

Haddock. This is the only previous record of fish-remains from the bed known to me.

Carcharodon (teeth), and other sharks.	Oxyrhina (teeth).
Chrysophrys (teeth).	Platax Woodwardi?
Lamna, sp. (teeth).	Raia batis (teeth).
Myliobatis (teeth).	Otoliths of Gadoid fish.
Notidanus microdon (teeth).	Fish vertebrae. Also a fragment of the tooth of a mammal.

#### APPENDIX D.

*Note on the Ostracoda and Foraminifera of the shelly Patches.*

By DR. H. W. CROSSKEY, F.G.S.

An examination of the material obtained by Mr. G. W. Lamplugh during the recent exposure of the shelly patches in the Boulder-clay at Bridlington, has both added to the catalogue and confirmed the previously existing evidence of the arctic character of the Ostracoda and Foraminifera contained in that bed.

In making this examination, I have to acknowledge the valuable assistance I have received from Mr. G. S. Brady, with respect to the Ostracoda, and from Mr. H. B. Brady with respect to the Foraminifera. From the facts to be narrated it would appear that the new exposure reveals the same deposit as that to which the name of Bridlington Crag was given when it was first observed; and Mr. Lamplugh informs me that its position on the beach agrees exactly with the early accounts.

#### OSTRACODA.

In order that the general character of the group of Ostracoda may be clearly understood, it is necessary to refer to the investigations that have already been made, especially since the identity of the newer and older exposures is a point of importance.

In the "Monograph of the Tertiary Entomostraca of England," by T. Rupert Jones\*, two species of Ostracoda are described, for which Bridlington is the only locality given, viz. *Cythere concinna*, Jones, and *Cytheridea Sorbyana*, Jones. Neither of these species, wrote Mr. Sorby†, "have been met with any where else either living or fossil."

Since the date of these publications both *Cythere concinna* and *Cytheridea Sorbyana* have, however, been found living as far north as Spitzbergen; and they occur in considerable abundance as fossils in the glacial clays of Scotland.

In the "Monograph of the Post-Tertiary Entomostraca of Scotland, including species from England and Ireland," by G. S. Brady, H. W. Crosskey, and D. Robertson, twenty one Bridlington species are described, of which the following analysis has been made‡:—

\* Palæontographical Society, 1856.

† "On the Crag-deposit at Bridlington, and the microscopic fossils occurring in it" (Polyt. Soc. West Riding, vol. iii. p. 559).

‡ A note by Dr. Crosskey, "On some additions to the fauna of the Post-Tertiary bed at Bridlington, Yorkshire. Proc. Birmingham Phil. Soc. vol. ii. p. 377.

- 2 are peculiar to Bridlington as fossils, one not being known living, and the other having a high northern range.  
1 is found in an English Boulder-clay, but not in Scotland.  
5 are most abundant in those Scotch clays in which the fauna is extremely arctic.  
11 are common in all Scotch glacial clay.  
1 has been found in one Scotch glacial clay only.  
1 has been detected in an upper bed only, but is known to live in the Gulf of St. Lawrence.

The whole group is remarkably analogous to that found in the glacial clays of the East of Scotland; and the newly exposed clay has yielded a large proportion of the same species.

The following is a list of the species obtained chiefly from the shelly patches described in Mr. Lamplugh's paper.

Genus CYTHERE, Müller.

- C. concinna*, Jones. Common.  
*C. dunelmensis*, Norman. Moderately common.  
*C. mirabilis*, Brady. Common.  
*C. tuberculata*, G. O. Sars. Common.  
*C. villosa*, G. O. Sars. Rare.  
*C. fimbriata*, Norman. Rare.  
*C. M<sup>c</sup>Chesneyi*, Brady & Crosskey. Rare.  
*C. globulifera*, Brady. Rare.

Genus CYTHERIDEA, Bosquet.

- C. Sorbyana*, Jones. Common.  
*C. elongata*, Brady. Rare.

Genus CYTHEROPTERON, G. O. Sars.

- C. latissimum*, Norman. Rare.

Genus EUCYTHERE, Brady.

- E. argus*, G. O. Sars. Common.

Genus KRITHE, Brady, Crosskey, & Robertson.

- K. glacialis*, B., C., & R. Common.

With two exceptions the whole of these species are characteristic of the Scotch glacial clays, and especially of those near the eastern coast. *O. mirabilis*, *Cytheridea Sorbyana*, and *Krithe glacialis*, for example, are especially associated with such arctic mollusca as *Pecten groenlandicus*, *Leda arctica*, and *Thracia myopsis* in the glacial clays of the East of Scotland, and are among the most abundant species in the Bridlington shelly patches. The forms I have excepted from this general statement are *Cytheridea elongata* and *Cythere M<sup>c</sup>Chesneyi*. Of these *C. M<sup>c</sup>Chesneyi*, Mr. Brady informs me, is "interesting as being the first notice of it on this side of the Atlantic." It was originally

discovered in gatherings of glacial clay from Montreal and Saco, which were sent to the writer of this note by Principal Dawson.

*Cytheridea elongata* "is common enough as a recent species all around these islands" and lives in the Gulf of St. Lawrence also, so that it is not surprising to find it in a glacial deposit\*.

The general statement made by Mr. Lamplugh in his paper respecting the fauna of the shelly patches in the Boulder-clay that (with the exception of a doubtful *Rissoa*) no "species are found save such as might form part of the same life-group," accurately represents the state of the case with respect to the Ostracoda.

#### FORAMINIFERA.

In the Monograph of the "Foraminifera of the Crag," by Prof. T. R. Jones, W. K. Parker, and H. B. Brady†, the following passage occurs:—"Some Foraminifera collected by Mr. H. C. Sorby, F.R.S., from the Bridlington Crag some years ago, and kindly placed at our disposal, have to be noticed. These comprise *Cornuspira*, *Miliola*, *Lagena*, *Dentalina*, *Cristellaria*, *Polymorphina*, *Cassidulina*, *Truncatulina*, *Polystomella*, and *Nonionina*, and are the most conspicuous of a probably more extensive fauna, nearly allied to that of the Suffolk Crag."

As Mr. H. B. Brady points out to me, however, much more is known of the distribution of the northern forms than when this paragraph was written; and, of the 18 Bridlington species described in the monograph, all save one have been discovered in the North Atlantic, and 14 of them in the Arctic seas.

When in connexion with this fact their association with Arctic Mollusca is considered, the application to them of the term "Crag" becomes more than questionable.

The new material has yielded 16 species, with two varieties of species.

Of these 16 species, 8 are catalogued as from Bridlington in the monograph; and the whole of these occur in the Scotch glacial clays. Of the remaining 8, 5 are Scotch glacial fossils; while 3 species and 2 varieties, although catalogued as glacial fossils for the first time, are not improbable members of the same group, so far as climatic conditions are concerned.

The following is the list of Foraminifera; the number of specimens found was far greater than of the Ostracoda:—

#### Genus BILOCULINA, D'Orbigny.

*B. ringens*, Lamk. Moderately common.

#### Genus CASSIDULINA, D'Orb.

*C. lævigata*, D'Orb. Rare.

\* Vide "Notes on fossil Ostracoda from the Post-Tertiary deposits of Canada and New England" by G. S. Brady and H. W. Croeskey. Geological Magazine, vol. viii. No. 2, where it is figured and described.

† Palæontographical Society, 1865, Preface, p. v.

Genus DENTALINA, D'Orb.

*D. communis*, D'Orb. Common.

Genus GLANDULINA, D'Orb.

*G. levigata*, D'Orb. Abundant.

\*var. *rotundata*, Reuss.

\*var. *æqualis*, Reuss.

Genus GAUDRYINA, D'Orb.

\**G. pupoides*, D'Orb. Rare.

Genus LAGENA, Walker and Jacob.

*L. globosa*, Mont. Rare.

*L. levigata*, Reuss. Rare.

*L. squamosa*, Mont. Moderately common.

*L. sulcata*, W. & J. Common.

Genus NONIONINA, D'Orb.

\**N. orbicularis*, Brady? Rare.

Genus POLYMORPHINA, D'Orb.

*P. lactea*, W. & J. Abundant.

*P. compressa*, D'Orb. Abundant.

Genus POLYSTOMELLA, Lamarek.

*P. striato-punctata*, F. & M. Abundant.

Genus PULVINULINA, Parker and Jones.

\**P. Karsteni*, Reuss. Rare.

Genus QUINQUELOCULINA, D'Orb.

*Q. seminulum*, Linn. Abundant.

Genus TRUNCATULINA, D'Orb.

*T. lobatula*, W. & J. Common.

With respect to the forms marked \*, which have not been previously given in the lists of glacial fossils, the following notes may be made.

*Glandulina levigata* is very rare in the Scotch beds; it is abundant at Bridlington, and its varieties therefore (var. *rotundata* and var. *æqualis*) may be expected.

*Gaudryina pupoides* is described by Mr. H. B. Brady† as a "common deep-water Foraminifer. The list of localities at which it

† The voyage of H.M.S. 'Challenger,' p. 378.

has been found includes fourteen stations in the North Atlantic, the most northerly being about lat. 60° N."

*Pulvinulina Karsteni* is a Shetland form, and is figured in Mr. H. B. Brady's paper on the "Rhizopodal Fauna of the Shetlands"\*.

Several species of *Nonionina* occur in the glacial clays, so that the appearance of a species doubtfully named *N. orbicularis* raises no difficulty regarding the general character of the group.

The Foraminifera, as well as the Ostracoda derived from the new material I have examined, when compared with the Scotch fossils and studied together, give considerable ground for the supposition that these "shelly patches" in the Bridlington Boulder-clay belong very closely to the same period of the glacial epoch as that represented by the fossiliferous clays of the coast of Scotland.

#### EXPLANATION OF PLATE XV.

- Fig. 1, 1 a. *Littorina? globosa*, Jeffreys, sp. n.  
2, 2 a. *Rissoa subperforata*, Jeffreys, sp. n.  
3, 3 a. — *Wyville-Thomsoni*, Jeffreys.  
4, 4 a. *Pleurotoma multistriata*, Jeffreys, sp. n.  
5, 5 a. *Utriculus constrictus*, Jeffreys, sp. n.  
6, 6 a. *Bulla crebristriata*, Jeffreys, sp. n.

The short lines indicate the natural size.

#### DISCUSSION.

Dr. J. GWYN JEFFREYS believed, from a personal inspection, that this was a *remanié* deposit. He had supplied Prof. Phillips with a list of the Bridlington shells for the second and posthumous edition of his 'Geology of Yorkshire.' The present list showed that the total number of species and varieties amounted to 74†, of which 33 were purely arctic forms, 1 a deep-water form (480 to 560 fms.), 2 American forms, 33 shallow-water forms (under 100 fms.), and there were 5 perfectly new species. Besides the peculiarly arctic species, 20 of the littoral species are also arctic, making the total number of the latter 61, or nearly 87 per cent. of the whole. Similar purely arctic forms had been lately found in deposits near Glasgow. These shells were much more arctic in character than those of Moel Tryfaen, which might be referred to a Celtic area of distribution.

Prof. T. M<sup>c</sup>K. HUGHES said that many years ago he had found, with Mr. Lyell, in Dimlington cliff, a lenticular bed of sand with *Nucula Cobboldiæ*, *Astarte compressa*, and other shells, some of the bivalves with the shells in contact. He thought it more probable that the shelly patches were pushed up by the grounding of ice-bergs and shore-ice from the sea-bottom close by, than that they

\* Transactions of the Linnean Society, vol. xxiv.

† After this paper was read 9 more species were discovered, and have been entered in the Appendix A.

328 ON SHELLY PATCHES IN THE BOULDER-CLAY AT BRIDLINGTON QUAY.

had been conveyed from a distance. He thought the shells lived in Glacial times and near the place where they are now found.

Mr. LEONARD LYELL did not agree with Prof. Hughes as to the shells found in a sandy bed at Dimlington being of the age of the Boulder-clay. The shells were excessively friable, and were found at various points along the coast. He thought they had been transported from a distance in frozen masses. He asked as to the state of preservation of the different shells in the deposit.

The AUTHOR, in reply to the President, said that the presence of deep-sea forms was a bar to the conclusion that they were entirely carried by coast-ice. The difference of this sand from that formed from the waste of rocks on the coast was an argument against the masses coming from the immediate locality. The state of preservation was very different in different patches, and seemed to depend more on the character of the matrix than on the nature of the different species. The patches were more abundant at Dimlington than at Bridlington, owing to the wider exposure of the Boulder-clay containing them.