hard Wack Floating Reef," which the writer apprehends may be the "Kimberlite proper," and laments that "no detailed examination" of this rock has been given, I need only remark that the slices used by Professor Lewis all represented the same *species* of rock, the difference among them being only varietal (none had descriptive labels); also that I strongly suspect I have examined a specimen of it, furnished to me by the late Professor A. H. Green (under a different name), and believe it to be nothing else than a more compact variety of the ordinary rock. I fail to understand the reviewer's remark about local writers and the shale on p. 368. So far as I remember, Professor Lewis nowhere asserts that the shale fragments are fused at the edges. A fragment of shale may be *altered* yet not *fused*. The perovskite I am disposed to consider generally, if not always, a secondary mineral.

IV.—NOTES ON THE GEOLOGY OF COUNTY WATERFORD.

1. THE FAUNA OF THE ORDOVICIAN BEDS NEAR TRAMORE.

By F. R. COWPER REED, M.A., F.G.S.

Introductory.

DURING an examination of the complicated series of Lower Palæozoic rocks in County Waterford, with which I am still engaged, I have had the opportunity of collecting largely from the few fossiliferous beds in the neighbourhood of Tramore, and a study of the fossils throws considerable light on the vexed question of their age. It is not my intention in this paper to discuss the relations of the igneous and sedimentary rocks, nor to attempt to explain the structure of the district. The palæontological evidence of the exact horizon of certain fossiliferous beds will here alone be

¹ The largest must be about 450 yards in diameter. Some of the necks in Scotland are considerably larger than this. See Sir A. Geikie's "Ancient Volcanoes of Great Britain," chs. xxv and xxxi.

considered, with a view to establish a definite base-line which has previously been wanting in descriptions of these rocks. The confusing statement has frequently been made that a mixture of Llandeilo and Bala fossils is found in these beds and elsewhere in Ireland, and that the principles of classification followed in Great Britain are not applicable. From my study of the literature on the Lower Palæozoic of this part of Ireland, and from my investigations in the field and museums, I feel convinced that this startling opinion is due partly to the erroneous identification of the fossils, partly to confusing fossils from distinct horizons, partly to the repetition by folds, etc., of the same beds, and partly from misapprehension of the distribution or vertical range of some species. I have given below a list of the literature containing references to the fossiliferous and associated rocks of this district, but for the above reasons we cannot unfortunately rely on the lists of fossils which are said to occur in them, and I have consequently drawn my conclusions only from specimens collected in the various localities by myself or from those of identifiable horizons which I have personally examined.

1821. Thomas Weaver, "On the Geological Relations of the East of Ireland": *Trans. Geol. Soc.*, ser. i, vol. v, p. 117.
1824. Rev. R. H. Ryland, "The History, Topography, and Antiquities of the County and City of Waterford." 8vo. London (*passim*).
1833. J. Hodgson Holdsworth, "On the Geology of the District of the Knockmahon Mines": *Journ. Geol. Soc. Dublin*, vol. i, p. 85.
1839. Sir R. Griffith, "On the Principle of Colouring adopted for the Geological Map of Ireland, etc.": *Journ. Geol. Soc. Dublin*, vol. ii, pt. 1, p. 78.
1839. Major Austin, "A brief Notice of the Geology around the Shores of Waterford Haven": *Proc. Geol. Soc.*, vol. iii, p. 154.
1840. Th. Weaver, "On the Geological Relations of the South of Ireland": *Trans. Geol. Soc.*, ser. ii, vol. v, p. 1.
1841. T. Austin, "Observations relative to the Elevation of Land on the Shores of Waterford Haven, etc.": *Proc. Geol. Soc.*, vol. iii, p. 360.
1841. J. Apjohn, Presidential Address: *Journ. Geol. Soc. Dublin*, vol. ii, p. 132.
1843. General J. E. Portlock, *Geol. Rep. Londonderry*, pp. 262, 283, 292, etc.
1844. Sir R. Griffith, "On certain Silurian Districts of Ireland": *Rep. Brit. Assoc. Trans.*, p. 46.
1844. H. N. Nevins, "Some Remarks on Three Localities of Silurian Fossils lately discovered in Co. Waterford": *Journ. Geol. Soc. Dublin*, vol. iii, p. 78.
1844. "Localities of Silurian Fossils lately discovered in Waterford, Wexford, and Wicklow": *Journ. Geol. Soc. Dublin*, vol. iii, part 1, p. 57.

1845. Sir R. Griffith, "On the Order of Succession of the Strata of the South of Ireland": *Journ. Geol. Soc. Dublin*, vol. iii, p. 150.
1846. F. McCoy, "Synopsis of the Silurian Fossils of Ireland," pp. 7, 16, 26, etc.
1852. J. Beete Jukes, "Sketch of the Geology of the County of Waterford": *Journ. Geol. Soc. Dublin*, vol. v, p. 147.
1854. Sir R. Murchison, "Siluria," 1st ed., p. 166.
1856. J. Kelly, "Researches among the Palæozoic Rocks of Ireland": *Journ. Geol. Soc. Dublin*, vol. vii, p. 115.
1857. Sir R. Griffith, "Notes on the Stratigraphical Relations of the Rocks of the South of Ireland": *Journ. Geol. Soc. Dublin*, vol. viii, p. 7.
1859. J. Beete Jukes and Professor Haughton, "The Lower Palæozoic Rocks of the South-East of Ireland": *Trans. Royal Irish Acad.*, vol. xxiii, p. 563.
1860. J. Kelly, "On the Graywacke Rocks of Ireland as compared with those of England": *Journ. Geol. Soc. Dublin*, vol. viii, pp. 2, 251.
1860. W. B. Brownrigg and Theo. Cooke, "Geological Description of the District extending from Dungarvan to Annestown, Co. Waterford": *Journ. Geol. Soc. Dublin*, vol. ix, p. 8.
1865. *Memoir Geol. Surv. Ireland*, Explan. Sheets 167, 168, etc.
1869. W. H. Bailey, "Notes on Graptolites and Allied Fossils occurring in Ireland": *Quart. Journ. Geol. Soc.*, vol. xxv, p. 158.
1872. Sir R. Murchison, "Siluria," 5th ed., p. 173 et seq.
1878. G. H. Kinahan, "The Geology of Ireland," p. 27.
1878. Prof. Hull, "Physical Geology and Geography of Ireland," p. 13.
1879. Prof. Ch. Lapworth, "Distribution of the Rhabdophora": *Ann. Mag. Nat. Hist.*, ser. v, vol. iv, p. 424.
1891. Prof. Hull, "Physical Geology and Geography of Ireland," 2nd ed., p. 16.
1895. A. McHenry and W. W. Watts, "Guide to the Collection of Rocks and Fossils belonging to the Geological Survey of Ireland," pp. 82, 89, 90.
1897. Sir A. Geikie, "Ancient Volcanoes of Great Britain," vol. i, pp. 242-50.

Description of the Beds and their Fossil Contents.

The best preserved and most abundant fossils near Tramore occur in three principal sets of exposures, but the beds represented in those localities are by no means all on the same horizon.

1. Taking the localities in order from east to west, we begin with the most easterly ones in the townlands of Quillia and Castletown. On the one-inch Geological Survey Map, Sheet 179, there is marked in about a mile east of the Tramore-Waterford Railway a sinuous band of limestone. The rock consists of a greyish calcareous sandstone, weathering to a brownish-yellow colour, and containing a large

number of fossils. The exposure in the field south of the Castle in the townland of Castleton (locality 17 of the Survey Memoir, Explan. Sheets 167, 168, etc.) is in an old overgrown quarry in which the dip of the beds is still visible, and is marked on the map as 80° N.W. From this small exposure I obtained, with difficulty, the following fossils:—

Phacops Jamesi, Portl.
Orthis flabellulum, Sow.
O. crispa, McCoy

Phyllopora Hisingeri, McCoy
Stenopora fibrosa, Goldf.
S. (?) lyceperdon, Hall

All of these also occur in the far richer locality at Quillia, to be immediately mentioned, and in addition to the above there are recorded in the Survey Memoir the following species:—

Cheirurus bimucronatus, Murch.
Cybele verrucosa, Dalm.
Ilkenus Bowmani, Salt.
Orthis calligramma, Dalm.

Orthis elegantula, Dalm.
Plectambonites (Leptana) sericea, Sow.
Rafinesquina expansa, Sow. (*Strophomena concentrica*)

The species of *Phacops* recorded in the Survey Memoir here and at Quillia as *Ph. Brongniarti* is really *Ph. Jamesi*, as I have determined by examination of the Survey specimens. I have not myself found nor recognized in any collection specimens of the true *Ph. Brongniarti* from these places.

At Quillia, about a mile south of the Castletown locality, this brown calcareous sandstone is exposed in the banks of a lane leading to a farm off the high road; it dips to the NNW. at about 50°. Its fauna is rich in individuals, but not particularly so in species. The following fossils I have collected at this spot:—

Asaphus gigas, De Kay
Cybele tramorensis, Reed
C. verrucosa, Dalm.
Phacops Jamesi, Portl.
Orthis calligramma, Dalm.
O. crispa, McCoy
O. elegantula, Dalm.
O. testudinaria, Dalm.

Rafinesquina expansa, Sow.
R. deltoidea, Conr.
Plectambonites sericea, Sow.
Caryocystites granatum, Forbes
Echinospheerites, sp. (?)
Glyptocrinus, sp. (?)
Stenopora fibrosa, Goldf.
Nebulipora lens, McCoy (?)

Of the above fossils *Phacops Jamesi* is by far the most abundant. *Plectambonites sericea* is also very plentiful. In the Dublin Museum there is from this spot a head-shield of *Cybele tramorensis*, a species which I described¹ from a solitary specimen found here by me in 1894. The Survey Memoir also mentions the following species from Quillia:—

Amphion pseudo-articulatus, Portl.
Calymene brevicapitata, Portl.
Orthoceras Brongniarti (?), Troost

The next locality for fossils lies on the west side of the Tramore-Waterford Railway, and the exposures occur on the hill in the townland of Pickardstown. It is sometimes spoken of as Drumcannon and corresponds to "locality 19" of the Survey Memoir.

There is more than one fossiliferous bed exposed on this hill, and the relations of the various beds are fairly plain. On the lower slopes of the east side of the hill occur black slates dipping N.W.

¹ GEOL. MAG., Dec. IV, Vol. II, 1895, p. 49, Pl. III, Fig. 1.

at about 50°; in these no fossils have as yet been found. They resemble in general character the great mass of highly folded unfossiliferous slates between this locality and Quillia. Above these slates comes a crushed calcareous flaggy sandstone (a) full of *Rafinesquina expansa*. In the quarry near Hammondville at the south end of the ridge the intrusive diabase is seen to be in contact with a greyish limestone, which is split up at this spot by thin shaly bands (b) containing very abundant *Entomostraca*. Thick bedded limestone (c) is found well exposed in a large quarry towards the north end of the ridge, and is the source of the majority of the fossils. It is a very tough bluish-grey rock when freshly broken, but weathers into a rotten brownish material. Perfect specimens are difficult to extract from it. It dips into the hill at about 45° N.W. and overlies the above-mentioned beds. Above it is a bedded felsite, which also can be traced sweeping round the northern end of the hill. In a lane at the north-west corner of the hill a sandy fossiliferous limestone is found dipping SSE. at about 60°, and containing *Orthis crispa*, *Rafinesquina expansa*, and *Stenopora fibrosa*. Thus we seem to have a synclinal existing in the hill. The diabase exposed in the southern quarry is found to cut obliquely across all the beds and is traceable to the northern end of the hill. The following fossils were collected by me from these beds:—

- | | |
|--|--|
| (a) <i>Phacops Jamesi</i> , Portl. | <i>Rafinesquina expansa</i> , Sow. |
| <i>Orthis calligramma</i> , Dalm., var. | <i>Stenopora fibrosa</i> , Goldf. |
| (b) <i>Agnostus agnostiformis</i> , McCoy | <i>Primitia mundula</i> , Jones |
| <i>Encrinurus sexcostatus</i> , Salt. | <i>P. mundula</i> var. <i>longa</i> , Jones |
| <i>Harpes</i> , sp. | <i>P. mundula</i> var. <i>producta</i> (?), Jones ¹ |
| <i>Trinucleus concentricus</i> , Eaton (?) | <i>Turrilepas</i> , sp. (?) |
| (c) <i>Amphion pseudo-articulatus</i> , Portl. | <i>Plectambonites quinquecostata</i> , McCoy |
| <i>Lichas</i> , sp. | <i>Conularia</i> , sp. |
| <i>Phacops Jamesi</i> , Portl. | <i>Glyptocrinus</i> , sp. (?) |
| <i>Orthis calligramma</i> , Dalm. | <i>Stenopora fibrosa</i> , Goldf. |
| <i>O. crispa</i> , McCoy | <i>Nebulipora lens</i> , McCoy (?) |
| <i>Plectambonites sericea</i> , Sow. | |

In the Survey Memoir and Collection there are the following additional fossils from this locality:—

- | | |
|---------------------------------------|---------------------------------------|
| <i>Asaphus gigas</i> , De Kay | <i>Rafinesquina deltoidea</i> , Conr. |
| <i>Cheirurus gelatinosus</i> , Portl. | <i>Palæaster obtusus</i> , Forbes |
| <i>Cybele verrucosa</i> , Dalm. | |

It will be seen on comparison of the lists that the fauna is practically identical with that from Quillia. The slight difference in the fauna of the shaly beds here is to be attributed to the different character of the deposit and of the original physical conditions. The abundance of *Phacops Jamesi* is a noteworthy feature at both Quillia and Pickardstown.

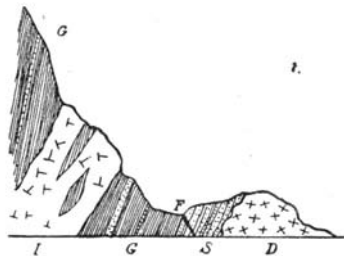
2. South of Tramore there is exposed along the coast a series of fossiliferous beds belonging to different horizons in the Ordovician system. The lower beds consist of black or dark-grey calcareous slates, which dip at high angles below bedded sandy limestones

¹ Professor Rupert Jones has kindly examined and named the specimens of *Entomostraca* from these beds.

containing nodular layers largely composed of *Stenopora* (?) *lycoperdon*. The black slates are exposed on the foreshore, and mostly only at low-water, between Tramore and Lady Elizabeth's Cove. The limestones form generally the base or whole face of the cliffs in the intervals between the igneous rocks. Where the sequence of beds is distinct, the black slates are found to become calcareous in their upper portion and to pass into thin-bedded shaly limestones, which are succeeded by the arenaceous nodular limestones, as may be seen near Lady Elizabeth's Cove. North of Lady Doneraile's Cove, however, and towards Tramore, the relations of these beds are much confused by faulting, folding, and intrusions of igneous rocks, and a fault-breccia frequently occurs along the line of their junction.

Fossils have not been found in the main mass of these slates; but in the small cove nearly opposite Carrigaghalla and adjoining on the north that cove called the "Ladies' bathing-place," there are seen in the cliffs black soft fissile argillaceous slates, dipping at 80° WNW., which in the Ladies' Cove are much pierced by igneous intrusions and contain graptolites (Fig. 1). Unfortunately their relation to

FIG. 1.—SECTION IN COVE OPPOSITE CARRIGAGHALIA.



- G. Graptolitic black shales, with thin flags and calcareous bands.
- S. Flags.
- D. Intrusive diabase.
- I. Intrusive andesitic dolerite, enclosing patches of G.
- F. Fault.

the arenaceous limestones of the cliffs north of Lady Elizabeth's Cove is not here seen, but in lithological characters they may be compared with the much crushed black slates between Lady Doneraile's Cove and Tramore, in which, however, no fossils have yet been found. These underlie the arenaceous limestones; and for palæontological reasons, as will appear, we must consider the graptolitic slates of the Ladies' Bathing Cove also to belong to a stratigraphical horizon immediately below the arenaceous limestones.

The following graptolites were collected by me in the black slates of the Ladies' Bathing Cove¹:—

Climacograptus perexcavatus, Lapw.
Cryptograptus, sp.
Dicellograptus sextans, Hall (?)

Dicranograptus Nicholsoni, Hopk.
D. ramosus, Hall

¹ Miss G. Elles, of Newnham College, kindly identified these for me.

A spicule of a Lyssakine Hexactinellid sponge, kindly identified by Dr. Hinde, F.R.S., was also found by me in these beds.

All these graptolites occur in the Glenkiln Shales of Scotland; and in addition to the above there are in the Dublin Museum the following, labelled "Lady Elizabeth's Cove, Tramore," but contained in exactly identical black slates and probably from the same spot as my specimens. Mr. Clark, of the Geological Survey of Ireland, has kindly furnished me with the list of the species, and the specimens I have also examined myself:—

Climacograptus bicornis, Hall

Cenograptus gracilis, Hall

Didymograptus, sp.

Dicellograptus, sp.

Dendrograptus, sp. (?)

In addition to the above, Professor Lapworth¹ quotes the following list of graptolites given by Baily,² from "dark shales in Tramore Bay":—

Climacograptus bicornis, Hall

Cenograptus gracilis, Hall

Dicellograptus sextans, Hall

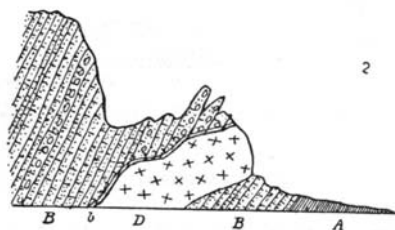
Dicranograptus ramosus, Hall

Didymograptus, sp.

Diplograptus foliaceus, Murch.

The whole assemblage is characteristic of the Glenkiln Shales, and we can therefore have no hesitation in ascribing the black slates which I have mentioned to that horizon. The list of graptolites given in the Survey Memoir of this district from the same locality (designated "locality 21") is misleading, owing to the incorrect determination of the species. No Ordovician beds older than these graptolitic shales have so far been proved to exist in this district.

FIG. 2.—SECTION IN CLIFFS, WEST SIDE OF TRAMORE BAY.



- A. Black calcareous slates on foreshore.
- B. Sandy impure and nodular limestones.
- D. Intrusive diabase.
- b. Crushed beds at junction.

The next beds to be described are the impure limestones which immediately overlie the graptolitic beds. These arenaceous and nodular limestones, which are so prominently developed along the coast from Tramore to Newtown Cove, contain in bands here and there a large number of fossils, which are, however, difficult to extract in anything but a fragmentary condition. The beds dip at angles from 45° to 70° to the WNW., but the average angle is

¹ Lapworth, Ann. Mag. Nat. Hist., ser. 5, vol. iv, 1879, p. 424.

² Baily, Q.J.G.S., vol. xxv, 1869, p. 158.

about 60°. (Fig. 2.) I have collected the following fossils from them :—

Calymene Blumenbachi, Brong.
C. brevicapitata, Portl.
Cybele, sp.
Phacops Jamesi, Portl.
Orthis calligramma, Dalm.

Plectambonites sericea, Sow.
Rafinesquina deltoidea, Conr.
Stenopora fibrosa, Goldf.
S. (?) lycoperdon, Hall

In the Survey Memoir it appears that the fossils from "locality 20" come principally from the sandy limestones; but a slight uncertainty prevails on this point, since on p. 19 of the Memoir the beds are described as "grey calcareous slates," while on p. 28 they are called "compact bluish limestones" and "brown shaly beds." The Newtown Cove fossils are also included in the description, but they come from beds which are stratigraphically rather higher and have a somewhat different faunistic facies, though a few species are common to them and the sandy limestones. The following fossils in the Survey and other collections seem to come from these sandy limestones :—

Ampyx mammillatus, Sars.
Asaphus gigas, De Kay
Calymene brevicapitata, Portl.
Cybele verrucosa, Dalm.
Encrinurus sexcostatus, Salt.
Illenus Bowmani, Salt. (?)
Lichas, sp.
Phacops Jamesi, Portl.
P. truncato-caudatus, Portl.
Remopleurides Colbii, Portl. (?)
Trinucleus seticornis, His., var. (?)
Phyllopora Hisingeri, McCoy

Ptilodictya dichotoma, Portl.
Porambonites intercedens, Pand.
Plectambonites sericea, Sow.
Orthis bifurcata, Schloth.
O. crispa, McCoy
O. elegantula, Dalm.
Rafinesquina deltoidea, Conr.
R. expansa, Sow.
Cyrtoceras (?) inaequiseptum, Portl.
Conularia, sp.
Glyptocrinus, sp.

If the foregoing lists are compared with those of the fossils from Pickardstown and Quillia, no important differences are apparent, except in the relative abundance of some forms such as *Phacops Jamesi*, which is rare near Tramore, while extraordinarily abundant at the other localities. This might be due to the less calcareous character of the Tramore beds rather than to any difference in the age of the strata, but the occurrence of the forms *Ampyx mammillatus* and *Remopleurides Colbii* may indicate a slightly higher horizon, since these genera are so prevalent in the overlying Newtown Cove beds, and are absent at Pickardstown, etc. Moreover, since the Tramore beds pass up into the Newtown Cove beds, whereas at Pickardstown a felsite immediately overlies the fossiliferous beds, it is probable that the latter correspond only with the lower part of the coastal series. Black slates underlie the calcareous fossiliferous beds in both localities, and there is no reason to doubt that they are of the same age, though palæontological evidence is, so far, unfortunately wanting. The correspondence in the faunas of the Tramore, Pickardstown, and Quillia rocks is so great that it seems impossible to do otherwise than group them together in the same *assise*; the dissimilarity in the bionomic conditions which is indicated by the difference in the lithological character of the

rocks and succession at each locality, appears sufficient to account for the slight modification in the relative abundance of some species and for the appearance of some new forms. The Newtown Cove beds have a somewhat different fauna, and must be considered separately.

The correlation of these impure limestones is not difficult when we remember that they immediately succeed beds containing a Glenkiln fauna. If we look at the succession in the South of Scotland, we see the Balclatchie beds with a somewhat similar fauna containing Hartfell graptolites, and the Hartfell Shales immediately succeeding the Glenkiln Shales. Additional evidence is afforded by the fact that some fossils of the Tramore limestones are only known in Great Britain from the Balclatchie and associated beds (*Asaphus gigas*, *Cheirurus gelasinus*, *Porambonites intercedens*), while one species (*Asaphus gigas*) is absolutely peculiar to the Balclatchie beds.

Certain species of the Tramore limestones are, however, peculiar, and have not so far been found outside Ireland :—

Amphion pseudo-articulatus.

Phacops truncate-caudatus.

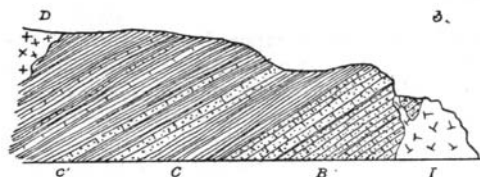
Cybele tramorensis.

Palæaster obtusus.

Phacops Jamesi.

This may be partly due to the fact that Ireland belonged to a different but adjoining zoological province, and partly that the Tramore limestones are not exactly on the same horizon as the Balclatchie

FIG. 3.—SECTION AT NEWTOWN COVE.



B. Sandy impure limestones.

C. Dark calcareous shales with fossils.

C'. Greenish calcareous shales and mudstones with thin limestone bands,
weathering yellowish-brown.

D. Intrusive diabase.

I. Intrusive andesitic dolerite.

beds. The latter suggestion is rendered all the more probable from the much closer correspondence of the fauna of the overlying Newtown Cove beds with that of the Balclatchie beds. I would therefore consider the Tramore limestones as corresponding with only the lower portion of the Balclatchie beds of Scotland, and with the whole or some portion of the underlying Benan conglomerate.

3. These Newtown Cove beds are found immediately above the impure limestones of the cliffs, and are well seen in the sides of the

(a) Lower beds (*C*, dark calcareous shales).

Echinosphærites arachnoideus, Forbes (?)

Crinoid stems.

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<https://doi.org/10.1017/S0016756800184948>

Ampyx rostratus, Sars.
Asaphus gigas.
Calymene brevicapitata.
Cybele verrucosa.
Harpes Dorani.
Illenus Bowmani.

Lichas hibernicus.
Remopleurides Colbii.
Trinucleus concentricus.
Orthis calligramma.
Plectambonites sericea.

The prominent feature of the fauna at Tirnaskea, as at Newtown Cove, is the trilobites, but the almost complete absence of mollusca at the latter place is a striking difference.

It is the Balclatchie fauna which bears the closest resemblance. Messrs. Nicholson and Etheridge¹ record the following Newtown Cove species from the Balclatchie beds :—

Agnostus agnostiformis.
Asaphus gigas.
Cheirurus gelasinus.
Cybele verrucosa.
Illenus Bowmani.

Lichas hibernicus.
Phacops Brongniarti.
Remopleurides laterispinifer.
Turrilepas scotica.

Several species of *Ampyx* are also recorded.

Professor Lapworth² mentions the following species from the Balclatchie beds, all of which occur at Newtown Cove :—

Asaphus gigas.
Phacops Brongniarti.
Remopleurides dorsospinifer.

Orthis calligramma.
Plectambonites quinquecostata.
P. sericea.

The genus *Barrandia*, which seems confined to the Lower Bala, is also mentioned. Of special importance do I consider the occurrence of the restricted species *Asaphus gigas* and *Cheirurus gelasinus*. The former species is only found in America in the homotaxial Hudson River beds and the Trenton Limestone. *Glyptocystites Logani*³ is also a Trenton Limestone species. The occurrence of some peculiar species (*Harpes Dorani*, *H. Flanagan*, *Barrandia Portlocki*, *Remopleurides platyceps*, *Trinucleus hibernicus*) gives the fauna the usual special Irish stamp.

The presence of typical Lower Bala species and genera, and the very close affinity of the fauna to that of the Balclatchie beds, demonstrate unmistakably the horizon of the Newtown Cove beds; and the palæontological evidence is found to be confirmed by the stratigraphical as shown in the field.

The succession, therefore, of the fossiliferous beds near Tramore is as follows :—

- (4) Shales, mudstones, and impure limestones of Newtown Cove (= greater portion of the Balclatchie Beds).
- (3) Impure sandy limestones of Tramore Bay cliffs, including towards the base the Quillia and Pickardstown beds (= lower portion of the Balclatchie Beds and portion of the Benan Conglomerate).
- (2) Black slates of Carrigaghalla, etc. (= Glenkiln Shales).
- (1) Unfossiliferous dark slates.

The fauna and succession of the beds at Newtown Head, near Passage, will be described on a subsequent occasion, as well as the other fossiliferous Ordovician beds in County Waterford.

¹ Mon. Girv. Silur. Foss., 1879, pp. 228–9.

² Q.J.G.S., vol. xxxviii, 1882, p. 586.

³ Billings, Canad. Organ. Rem., 1858, dec. iii, p. 57, pl. iv, fig. 1.