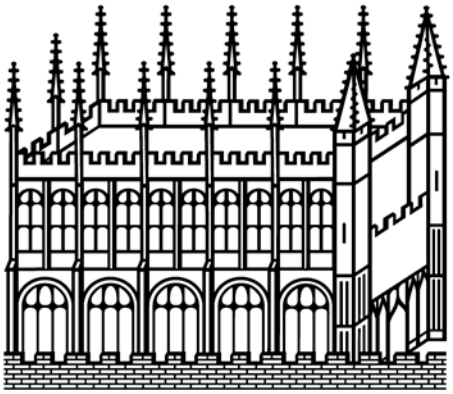


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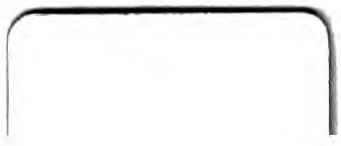
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SILURIAN FOSSILS

OF THE

GIRVAN DISTRICT IN AYRSHIRE

VOL. I.

THE PROTOZOA, ACTINOZOA, CRUSTACEA,
ANNELIDA, AND ECHINODERMATA

A MONOGRAPH

OF THE

SILURIAN FOSSILS OF THE GIRVAN DISTRICT IN AYRSHIRE

WITH SPECIAL REFERENCE TO THOSE CONTAINED IN THE "GRAY COLLECTION"

BY

H. ALLEYNE NICHOLSON

PROFESSOR OF NATURAL HISTORY IN THE UNIVERSITY OF ST ANDREWS

AND

ROBERT ETHERIDGE, JUN.

OF THE GEOLOGICAL DEPARTMENT, MUSEUM OF NATURAL HISTORY

VOL. I.



WILLIAM BLACKWOOD AND SONS
EDINBURGH AND LONDON
MDCCCLXXX

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CONTENTS.

FASCICULUS I.—1878.

	PAGE
BIBLIOGRAPHY,	1
LIST OF LOCALITIES,	7
DESCRIPTION OF THE PLANTS,	9
" " RHIZOPODA,	10
" " ACTINOZOA,	25
GENERAL REMARKS ON ACTINOZOA,	92
DESCRIPTION OF THE TRILOBITES,	98

FASCICULUS II.—1879.

DESCRIPTION OF THE TRILOBITES (*continued*),	137
ADDENDA TO THE TRILOBITES,	201
DESCRIPTION OF THE PHYLLOPODA,	207
" " CIRRIPEDIA,	213
" " OSTRACODA,	216
GENERAL REMARKS ON THE CRUSTACEA,	223
TABLE OF DISTRIBUTION OF THE CRUSTACEA,	235

FASCICULUS III.—1880.

DESCRIPTION OF THE RHIZOPODA (*continued*),	237
" " ACTINOZOA (*continued*),	241
" " TRILOBITES (*continued*),	283
" " CIRRIPEDIA (*continued*),	299
" " ANNELIDA,	303
" " ASTEROIDEA,	318
" " CRINOIDEA,	326
INDEX,	335

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ACTING-PALÆONTOLOGIST TO THE GEOLOGICAL SURVEY OF SCOTLAND

FASCICULUS I.

(RHIZOPODA, ACTINOZOA, TRILOBITA)



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GENERAL PREFACE.

THE present work is the first Fasciculus of a detailed descriptive catalogue of the fossils of the Silurian area of Girvan, in Ayrshire. The district in question has long been known to be occupied by a great and complicated series of Silurian rocks, the disentanglement and correlation of which has presented exceptional difficulties to the stratigraphical geologist. It has also long been known that the Girvan deposits were largely fossiliferous, but the organic remains have, up to this time, been only very partially worked out, in spite of the excellent descriptions of various forms which have been published by M'Coy, Salter, Sir C. Wyville Thomson, Mr Davidson, Professor John Young, and others. As will be seen, indeed, from the bibliographical list which follows, a large number of valuable papers have been written, dealing with fossils derived from the Girvan area; but these memoirs only treat of limited portions of the subject; while they are to be found in separate and often hardly accessible publications.

Under these circumstances, it appeared to us that a systematic descriptive account of the fossils of the Girvan district would be of value to the geological student, and would be likely to solve some important problems in both palæontology and geology. We therefore made application to the Royal Society

for assistance from the Government grant, and we take this opportunity of expressing our gratitude for the sum of seventy-five pounds, which was allotted to us. This sum was of course insufficient to defray the cost of the first Fasciculus; but without this assistance we could not have commenced the work in a satisfactory manner; and we have to record our best thanks to our friend Robert Gray, Esq., F.R.S.E., to whose generosity we owe further aid.

Apart, however, from matters of this kind, our greatest debt of gratitude was due to Mrs Robert Gray, without whose co-operation the present work could not have seen the light. By giving us the free and uncontrolled use of her cabinet, Mrs Gray has put us in possession of the most complete series extant of the Silurian fossils of Ayrshire, and has thus enabled us to undertake a systematic review of the interesting and important organic remains of the Girvan area. In this connection, we have only to add that our further thanks are due to our friend Charles Lapworth, Esq., F.G.S., who has kindly presented us with some interesting specimens collected by himself in this region. Lastly, a visit to the ground in person has resulted, not only in giving us a direct knowledge of the rocks from which our specimens have been derived, but also in considerably increasing the available material for our work.

PREFACE TO THE FIRST FASCICULUS.

In the present Fasciculus we have dealt with the *Protozoa*, the Corals, and a portion of the *Crustacea* of the Girvan district, so far as we are at present acquainted with them. In the case of well-known and thoroughly understood forms, on which our specimens throw no new light, we have contented ourselves with simply recording the occurrence of the species, accompanying this with any observations which the Ayrshire examples might call for. In the case of new or imperfectly understood forms, we have always given as full a description as our materials would allow, availing ourselves as far as possible of illustrations in elucidation of the text.

In connection with the Protozoa, the description of *Saccammina* is from the pen of Henry B. Brady, Esq., F.R.S., on whose unimpeachable authority this interesting type of the *Foraminifera* can now be asserted to have been in existence in Lower Silurian times. For this and much other kind assistance from the same source, we are glad to have this opportunity of publicly expressing our obligation.

As regards the Corals of the Girvan area, we had unusual difficulties to confront. Though the total number of specimens available for examination was very large, the great majority of these were in such a state of preservation that their external

characters could only be made out imperfectly, if at all. This necessitated the sectioning of a great number of examples, as well as the preparation of an extensive series of microscopic slides. For this reason, also, the figures which we have given are more largely concerned with the minute internal structure, and less with external features, than has been usual in works dealing with fossil corals. In spite of these disadvantages, the results obtained have been very satisfactory, the coral-fauna proving to be one of high interest. The only other point about the corals worth mentioning is, that we have thought it advisable, in the meanwhile, to retain such forms as *Chætetes* and *Fistulipora* in the *Actinozoa*, rather than to keep them back till we come to deal with the *Polyzoa*. It may ultimately be shown that these forms should properly find their place among the latter; but this view cannot be regarded as proved, and there are considerable difficulties in the way of its adoption.

The Trilobites, so far as we have at present investigated them, do not call for any particular remarks. On the whole, we are able to support the determinations of previous writers; and it appears probable that more good work has been accomplished and published in the direction of this order than of any other, by those who have, up to the present time, investigated the Girvan fauna. We hope to complete the Trilobites and other orders of Crustacea in our second Fasciculus, when we intend giving a short chapter upon their relations with the Trilobite faunæ of other areas, and particularly their bearing upon the age of the various subdivisions of the Girvan series.

In connection with the Trilobites, we are under obligations to R. Etheridge, Esq., F.R.S., and G. Sharman, Esq., of the Museum of Practical Geology, who have rendered us material assistance in the comparison of some of our specimens with those in the valuable collection of that institution. We are

also indebted to Dr J. C. Purves, for suggestions on many points.

As regards the plates, we have only to say that those dealing with the corals were drawn by one of us, and that the others were drawn, and all were put upon the stone, by Mr Charles Berjeau, F.L.S., whose skill as a scientific artist is too well known to need any praise from us, and whose reputation certainly will not suffer from these specimens of his handiwork. Unless otherwise stated, the specimens figured form a part of the "Gray Collection."

St Andrews and Edinburgh,
October 1878.

A MONOGRAPH

OF THE

SILURIAN FOSSILS OF THE GIRVAN DISTRICT.

BIBLIOGRAPHY.

1849. SALTER, J. W.—Note on the Fossils from the Limestone on the Stinchar River, and from the Slates of Loch Ryan. *Quart. Jour. Geol. Soc.*, v., pp. 13-17, t. 1.

Mentions the occurrence of seven species in the Stinchar River Limestones, and describes six of them—viz., *Pleurotomaria Moorei*, Salter; *P. latifasciata*, Portlock (?); *Murchisonia scalaris*, Salter; *Euomphalus* (?), sp. ind.; *Orthis confinis*, Salter; *Illænus Davisii*, Salter.

1850. M'COY, Prof. F.—On some New Genera and Species of Silurian Radiata in the Collection of the University of Cambridge. *Annals and Mag. Nat. Hist.*, 2d ser., vi., pp. 270-290.

Describes *Strephodes Craigensis*, M'Coy, Craighead; *Petraia æquisulcata*, M'Coy, Mulloch Quarry; *Palæopora favosa*, M'Coy, Craighead and Mulloch Quarry.

Ibid.—On some New Silurian Radiata, *loc. cit.*, pp. 474-477.

Describes *Palæopora subtilis*, M'Coy, Mulloch Quarry.

1851. M'COY, Prof. F.—On some New Silurian Mollusca. *Annals and Mag. Nat. Hist.*, 2d ser., vii., pp. 45-63.

Describes *Orthoceras politum*, M'Coy, Glenwhapple; *Bellerophon subdecussatus*, M'Coy, Mulloch Quarry; *Trochus Moorei*, M'Coy, Dalquharran.

Ibid.—id., 2d ser., vii., pp. 387-409.

Describes *Cytheropsis Aldensis*, M'Coy, Aldens; *Hemithyris angustifrons*, M'Coy, Mulloch Quarry; *H. nasuta*, M'Coy, Craighead Quarry; *Orthisina Scotica*, M'Coy, Craighead Quarry and Colmonell; and *Holopella tenuicincta*, M'Coy, Mulloch Quarry.

1851. SALTER, J. W.—List of some of the Silurian Fossils of Ayrshire. *Quart. Jour. Geol. Soc.*, vii., pp. 170-178, plates 8-10.

Mr Salter gave an exhaustive list of the fossils from the Girvan district, obtained from twelve localities. His list comprised the following new species: *Diplograpsus bullatus*, *Nidulitus favus*, *Pleurorhynchus dipterus*, var. *rhomboideus*, *Maclurea magna*, M'Coy, *Orthoceras Barrandei*. In addition to these, several already known species are noticed.

1851. SEDGWICK, Rev. Prof.—On the Geological Structure and Relation of the Frontier Chain of Scotland. *Brit. Assoc. Report for* 1850, pt. ii., pp. 103-107; with List of the Organic Remains by Prof. M'COY.

The rocks of the Girvan district are divided into two subdivisions, a north and south Girvan group. A copious list of fossils, arranged under localities, is given. (This paper was also published in the *Edinb. N. Phil. Jour.*, li., p. 250.)

1852. M'COY, Prof. F.—Contributions to British Palæontology; some New Lower Palæozoic Mollusca. *Annals and Mag. Nat. Hist.*, 2d ser., x., pp. 189-195.

Describes *Murchisonia cancellatula*, M'Coy, Mulloch Quarry; *M. simplex*, M'Coy, Dalquharran; *Maclurea macromphala*, M'Coy, Craighead; *Ecculiomphalus Scoticus*, M'Coy, Mulloch Quarry.

1852. M'COY, Prof. F.—British Palæozoic Fossils, fas. ii., p. 351.

In this valuable work there will be found a list of fossils arranged alphabetically in localities, and preserved in the Woodwardian Museum, Cambridge. For the descriptions of the species the work may itself be referred to; we shall have occasion to notice many of the forms in question.

1853. SALTER, J. W.—Figures and Descriptions illustrative of British Organic Remains. *Mem. Geol. Survey United Kingdom*, Dec. vii., No. 2, p. 11.

Describes *Cheirurus gelasinosus*, Portlock, from the "limestone of Ayrshire."

Ibid.—Id., Dec. vii., No. 5.

Describes *Cyphaspis megalops*, M'Coy, and gives as one locality sandstones of Mulloch Quarry, on the authority of M'Coy.

1854. MORRIS, Prof. J.—A Catalogue of British Fossils, comprising the Genera and Species hitherto described; with reference to their Geological Distribution, and to the Localities in which they have been found. 2d edition, London, 8vo.

1857. THOMSON, Sir C. WYVILLE.—On some Species of *Acidaspis* from the Lower Silurian beds of the South of Scotland. *Quart. Jour. Geol. Soc.*, xiii., pp. 206-210, t. 6.

Describes four species of *Acidaspis* from the schists at the base of the "Graptolite and Orthoceratite flags" of Penwhapple Glen, Girvan district, which the author considers to be of Upper Bala age—*Acidaspis Lalage*, *A. hystrix*, *A. callipareos*, and *A. unica*.

1864. SALTER, J. W.—Figures and Descriptions illustrative of British Organic Remains. *Mem. Geol. Survey United Kingdom*, Dec. xi., No. 1, p. 8.

Describes *Agnostus trinodus*, Salter, and gives as one locality Penwhapple Burn, Girvan district.

Ibid.—*Id.*, Dec. xi., No. 5, p. 4.

Describes *Staurocephalus* (?) *unicus*, Wy. Thomson, Penwhapple Glen, Girvan District.

Ibid.—A Monograph of British Trilobites, pt. 1, 4to.

Describes the following species from the Girvan district: *Phacops Stokesii*, Milne-Edw.; *Cheirurus bimucronatus*, Murchison, Mulloch Quarry; *C. octolobatus*, M'Coy, Penwhapple; *C. gelasinosus*, Portlock, Craighead limestone.

1864. THOMSON, Sir C. WYVILLE.—Figures and Descriptions illustrative of British Organic Remains. *Mem. Geol. Survey United Kingdom*, Dec. xi., No. 6.

Describes an entirely new form of Trilobite, under the name of *Salteria primæva*, Wy. Thomson.—Schists forming the base of the "Graptolite and Orthoceratite flags," Penwhapple Glen, Girvan district.

1865. SALTER, J. W.—A Monograph of British Trilobites, pt. 2.

Describes, from Girvan localities, *Staurocephalus globiceps*, Portlock; *Calymene Blumenbachii*, Brongniart, Mulloch Quarry.

1866. DAVIDSON, T.—A Monograph of the British Fossil Brachiopoda, pt. vii. The Silurian Brachiopoda, No. 1.

Describes from Girvan localities the following: *Lingula attenuata*, Sow.; *Discina perrugata*, M'Coy; *D. oblongata*, Portl.; *D. crassa*, Hall; *Siphonotreta micula*, M'Coy.

1867. MURCHISON, Sir R. I.—Siluria, 4th ed., London, 8vo, pp. 155-157.

A general outline of the Geology is given, and the occurrence of certain fossils on the Stinchar and Girvan rivers, and at Mulloch Hill, Saugh Hill, and other localities, is mentioned.

1867. SALTER, J. W.—A Monograph of British Trilobites, pt. iv.

Describes from Girvan localities—*Illænus Bowmani*, Salter, Girvan; *I. Thomsoni*, Salter, Mulloch Quarry; *I. Macallumi*, Salter, Mulloch Quarry.

1867. DAVIDSON, T.—A Monograph of the British Fossil Brachiopoda, pt. iii. The Silurian Brachiopoda, No. 2.

Describes *Meristella angustifrons*, M'Coy; *Atrypa reticularis*, Dalman; *A. imbricata*, J. de C. Sow.; *A.* (?) *hemisphærica*, J. de C. Sow.; *A.* (?) *Scotica*, M'Coy; *Pentamerus oblongus*, J. de C. Sow.; *Rhynchonella cuneata*, Dalman.

1868. GEIKIE, Prof. A.—On the Order of Succession among the Silurian Rocks of Scotland. *Trans. Geol. Soc. Glasgow*, iii., pt. 1, pp. 74-95.

The Carrick limestones are noticed, and referred to the Caradoc or Bala group; so also is the Craighead limestone, and again the beds at Ardwell, Piedmont Glen, and Penwhapple Burn. The shelly sandstones of Drummuck, Mulloch, and Saugh Hill are placed as Llandovery. From all the foregoing localities lists of fossils are given.

1868. JONES, Prof. T. RUPERT.—Notes on the Palæozoic Bivalved Entomostraca, No. viii. *Annals and Mag. Nat. Hist.*, 4th ser., ii., pp. 54-62.

Describes *Cythere Aldensis*, M'Coy, from Aldens, to the south-west of Girvan. The species is placed in the genus *Cythere*, rather than *Cytheropsis*, with which it had been previously associated.

1868. GRAY, R.—Note on Silurian Fossils from Girvan. *Proc. Glasgow Nat. Hist. Soc.*, i., pt. 1, p. 101.

A list, comprising many of the genera found in the district, is given.

Ibid.—Note on a Series of Silurian Brachiopoda, from the neighbourhood of Girvan, *loc. cit.*, p. 124.

The following are mentioned: *Lingula Ramsayi*, *L. attenuata*, and *Discina perrugata*.

1868. YOUNG, J.—Remarks on four species of Silurian Brachiopoda, new to Ayrshire, *loc. cit.*, p. 169.

Notices *Siphonotreta micula*, *Orthis galea*, *O. alata*, and *Lingula Ramsayi*.

1868. YOUNG, Prof. J., M.D.—On New Forms of Crustacea from the Silurian Rocks at Girvan. *Proc. Nat. Hist. Soc. Glasgow*, i., pp. 169-173.

Describes as a new species *Cheirurus trispinosus*, from Penkill, and as a new genus and species *Solenocaris solenoides*.

1868. GRAY, R.—On the occurrence of *Ischadites Kœnigi* in the Silurian Rocks of the Girvan District, *loc. cit.*, p. 197.

First discovery of this species in the rocks in question.

1868. YOUNG, J.—Note on a new Brachiopod Shell, *Triplesia Grayæ*, Davidson, discovered in the Silurian Strata of the Girvan valley by Mrs Robert Gray, *loc. cit.*, p. 207.

1868. BIGSBY, Dr J. J.—Thesaurus Siluricus. The Flora and Fauna of the Silurian Period, &c. London. 4to.

A detailed and tabulated list of Silurian fossils generally, amongst which will be found a record of the Girvan forms.

1869. GRAY, R.—Note on *Leptæna Youngiana*, Davidson, a new Silurian Brachiopod Shell from the Girvan District; and also on the Occurrence of *Leperditia* in the same, *loc. cit.*, pt. ii., pp. 230, 231.

1869. DAVIDSON, T.—A Monograph of the British Fossil Brachiopoda, pt. vii. The Silurian Brachiopoda, No. 3.

Describes *Rhynchonella nasuta*, M'Coy; *R. nucula*, Sow.; *R. Thomsoni*, Davidson; *R. Salteri*, Dav.; *Triplesia Grayæ*, Dav.; *Atrypa* (?) *incerta*, Dav.; *Orthis Bouchardii*, Dav.; *O. elegantula*, Dalman; *O. Girvanensis*, Dav.; *O. vespertilio*, J. de C. Sow.; *O. calligramma*, Dalman.

1869. GEIKIE, Prof. A.—Lists of Fossils, determined by Mr R. ETHERIDGE, from (*a*) the Craighead limestone, (*b*) the Ladyburn (Drummuck) section, and (*c*) from the lower Llandovery Rocks of Kirk Hill, Girvan district. *Mem. Geol. Survey Scotland*, Expl. sheet 14 (pp. 9-10).

Eleven species are mentioned from the first locality, six from the second, and eight from the third.

Ibid.—Lists of Fossils, determined by Mr R. ETHERIDGE, (*a*) from the Aldens limestone, and (*b*) from Ardmillan Brae, in the Girvan district. *Mem. Geol. Survey Scotland*, Expl. sheet 7 (pp. 9-10).

From the first locality nine species are mentioned, and from the second forty-five and a few doubtful ones.

1871. DAVIDSON, T.—A Monograph of the British Fossil Brachiopoda, pt. vii. The Silurian Brachiopoda, No. 4.

Describes *Orthis turgida*, M'Coy; *O. confinis*, Salter; *O. insularis*, Eichwald (?); *Strophomena rhomboidalis*, Wahl.; *S. retroflexa*, Salter; *S. antiquata*, Sow.; *S. corrugatella*, Dav.; *S. grandis*, Sow.; *Leptæna Youngiana*, Dav.; *L. quinquecostata*, M'Coy; *L. sericea*, Sow.; *L. tenuicincta*, M'Coy.

1873. ETHERIDGE, R., with Prof. J. YOUNG and R. ETHERIDGE, jun.—List of Fossils collected by the Geological Survey from the Silurian Rocks of the south-west of Ayrshire. *Mem. Geol. Survey Scotland*, Expl. sheet 3 (pp. 29-34).

The Fossils are arranged under thirty-one localities.

1873. LAPWORTH, C.—On the Silurian Rocks of the south of Scotland. *Trans. Geol. Soc. Glasgow*, iv., pt. 2 (pp. 164-174).

In the appendix to this paper will be found 'Lists of the Fossils of the various subdivisions of the south Scottish Silurians,' the ninth paragraph of which relates exclusively to the Girvan series.

1875. YOUNG, J.—Notes on the Genera of Extinct Fossil Shells, *Bellerophon* and *Porcellia;* their classification amongst the Mollusca, and their distribution in the Silurian and Carboniferous strata of the west of Scotland. *Proc. Nat. Hist. Soc. Glasgow*, 1875, ii., pt. 1, p. 16.

States that four species of *Bellerophon* occur in the Girvan Silurian beds.

Id.—Note on a small collection of Fossil Brachiopoda from the neighbourhood of Girvan. *Loc. cit.*, p. 21.

Records the occurrence of *Atrypa incerta*, *Rhynchonella æmula*, *R. Thomsoni*, *R. Weaveri*, *Orthis Bouchardii*, *O. vespertilio*, *O. calligramma*, var. *Scotica*, *O. elegantula*, *Triplesia Grayæ*, *Strophomena imbrex*, *Leptæna Youngiana*, *L. tenuicincta*, *L. sericea*, and *Strophomena Grayi.*

YOUNG, Dr J.—Note on a new species of Crustacean, belonging to the genus *Solenocaris*, from Silurian strata near Girvan, and on fragments, probably the appendages of a Trilobite or Limuloid Crustacean. *Loc. cit.*, p. 66.

1876. LAPWORTH, C.—On Scottish Monograptidæ, pt. 8. *Geol. Mag.*, Dec. 2, 1876, iii., pp. 544-552.

Describes *Cyrtograptus Grayæ*, a new species from the Penwhapple Glen beds, near Girvan.

1876. YOUNG, J.—Notes on a series of Fossils from the Silurian Rocks of the Girvan Valley. *Proc. Nat. Hist. Soc. Glasgow*, ii., pt. 2, p. 166.

Notes the occurrence in the Gray collection of *Bellerophon dilatatus*, *Murchisonia obscura*, *Holopella obsoleta*, *Scalites angulatus*, *Lingula quadrata*, *Orthis biforata*, *Rhynchonella Salteri*, *Orthis Girvanensis*, and *Acidaspis Brightii.*

Id.—Note on a series of Trilobites of Caradoc age from the Silurian strata of the Girvan Valley. *Loc. cit.*, p. 179.

Notes the identification of the following species in the Gray collection — viz., *Illænus Bowmani*, *I. Thomsoni*, *I. Barriensis*, *Cybele verrucosa*, *Staurocephalus* (?) *unicus*, *Proetus latifrons*, *Cheirurus latifrons*, *Zethus rugosus*, and *Odontopleura ovata* (?)

Id.—Note on a series of Graptolites from the Silurian strata of the Girvan Valley. *Loc. cit.*, p. 182.

The following are stated by Mr Young to be in the Gray collection from Penwhapple Glen—viz., *Graptolithus priodon*, *G. Sedgwickii*, *G. colonus*, *Cyrtograptus Grayianus*, Lapworth; and *Dicranograptus tardiusculus*, Lapworth.

Id.—Note on Crinoid remains from the Silurian strata of the Girvan district. *Loc. cit.*, p. 216.

Obtained from two localities, Craighead and Balcletchie.

YOUNG, Prof. J.—Note on a Silurian Fossil from the Girvan district. *Loc. cit.*, p. 223.

The specimen was referred to Salter's genus *Pterotheca*.

1876. ARMSTRONG, J., with J. YOUNG and D. ROBERTSON.—Catalogue of the Western Scottish Fossils. Glasgow. 8vo (pp. 12-22).

Gives a list of fossils, zoologically arranged, of the Girvan district, with localities, compiled from various sources.

1877. DAVIDSON, T.—Notes on four species of Scottish Lower Silurian Brachiopoda.—*Geol. Mag.*, Dec. 2, iv., pp. 13-17, t. 2.

Describes *Siphonotreta Scotica*, Dav., Craighead Quarry; *Lingula quadrata*, Eichwald, Craighead Quarry; and *L. Canadensis*, Billings, Balcletchie, near Girvan.

1877. WOODWARD, Dr H.—A Catalogue of British Fossil Crustacea, with their Synonyms, and the Range in Time of each Genus and Order. London. 8vo.

1877. NICHOLSON, Prof. H. A., and R. ETHERIDGE, jun.—On *Prasopora Grayæ*, a New Genus and Species of Silurian Corals. *Annals and Mag. Nat. Hist.*, 4th ser., xx., pp. 388-392.

A small, peculiar, button-shaped little coral, having much the external appearance of a *Favosites*. The internal structure is, however, unique, and quite different from that of the latter. Abundant at Craighead Quarry.

1878. ETHERIDGE, R., and E. T. NEWTON.—A Catalogue of the Cambrian and Silurian Fossils in the Museum of Practical Geology. London. 1878. 8vo.

Many species from the Girvan ground are given, with their localities.

ETHERIDGE, R., jun.—Notes on Silurian Fossils from Ayrshire. (*Proc. R. Physical Soc. Edinb.*, 1878, iv., pt. iii., pp. 164-177, t. 2.)

Describes as new species *Turrilepas Scotica* and *Acidaspis Grayæ*; and as a new genus and species *Pinnocaris Lapworthi*.

LOCALITIES AT WHICH FOSSILS HAVE BEEN COLLECTED IN THE GIRVAN DISTRICT, AND REFERRED TO IN THE SUCCEEDING PAGES OF THIS WORK.

1. High Mains, about 6 miles N.E. of Girvan.
2. Kirk Hill, near last locality.
3. Littleburn, S.W. of High Mains.
4. Quarry at pond, S.W. of Rough Neuk, about 6 miles N.E. of Girvan.
5. Quarry at Rough Neuk.
6. Roadside, near Old Fort at Kirk Hill.
7. Quarry on roadside, east of last locality.
8. Littleburn, Quarrel Hill, near Auldthorn, about 6 miles N.E. of Girvan.
9. Drummuck Burn, about 4 miles N.E. of Girvan.
10. Lady Burn, above Drummuck.
11. Lady Burn, opposite Threave.
12. Craighead Quarry, about 3 miles N.E. of Girvan.
13. Craigens, near Kirk Hill, about 5½ miles N.E. of Girvan.
14. Ardmillan Brae, about 2½ miles S.W. of Girvan.
15. Piedmont Glen, S. of Girvan.
16. Laggan Burn, S.E. of Girvan.
17. Ardwell Shore, about 4 miles S.W. of Girvan.
18. Penwhapple Glen, E. of Girvan.
19. Saugh Hill, about 1½ mile E. of Girvan.
20. Camregan Plantation, about 2 miles E. of Girvan.
21. Balcletchie, about 4 miles E. of Girvan.
22. Tramitchell, about 3 miles S.E. of Girvan.
23. Barbae, nearly 3 miles S.E. of Girvan.
24. Pinmacher, about 2½ miles S. of Girvan.
25. Letterpin, nearly 4 miles S. of Girvan.
26. Auchensoul, about 5 miles S.E. of Girvan.
27. Aldons, on the Stinchar R., about 5 miles S. of Girvan.
28. Head of burn passing Bargany Pond, about 6 miles east by north of Girvan.
29. Hillside opposite Blair farm, about 8½ miles N.E. of Girvan.
30. Quarry on roadside near Knockgardner, about 10 miles N.E. of Girvan.
31. Mulloch Hill, 4½ miles N.E. of Girvan.
32. Penkill, 3½ miles N.E. of Girvan.
33. Colmonell, on the Stinchar R., about 7 miles S. of Girvan.
34. Braes, about 1½ mile E. of Girvan.
35. Knockdolian Mountain, near Colmonell, on the Stinchar R., S. of Girvan.
36. Cuddystone Glen, about 1 mile S. of Girvan.
37. Knockgerran, about 4½ miles E. of Girvan.
38. Shalloch Mill, on sea-shore, 1½ mile S. of Girvan.
39. Burn a little south of Shalloch Mill (Graptolites, &c.)
40. Ardmillan shore, 2½ miles S. of Girvan.

DESCRIPTION OF THE SPECIES.

PLANTÆ.

ORDER ALGALES.

Genus CHONDRITES, Sternberg, 1833.

CHONDRITES, *sp.*

(Near *Chondrites verisimilis*, Salter, Mem. Geol. Survey, Scotland, No. 32, p. 134, t. 2, f. 1 and 2.)

Obs.—A single, small, and imperfect fragment is in the Gray collection, which has all the appearance of a *Chondrites*, and very near the above species. The probability of this fact is increased by the occurrence at another locality in the Girvan area of a form which cannot be distinguished from *C. verisimilis*, Salter. The specimen in question was found by Mr A. Macconochie, near Bargany Pond, about six miles north-west of Girvan, and is in the collection of the Geological Survey of Scotland.[1] In the 'Catalogue of Western Scottish Fossils,'[2] by Messrs Armstrong, Young, and Robertson, *C. verisimilis* is relegated to the Annelida, a step to which we must express our unqualified dissent, as an inspection of Salter's figure will at once show that it can have no possible connection with that class.

Locality.—Penkill, in a fine-grained, slightly micaceous shale, (Gray collection).

[1] Etheridge, Mem. Geol. Survey, Scot., Expl. 3, p. 34.
[2] Glasgow, 1876, p. 15.

SUB-KINGDOM PROTOZOA.

CLASS RHIZOPODA.

Genus NIDULITES, Salter, 1851.

Nidulites, Salter, Quart. Jour. Geol. Soc., 1851, vii. 174.
„ Morris, Cat. Brit. Foss., 1854, 2d ed., p. 362.
„ Bigsby, Thesaurus Sil., 1868, p. 4.
„ Salter, Cat. Camb. and Sil. Foss., Woodwardian Mus., Cambg., 1873, p. 72.

(Compare *Cyclocrinus*, Eichwald, Lethæa Rossica, i. 637; *Pasceolus*, Billings, Logan's Geol. Survey Report, Canada, for 1856, p. 342; Pal. Fossils, Canada, p. 390, f. 366, 367; Cat. Sil. Foss. I. of Anticosti, p. 69; *Sphærospongia*, Salter, Pal. Niti in the N. Himalaya, 1865, p. 48; Cat. Camb. Sil. Foss., Woodwardian Mus., Cambg., 1873, p. 40.)

(*a*) *Gen. char.* — Body pyriform or sphæroidal (?), pedunculate, with an outer integument of hexagonal calcareous plates, articulated (or fused ?) by their edges. Each plate is deeply convex, with the convexity directed to the hollow interior of the sphere, into which it further sends a small central papilla or styliform projection, leaving a pit in the cast. The edges of the plates are prominent, thus closely resembling honeycomb. Plates to a certain extent variable in size, decreasing towards the contracted base. Apertures, none (?). Traces of an enclosing sac or investment. Perfect condition of organism unknown.

(*b*) *History.*—Mr Salter described *Nidulites* as oval or round plates, about two inches in diameter, spreading from a centre of attachment into a flattened irregularly wavy form, the entire surface of both the upper and under sides being covered with hexagonal cups. The edges of the latter were stated to be smooth and even with the general surface, their bases rounded, and usually with a central puncture or pit. A narrow space was always found to exist between the two series of cups, which Mr Salter considered to be occupied in the perfect organism by a membrane giving attachment to the

cups, probably by means of the punctures before mentioned. The lower surface of the cups themselves appears to have been somewhat wrinkled. Their bodies were supposed by Mr Salter to be the egg-ribbons of marine Gasteropoda, probably of a genus nearly allied to *Natica*, an idea suggested to him by Professor Milne-Edwards. Mr Salter adds that one condition of *Nidulites* was figured by Professor M'Coy as a specimen of the latter's *Palæopora favosa*.

Professor Morris in his 'Catalogue' placed *Nidulites* amongst the "Incertæ sedis," expressing thereby his appreciation of the difficulties in assigning to it any definite systematic position.

In the palæontological notes attached to the third edition of Sir R. Murchison's 'Siluria,' furnished by Mr Salter, *Nidulites* is in one place doubtfully referred to the Polyzoa,[1] whilst in another his original theory is given up, and Mr Salter evidently conceived that it might possibly be an Amorphozoön.[2] He states that he had not met with any upper plate or covering to the cells, which appear to have been quite open.

In the 'Palæontology of Niti,'[3] Salter remarks upon the relation of *Nidulites* to his genus *Sphærospongia*, and the probable sponge nature of both of them.

In the Cambridge Catalogue,[4] Salter again compares *Nidulites* to his genus *Sphærospongia*.

(*c*) *Obs.—Nidulites favus* is only known to us in the condition of casts. It occurs in the form of irregularly oval, globular, or pyriform masses, when at all approaching the complete outline, or as flat expansions when in a fragmentary state. The true test, shell, calyx, or skeleton, by whichever name the reader may think fit to call it, is never met with, but we either have a globular body consisting of a series of moulds in the form of hexagonal cups, or, on the other hand, concave or flattened expansions, consisting of rounded hexagonal promi-

[1] Siluria, 1867, 3d ed., p. 188. [2] Ibid., p. 208.
[3] Pal. of Niti in the Northern Himalaya, &c. Calcutta, 1865, 8vo, p. 48.
[4] P. 72.

nences, often ranged in quincunx. Whenever these two conditions are found in apposition, a narrow space is always left between them, which, according to Salter's view, was occupied by a connecting membrane or lamina, but which we conceive to represent the position of the actual calcareous skeleton. It must also be borne in mind that Mr Salter believed the cups were placed back to back, adhering to the membrane represented by the space in question—a conception which we think resulted from an examination of a number of examples crushed together. The convex casts of the hexagonal cups are often, but by no means in every case, provided with central papillæ, which are themselves the casts of pits existing in the cup-moulds; but, as in the case of the papillæ or styliform processes, their presence is not constant. In the masses of the convex casts there is a tendency in the respective hexagons for the surface to peel off in concentric layers. When the cups are filled with matrix to a similar level, and the observer is looking down on the specimen, the appearance of a series of roughly hexagonal plates is presented.

The slight irregularities visible in the form of the globose or pyriform body of *Nidulites* lead us to suspect that the test possessed a certain amount of flexibility when in the living state. We have not seen an individual perfect in outline, but the figures given on Plate IX. leave little doubt as to the true form of the organism; neither do we doubt that there existed a peduncle or short stem, especially when we take into consideration its remarkable resemblance to its allies *Pasceolus*, Billings, and *Sphærospongia*, Salter. This is to a great extent borne out by a specimen from Haverfordwest, in the Museum of Practical Geology, which shows, at a point we take to be the crushed-in base, the remains of a peduncle, with, spreading out from it on all sides, the remains of an enclosing membrane or epidermal integument. A single specimen in the Gray collection shows this to a small extent. In the examination of a large series of *Nidulites* fragments, our great endeavour has been all along to obtain some definite insight into the charac-

ters of the true skeleton; but, with the exception of one specimen, our efforts have been quite unsuccessful. The specimen in question has enabled Mr F. G. Cuttell to prepare us a microscopic section showing the space previously mentioned as occurring between the cups and their casts occupied by carbonate of lime, but merely as an infilling, and not as the actual skeleton, since it consists of crystalline calcite.

(*d*) *Affinities.* — The nearest affinities of *Nidulites* are probably with *Cyclocrinites*, Eichwald, and *Receptaculites*, Defrance, but its relationships are extremely obscure. Two other forms to which *Nidulites* is even, perhaps, more closely allied, are *Sphærospongia*, Salter, and *Pasceolus*, Billings.[1] It is necessary for us to enter somewhat more into details connected with these genera before closing our remarks on *Nidulites*.

The genus *Pasceolus* (fig. 1 *a* and *b*) was described by the late Mr Billings as a body possessing "an ovate or globular form covered with an integument of small polygonal plates (?), and with one or more circular apertures. . . . At one end there is a narrow prolongation, which, most probably, constituted the pedicle by which the body was attached to the bottom. . . . A little below the mid-height of the body there is a small circular elevation which appears to mark the place of an orifice. . . . No sutures can be distinguished, and the form of the plates can only be made out as so many obscure convexities on the outside. . . . The cast shows the place of the sutures most distinctly, and that the plates were deeply concave on the inside. . . . The whole surface of the cast of the fossil is covered with small convex elevations. . . . Many of these elevations have a small round knob in the centre, with an obscure ridge radiating to the middle of each of the sides."[1] Mr Billings at one time referred *Pasceolus* to the Tunicata, but in his second description he considers its true zoological position to be "quite undecided."[2]

[1] Pal. Foss. Canada, i. 390, 391.

[2] Ibid., p. 392.

Messrs A. E. Verrill and W. H. Niles have referred,[1] and so, indeed, has Mr Billings,[2] to the resemblance of *Pasceolus* to *Cyclocrinites*, Eichwald.

Professor Verrill states that the exterior of *Pasceolus* "was formed by a shell of considerable thickness, composed of small hexagonal and pentagonal plates or prisms, having the outer

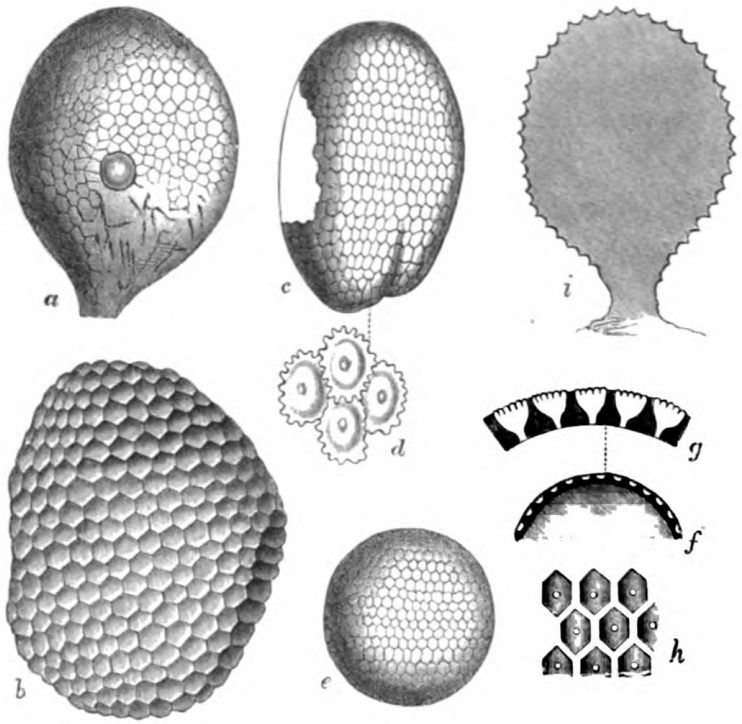


Fig. 1.—*a*, *Pasceolus Halli*, Billings, of the natural size, from the Middle Silurian of Anticosti. *b*, *Pasceolus globosus*, Billings, from the Trenton Limestone of Ottawa, of the natural size. *c*, *Sphærospongia melliflua*, Salt., from the Silurian of India, of the natural size. *d*, Four of the integumentary plates of the same, enlarged. *e*, *Cyclocrinus Spaskii*, Eichwald, from the Silurian of Esthland, natural size. *f*, Part of a vertical section of the same, of the natural size, showing the thickness of the integument. *g*, Part of the test, enlarged. *h*, Portion of the mould of the inner surface of the same, enlarged. *i*, Diagrammatic representation of a vertical section of *Nidulites favus*, Salt., the central cavity being supposed to be filled with the matrix. (*a* and *b* are after Billings, *c* and *d* are after Salter, and *e*, *f*, *g*, and *h* are after Roemer.)

surface marked with raised radiating lines. Moreover, some of the specimens had the lateral openings well preserved, and surrounded by six plates differing in form from the rest." From this we gather that Verrill considered *Pasceolus* to be a

[1] Proc. Nat. Hist. Soc. Boston, 1864-66, x. p. 19.

[2] Pal. Foss., i. 392.

Cystidean: indeed, his colleague, Mr Niles, supported him in this view, and definitely referred *Pasceolus* to *Cyclocrinites*, Eichwald. It will be noticed that in Professor Verrill's description, a considerable advance is made in the structure of *Pasceolus*: we have prisms introduced, and the lateral openings surrounded by six plates, dissimilar to the others forming the test. To these criticisms Billings replied at some length,[1] dissenting from the views expressed by the above authors. He further pointed out that *Pasceolus Halli* is covered with a thin, translucent, horny, wrinkled integument, and also noticed its relationship to the form at present under consideration, in these words—"It may be that these bodies are akin to Salter's *Nidulites*."[2]

We now pass on to *Cyclocrinus* (fig. 1, *e-h*), small globular bodies, covered with hexagonal or pentagonal plates, and placed by Eichwald in the Cystoidea. Each of the plates has a tubercle in the centre, as before described in some conditions of *Pasceolus*, and similar obscure radiating ridges; the apex is provided with an orifice, considered to be oral, and the opposite extremity is provided with a small pedicle. There is also an incrustation present in one of the figured specimens, probably analogous to that mentioned by Billings in *Pasceolus Halli*. The latter author, although admitting the possibility of Cystidean affinities, shows that some of the essential structures of that order are wanting in *Cyclocrinus*. Eichwald further states that the plates of his genus rest on a common calcareous base, which passes between them, and fills the interstices.[3]

Dr F. von Roemer[4] has supplemented Eichwald's figures by giving a section of *Cyclocrinus* (fig. 1 *f*), in which are the plates of the test represented in the form of small cups with delicate styliform processes; and in another figure, which we suppose represents a cast of the cup-like plates, the place of the processes is represented in each by a median puncture. By Roemer *Cyclocrinus* is referred to the Receptaculitidæ. From

[1] Cat. Sil. Foss. I. of Anticosti, 1866, p. 71. [2] Ibid.
[3] Lethæa Rossica, i. p. 638. [4] Lethæa geognostica, 1876, Atlas, t. 3, f. 21, *a-e*.

the points we have brought forward, it is quite clear that even on Mr Billings's diagnosis there is a close resemblance between *Pasceolus* and *Cyclocrinus*, and if we accept the remarks of Messrs Verrill and Niles, there is a still closer one; however, if *Cyclocrinus* really possesses an apical aperture, then, as Billings has truly said, "it must be a distinct genus from *Pasceolus*."[1] Unfortunately we have no material at our disposal to enable us to express an opinion; we can only notice the relation of the two genera, one to the other, and to *Nidulites*.

We have now to consider the third genus, *Sphærospongia*, Salter (fig. 1 *c* and *d*), with which we are acquainted only from figures and descriptions given by Mr Salter. It was proposed in the "Geology of the Neighbourhood of Edinburgh,"[2] and described in the 'Palæontology of Niti,' the type of the genus being the large *Sphæronites tesselatus*, Phill. *Sphærospongia*, then, is an oval or pyriform body, hollow within, composed of a series of hexagonal or pentagonal plates, with sinuous margins, united laterally, and each bearing a central pit or depression. The walls are strengthened internally by longitudinal bars or ribs. The internal structure has been illustrated by Mr Pengelly.[3] Mr Billings has remarked[4] upon the resemblance between *Pasceolus* and *S. tesselatus*, Phill.[5]—viz., the same semi-pyriform outline and mammillated hexagonal plates. Mr Pengelly's figure, if it be the same fossil as the latter, represents the interior, with a network of vertical and longitudinal ribs.

Nidulites agrees with *Pasceolus* and *Sphærospongia* in the ovate, globular, or pyriform body, and probable pedicle, in the form of the plates composing the test, and, so far as the former is concerned, in the presence of the papillæ in the casts of the concave plates. There is, however, this very marked difference: in *Pasceolus* the plates are described as concave or cup-like, with the concavity directed towards the interior of the

[1] Cat. Sil. Foss. I. of Anticosti, p. 71.
[2] Mems. Geol. Survey, Scot. No. 32, p. 136.
[3] Geologist, 1861, iv. 340, 341.
[4] Pal. Foss. Canada, p. 392.
[5] Pal. Foss. Devon., t. 59.

body; but in *Nidulites* just the contrary occurs,—the plates are concave externally, and convex towards the hollow interior. The result of this is, that whereas the styliform processes of the cup-like plates in *Nidulites* are exhibited as papillæ on the whole concave casts of the organism, in *Pasceolus* they are seen on the convex cast of the interior of the body, producing in the perfect organism a very marked and peculiar structural difference. Moreover, if there are "circular apertures" or "circular elevations" in *Pasceolus*, there are none, nor any trace of any, so far as our observation has gone, in the numerous specimens of *Nidulites* examined by us. The absence of openings, again, will at once separate the latter from *Cyclocrinus*, if there exists one in the summit of that genus, as described by Eichwald, and another on the sides with modified plates, as observed by Verrill and Niles, who make *Cyclocrinus* and *Pasceolus* identical. On the other hand, with the aid of Roemer's well-executed figures, we observe that the feature which served as a point of departure between *Nidulites* and *Pasceolus* has, in the case of the former and *Cyclocrinus*, quite an opposite effect—in other words, the plates of the test are convex towards the hollow interior, and are prolonged inwards as a styliform process in a similar manner. This would produce in external casts similar papillæ to those seen on the surface of that particular condition of *Nidulites*. There is no trace of radiating striæ on the casts of *Nidulites*, as shown in *Cyclocrinus* and described in *Pasceolus*.

We are unfortunately precluded from doing more than calling attention to these facts. Much progress yet requires to be made in our knowledge of *Pasceolus*, *Cyclocrinus*, *Sphærospongia*, and *Nidulites*, before their exact relation to one another, and to the lower sections of Palæozoic Invertebrates, can be determined. That they are all congeneric we think there is little doubt, but which is identical with which it is at present quite impossible to tell; but so far as *Nidulites* is concerned, the balance of evidence appears to indicate *Pasceolus* and *Sphærospongia* (as typified by *S. hospitalis*, Salter) as its nearest connections. As regards the systematic position

of these forms, we are inclined to consider them very near to *Receptaculites*.

Nidulites favus, Salter.

(Pl. IX. figs. 15-22.)

N. favus, Salter, Quart. Jour. Geol. Soc., 1851, vii. 174, t. 9, f. 16, 17.
Palæopora favosa (pars), M'Coy, Brit. Pal. Foss., 1851, p. 15, t. 1 C, f. 3, *c* and *d* (excl. f. 3, *a* and *b*).
N. favus, Morris, Cat. Brit. Foss., 1854, 2d ed., p. 362.
" " Huxley and Etheridge, Cat. Foss., Mus. Pract. Geol., 1865, p. 34.
" " Salter, in Murchison's Siluria, 1867, 4th ed., pp. 188, 208, 509, foss. 30.
" " Bigsby, Thesaurus Sil., 1868, p. 4.
" " Salter, Cat. Camb. and Sil. Foss., Woodwardian Mus., Cambg., 1873, p. 72, fig.

Spec. char.—The characters of the species are essentially those given under the generic heading, and need not be repeated here.

Obs.—Prof. M'Coy described *N. favus* as a condition of his *Palæopora favosa*, and both mentioned and figured all the essential characters of the form as then known. Examination enables us to quite corroborate Mr Salter in the separation of the two species, for *P. favosa* is a common fossil at Craighead Quarry, near Girvan, and we have examined many specimens of it.[1]

A single individual, with the cups very much smaller in size, would almost induce us to found a new species for its reception, were it not that in one of the most complete representations[2] known to us of the very closely allied, if not identical, genus *Pasceolus*, the plates, or cups, become gradually smaller in size towards the base (of attachment?). The specimen in question, therefore, may be only a portion of the larger *N. favus*, although we are inclined to an opposite view. Should this example from Balcletchie ultimately prove to be distinct, we would propose for it the name of *Nidulites parvus*, Eth. and Nich.

Loc. and Horizon.—Mulloch Hill, in a fine-grained buff to

[1] See *post*, under *Lyopora favosa*.

[2] Illinois Survey Report, iii. t. 5, f. 2ª.

liver-coloured sandstone of Upper Silurian age. (Gray *Coll.*) It is of frequent occurrence in a somewhat similar rock at Haverfordwest, N. Wales, of Llandovery age. *N. favus* has also been met with at the following further localities in the Girvan district: High Mains, Kirk Hill, Roughneuk Quarry, Craighead Quarry, Craigens, Barbae, and Letterpin (Geological Survey, collected by the late Mr R. Gibbs, and Mr A. Macconochie).[1]

Genus ISCHADITES, Murchison, 1839.

Ischadites, Murchison, Sil. Syst., 1839, pp. 697, 698.
„ Eichwald, Lethæa Rossica, 1860, v. 435.
„ Salter, Mem. Geol. Survey, 1866, iii. 282.
„ Bigsby, Thesaurus Siluricus, 1868, p. 3.
„ Salter, Cat. Camb. Sil. Foss., Woodwardian Mus., Cambg., 1873, pp. 40, 100.

Gen. char. — Globular, pedunculated bodies; surface subdivided by a number of direct or wavy ridges, crossing one another at oblique angles, into a series of rhomboidal or lozenge-shaped spaces; the peduncle terminating in a series of branching and diverging root-fibres; rhomboidal spaces subdivided by two lesser ridges crossing them at their greater and lesser diameters. Aperture situated at the apex.

Obs.—So far as we are aware, very little has been done to elucidate this genus. Many authors have united it with *Receptaculites*, Defrance, but although admitting that they appear to be very closely connected, and perhaps identical, we retain the name until the form has been more thoroughly worked out, and its characters better defined. The necessary material for this purpose is not accessible to us, and we cannot, therefore, offer more than a general opinion just now. *Ischadites* was considered by König to be an Ascidian allied to his genus *Leucophthalmus*;[2] by Salter[3] to be a regular sponge with vertical and transverse bundles of fibres resembling his genus

[1] Etheridge, Young, and Etheridge, Mem. Geol. Survey, Expl. 3, 1873, pp. 29-33; Armstrong, Young, and Robertson, Cat. W. Scot. Foss., 1876, p. 13.
[2] Icones Fossilium Sectiles, p. 1. [3] Mem. Geol. Survey, Scot., No. 32, p. 136.

Sphærospongia, and having roots[1] and an aperture like the recent genus *Grantia*; whilst by the larger majority of writers *Ischadites* has been, as stated above, referred to *Receptaculites*. The late Mr Billings stated[2] that the sculpture of *Ischadites* and of his *Receptaculites Canadensis* was quite similar.

According to Salter, the genus occurs in the Upper Llandeilo, Caradoc, Woolhope, Wenlock, and Ludlow beds.

The following are the British species known :—

I. antiquus, Salter, Mem. Geol. Survey, 1866, iii. 282; Upper Llandeilo, N. Wales.
I. Grindrodi, Salter, Bigsby's Thesaurus Siluricus, 1868, p. 4; Woolhope, &c.
I. Königii, Murchison, Sil. Syst., 1839, p. 697; Wenlock and Ludlow; Dudley, Malvern, &c.
I. micropora, Salter, Cat. Camb. Sil. Foss., Woodwardian Mus., Cambg., p. 40; N. Wales.
I. tesselatus, Salter, MS., Siluria, 1867, 4th ed., p. 509; Caradoc.

Ischadites Königii, Murchison.

I. Königii, Murchison, Sil. Syst., 1839, p. 697, t. 26, f. 11.
Receptaculites Neptuni (pars), D'Archiac and De Verneuil, Trans. Geol. Soc., 1842, 2d ser., vi., pt. 2, p. 407.
„ „ C. F. Roemer, das Rhein, Ubergangs. 1844, pp. 59, 60.
„ „ Bronn, Index Pal. Nomen., 1849, p. 1079.
„ „ Morris, Cat. Brit. Foss., 2d ed., 1854, p. 363.
I. Königii, Salter, in Murchison's Siluria, 4th ed., 1867, p. 509, t. 12, f. 4.
„ „ Gray, Proc. Nat. Hist. Soc., Glasgow, 1868, i. 169.
„ „ Bigsby, Thesaurus Sil., 1868, p. 3.
„ „ Salter, Cat. Camb., Sil. Foss., Woodwardian Mus., Cambg., 1873, p. 100.
„ „ Armstrong, Young, and Robertson, Cat.W. Scot. Foss., 1876, p. 13.

Obs.—The Gray collection contains two specimens of *Ischadites*, both fragmentary, and without the original integument preserved. The larger of the two specimens is probably an example of *I. Königii*, whilst the second appears to us to have areolæ possessing more the characters of *I. antiquus*, Salter; it shows the top and the so-called aperture. Neither of the

[1] Pal. of Niti, 1865, p. 48. [2] Pal. Fossils of Canada, i. 384.

specimens affords characters sufficient for description. *Ischadites* was first indicated as a Girvan fossil by Mr R. Gray, F.R.S.E.

Loc. and Horizon. — Balcletchie, near Girvan, in a fine-grained shale of Upper Silurian age. Penkill, in a fine greenish-coloured conglomerate, also of Upper Silurian age (smaller specimen). Gray *Coll.*

Genus SACCAMMINA, Sars.

(Videnskc.-Selsk, Förhandl., 1868.)

Saccammina Carteri, H. B. Brady.

(Pl. IX. fig. 23.)

Saccammina Carteri, H. B. Brady, Ann. and Mag. Nat. Hist., ser. iv., vol. vii. p. 177, Pl. XII., 1871. Also, in Monograph of the Carboniferous and Permian Foraminifera, Pal. Soc., p. 57, Pl. I., figs. 1-7, and Pl. XII., fig. 6, 1876.

Having obtained from the "Craighead Limestone," at Tramitchell, some small fossils which we believed to be referable to the above species, we submitted them to our friend Henry B. Brady, Esq., F.R.S., one of the greatest of living authorities upon the fossil and recent *Foraminifera*, and he not only confirmed our determination, but kindly furnished us with the subjoined notes upon this interesting form, as well as upon the microscopical characters of the limestone in question. The other Microzoön referred to by Mr Brady as probably allied to the recent genus *Hyperammina* we have thought it well to describe provisionally under the name of *Girvanella problematica*, a title which does not imply its absolute identity with the living form :—

"Of the specimens of limestone which I have examined some are very dark-grey, others lighter coloured and brownish. The polished surfaces of the latter often show blue-grey patches, as though the brown tint were due to some alteration in chemical composition. The rough weathered surface of the stone is studded with fossil remains of one sort or other, chiefly the projecting fractured ends of the stems of encrinites; but there

are in addition certain rounded bodies varying in size from 1-20th to 1-8th of an inch in longer diameter. These are generally too much worn, and otherwise altered, to give any satisfactory indications of their nature or origin; but transparent sections of the rock leave no sort of doubt that they are segments of *Saccammina Carteri*, a well-known Carboniferous Rhizopod.

"In the Carboniferous limestones *Saccammina* is sometimes so abundant that the rock may fairly be said to be built up of its remains: in other cases it is sparsely distributed, the segments are few and far apart, but individually they are of larger size. At Elfhills, in Northumberland, where the fossil was originally discovered, both these conditions exist, a thin bed near the surface being crowded with the fusiform segments; whilst in a much thicker bed, lower down in the series, they are few and far between.

"The Girvan limestones, such of them as I have seen, bear considerable resemblance to the lower of these two formations; but the specimens of *Saccammina*, as indeed of all the fossils, have undergone even more change in the process of mineralisation than is usual in the Carboniferous rocks. The chambers are completely filled with crystalline carbonate of lime, which has become so incorporated with the substance of the shell-wall as to obliterate its principal structural features, so that in transparent sections of the limestone, the segments often appear only as colourless rounded patches, without any trace of the original investment. At times the peripheral portions are slightly denser, and less transparent, than the rest of the patch, whilst an occasional specimen still shows the outline and thickness of the shell-wall with comparative distinctness. So far as can be observed, the *Saccammina* of the Girvan limestone agrees precisely in size, form, and structure with that of the Carboniferous beds.

"Under the most favourable conditions it is not easy to identify the Microzoa of compact sub-crystalline limestones; and from the fragments of minute fossils which appear in the

sections of the Girvan rock there is scarcely anything to be gathered. One organism, however, deserves a passing notice from the frequency with which it is met with. It is found in the form of little masses of thin, fine, arenaceous tubes—either a continuous tube of nearly even diameter coiled irregularly on itself, or possibly of more than one, intertwined. The masses are exceedingly minute, and they are too obscure for detailed description, but they are of interest in connection with certain organisms of the genus *Hyperammina* recently obtained from the deep-water dredgings of the Challenger expedition. One of these, of which the description and figures are not yet published (*H. vagans*, Brady, MS.) often occurs in a condition very similar to these little bodies, though usually of much larger size. When quite perfect the recent species has a swollen primordial chamber, but it is very rarely, indeed, that complete specimens are met with. I know of no other organism, recent or fossil, that these little masses of tubes so closely resemble."

Genus GIRVANELLA, Nich. and Eth., jun. *Gen. nov.*

Gen. char. — Microscopic tubuli, with arenaceous or calcareous (?) walls, flexuous or contorted, circular in section, forming loosely compacted masses. The tubes apparently simple cylinders, without perforations in their sides, and destitute of internal partitions or other structures of a similar kind.

Obs.—We have founded the above provisional genus for the minute fossils alluded to above, to which, for convenience' sake, we shall attach the following specific title—

Girvanella problematica, Nich. and Eth., jun. *Sp. nov.*
(Pl. IX., fig. 24.)

Spec. char. — Tubes from 1-600th to 1-700th of an inch in diameter, not observed to taper, twisted together in loosely reticulate or vermiculate aggregations of a rounded or irregular shape, which seem to be mostly from 1-20th to 1-10th of an inch across.

Obs.—Minute bodies having the above structure are very abundant in the "Craighead Limestone" in certain beds, and seem to deserve notice and a name. Their presence can sometimes be recognised by the naked eye, in the form of small irregular patches of a brownish or greyish colour; but we have only been able to examine them by means of transparent slices of the stone, and we know nothing of their external characters. Microscopic examination shows them to consist of small detached aggregates of twisted or flexuous cylindrical tubes, which are clearly hollow, and are presented to us with such a variable section as to show that they were irregularly contorted. Many are cut right across, and show only the divided ends of the tubes; others are shown in short lengths of varying extent. Here and there two or three tubes run side by side, but they unquestionably were independent of each other, never actually attached by their walls; and they are always so loosely reticulated together that the interstices of the mass are filled up with transparent calcite, readily distinguishable from the more opaque and granular matrix which surrounds them.

As to the affinities of these curious bodies we are inclined to regard them as Rhizopods. Our friend John Murray, Esq., suggested to us that they might possibly be of the same nature as certain Rhizopod-tubes obtained by the Challenger Expedition, and about to be described by Mr H. B. Brady under the name of *Rhizammina algæformis*; and they certainly have a curious resemblance to these. The last-named authority, however, as before stated, thinks that they are more nearly allied to forms like *Hyperammina vagans* "with an unlimited length of fine, thin, arenaceous tube, which curls, twists, coils, and plaits itself in every conceivable way" (H. B. Brady, in a letter to the authors).

Form. and Loc.—Very abundant in parts of the "Craighead Limestone," at Tramitchell, near Girvan. (*Coll.*, H. A. Nicholson.

SUB-KINGDOM CŒLENTERATA.

CLASS ACTINOZOA.

Genus LYOPORA, Nich. and Eth., jun. *Gen. nov.*

Gen. char. — Corallum composite, massive, composed of tubular, sub-cylindrical, or hexagonal corallites, which are more or less completely fused with one another. Walls of the corallites extraordinarily thick and dense, destitute of mural pores. Columella absent. Septa rudimentary, few in number, having the form of irregular obtuse ridges on the interior of the wall. Tabulæ complete. No cœnenchyma.

Obs.—We have found ourselves compelled to establish the new genus *Lyopora* for the reception of the very singular corals described by Prof. M'Coy under the name of *Palæopora* (?) *favosa* (Ann. and Mag. Nat. Hist., ser. 2, vol. vi. p. 285), the same name being subsequently given to it, without the note of interrogation (Brit. Pal. Foss., p. 15). In both the descriptions quoted, M'Coy expresses the opinion that this coral should probably be regarded as a new genus, and this surmise we are fully able to sustain. The reference of the coral under consideration to the genus *Palæopora*, M'Coy (=*Heliolites*), was the result of a reliance upon appearances which are wholly illusory, its affinities with *Heliolites* being of the slightest possible character. The total absence of "cœnenchymal tubuli," as conclusively demonstrated by thin sections, is sufficient proof of this, and M'Coy's belief in the existence of such tubules appears to be really based only upon the occasional existence of small interspaces, of an entirely irregular character, at the angles of junction of the corallites, or sometimes in the substance of the thick walls of these tubes. Microscopic examination also renders it quite certain that M'Coy was in error in supposing that a columella was present, no traces of such a structure existing. He does not state specifically whether he

had observed this organ in specimens preserved in the limestone; but we should be disposed to think that his belief in the occurrence of a columella was really based upon the bodies which he describes as the *casts* in sandstone of *Palæopora favosa;* these bodies in reality being (as noted by Salter, Quart. Jour. Geol. Soc., vol. vii., p. 174) unquestionably casts of the singular *Nidulites favus*, and having, therefore, no connection with the present form.

In superficial aspect, as remarked by M'Coy, the corals of this genus closely resemble *Favosites;* but they are fundamentally distinguished therefrom by the immense thickness of the wall, the absence of mural pores, and the presence of rudimentary septa. The genus, in fact, is apparently most closely allied to those forms of *Columnaria*, Goldfuss (as this is usually understood), in which the septa are imperfect and marginal; but it is sufficiently separated by the enormous development of the walls of the corallites, the comparative irregularity of these tubes, and the more incomplete condition of the septa.

The only other genus with which the present could be confounded, and the resemblance between the two is very remote, is *Pachypora*, Lindström. In the latter, however, apart altogether from differences of size, form, and mode of growth, the thickening of the walls of the corallites is by the deposition of successive concentric layers of carbonate of lime, and mural pores are present.

Lyopora favosa, M'Coy, *sp.*

(Pl. II., figs. 1-1 *e.*)

Palæopora (?) *favosa*, M'Coy, Ann. and Mag. Nat. Hist., ser. 2, vol. vi. p. 285, 1850.
„ *favosa*, M'Coy, Brit. Pal. Foss., p. 15, Pl. I. C, fig. 3, 1851.
Heliolites (*Palæopora*) *favosus*, Salter, Quart. Jour. Geol. Soc., vol. vii. p. 170, 1851.

Spec. char.—Corallum composite, massive, spheroidal, hemispheric, pyriform, or irregular in shape; the corallites subcylindrical, elliptical, hexagonal, or irregular in outline, firmly

united with one another. Calices usually circular or hexagonal, averaging a line and a half in diameter, the lip coarsely granular. Walls imperforate, extraordinarily thick, the interspaces between any two contiguous calices being occupied by dense calcareous tissue, of from three-quarters of a line to more than a line in thickness, sometimes with minute and entirely irregular vacuities. Septa rudimentary, often wanting in individual calices, varying in number from two or three up to ten or twelve or more, always abortive, and represented only by rough and blunt ridges on the interior of the wall. Visceral chamber crossed by strong, solid, complete tabulæ, distant from a line to a line and a quarter from one another.

Obs.—In their great work on British Fossil Corals, Milne-Edwards and Haime express the opinion that this species is really founded upon ill-preserved specimens of *Heliolites interstincta*, Wahl. (Brit. Foss. Corals, p. 250). It should be remembered, however, that this opinion was not based upon any inspection of actual specimens, and that it was to a large extent justified by the very misleading figures of the internal structure of the species given by M'Coy (Brit. Pal. Foss., Pl. I. C, figs. 3 *a* and 3 *b*).[1] On the other hand, the careful examination of a large number of specimens, both macroscopically and by means of microscopic sections, has thoroughly satisfied us not only of the validity of the species, but also of its belonging to a special generic type. So great, indeed, are the discrepancies in the respective observations of M'Coy and ourselves as to the structure of this coral, that we were at first disposed to think that we must be in error in supposing that our form was that originally described as *Palæopora* (?) *favosa*. M'Coy, however, only gives two localities for his fossil—viz., in the limestone of Craighead, near Girvan, where it is said to be "extremely abundant," and in the sandstone of Mulloch Quarry, where it is said to occur in the state of casts. The

[1] These figures have similarly misled Lindström, who, in a list of Silurian Corals from Sweden (Öfversigt. af Kongl. Vetenskaps Akad. Förhandl., 1873), describes a *Heliolites* under the name of *Heliolithes favosus*, M'Coy.

supposed casts of the latter locality are undoubtedly referable to *Nidulites favus*, so that we have only the specimens from the limestone to deal with; and as the form which we consider to be *Palæopora* (?) *favosa*, M'Coy, not only occurs abundantly at Craighead, but is the only coral which could possibly be supposed to agree with M'Coy's description and figures, we cannot doubt the identity of the two.

As regards its general form, *Lyopora favosa* appears to be very variable, but it occurs most commonly as pyriform or subhemispheric masses (Pl. II., fig. 1), which are rooted at one point, and seem to have the whole of the rest of the surface covered with the calices, the corallites thus diverging from a basal point or from a median line. No epitheca seems to have existed. The size of ordinary specimens varies from an inch or less in height and breadth up to half a foot or more. The calices are rarely well preserved, but even in worn examples their margins are rendered tubercular by the rudimentary septa. The most conspicuous feature in the minute structure of the species is certainly the great thickness of the walls of the corallites, as shown both in tangential and vertical sections. Microscopic examination of such sections (Pl. II., figs. 1 *b*-1 *e*) conclusively proves the total absence of both "mural pores" and "cœnenchymal tubules," and the figures of the latter given by M'Coy (*loc. cit.*) cannot, therefore, be accepted as otherwise than apocryphal. The calcareous walls of the corallites (Pl. II., fig. 1 *e*) are in fact quite compact, usually fused completely with one another, or sometimes allowing the junction between contiguous tubes to be detected, and occasionally showing minute irregular spaces, which are undoubtedly only due to imperfect deposition of the sclerenchyma. The tabulæ are remote, approximately horizontal, and unusually thick; and though best seen, of course, in vertical sections, they are often displayed in portions of tangential sections, either owing to the plane of the section cutting some of the corallites obliquely, or to its absolutely coinciding with the plane of a tabula. Lastly, the septa (Pl. II., 1 *a* and 1 *e*) vary much in number, appearing

most commonly to be from ten to fifteen, but they are always mere blunt inward projections of the wall.

Form. and Loc.—Abundant in the limestone and calcareous shales (Lower Silurian) of Craighead, near Girvan. (*Coll.*, Mrs R. Gray and H. A. Nicholson.)

Genus TETRADIUM, Dana, 1846.

(Wilkes's Expl. Exped. Zoophytes, p. 701.)

Gen. char.—Corallum massive, sub-hemispheric or irregular in form, composed of long prismatic corallites, in close contact, but not amalgamated by their walls, and not arranged in superimposed strata in the typical forms. No mural pores; septa distinct, few in number, typically four, short, not reaching the centre of the visceral chamber, seeming as if formed by inflections of the wall. Calices generally petaloid, as are the corallites in transverse section. Tabulæ numerous, complete. Increase by fission of the old tubes.

Obs.—The genus *Tetradium* is a small and peculiar one, which, as we have elsewhere suggested (Ann. Nat. Hist., ser. 4, vol. xx., p. 163), may perhaps be placed in the neighbourhood of *Halysites*, though it has certain resemblances to *Chætetes*. It is easily recognised, in typical examples, by the peculiar shape of the long imperforate tubular corallites, which, in transverse section, appear to be petaloid, owing to the presence of generally four or five short septa, formed by inflections of the wall. The accompanying engraving (fig. 2) shows the minute structure of the corals of this genus, as displayed in transverse and vertical sections.

Though common in the Lower Silurian of North America, the genus *Tetradium* was not recognised as occurring in Britain, till we pointed out (*loc. jam cit.*) that a peculiar form belonging to it was present in pebbles of Silurian limestone contained in the Old Red conglomerates of Habbie's Howe, in the Pentland Hills, near Edinburgh. These pebbles are

peculiar in being often composed of a coarsely oolitic limestone; and at the time that we described the form of *Tetradium* in question, we were unable to point to any limestone of similar characters as occurring in place in the Silurian series of

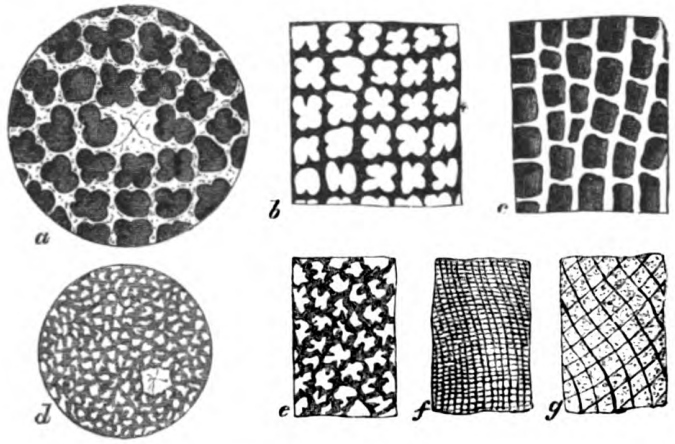


Fig. 2.—*a*, A small portion of a transverse section of *Tetradium minus*, magnified about ten diameters. The section is a transparent one; and the visceral chambers of the corallites, being filled up with the matrix, appear black, whilst the walls are composed of crystalline calcite; in the centre of the section is a vacant space filled with calcite (a water-canal?). *b*, Portion of polished transverse section of same, not so highly magnified; in this section the visceral chambers appear as light spaces, and the walls are dark. *c*, Portion of a longitudinal section of the same, showing tabulæ. *d*, Portion of a transparent transverse section of *Tetradium Peachii*, Nich. and Eth., jun., magnified about twenty diameters. Near the bottom of the section a water-canal (?) is seen cut across. *e*, Portion of transverse section of the same, magnified still further. *f*, Portion of the longitudinal section of the same, magnified about fifteen diameters. *g*, Portion of the same, enlarged still further.

Scotland. Since then, however, we have found that a similar oolitic limestone, of Silurian age, is developed in at least two localities near Girvan—viz., plentifully at Tramitchell, and to a less extent at Craighead; and we have further had the satisfaction of finding that the limestone at the latter place is largely made up of masses of the same *Tetradium* (*T. Peachii*) as that of the pebbles of the Habbie's Howe conglomerate. We can hardly doubt, therefore, that these pebbles were derived originally from the existing Craighead limestone of Girvan, or from some former extension of this bed.

Tetradium Peachii, Nich. and Eth., jun.

(Pl. I., fig. 3, and Pl. II., figs. 1-1 *b.*)

Alveolites (?), sp., R. Eth., jun., Proc. Roy. Phys. Soc. Edinb., 1874-75, p. 51.
,, (?), *Peachii*, R. Eth., jun. (MS.), Coll. Geol. Survey of Scotland, Mus. Science and Art, Edinb.
Tetradium Peachii, Nich. and R. Eth., jun., Ann. and Mag. Nat. Hist., ser. 4, vol. xx. p. 166.

Spec. char. — Corallum massive, very irregular in shape, often more or less lobulate on the surface, composed of excessively minute, closely approximated corallites, from 1-25th to 1-35th of a line in diameter. The corallites are amalgamated by their comparatively thick walls, irregularly circular or oval in outline, running parallel with one another in straight, slightly curved, or undulating lines. Very often the corallum consists of successive layers of corallites disposed in a concentric manner round one or more centres. Septa generally present, mostly three or four in number, short, looking as if formed by an inflection of the wall of the corallite, to the transverse section of which they communicate a petaloid aspect. Tabulæ usually numerous and complete.

Obs.—As before remarked, this singular form is extremely abundant in the Silurian limestone of Craighead, near Girvan, and the specimens from this locality are in a much better condition for microscopic examination than those from the pebbles in the Habbie's Howe conglomerate. We are therefore now able to confirm our former reference of the species to the genus *Tetradium*, and we are in the position to describe some additional points in its minute structure. As seen at Craighead, *Tetradium Peachii* occurs both in the limestone and in its associated shales, and presents itself in the form of wholly irregular masses, of very variable size. Small masses from the shale range from three lines to an inch and a half in diameter, and are generally more or less spheroidal or oval in shape. When not obscured by matrix, the surface is often more or less con-

spicuously mammillated or botryoidal (Pl. I., fig. 1 *b*), but in no case have we succeeded in detecting the calices by a simple examination of the weathered surface with a lens. Specimens from the limestone rarely weather out to any extent, and yield to fracture as if they formed part of the rock itself. They form masses often two or three inches in diameter, which are easily recognised by their whitish or light-brown colour, and by their dense texture; and which not uncommonly show on broken surfaces an arrangement in concentric layers of growth, similar to that observed in the specimens from the Habbie's Howe conglomerate, and reminding one of some of the more compact forms of the Stromatoporoids.

Even in the Craighead specimens, the minute structure of *Tetradium Peachii* can only be made out by transparent slices, examined with the microscope. Transverse sections (Pl. I. 3), when they are at all accurately at right angles to the corallites, show that these possess the characteristic form of the tubes in this genus. Extraordinarily minute as the corallites are—generally about 300 in the space of an inch—they usually show the characteristic petaloid form and the four short septa of *Tetradium*. The septa, however, vary from one to five, and in many of the corallites they can only be detected with difficulty, apparently owing to the fact that the section does not pass through the tubes at right angles to their long axis. In long sections (Pl. II., figs. 1 and 1 *a*), the corallites are seen to generally possess more or less wavy walls, and to increase by fission, and the chief new point that we have noticed is that the tabulæ are very variable in their occurrence. In the Habbie's Howe specimens the tabulæ seem to be rarely wanting, and they are usually very numerous and close-set (*see* fig. 2, *f* and *g*). In the Craighead specimens tabulæ of a similar character are sometimes present (Pl. II., fig. 1); but they may be only present in a portion of a mass, and in many sections (Pl. II., fig. 1 *a*) they cannot be detected at all. This, however, is only in accordance with what we know commonly to occur in *Favosites* and other similar forms, in which the

tabulæ often seem to have been completely or partially destroyed during fossilisation. Lastly, in many of the specimens from Habbie's Howe, we have noticed that the corallum is perforated by irregular tubes, perhaps of the nature of water-canals, varying from 1-40th to 1-50th of an inch in diameter; but we have not detected similar structures in the examples from Ayrshire.

The rediscovery of this peculiar coral at Girvan is a point of particular interest. Whence the limestone blocks and pebbles containing *T. Peachii*, contained in the Habbie's Howe conglomerate, originated, was to us, as to all others who had examined them either *in situ* or in the laboratory, an unsolved problem; for on appealing to Professor Geikie, F.R.S., we found that he was unacquainted with such a limestone at any other locality known to him in Scotland. Although the abundant occurrence of *T. Peachii* in the Craighead limestone, accompanied as it is at times by the well-marked oolitic structure so common in some of the Pentland Hill pebbles, would justifiably lead one to suppose that we had here met with the point of origin of the pebbles in question, still this is not altogether borne out by the other coral forms which accompany *T. Peachii* at the latter locality. We here meet with, in the same blocks, such forms as *Halysites* (*H. catenularia*, Linn. ?), *Plasmopora* (*P. petalliformis*, Lonsd. ?), *Favosites* (2 or 3, sp.), one of the latter very near *F. Hisingeri*, Ed. and H., *Heliolites* (*H. interstincta*, Linn. ?). These corals have been very carefully examined by one of the writers and Dr J. C. Purves, and although there may be some little doubt as to the exact specific identifications arising from the mode of preservation of the specimens, we have little hesitation in placing reliance on them.

Form. and Loc.—Very abundant in the limestone (Lower Silurian) of Craighead, near Girvan. (*Coll.*, Mrs R. Gray and H. A. Nicholson.) Also in pebbles of limestone of Silurian age contained in the Old Red Sandstone conglomerate of Habbie's Howe, Pentland Hills, near Edinburgh. (*Coll.*, J. Henderson, R. Etheridge, jun., and Geol. Surv. Scot.)

Genus FAVOSITES, Lamarck, 1816.

(Hist. des An. sans Vert., vol. ii. p. 204.)

Favosites Girvanensis, Nich. and Eth., jun., *sp. nov.*

(Pl. I., figs. 2-2 *c*.)

Spec. char.—Corallum diminutive, discoidal or sub-hemispheric in shape, with a flat or convex base, which is covered by a concentrically wrinkled epitheca. Diameter varying from half an inch to rather more than an inch, and the height from three to eight lines. Corallites prismatic, thin-walled, three- to six-sided, closely approximated, of unequal sizes, the average tubes being from a third to a fourth of a line in diameter, generally the latter, while the angles of junction of these are filled in by much smaller tubes. Mural pores not detected. Septa wholly absent. Tabulæ, when preserved at all, few and remote, distant from one another from one-third to one-half of a line. Walls of the corallites in longitudinal sections more or less undulated and wavy.

Obs.—This little *Favosites* occurs in plenty in the shales associated with the limestone at Craighead, near Girvan; and from the fact that its tubes exhibit wavy margins in longitudinal section, we were disposed at first to think that it might possibly be the young form of *Favosites aspera*, D'Orb. After examining and cutting some fifty specimens, however, we have come to the conclusion that it is really quite distinct from this form, and, indeed, from all other described species. We are very reluctant to add a new species to the already numerous and often imperfectly defined forms of *Favosites*, but the present species has peculiarities which preclude our placing it under any type known to us. That it is merely the young of some other form, as we at first imagined, is sufficiently disproved by the fact that of the large number of individuals known to us, no one exceeds one and a quarter inch in diameter, while most are considerably under the inch—no other larger form of the genus

Favosites being at present known to occur at all in the same beds. We are therefore bound to accept it as an adult form. Not only does its size become thus a specific character, but its discoidal form and concave base, with its concentrically striated epitheca (Pl. I., figs. 2 and 2 *a*), are equally so. In these last-mentioned features, *Favosites Girvanensis* agrees with the associated *Prasopora Grayæ*, nobis, as well as with small examples of *Chætetes petropolitanus*, Pand., to both of which it presents a very close superficial resemblance. The latter, however, does not occur at all (so far as we know) in the Craighead limestone, and even if it did, is quite distinct in its minute structure, the latter observation holding true of *Prasopora* also. As it occurs only in the shales associated with the Craighead limestone, *F. Girvanensis* shares with all the forms from this position the misfortune of almost never exhibiting any distinct structural features until it is sectioned; but its characters can be readily determined by microscopic examination. That it is a true *Favosites* is, in our opinion, sufficiently shown by the prismatic, thin-walled, closely-approximated tubes, the total absence of cœnenchyma and of septa, and the characters of the tabulæ when present. That we should have failed to detect mural pores does not invalidate this conclusion, as these structures can rarely be detected except in specimens showing the exterior of the tubes, and we possess none such. Nor does the variable condition of the tabulæ, and their commonly-occurring total absence, materially affect our views, since similar conditions are well known to obtain in apparently similarly preserved specimens of the larger forms of this genus. When present, however, the tabulæ are characteristic, in their comparatively small number, and the distance at which they are placed from one another (Pl. I., fig. 2 *b*). In all cases, also, the markedly wavy and undulated walls of the tubes (Pl. I., fig. 2 *c*) are highly characteristic. The other points which seem to us to adequately separate this form as a distinct species are the diminutive size, the constant discoidal form, the concave base, the concentrically wrinkled epitheca, the small size

of the corallites, and the presence of minute prismatic tubes intercalated between those of average size.

Form. and Loc.—Not uncommon in the shales associated with the limestone at Craighead, near Girvan. (*Coll.*, Mrs R. Gray.) We have also a single specimen from the Gray collection, which is labelled as coming from Penkill, near Girvan, the greenish mudstones of this locality being much higher in the Silurian series than the Craighead limestone.

Favosites Mullochensis, Nich. and Eth., jun., *sp. nov.*

(Pl. II., figs. 2-2 *b*.)

Spec. char.—Corallum small, forming ovoid or hemispherical masses, from half an inch to an inch in diameter. Corallites more or less pentagonal, with very thin wavy walls. The majority of the tubes large, from half a line to nearly a line in diameter, but having wedged in between them a few much smaller tubes. Mural pores apparently few and remote, not serially disposed. Septa wanting. Tabulæ few, very delicate, remote, from half a line to a line apart, generally represented only by short spines springing from the undulated walls of the tubes.

Obs.—This appears to be a genuine *Favosites*, though in some respects an abnormal one. We possessed only three specimens to work with, and in all of these, owing to the great thinness of the walls of the corallites, the internal structure had been to some extent obscured by fractures taking place during fossilisation, while in all the specimens the tubes had been largely filled up with the matrix, and were only infiltrated with calcite in their centre. When viewed in transverse section (Pl. II., fig. 2 *a*) the corallites are seen to be mostly of large size, though here and there a very small tube is intercalated between the others. The tubes are not strictly rectilinear, as in the most typical species of *Favosites*, but the walls are usually more or less curved, and often at places sharply bent and wrinkled — this latter feature perhaps due to changes

taking place showing mineralisation. In the only specimen in which we could detect mural pores, these openings are few, large-sized, and irregular in distribution. The most characteristic features of the species are seen in longitudinal sections (Pl. II., 2 *b*), and are displayed by all our specimens. These features are,—firstly, the fact that the walls of the tubes are conspicuously undulated; secondly, the presence of a very few extremely thin tabulæ; and thirdly, the fact that the majority of tabulæ are represented by short spines springing from the walls.

Form. and Loc.—In the dark-green mudstone (Upper Silurian) of Mulloch Hill. (*Coll.*, Mrs R. Gray.)

Favosites Gothlandica, Lamarck.

Favosites Gothlandica, Lamarck, Hist. des An. sans Vert., vol. ii. p. 206, 1816.
Calamopora Gothlandica, Goldfuss, Petref. Germ., Pl. XXVI., figs. 3 *a*, 3 *b*, 3 *c*, 3 *e* (cæt. exclusis), 1829.
Favosites sub-basaltica, D'Orbigny, Prodr. de Paléont., vol. i. p. 49, 1850.
„ *Gothlandica*, M'Coy, Brit. Pal. Foss., p. 20, 1851.
„ *Goldfussi*, D'Orbigny, Prodr. de Paléont, vol. i. p. 107, 1850.
„ *Goldfussi*, Milne-Edwards and Haime, Pol. Foss. des Terr. Pal., p. 235, Pl. XX., fig. 3, 1851.
„ *Gothlandica*, Milne-Edwards and Haime, Brit. Foss. Cor., p. 256, 1854.
„ *Niagarensis*, Hall, Pal. N.Y., vol. ii., Pl. XXXIV. A, bis, fig. 4, 1851.
„ *Gothlandica*, Billings, Can. Journ., new ser., vol. iv. p. 99, 1859.
„ *Gothlandica*, Nicholson, Report on the Palæontology of Ontario, 1874, p. 45.

(For a full synonymy of *F. Gothlandica* up to the year 1854, see Milne-Edwards and Haime in Brit. Foss. Cor., p. 256.)

Obs.—So far as the specimens which we have personally examined are concerned, the only undoubted examples of *Favosites Gothlandica*, Lam., are some that were detected by our friend Mr Charles Lapworth, F.G.S., in a limestone-band on the shore near Girvan. They are well preserved, and are in all respects identical with the typical examples of this species from the Upper Silurian and Devonian; but as they present no points of special interest, they need no further description here. They are associated with the next species (which we

believe to be *Alveolites Labechei*), and with casts of a small *Pentamerus*, and they are noteworthy as indicating the existence of a limestone near Girvan, of Llandovery or Wenlock age.

Form. and Loc.—Common in a coralline limestone-band on the sea-shore, not far from Shalloch Mill, near Girvan. (*Coll.*, Mr Charles Lapworth.)

Genus ALVEOLITES, Lamarck, 1801.

(Syst. Anim. sans Vertebres., p. 375.)

Alveolites Labechei, Edw. and H.

Favosites spongites (pars), Lonsdale, in Murchison's Sil. Syst., Pl. XXV., bis, figs. 8, 8 *b* (cæt. exclusis), 1839.
Calamopora spongites, Eichwald, Sil. Syst. in Esthland, p. 197, 1840. (Not *Calamopora spongites* of Goldfuss.)
Alveolites Labechei, Milne-Edwards and Haime, Pol. Foss. des Terr. Pal., p. 275, 1851.
„ „ Milne-Edwards and Haime, Brit. Foss. Cor., p. 262, 1854.

Obs.—The limestone-band which we have referred to in the description of the previous species has yielded to the researches of Mr Lapworth specimens of an *Alveolites* which we feel no hesitation in identifying with *A. Labechei*, Edw. and Haime. Our examples do not show any surface-characters, but microscopic sections indicate that the internal structure is well preserved, and this is quite in accordance with that of specimens of the well-known Wenlock form, so that it will be unnecessary to occupy any space here with a detailed description.

Form. and Loc.—In a band of coralline limestone on the sea-shore, not far from Shalloch Mill, near Girvan. (*Coll.*, Mr C. Lapworth.)

Genus FISTULIPORA, M'Coy, 1849.

(Ann. Nat. Hist., ser. 2, vol. iii. p. 130.)

Gen. char.—Corallum very variable in form, encrusting, sub-massive, massive, or ramose, composite, of numerous com-

paratively large-sized corallites surrounded by a very varying number of smaller tubes (the latter corresponding to the "cœnenchymal tubules," so-called, of *Heliolites* and its allies). Septa wanting. Tabulæ well developed and complete, usually more numerous in the smaller than the larger tubes. No mural pores. Larger corallites typically circular, and usually with slightly exsert calices.

Obs.—Though it is not possible at present to limit the genus *Fistulipora* precisely, we may include under the above emended definition a number of Palæozoic corals, which for the most part present unusual difficulties in the way of their study. The superficial features of these forms—especially the presence of large-sized circular corallites, usually with slightly elevated calices, without septa, and surrounded by smaller circular or angular tubes—are sufficiently distinct to separate them readily from their allies, such as *Chætetes*. The absence of mural pores and of septa, and the presence of complete tabulæ in both sets of tubes, are the chief features in their internal organisation. We have no personal knowledge of forms with funnel-shaped tabulæ in the larger tubes —a character to which generic importance is assigned by M'Coy —nor have we ever observed the tabulæ to be confined to the smaller tubes, and wholly wanting in the larger ones.

We cannot enter here into a discussion as to how far *Fistulipora*, M'Coy, covers the ground occupied by the later genus *Callopora*, Hall (Pal. N.Y., vol. ii. p. 144, 1852). Our present impression, however, is that the two are incapable of separation, in which case M'Coy's name must be retained. Nor have we found it possible to accurately compare the species of *Fistulipora* which we are about to define with the very numerous forms of *Fistulipora* and *Callopora* which have been described by American palæontologists from Silurian and Devonian strata. There exist, in fact, no sufficient elements for such a comparison, since the American species are at present mostly known only by short verbal descriptions, rarely accompanied by figures, and for the most part without allusion

to the microscopic structure. Under these circumstances, we are therefore compelled to describe the following species as new.

Fistulipora favosa, Nich. and Eth., jun., *sp. nov.*

(Pl. II., figs. 3-3 *c*.)

Spec. char.—Corallum sub-massive, composed of numerous closely-approximated slender corallites, which diverge from an expanded base of attachment. Calices very markedly of two sizes, the larger ones circular or oval, and the smaller ones more or less angular, the former varying from 1-7th to 1-6th of a line in diameter, and the latter from 1-12th to 1-6th of a line. One or two rows of the smaller calices intervene between the larger, the latter being thus separated from one another by spaces varying from half their own width to the whole of their width. Septa wholly wanting. Tabulæ complete, strong, straight or slightly curved, from four to eight in the space of one line, generally fewer and more remote in the larger tubes than in the smaller ones. Though the openings of the larger corallites upon the surface are distinctly circular, all the tubes appear to be angular in cross-sections taken a little below the surface.

Obs.—The surface characters of this species are quite conclusive as to its being a true *Fistulipora* and not a *Favosites* (see Pl. II., fig. 3 *a*). The larger tubes, in fact, are always filled up near the surface with the dark matrix, which passes down to the first tabula, while the smaller and more closely tabulate intervening tubes are infiltrated with calcite; so that there is a most conspicuous difference between the two sets of tubes as examined at the surface. In thin sections, however, this difference to a large extent disappears, and the structure of the coral cannot readily be distinguished from that of a *Favosites* or a *Chætetes*. In transverse sections (Pl. II., 3 *b*), all the corallites are seen to be more or less angular, usually pentagonal, and the larger tubes are with difficulty recognised,

as they have lost their circular outline, and are usually infiltrated with lime, thus agreeing with the intervening tubules. A little care, however, will still distinguish the two sets of tubes; and the same distinction can also be carried out in long sections (Pl. II., fig. 3 *c*), where the larger tubes are recognised both by their comparative size and by their having fewer and more remote tabulæ than the smaller ones.

Upon the whole, *Fistulipora favosa* appears to be sufficiently characterised by its sub-massive form; the long corallites, not superimposed in successive layers; the round mouths of the larger tubes, combined with their angular section at points below the mouth; the presence of one or two rows of smaller angular tubes between the larger ones; and the existence of strong and complete tabulæ in all the tubes, but most numerously so in the small tubes.

The only individual of this species which we have examined is an ovoid mass, with a comparatively expanded base of attachment (Pl. II., fig. 3), its height being an inch and a half, and its greatest width rather more than an inch.

Form. and Loc.—Dark-green ashy beds of Balcletchie, near Girvan (? Lower Silurian). Gray collection.

Fistulipora (?) pilula, Nich. and Eth., jun., *sp. nov.*
(Pl. III., figs. 1-1 *b*.)

Spec. char. — Corallum small, completely ovoid or subglobular, from three to five lines in its longest diameter in the specimens examined by us. Corallites radiating from a central line and opening over the greater part of the surface, of different sizes, but not clearly divisible into two sets of different dimensions. Small tubes comparatively few, wedged in at the angle of junction of the larger ones, angular in form, the latter being rounded or sub-polygonal in section. The larger tubes have an average diameter of about one-fifth of a line, and the smaller ones are variable in size. Septa absent. Tabulæ numerous and close-set (12-15 in the space

of a line) in the smaller tubes, but very few and remote in the larger ones.

Obs.—As none of our examples show the characters of the surface, we do not feel certain whether this is a *Fistulipora*, or whether it should not rather be placed under *Chætetes;* and the characters presented by the microscopic sections are not conclusive upon this point. There is a great difference between the sizes of the tubes which compose the corallum, but it cannot be said that there is a series of large tubes surrounded and separated by another series of small tubuli. There is rather a series of large tubes, usually rounded or slightly angular, partially separated but never completely isolated by small angular tubes (Pl. III., fig. 1 *a*). The general aspect of cross-sections is certainly rather that of a *Fistulipora* of the type of *F. favosa* than of a true *Chætetes*, and longitudinal sections support this view. These (Pl. III., fig. 1 *b*) show a series of large tubes, in which tabulæ are wholly wanting or very sparingly developed, separated by much narrower tubes, in which tabulæ are very numerous and close-set. In no case do we find more than a single one of the smaller tubes separating any two of the larger ones. Increase is by fission of the old tubes. The only other characters which distinguish the species are those founded upon the small size of the corallum and its ovoid or globular shape; and these features seem to be constant, as eight individuals examined by us have all the same figure, and the largest does not exceed half an inch in diameter, the smallest being half the size of this.

Form. and Loc.—In the shales associated with the limestone, Craighead, near Girvan. (Gray collection.)

Genus CHÆTETES, Fischer, 1837.

(Oryct. du Gouv. de Moscou, p. 159.)

Chætetes, *sp.*

(Pl. III., figs. 2-2 *b*.)

Obs.—The Craighead limestone has yielded various fragments of a dendroid species of *Chætetes* (or *Monticulipora*) which appears to be well characterised, and which we cannot identify with any species of the genus known to us. We shall not, however, assign a new specific title to this form, as it is quite likely to prove identical with some already well-known species, when all the latter have been subjected to microscopic examination. We shall therefore content ourselves with simply appending a brief notice of the general characters and minute structure of the present form :—

Corallum (Pl. III., fig. 2) dendroid, from one to two lines in diameter, branching at short intervals. Calices sub-circular or polygonal, nearly equal-sized, about 1-6th or 1-7th of a line in diameter on an average, with here and there a much smaller tube, but without minute interstitial tubuli. Surface destitute of monticules. In cross-sections (Pl. III., fig. 2 *a*) all the tubes appear to be polygonal. In longitudinal sections (Pl. III., fig. 2 *b*) the tubes are seen to be vertical in the centre of the branches, and to be here crossed by well-marked, straight, and complete tabulæ, of which about ten or twelve occupy the space of one line. On approaching the surface, the tubes bend outwards, and widen somewhat, being crossed by curved and considerably more closely arranged tabulæ for some little distance below their mouths.

Though of the same general type as various well-known Silurian species (such as *C. pulchellus*, Edw. and H., and *C. Fletcheri*, Edw. and H.), we cannot identify the form above described with any previously recorded. The principal features which separate it from its nearest allies are the approximate equality of the tubes, and their regularly tabulate charac-

ter, together with the total absence of interstitial tubules, groups of large-sized tubes, or "monticules."

Form. and Loc.—In the shales associated with the limestone, Craighead, near Girvan. (Gray collection.)

Genus PRASOPORA, Nich. and R. Eth., jun., 1877.

(Ann. Nat. Hist., ser. 4, vol. xx. p. 38.)

Gen. char.—Corallum compound, forming small hemispheric or concavo-convex masses, composed of numerous prismatic corallites radiating from a wrinkled basal epitheca, and connected by smaller cœnenchymal tubules. Corallites with imperforate walls, destitute of septa, furnished with an exterior zone of vesicular tabulæ surrounding a vacant central tube, which may be crossed here and there by an occasional tabula. Calices showing a central aperture surrounded by a ring-like tabula. Cœnenchymal tubes much smaller than the corallites, prismatic, usually arranged in a single zone round each corallite, and crossed by numerous complete tabulæ. Corallites and cœnenchymal tubes in contact with one another, but not soldered together by their walls.

Obs.—The corallum in this genus is composite, and has the general form and aspect of the massive species of *Chætetes* (*Monticulipora*). Its general shape (fig. 3, B) is concavo-convex or hemispherical, the concave or flat base being covered by a concentrically wrinkled and striated epithecal plate (fig. 3, A). From the centre of this the corallites radiate in all directions, those in the middle of the corallum taking a nearly vertical course, while those near the margins are horizontal, or even deflexed, so as to run nearly parallel with the epitheca, corallites holding an intermediate position between these two points being bent at correspondingly intermediate angles. The corallum is made up of comparatively large-sized corallites interspersed with smaller "cœnenchymal" tubules; and the structure of these two elements is very different internally.

The corallites, as shown by microscopic sections, have a

unique internal structure. In *longitudinal* sections (*i.e.*, in sections parallel with their long axes) they are seen to be divided into a central tube and an exterior tabulate area (fig. 3, D). The central tube is either completely uninterrupted, or is occasionally traversed by a delicate transverse tabula (perhaps at intervals of a line or less), marking a temporary arrest in the process of growth. In some cases the central tube is filled with crystalline calcite; but it is often more or less completely occupied by an infilling of the surrounding matrix; and there are commonly little accumulations of the same material above each of the transverse tabulæ just alluded to. The central tube is surrounded by a zone of tabulæ which spring from the wall of the corallite, and are then bent downwards so as to become parallel to the long axis of the corallite, finally joining the tabula next below. There is thus formed a series of large circumferential vesicles, the convexities of which are directed upwards and towards the centre of the corallite. When divided fairly through the centre, the internal structure is seen to be as above; but when the section is excentric it passes through the exterior tabulate zone, and the cut edges of the vesicular tabulæ appear as cross lines, looking like ordinary tabulæ. As most of the corallites are curved, an ordinary longitudinal section divides them partly through the centre and partly excentrically, so that part of the tube shows the one set of appearances and part the other.

In order to examine the corallites in *transverse* section it is necessary to cut a slice tangential to the upper surface (slices cut tangential to the lower surface, owing to the deflection and approximate horizontality of the marginal corallites, exhibit oblique longitudinal sections of the tubes). In a properly prepared transverse section (fig. 3, C), the corallites are seen to be of a rounded or more generally hexagonal figure, with thick and well-defined walls. In the centre of each is a rounded or oval opening, representing the section of the central tube of the corallite, filled either with calc-spar or with the dark matrix of the enclosing rock. This opening is surrounded by one or

more curved lines, which are often tangents to the margin of the central aperture, or are concentric to it, or intersect one another. These lines are the cut edges of the tabulæ which form the exterior zone of each corallite, and they forcibly remind one of the somewhat similar appearance presented by

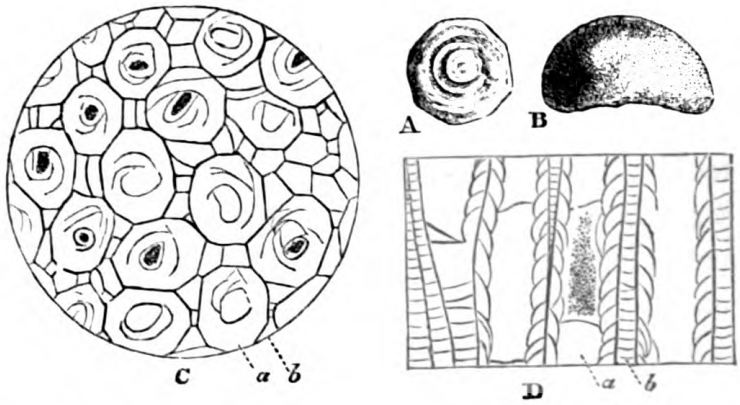


Fig. 3. A, Under surface of a small specimen of *Prasopora Grayæ*, natural size, showing the epitheca. B, Side view of another, larger specimen, of the natural size. C, Transverse section of the same, enlarged about twenty diameters. D, Longitudinal section, similarly enlarged : *a*, One of the corallites ; *b*, One of the cœnenchymal tubes. The dark shading in the microscopic sections indicates where the matrix is present.

transverse sections of the corallites of *Syringopora*, with their infundibuliform tabulæ. The corallites, in fact, in transverse section present a general resemblance to the bulb of an onion when cut across; and our generic name (Gr. *prason*, a leek) is in allusion to this. The central tube of the corallites is about one-third or often more of the total diameter; and the walls of the corallites are destitute of mural pores, and are not fused with one another or with the tubes of the cœnenchyma.

The cœnenchymal tubules are very variable in shape and size; but they are always much smaller than the true corallites, and are mostly oblong, triangular, or trapezoidal in shape (fig. 3, C). They are wedged in amongst the corallites, round which they are usually disposed in a single row; but the zone thus formed is rarely or never complete, each corallite coming into contact at different points with one, two, three, or even four contiguous ones. In some cases, also, there may be a double row of cœnenchymal tubes between the corallites. In internal

structure the tubes of the cœnenchyma possess none of the special characters which distinguish the true corallites, longitudinal sections showing them to be simply traversed by numerous close-set, complete tabulæ (*b*, fig. 3, D), generally slightly curved, with their convexities directed downwards. Transverse sections also show them to want the central tube of the true corallites, and to be irregular in form. Though we have retained the name of "cœnenchymal tubes" for these, we think it most probable that they are really of the nature of rudimentary corallites, which contained in the living state a series of small and specially modified zooids.

There are no traces of septa or of radial internal processes of any kind, either in the ordinary corallites or in the cœnenchymal tubes of *Prasopora*.

Affinities.—The only forms with which it is necessary to compare *Prasopora* are—(1) *Chætetes* and *Monticulipora;* (2) *Fistulipora* and *Callopora;* and (3) *Heliolites* and its allies.

The general appearance of the corallum in *Prasopora*, as before remarked, is very closely similar to that of massive examples of *Chætetes*, Fischer, and *Monticulipora*, D'Orb. From the forms included under these names, however, our genus is widely removed by the possession of a well-developed series of cœnenchymal tubules (very different in character from the minute tubuli found in many species of the two former groups), and by the internal structure of the corallites. No species of *Chætetes* or *Monticulipora*, so far as we know, exhibits anything to be compared with the external zone of vesicular tabulæ and the central tube of the corallites of *Prasopora*.

To *Fistulipora*, M'Coy, and the closely-allied or identical *Callopora*, Hall, the present genus is related by the fact that the corallites are surrounded by a greater or smaller number of cœnenchymal tubules. The two former, however, have the tubes of the corallites simply intersected by numerous complete tabulæ (said to be absent in some species of *Callopora*); and neither of them presents any approach to the peculiar structure

of the corallites of *Prasopora*, though it is in their neighbourhood that we may at present place the last-named genus.

Lastly, *Prasopora* resembles *Heliolites* and its allies in the fact that the corallites are surrounded by numerous transversely tabulate cœnenchymal tubules; but the total absence of septa and the peculiar structure of the corallites fundamentally separate the former from any member of the Helioporidæ. We may just add that the corallites of *Prasopora* in structure closely resemble those of *Roemeria* (the true *Calampora* of Goldfuss), but our genus is at once distinguished from this by the possession of "cœnenchymal tubules."

Prasopora Grayæ, Nich. and Eth., jun.

Spec. char.—Corallum forming small hemispheric or concavo-convex masses, generally from half an inch to three-quarters of an inch in diameter, and from a quarter to half an inch in height. Corallites more or less prismatic, from five to six in the space of one line (counting-in the intervening cœnenchymal tubules as well), thus averaging about 1-70th to 1-80th of an inch in diameter. Cœnenchymal tubules exceedingly variable in size and form, but rarely equal to half the diameter of the corallites. Epitheca and internal structure as described in the generic characters.

Obs.—Though we have now carefully examined considerably over a hundred specimens of this exceedingly interesting coral, we have nothing to add to the above description, as originally given by us. In both superficial characters and internal structure it appears to be extremely constant, and even its size varies very little. Out of the large series in Mrs Gray's collection the smallest example that has come under our notice is three and a half lines in diameter, and two and a half lines in height, while the largest is thirteen lines across, and six lines in height.

Form. and Loc.—Common in the shales associated with the limestone at Craighead, near Girvan. (Gray collection.)

Genus HALYSITES, Fischer, 1813.

(Zoognosia, 3d ed., vol. i. p. 387.)

Halysites catenulata, Linn.

Tubipora catenularia, Linné, Syst. Nat., ed. xii., p. 1270, 1767.
„ *catenulata*, Gmelin, Linné. Syst. Nat., ed. xiii., p. 3753, 1789.
Catenipora escharoides, Lamarck, Hist. des An. sans Vert., vol. ii. p. 207, 1816.
„ *tubulosa* and *C. escharoides*, Lamouroux, Exp. Méth., p. 65, 1821.
„ *labyrinthica* and *C. escharoides*, Goldfuss, Petref. Germ., vol. i. pp. 74 and 75, 1826.
Halysites attenuata, Fischer von Waldheim, Note sur des Tubip. Foss., p. 16, 1828.
Catenipora approximata, Eichwald, Zool. Spec., vol. i. p. 192, 1829.
Halysites escharoides, De Blainville, Dict. Sc. Nat. Atlas, Pl. XLIII., fig. 5, 1830.
„ *labyrinthica* and *H. escharoides*, Bronn, Lethæa Geognostica, vol. i. p. 52, 1835.
Catenipora labyrinthica, Milne-Edwards, in 2d ed. of Lamarck's Hist. des An. sans Vert. vol. ii. p. 322, 1836.
„ *escharoides*, Lonsdale, in Murchison's Silurian System, p. 685, 1839.
Halysites catenularia, Milne-Edwards and Jules Haime, Pol. Foss. des Terr. Pal., p. 281, 1851.
„ *catenulatus*, M'Coy, Brit. Pal. Foss., p. 26, 1851.
Catenipora escharoides, Hall, Pal. N.Y., vol. ii. pp. 44 and 127, 1852.
Halysites catenularia and *H. escharoides*, Milne-Edwards and Jules Haime, Brit. Foss. Cor., pp. 270 and 272, 1854.

(The above list comprises some of the most important references to this well-known coral. For a full synonymy up to date, *see* Milne-Edwards and Haime, Brit. Foss. Cor., pp. 270 and 272.)

Form. and Loc.—In cement-stones at Shalloch Mill, near Girvan, associated with *Dicellograptus Moffatensis* and other Lower Silurian (Caradoc ?) forms. (*Coll.*, Charles Lapworth.) As our specimens show no points of special interest, we have not thought it necessary to describe this familiar species. We have also a single specimen of the same from the greenish mudstones of Penkill, near Girvan, of Upper Silurian age. (Gray collection.)

Genus THECOSTEGITES, Milne-Edwards and Haime, 1849.

(Compt. Rend., t. xxix. p. 261.)

Thecostegites (?) Scoticus, Nich. and Eth., jun., *sp. nov.*

(Pl. IV., figs. 1-1 *b*.)

Spec. char. — Corallum composite, forming small masses, apparently not encrusting, composed of short cylindrical corallites, which diverge from the median line to open on the surface. The corallites are sometimes partially free, at other times in contact, but they widen out towards their mouths, where they are united by a continuous calcareous expansion, in which the calices are perforated. Calices mostly about half a line in diameter, but varying from ¼ to ¾ of a line, distant from one another from ¼ to ½ line, usually circular or oval, with slightly elevated lips, and furnished with a variable number of extremely short inward projections representing septa. Strong curved or flexuous tabulæ intersect the tubes at distances of from half a line to a line.

Obs.—The genus *Thecostegites*, Edw. and H., is only known by Devonian species; and it is defined by its authors as possessing a sub-massive encrusting corallum, with short cylindrical corallites, which are united by strong mural expansions, and are only free in the interspaces between these, the calices being circular, with rudimentary septa, and the tubes being crossed by horizontal tabulæ.

In Mrs R. Gray's collection we find two small specimens from the limestone at Craighead, which we are disposed to place provisionally in this genus; though it must be admitted that they do not agree in some important respects with the definition of *Thecostegites* above given, while the type has not previously been recognised in rocks of such ancient date. Our material, though well preserved as far as it goes, consists only of two small and imperfect specimens, the largest not an inch in length; and they do not exhibit the mural expansions which are said by Milne-Edwards and Haime to unite the

corallites, in places at any rate, in the genus *Thecostegites*. On the contrary, they are seen in longitudinal sections (Pl. IV., fig. 1 *b*) to have the walls of the corallites usually in contact. In places, on the other hand, the corallites are certainly not in contact, though it does not appear that they are here connected by epithecal outgrowths. However this may be, our form agrees with *Thecostegites* in the following points, which appear to us to be sufficiently weighty to justify our referring it to this genus as, at any rate, a provisional arrangement: (1.) The characters presented by the surface are very similar to those of *Thecostegites Bouchardi* (Pol. Foss. des Terr. Pal., Pl. XIV., fig. 1 *a*). Thus, the calices are slightly elevated, and are seen to rise from a continuous calcareous expansion, which separates them to a comparatively considerable distance (Pl. IV., fig. 1). So far as we can make out, the calcareous expansion in which the calices are pierced is formed by a thickening and coalescence of the corallites near their mouths; but our observations on this point are not decisive. (2.) Rudimentary septa are present. These can only be seen in microscopic sections transverse to the corallites; and they only exist as very short blunt inward projections, of variable number (Pl. IV., fig. 1 *a*). (3.) Strong and remote tabulæ intersect the corallites, though in our form these are oftener curved than straight (Pl. IV., fig. 1 *b*). (4.) Growth is by lateral gemmation, as clearly shown in long sections. (5.) Our species reminds us in many respects of an *Aulopora*, though wholly different in internal structure, and the same resemblance exists between the latter and one of the forms of *Thecostegites* described by Milne-Edwards and Haime (viz., *T. auloporoides*).

Should our reference of the Craighead specimens to the genus *Thecostegites* be confirmed by subsequent researches, we cannot doubt their entire distinctness from the species of this genus already known, and we have therefore given them a specific title. If finally established, the occurrence of the genus in rocks of Lower Silurian age will be a point of considerable interest.

Form. and Loc.—Rare in the shales associated with the limestone at Craighead, near Girvan. (*Coll.*, Mrs R. Gray).

Genus PINACOPORA, Nich. and Eth., jun., *gen. nov.*

Gen. char.—Corallum composite, coin-shaped, of extremely short corallites supported upon the upper convex surface of a free, discoidal, concavo-convex, concentrically-striated epitheca. Corallites of two sizes, regularly alternating with one another. Large-sized corallites disposed in obliquely decussating rows, each completely surrounded by a circle of very much smaller corallites ("cœnenchymal tubes"), rarely more than a single row of these latter, however, intervening between any given pair of the larger tubes. Large tubes furnished with twelve short septa, in the form of blunt spiniform projections; small tubes without septa. Large tubes furnished with one or two tabulæ, or rarely more, situated close to their base, the upper portion of the tube being open. Small tubes furnished with from two to four strong and complete tabulæ, which extend to close to their summits. Large tubes oval or circular in form; small tubes irregular in shape. No mural pores. No columella.

Obs.—The characters of this extraordinary genus are so peculiar that we shall consider them at some length,—a method of procedure which will enable us to dispense with more than a very brief notice of the single species upon which it is established. The specimens upon which we have founded the genus *Pinacopora* are only known to us as occurring in a single locality—viz., in the greenish mudstones of Mulloch Hill, of Upper Silurian age; and we possess an extensive series of these, from which we have been able to make out its structure in almost every particular. The corallum is compound and free, and has the form of a thin circular expansion, the under surface of which is covered with a thin, wrinkled, and concentrically-striated calcareous epitheca (Pl. III., fig. 3), which in nature and character entirely resembles the same

structure in such corals as *Chætetes petropolitanus*, *Prasopora Grayæ*, and other forms belonging to different types. The epitheca is always symmetrically concave, and its upper convex surface carries the corallites, which are remarkable for their extreme shortness, when we consider their comparatively large size. Thus, in a specimen one inch in diameter, the height of the corallites is only about half a line, while the diameter of the larger tubes is equal to their height. The corallites are of two kinds, large and small; or, in other words, to use the nomenclature of Milne-Edwards and Haime, the corallites are surrounded by "cœnenchymal tubes." In view, however, of the researches of Moseley upon *Heliopora*, we shall consider the smaller tubes to be really of the nature of corallites, tenanted, probably, in the living condition by a peculiar kind of zoöids. The larger and smaller corallites are symmetrically arranged upon the upper surface of the epitheca, the former being disposed in intersecting rows, and being isolated and separated from one another by the latter. In the only species of the genus known, the amount of the smaller tubes is not large, but there is always a single zone of them surrounding each of the large tubes (Pl. III., fig. 3 *d*). The large corallites, except in their shortness, are constructed upon the type of *Heliolites*, the resemblance between the two genera being especially manifest in the presence of short septa, apparently always twelve to each corallite when well preserved. The septa, however, are not so well developed as in *Heliolites*, being mere short blunt ridges (Pl. III., fig. 3 *d*). They are wholly wanting in the small tubes, as is also the case in *Heliolites*. Considering the extreme shortness of the corallites, the tabulæ may be said to be well developed, and they are always strong and complete. In the large tubes the tabulæ are confined to the bottom of the visceral chamber (Pl. III., fig. 3 *e*), and there is generally only one of them, though there may be two, or sometimes even three or four; though in the latter case they are very closely approximated. In the smaller corallites the tabulæ are more extensively developed, and they extend to close upon the summit of

the tubes (Pl. III., fig. 3 *e*). Lastly, the walls of the corallites are of considerable thickness, but wholly without mural pores, and the axis of the visceral chamber is never traversed by a columella.

As to the affinities of the genus *Pinacopora*, we are disposed to regard it as a member of the Alcyonarian family of the *Helioporidæ* of Moseley, and to place it in the neighbourhood of *Heliolites*, this being the only genus known to us with which it presents any relationship. It agrees, in fact, with *Heliolites* in the important feature that the corallum consists of a series of full-sized corallites, furnished with tabulæ, and with short septa, which are typically twelve in number; while these are surrounded and isolated by a series of smaller tubes, which are more closely tabulate, but are without septa. On the other hand, it differs from all known species of *Heliolites* in its forming a thin, concavo-convex, leaf-like plate; in the extraordinary shortness of its corallites; in the comparatively rudimentary condition of the septa; and in the small number of the smaller tubes, and the absence in them of anything like a regular or geometric form, while their tabulæ are remote and comparatively irregular.[1]

There is no other genus with which we find it necessary to compare *Pinacopora* in detail, but we may just notice the possibility that some of the forms upon which Hall founded the genus *Lichenalia* may perhaps turn out, when fully examined, to belong to the present genus, though others are probably of a different nature.

Pinacopora Grayi, Nich. and Eth., jun., *sp. nov.*

(Pl. III., figs. 3-3 *j*.)

Spec. char.—Corallum composite, in the form of a concavo-convex, leaf-like, calcareous expansion, of circular or oval form,

[1] The resemblance between *Pinacopora* and *Heliolites* is not conspicuously striking, except with one or two forms of the latter genus, such as *Heliolites dubia*, Fr. Schmidt, in which the larger tubes are closely applied to one another, and the cœnenchyma is reduced to a minimum.

varying from six to sixteen lines in diameter. Concave surface of the discoid corallum covered by a concentrically-striated calcareous epithecal plate. Upper convex surface of the disc completely covered with extremely short corallites, of two sizes, the height varying from two-thirds of a line to nearly a line. Large-sized corallites oval or nearly circular in shape, averaging about two-thirds of a line in diameter, completely open above, but occupied below by one, two, or rarely more, strong and complete tabulæ. Short septal ridges, typically twelve in number, also extend towards the interior of the visceral chamber. The larger corallites are regularly arranged in obliquely intersecting lines, and are completely surrounded by a zone of small tubes, averaging one-fifth of a line in diameter. These smaller tubes are very variable in shape, but they are furnished with strong and remote tabulæ to near their summits, and they are devoid of septa. Generally only a single row of small tubes intervenes between any given pair of large tubes, but there may be a partial duplication of this by the occasional development of additional tubuli in places.

Obs.—As there is only this single species in the genus, and as we have discussed the characters of the latter in detail, we need only add here a few remarks on the condition of preservation of the specimens with which we have worked. The cabinet of Mrs R. Gray contains a large and instructive series of examples from the mudstone of Mulloch Hill—the sole locality known for the species — and the following are the principal variations in the mode of their occurrence :—

(1.) In some specimens nothing whatever is to hand except the *cast* of the *under* surface of the epitheca.

(2.) In others, the polypiferous surface of the corallum is embedded in the stone, so that nothing is visible except the striated and concave under surface of the epitheca (Pl. III., fig. 3); but this has its structure preserved, and vertical sections of these specimens yield excellent results.

(3.) In others, again, we have the *cast* of the *upper* convex

surface of the epitheca (Pl. III., fig. 3 *a*), from which all the corallites have been broken off.

(4.) In other very instructive examples, while part of the epitheca is shown as a cast (as in the preceding), the rest of the original epithecal plate, along with the bases of the corallites, has been preserved (Pl. III., fig. 3 *b*), the upper portions of the latter being broken off.

(5.) In a fifth group of specimens, the actual calcareous corallum is wholly preserved, but, thin as it is, it has given way along a plane midway between the upper and lower surfaces of the disc. In such cases, one side of the split stone shows the convex upper side of the epithecal plate and the bases of the corallites which it supports; while on the other piece we have a corresponding concavity, which is occupied by the upper portions of the corallites, the actual mouths of which are embedded in the stone, and which the spectator thus looks at *from below* (Pl. III., fig. 3 *h*).

(6.) Lastly, there are many beautiful, and at first sight very puzzling, specimens in which we have *casts* of the upper or polypiferous side of the corallum (Pl. III., figs. 3 *f* and 3 *g*). These casts are circular or oval, and always concave, as corresponding with the convex upper surface of the coral upon which they are moulded. They exhibit a series of short columns, directed at right angles to the plane of the cast, about half a line in height, and the same in diameter, oval or circular in shape, arranged in intersecting lines, and indented on their sides with twelve vertical sulci. These columns are the casts of the large-sized corallites, and they are separated by interspaces which represent the zone of smaller tubes by which each of the latter is surrounded. These smaller tubes, being tabulate to close upon their summits, do not appear to have been penetrated by the surrounding matrix to any extent, so that one can only very indistinctly make out any projections in the cast, which might be considered as representing the cavities of these. We have named this interesting form in honour of our friend, R. Gray, Esq., F.R.S.E.

Form. and Loc.—Not uncommon in the mudstones (Upper Silurian) of Mulloch Hill. (*Coll.*, Mrs R. Gray.) We may add that we have seen specimens in the collection of Mr George Jennings Hinde of a species of coral from the "junction-beds" of Anticosti (base of Upper Silurian), which is undoubtedly congeneric with *Pinacopora Grayi.*

Genus HELIOLITES, Dana, 1846.

(Zooph., p. 541.)

Heliolites interstincta, Linn.

Madrepora interstincta, Linné, Syst. Nat., ed. xii., p. 1276, 1767.
Madreporites interstinctus, Wahlenberg, Nov. Acta Soc. Scient. Upsal., vol. viii. p. 98, 1821.
Porites pyriformis, Lonsdale, in Murchison's Silurian System, p. 686, 1839.
Palæopora interstincta, M'Coy, Brit. Pal. Foss., p. 15, 1851.
Heliolites interstincta, Milne-Edwards and Haime, Pol. Foss. des Terr. Pal., p. 214, 1851.
,, *pyriformis*, Hall, Pal. N.Y., vol. ii. p. 133, 1852.
,, *interstincta*, Milne-Edwards and Haime, Brit. Foss. Corals, p. 249, 1854.
(For full synonymy up to date, see Milne-Edwards and Haime's Monograph of British Fossil Corals, p. 249.)

Obs.—We have a few specimens which we are enabled to identify with this widespread and familiar form. All but one of our examples are simply in the condition of casts; but one small specimen from another locality (Penkill) is infiltrated with carbonate of lime, and was therefore in a condition suitable for microscopic examination. All the specimens, however, appear to be clearly referable to *Heliolites interstincta*, with which they agree in possessing large calices about three-quarters of a line in diameter, separated by spaces of about half a line, which are occupied by polygonal corallites of from 1-6th to 1-8th of a line in diameter.

Form. and Loc.—In the condition of casts in the dark-green mudstones of Mulloch Hill. Also at Penkill, near Girvan, the strata at both these localities being of Upper

Silurian age. (*Coll.*, Mrs R. Gray). We have no doubt that our specimens are specifically identical with those quoted by Salter under the name of *Heliolites subrotundus*, Fougt (= *Porites pyriformis*, Lonsd.), as occurring at Mulloch (Quart. Journ. Geol. Soc., vol. vii. p. 171).

Heliolites Grayi, Milne-Edwards and Haime (?).

(Pl. IV., figs. 4 and 4 *a*, and Pl. V., fig. 1.)

Heliolites Grayi, Milne-Edwards and Haime, Pol. Foss. des Terr. Pal., p. 217, 1851.
„ „ Milne-Edwards and Haime, Brit. Foss. Cor., p. 252, 1854.

Spec. char.—Corallum forming irregularly-branched or sublobate masses, which when of large size are clearly formed by the superposition of successive layers of corallites upon one another. In branched specimens the branches are cylindrical or flattened, sometimes palmate or lobulate, from four to about seven lines or more in diameter. The larger masses are irregularly lobed, and sometimes attain a diameter of one to two inches. The corallum appears to have been rooted at the base, and to have had all its free surface covered with the calices. The larger calices are half a line in diameter, or very slightly less, and they are separated by interspaces of from one-third of a line to half a line. The smaller tubes ("cœnenchymal tubes") are minute, four or five of them occupying an interspace between any pair of large tubes, and they appear to be irregular, or somewhat vermiculate in shape. There are twelve septa, with broad bases, and narrow interseptal chambers, in each of the larger tubes. Tabulæ unknown.

Obs.—The Craighead limestone has yielded a considerable number of specimens of coral with the characters above given, which we identify, with a little hesitation, with the *Heliolites Grayi* of Edwards and Haime. In most respects our specimens agree well with those ascribed to *H. Grayi* by its describers. It has the same peculiar mode of growth, and is often (though by

no means always) in the form of thick lamellar branched expansions, while its larger calices have the same diameter and the same number of thick triangular septa. Edwards and Haime, however, give as a specific character that the larger calices are "limited by a small, well-marked, circular ridge," formed by the exsert edge of the septa; but we cannot lay much stress upon the apparent absence of this in our forms, as with hardly an exception their surface-characters are absolutely undeterminable, and in the best of our specimens are exceedingly badly preserved. Upon the whole, therefore, we are tolerably confident that we are right in regarding the Craighead specimens as identical with the unique *Heliolites Grayi*, Edw. and H., of the Wenlock Limestone.

On the other hand, we entertain a little doubt as to the true generic position of this species, in spite of its close superficial resemblance to *Heliolites*. Could we rely with safety upon the appearance presented by microscopic preparations of our specimens, we should unhesitatingly remove it from *Heliolites*, since these do not exhibit a trace of tabulæ, and have other peculiarities as well. Unfortunately, however, they are so highly mineralised that we have found it extremely difficult to make satisfactory sections of them, and we cannot assert positively that both some of the positive and the negative phenomena which we have observed are not really due to the mode of preservation of the specimens. Still, it should be borne in mind that Milne-Edwards and Haime give no details as to the minute internal structure of *Heliolites Grayi*, and that the form and mode of growth of the corallum are very peculiar in this species, so that its reference to *Heliolites* will require confirmation.

Transverse sections of our specimens (Pl. V., fig. 1) remind us far more of such perforate corals as *Protaræa* and *Stylaræa* than of *Heliolites*. The stellate sections of the larger corallites, with their twelve broad septa, are evident enough, but the intervening tubules are only to be made out with difficulty, if at all, while they are often irregular and elongated in shape,

thus closely resembling what we see in cross sections of the reticulate sclerenchyma of *Protaræa*. On the other hand, in sections taken parallel with the larger tubes (Pl. IV., fig. 3 *a*), the appearances presented are very puzzling, though it is quite probable that they are only due in reality to the undoubted changes which the specimens have undergone subsequent to fossilisation. They show, in fact, no distinction between the larger and smaller tubes, and absolutely no traces of *tabulæ;* but they simply exhibit irregular, overlapping, and wavy lines, which run parallel with one another, and look as if they represented the division-walls between contiguous tubes. Sections taken across the branches of the corallum often clearly show that increase to its growth was effected by means of the addition of successive layers of short corallites. These sections also often show the characters of the surface to some extent (Pl. IV., fig. 3 *a*), and we learn from them that the actual cup of the larger corallites extended about half a line below the surface, its floor having often two or three tooth-like projections, while the smaller calices extended only to about one-sixth of a line or less below the surface.

Form. and Loc.—Not uncommon, but very badly preserved, in the limestone at Craighead, near Girvan. (*Coll.*, Mrs R. Gray, and *Coll.*, H. A. Nicholson).

Genus Stylaræa, Von Seebach, 1866.

(Zeitschr. d. deutsch. Geol. Ges., Bd. XVIII. p. 304.)

Gen. char.—Corallum composite, the sclerenchyma traversed by numerous fine inosculating canals. Corallites short, opening on the surface by rounded or polygonal calices, of moderate depth. Septa in the form of a variable number of short blunt ridges extending into the interior of the visceral chamber, the axis of which is occupied by a well-developed circular or oval columella, which the septa do not nearly reach. Strong and complete tabulæ present or absent. Corallum encrusting, or (?) attached only at a single point.

Obs.—The genus *Stylaræa*[1] was founded by Von Seebach (*loc. cit.*) for certain corals from the Lower Silurian of Esthland, which entirely agree with the well-known *Protaræa* of Milne-Edwards and Haime in most points, but are essentially distinguished by the possession of a well-developed columella. *Protaræa*, as is well known, always occurs in the form of thin crusts attached parasitically to foreign bodies, and some of its peculiarities may be merely adaptations to its special habit of growth. *Stylaræa*, however, must be so far different to *Protaræa* in habit, that it is stated to possess a distinct epitheca, which is hardly consistent with the use of the term "encrusting" employed by Von Seebach in his generic description. In their reticulate sclerenchyma, tuberculated walls, and short crenulated septa, the two genera are completely identical.

Amongst the specimens collected by Mrs R. Gray from Craighead, we find one which we cannot possibly place elsewhere than in the immediate neighbourhood of *Protaræa*, and which we think ought to be considered as a species of *Stylaræa*, though in order to place it in this genus, some extension of the characters of the latter, as given by Von Seebach, is necessary. Our form agrees with both *Protaræa* and *Stylaræa* in the minute structure of the sclerenchyma, in the form and disposition of the calices, and in the characters of the septa; while it further agrees with the latter genus in the possession of a strong and well-developed columella. This columella, however, cannot be said to be "spongy," as stated in Von Seebach's definition, for it is quite compact; and though we are unfortunately unable to say positively what was the mode of growth of our species, it certainly possessed much longer corallites than was the case with either *Protaræa* or *Stylaræa*, and can hardly be stated to have been "encrusting." Moreover, there is the very important point that the corallites in our form are provided with strong and well-developed *tabulæ*, structures

[1] So far as we can judge from his figures and description, the genus *Coccoseris* of Eichwald (Leth. Ross., vol. i. p. 442, Pl. XXV., fig. 4) is founded upon corals very similar in structure to *Stylaræa*, Von Seebach, if not absolutely identical with the latter.

which are wholly wanting in the two genera just mentioned. The absence of tabulæ, however, in *Stylaræa Rœmeri*, and in *Protaræa*, may well be due to the extreme shortness of the corallites in these forms, and for this reason we are not disposed to attach a generic value to their presence in our species. Without ignoring the differences which we have just alluded to, the general structure of the Ayrshire coral is so entirely similar to that of *Protaræa vetusta*, Hall,—as we have fully satisfied ourselves by a careful microscopic examination of both —that we should not feel justified in removing it far from the latter, and its possession of a columella would naturally place it in *Stylaræa*. If this reference be admitted, we must not only allow the occasional presence of tabulæ as one of the characters of the genus *Stylaræa*, but we have to note a further confirmation of the now acknowledged fact that well-developed tabulæ may exist in unquestionable perforate corals.

Stylaræa occidentalis, Nich. and Eth., jun., *sp. nov.*

(Pl. IV., fig. 2-2 *b*.)

Spec. char.—Corallum composite, forming a flattened expansion (?), of small size. Corallites irregularly cylindrical, about half a line in diameter, separated by thick sclerenchyma, which is equal in thickness to half the diameter of the tubes or more, and is traversed by numerous inosculating canals (Pl. IV., figs. 2 and 2 *a*), whereby each corallite is brought into communication with those immediately surrounding it. Calices slightly depressed, about half a line in diameter. Septa in the form of short blunt ridges, with broad bases (Pl. IV., fig. 2), which extend inwards for a variable distance into the visceral chamber, but always fall far short of the columella. Usually eight principal septa, sometimes with indications of as many short secondary septa alternating with them. Tabulæ strong, straight or curved (Pl. IV., fig. 2 *b*), placed at distances of from one-fifth to one-quarter of a line apart. Columella strong and compact, generally circular, and extending through the

tabulæ as a continuous rod in the axis of the visceral chamber, the course of the latter not being thereby deflected.

Obs.—The only described species of *Stylaræa*—viz., *S. Rœmeri*—is stated by Von Seebach to form thin laminar expansions, and to resemble *Protaræa vetusta*, Hall, in all essential points except in its possession of a columella. (We may here note, however, that *Protaræa vetusta* is seen in vertical sections not uncommonly to possess a predominant tubercle in the floor of the calice, as shown in Pl. IV., fig. 3 *a*; and this may perhaps be regarded as a rudimentary columella.) *S. occidentalis* appears to have grown in the form of a thin expansion, but as our material consisted of only a single specimen, we cannot assert anything positive as to its mode of growth. The corallites, however, in this specimen, are no less than three lines in height, and therefore greatly exceed those of *Protaræa vetusta* in this particular; and Von Seebach does not state that the tubes of his *Stylaræa Rœmeri* are any higher than those of the latter form. Apart from this difference, however, our species is fundamentally distinguished from that of Von Seebach by its possession of strong and complete tabulæ, by its compact, not spongy, columella, and by the absence of crenulation of the septa, these structures being apparently primarily eight in number.

Form. and Loc.—Rare in the shales associated with the limestone at Craighead, near Girvan. (*Coll.*, H. A. Nicholson).

Genus CALOSTYLIS, Lindström, 1868.

(Öfversigt K. Vetenskaps-Akad. Förhandl., 1868, p. 421.)

Gen. char. — Corallum compound or simple, increasing by lateral gemmation; wall rudimentary; epitheca poorly developed or wanting; septa porous, united with one another by lateral processes or imperfect dissepiments, continued centrally into a loosely reticulate or trabecular columella. Rudimentary tabulæ present or absent.

Obs.—The genus *Calostylis* was founded by Lindström for some very remarkable corals from the Upper Silurian of Gotland, which had previously been described by Kjerulf under the name of *Clisiophyllum denticulatum.* Lindström, however, showed (*loc. cit.*) that the form in question had no relation to the genus above named, but that it was truly the type of a new group of Palæozoic Perforate Corals, which, as far as known, are the only representatives of the *Eupsammidæ*,[1] which have been discovered in the entire series of the Palæozoic deposits. The peculiarities of *Calostylis denticulata* were subsequently described in greater detail by Lindström in a paper entitled "Description of the Anthozoa Perforata of Gotland" (Kongl. Svenska Vetenskaps-Akad. Handl., Bd. ix., 1870); and we are entirely able to confirm the general accuracy of the account there given, as we have made a careful microscopic examination of specimens which he himself kindly presented to us. We agree, therefore, with him in the conclusion that *Calostylis* is a true Perforate Coral, belonging to the family of the *Eupsammidæ*, and related to the genera *Endopsammia* and *Balanophyllia.* Lindström points out, however, that *C. denticulata* possesses some characters which remind one of the *Rugosa*, such as the existence of epithecal outgrowths, which occasionally act as processes of attachment. In a longitudinal thin section which we have prepared of this species, we further find that the visceral chamber is crossed by distinct though sometimes discontinuous horizontal plates, which appear to be clearly of the nature of tabulæ. Whether these structures are always present or not is a point which we are unable to determine, but their occurrence is not alluded to by Lindström.

The "Gray collection" contains a number of specimens of a small coral which are at once shown by microscopic examination to agree in every particular with *Calostylis*, and which differ from *C. denticulata*, Kjerulf sp., only in points of specific

[1] "*Palæacis*, Haime, has been regarded as a Carboniferous representative of the *Eupsammidæ*, but we have elsewhere given reasons (Ann. Nat. Hist., 1878) for thinking that it is not referable to the *Actinozoa*.

importance. This coral we shall describe under the name of *Calostylis Lindströmi;* and its occurrence is of special interest, as it affords the first known instance of the discovery of this remarkable and ancient type of Perforate Corals outside of the Silurian rocks of Sweden.

Calostylis Lindströmi, Nich. and Eth., jun., *sp. nov.*

(Pl. V., figs. 2-2 *c.*)

Spec. char.—Corallum simple, or sometimes throwing out a few lateral buds, cylindrical, contorted, and generally more or less constricted at intervals, the usual diameter of seemingly full-grown specimens being from two to three lines. No wall. An epitheca, of small thickness, may be partially developed; but in other cases the outer edges of the septa appear on the surface as so many longitudinal ridges. Septa porous and cribriform, irregular, the larger ones thirty or more in number, sometimes with smaller septa which become coalescent with the larger ones. Centre of the corallum occupied by a very loosely reticulated and trabecular mass, which represents a spongiose columella occupying about one-third of the total diameter of the corallum. In the interval between the columella and the wall on each side, delicate and remote plates representing tabulæ can be detected. Contiguous septa send out imperfect tooth-like dissepiments by which they are loosely united to one another.

Obs. — This remarkable species can generally be without difficulty picked out by its slender, cylindrical corallum, apparently always more or less twisted, and usually constricted at intervals (Pl. V., fig. 2)—superficial characters exhibited by none other of the Girvan corals known to us. Its size varies from half an inch to nearly an inch in length, with an average diameter of about two lines; but none of our specimens can be certainly said to be perfect, so we do not know if this length was exceeded or not. Towards the base the corallum tapers, and most of the specimens appear to have been

simple. Some, however, show distinct lateral buds, though we have not noticed more than one such bud in any given individual. In the points just mentioned, the present form agrees with *C. denticulata*, which sometimes has a simple conical corallum, and at other times produces lateral buds. Its surface-characters—as almost universally with the Girvan corals—are extremely badly preserved; but we sometimes recognise a thin epitheca, which, at places where the corallum is constricted or contorted, may be developed into thickened encircling ridges. At other times, the surface shows longitudinal ridges formed by the outer edges of the septa. The characters of the calice, and the mode of attachment of the coral, are unknown to us.

Microscopic sections at once reveal the structure and true affinities of *Calostylis Lindströmi*. These show that the entire corallum is made up of reticulate and trabecular sclerenchyma. The septa are well developed, comparatively speaking; but as the shorter ones often become confluent with the larger as the latter in turn pass into the central spongy mass, and as all are more or less united together by lateral processes, it is very difficult to determine their number precisely. There appear to be about thirty principal septa in a specimen of three lines in diameter. Long sections show that imperfect horizontal partitions or tabulæ (Pl. V., fig. 2 *c*) are present, and that the septa are more or less largely cribriform; while both longitudinal and transverse sections show that the axis of the visceral chamber is occupied by a broad cylindrical mass of columellar tissue in the form of reticulating and inosculating trabeculæ (Pl. V., figs. 2 *b* and 2 *c*).

Calostylis Lindströmi, though agreeing with *C. denticulata*, Kjerulf, in its general plan of structure, is readily separated from it by its very much smaller dimensions, and the contortion and periodic constriction of all specimens known to us. It also has much fewer septa, and does not appear to produce epithecal processes of attachment. On the other hand, *C. denticulata*—the only other known representative of the type—attains a maximum length of from four to six inches, with a

diameter of an inch and a quarter, while its septa reach the great number of one hundred and forty, and in the early stages of its growth it fixes itself by root-like epithecal processes developed from the border of the calice.

We have named the species in honour of our friend Dr Gustav Lindström, one of the most distinguished of authorities on the subject of fossil corals.

Form. and Loc.—Apparently not uncommon in the greenish mudstones of Penkill, near Girvan, of Upper Silurian age. (Gray collection).

Genus STREPTELASMA, Hall, 1847.

Streptelasma, Hall, Pal. N.Y., vol. i. p. 17, 1847. (By clerical error, subsequently corrected, the name of the genus is spelt *Streptoplasma*).
„ Milne-Edwards and Haime, Pol. Foss. des Terr. Pal., p. 398, 1851.
Petraia (*pars*), M'Coy, Brit. Pal. Foss., p. 39, 1851.
Palæophyllum, Billings, Geol. Survey of Canada, Rep. of Progress, p. 168, 1857.
Streptelasma, Ferd. Roemer, Die foss. Fauna von Sadewitz, p. 17, 1861.
„ Kunth, Zeitschr. d. deutsch, Geol. Ges., 1871, p. 647.
„ Dybowski, Mon. Zoanth. sder. Rug., p. 125, 1873.
„ Nicholson, Pal. of Ohio, vol. ii. p. 217, 1875.
„ Nicholson, Ann. and Mag. Nat. Hist., Ser. 4, vol. xviii. p. 94.

Gen. char.—Corallum simple, cylindrical or turbinate; or compound and more or less fasciculate. Epitheca well developed. Proper wall doubtfully present; but a thick false wall, formed by the fusion of the broad outer ends of the septa with intermediate calcareous deposit. Septa well developed, lamellar, of two orders, the primary septa usually more or less flexuous, and always more or less extensively united at their inner ends with one another and with a pseudo-columella, which is composed of the twisted and inosculating edges of the septa; secondary septa of approximately equal size, much shorter than the primary septa, with which they are often united by their inner ends. Dissepiments in variable number

intersect the interseptal spaces, but never exist in amount sufficient to constitute an outer vesicular zone. Tabulæ are well developed in the outer zone of the corallum, but often do not completely cross from side to side. They are usually more or less convex upwards externally, and flat or convex centrally. A septal fossula present or absent.

Obs.—As regards the history of the genus *Streptelasma* we have but little to remark. It was originally founded by Hall (*loc. cit.*) upon the still undetermined and imperfectly understood *S. expansa* of the Chazy Limestone; and almost the only character of importance given in the generic diagnosis is that the septa are more or less spirally twisted in the centre. As the true structure of *S. expansa* is, however, still unknown, we must take the common and sufficiently investigated *S. corniculum* of the Cincinnati group as the type of the genus—a course the more justifiable as this species was described by Hall in the same volume and in the same year as *S. expansa* (Pal. N.Y., vol. i. p. 69). As the twisting of the primary septa in the centre of the visceral chamber is not particularly marked in *Streptelasma*, and as this feature is found in corals of very different affinities, it is not surprising that Milne-Edwards and Haime (*loc. cit.*) regarded the genus with some doubt, and only retained it upon the ground that the well-preserved specimens which they had seen rendered it certain that the coral is "destitute of an epitheca and covered by sub-lamellar costæ." This statement can only be explained upon the supposition that the eminent observers just named founded their remarks upon specimens which were really weathered and decorticated, since all the well-preserved examples of the genus which we have seen possess a distinct, though sometimes thin, epitheca. It is also probable that some of the so-called "*Petraiæ*" will prove to be really referable to *Streptelasma*, and this is certainly the case with at least one species of M'Coy's *Strephodes*. The only other point connected with the history of the genus which needs notice is the establishment, in 1857, by Billings (*loc. cit.*), of the genus *Palæophyllum* to include forms which only differ

"from *Petraia* or *Streptelasma* in forming long fasciculate or aggregate masses, instead of being simple." The generic diagnosis given by Billings is very brief and imperfect, and the only structural point of importance noted in it is, that the tabulæ are "either none or rudimentary." This, if certainly established, would separate the genus from *Streptelasma*, as we now understand it; but in the absence of information as to the microscopic structure of the type-specimens, it would be hazardous to attach much weight to this; and there remains, therefore, only the composite character of the corallum to consider. This, no doubt, is often considered as of itself sufficient to establish generic distinction, and we do not desire to express any opinion on this practice; but in this particular instance we think that it would be, at any rate, very inconvenient to adopt a similar course. Our reason for this opinion is, that though certain specimens, and certain species, can be said with certainty to be simple, while others with equal decision can be said to be compound, there are many broken examples which cannot be asserted positively to be one or the other, so that in the case of some species it becomes impossible to say if the corallum was always compound. This is the case, for example, with *S. Craigense*, M'Coy, sp., which, though certainly usually simple, cannot be structurally separated from examples exhibiting multiplication by division. For this reason we prefer at present to consider the genus *Palæophyllum*, Bill., as, at most, a sub-genus of *Streptelasma*.

From its minute structure, as elucidated by microscopic sections, the affinities of *Streptelasma* become abundantly clear. It is a Zaphrentine, and not a Cyathophylloid type. This is shown quite conclusively by the condition of development of the dissepiments alone, which, in all the true Cyathophylloids, are present in such quantity as to give rise to a regular exterior zone of vesicular tissue, the central twisting together of the septa being a wholly secondary feature. In all the *Streptelasmæ*, however, dissepiments are present in small number; and they agree further with *Zaphrentis* in possessing, without excep-

tion, well-developed tabulæ. Their special points of differentiation from *Zaphrentis* are to be found in the presence of a central reticulate pseudo-columella, and in the condition of the fossula. In all forms of *Streptelasma*, the axis of the visceral chamber is occupied by a very loosely constructed pseudo-columella, which often projects in the floor of the calice as a rounded boss, while in cross-sections it is seen to be formed by the irregular anastomosis centrally of a certain number of the primary septa. In long sections of the corallum, taken across the median line, it is equally conspicuous as a series of irregular and disconnected vertical rods. This pseudo-columella must be considered as the special feature distinguishing *Streptelasma* from *Zaphrentis*. On the other hand, the condition of the septal fossula varies. In *S. corniculum*, Hall, which, as before said, we may take as the type of the genus, a septal fossula is present, though this is not formed by the coalescence of a number of the primary septa. In other species (*S. aggregatum*, *S. Craigense*, &c.) we have failed to find any indications of a fossula at all. Upon the whole, therefore, we must rely upon the axial structure of the corallum, as separating *Streptelasma* and *Zaphrentis;* and we obtain thus an additional proof of the necessity of breaking up the latter genus. Some of the forms which would usually be referred here, will doubtless turn out to be referable to *Streptelasma*. Others, such as *Zaphrentis cylindrica*, E. and H., must form the type of a new genus; and others, again, of the type of *Z. Guerangeri*, E. and H., will remain as a compact and well-characterised group to form *Zaphrentis* proper.

There are two other points in the structure of *Streptelasma* which may be just alluded to. In all well-preserved specimens which have come under our notice, we find, as before remarked, a true epitheca to be present; but we have not been able to satisfy ourselves as to the existence of any proper *wall*. All the forms of the genus known to us have the visceral chamber bounded by a thick and dense investment, which looks at first sight like a true wall, but which seems really to be a kind of

false wall, formed by the widening out of the outer ends of the septa, which are united with one another by a small amount of intermediate sclerenchyma of secondary deposition (see Pl. V., fig. 3 *b*). The other point in question concerns the disposition of the septa. Dr Ferd. Roemer, in describing *Streptelasma Europæum* (Foss. Fauna von Sadewitz, p. 17 *et seq.*) lays considerable stress upon the pinnate arrangement of the septa (and consequently of the costæ), which diverge from a dorsal, and sometimes from two lateral lines. We cannot, however, agree with this distinguished palæontologist in regarding this as a character of generic importance; since it merely indicates a peculiarity in the method of development of the new septa, and is not only absent in some species of *Streptelasma*, but is present in other types of different affinities.

The genus *Streptelasma* (including *Palæophyllum*) is an essentially Lower Silurian type, though forms believed to be referable to it are found in the Upper Silurian. Originally known as abundant in the Silurian of North America, species of the genus have been described by Roemer, Fr. Schmidt, and Dybowski from European deposits of the same age. In the Craighead limestone at Girvan, we find at least three well-marked and common forms of *Streptelasma*, which we shall next proceed to describe.

Streptelasma (Palæophyllum) aggregatum, Nich. and Eth., jun., *sp. nov.*

(Pl. V., figs. 3-3 *c*.)

Spec. char.—Corallum composite, fasciculate, forming large colonies of slender cylindrical corallites, which have an average diameter of from two to three lines. Epitheca well developed; a thick false wall made up mostly of the thickened bases of the septa, and forming a dense outer investment to the visceral chamber. Calices, so far as known, deep, and having the septa continued over their sides as short ridges. Septa regularly developed, of two orders, the longer and shorter ones alternating, and each series varying from twenty to twenty-five in

number. No traces of a septal fossula. The septa are slightly flexuous, never conspicuously twisted centrally; but some of the principal ones unite with one another at their inner ends, and become connected with an irregular and loose pseudo-columella, which in long sections appears to be formed of discontinuous or partially anastomosing vertical rods. Tabulæ well developed, convex, with their convexity directed upwards, rarely or never extending completely across the visceral chamber, three or four in the space of one line. Dissepiments variable; sometimes absent in individual corallites; sometimes sparsely developed in the outer zone of the tubes. Increase by fission.

Obs.—This well-marked species is invariably compound, and belongs, therefore, to the section *Palæophyllum*, Billings. Fragments of individual corallites are found, of course; but these are in general easily distinguished from young examples of *S. Craigense*, M'Coy, either by the much smaller number of the septa, or by their showing marks of division. As a rule, the corallum occurs in the form of large colonies of cylindrical or slightly oval corallites, pretty uniformly between two and three lines in diameter, placed from two to four or five lines apart (Pl. V., fig. 3), and completely embedded in the rock, so that their characters can only be determined by microscopic examination. Sometimes two or three corallites occur in close contact, or even partially united; but this is due to their having been produced by fission from a single tube—this being clearly the regular mode of increase of the corallum, though, possibly, lateral budding occurs as well. In Pl. V., fig. 3 *a*, we have figured the summit of an old corallite dividing into no less than seven new ones, and thus appearing to increase by calicular gemmation; but more ordinarily a corallite simply divides into two. Owing to the mode of preservation of the specimens, little can be said as to the superficial characters. The epitheca is well developed, longitudinally striated, and with delicate annulations of growth, and the calice seems to have been deep, with a nearly flat floor. The internal characters, however, are

thoroughly determinable. In *transverse* sections (Pl. V., fig. 3 *b*) we are at once struck with the great thickness and density of the outer investment of the visceral chamber; but this is principally due to the thickening and fusion of the bases of the septa. There are from 20 to 25 long septa, not interrupted by a fossula, and regularly alternating with an equal number of short septa; and the interseptal loculi, though sometimes nearly or quite vacant, are usually crossed by a few, remote, curved dissepiments. Some of the primary septa always unite with one another by their inner ends, in groups, without being notably twisted; and they are generally more or less freely connected with a central pseudo-columella, the cross-section of which appears as a loosely reticulate framework in the axis of the visceral chamber. In long sections (Pl. V., fig. 3 *c*), the thickness of the false wall is as conspicuous as in transverse slices; the visceral chamber is seen to be crossed by irregular but well-developed curved tabulæ, rarely or never quite complete; and the centre is occupied by the pseudo-columella, in the form of a broad median band of reticulate calcareous tissue, mainly made up of short longitudinal rods.

The only other species of the genus with which it is necessary to compare the present form are *Palæophyllum rugosum*, Bill., and *P. divaricans*, Nich., these being the only compound members of the genus *Streptelasma* as yet described. In the case of neither of these species is the internal structure adequately known; but *S. aggregatum* is sufficiently distinguished from either by its general form, since *P. rugosum*, Bill., forms large masses of hardly separable corallites, which attain an individual diameter of six lines, while the colonies of *P. divaricans*, Nich., are composed of only from two to seven short conical corallites produced by budding.

Form. and Loc.—Not uncommon in the limestone of Craighead, near Girvan; forming large colonies half a foot or more in diameter (*Coll.*, C. Lapworth, H. A. Nicholson, and Mrs R. Gray).

Streptelasma Craigense, M'Coy, *sp.*

(Pl. V., figs. 4-4 *c*.)

Strephodes Craigensis, M'Coy, Ann. and Mag. Nat. Hist., ser. 2, vol. vi. p. 275, 1850.
„ „ M'Coy, Brit. Pal. Foss., p. 30, 1851.
Cyathophyllum articulatum, Milne-Edwards and Haime, Brit. Foss. Corals, p. 283, 1854.
Ptychophyllum Craigense, Lindström, Öfversigt af K. Vetenskaps Akad. Förhandl., 1873.

Spec. char.—Corallum simple, or rarely throwing out a few offsets, never forming large colonies. General form of the corallum straight, cylindrical, very slowly tapering to the base, full-grown examples attaining a diameter of seven, nine, or eleven lines. Epitheca well developed, marked with strong rounded vertical striæ, six in the space of two lines, and thrown into numerous conspicuous sharp-edged annulations of growth, of which about five occupy the space of one inch. A thick false wall formed by the fusion of the broad and widened outer ends of the septa. Septa numerous, slightly flexuous, never conspicuously twisted towards the centre of the corallum, of two sizes regularly alternating with one another. Fully adult examples have from seventy-two to eighty septa in all, half of these being long and the other half short, the larger number of the primary septa either being connected together in groups towards the centre, or becoming directly connected with a large reticulate pseudo-columella, composed of twisted and anastomosing vertical rods occupying the axis of the visceral chamber. The calice is apparently deep, but the form assumed by the columella in its floor has not been observed. A few remote and curved dissepiments are always developed in the interseptal loculi, but never form an exterior zone of vesicular tissue. No septal fossula. Tabulæ well developed, often complete, sometimes inosculating, curved upwards in the outer portions of the visceral chamber, but flat or depressed centrally, about five in the space of two lines.

Obs.—We feel no hesitation whatever in identifying the specimens upon which the above description is founded with the *Strephodes Craigensis*, M'Coy (*loc. cit.*); nor can we feel any more doubt as to their being in all respects properly referable to the genus *Streptelasma*. In their great work on the British fossil corals (*loc. cit.*), Milne-Edwards and Haime place *Strephodes Craigensis* as a synonym of *Cyathophyllum articulatum*, Wahl.; but they do not mention having seen examples of the former, and the slightest examination of its internal structure at once shows its radical dissimilarity to any form of *Cyathophyllum*. On the other hand, *S. Craigensis* is proved unquestionably to be a true *Streptelasma* by its thick false wall, composed largely of the amalgamated outer ends of the septa; its sparse dissepiments, and total absence of an exterior vesicular zone; its Zaphrentine tabulæ; and its large reticulated pseudo-columella. Lindström (*loc. cit.*) describes a coral from the Silurians of Sweden under the name of *Ptychophyllum Craigense;* but we are unable to say whether this is really the same coral as *Strephodes Craigensis*, M'Coy, or not.

From all the more ordinary forms of *Streptelasma*, such as *S. corniculum*, Hall, *S. Europæum*, F. Roemer, and the like, the present species is at once separated by its general shape. No other described species of the genus possesses a corallum so long, cylindrical, and slowly-tapering. None of our larger specimens are perfect; but as our larger fragments only taper at a rate of about one line in nine, and as they have a diameter of ten or eleven lines at the larger extremity, we should suppose the corallum to have attained a length of at least half a foot. The strong rounded longitudinal striæ, and the close-set and strongly-marked annulations of growth, are also good superficial features by which fragments may be recognised. Large examples of the species are invariably simple, and so cannot be confounded with any of the compound forms of the genus (*Palæophyllum*). We have, however, various small specimens, which agree in internal structure with *S. Craigense*, and which we suppose to be its immature form, but which present the

peculiarity that they give rise to one or two corallites, apparently by a process of fission. One of these is figured in Pl. V., fig. 4 *c*. Such specimens might easily be confounded with broken fragments of a colony of *S. aggregatum*, nobis, but they agree with the isolated coralla of the typical *S. Craigense* in the large number of their septa; and their corallites are of larger diameter than even full-grown stems of *S. aggregatum*.

Form. and Loc.—Common in the limestone and associated shales of Craighead, near Girvan. (*Coll.*, Mrs R. Gray and H. A. Nicholson.)

Streptelasma Europæum, F. Roemer.

(Pl. VI., figs. 1-1 *b*.)

Streptelasma corniculum, Fr. Schmidt, Untersuchungen über die Silur. Form. von Esthland, &c., p. 233, 1861 (not Streptelasma corniculum, Hall).

„ *Europæum*, Ferd. Roemer, Die Sil. Fauna von Sadewitz, p. 16, Pl. IV., figs. 1 *a-f*, 1861.

Spec. char.—Corallum simple, conical, more or less curved, varying in length (in our specimens) from one to more than three inches, the diameter of the calicular extremity being respectively from eight lines to an inch. Epitheca well developed, marked with strong rounded longitudinal ridges corresponding with the interseptal loculi, which, in well-preserved specimens, are crossed in turn by fine encircling striæ. Annulations of growth low and rounded, often inconspicuous. In specimens clearly exhibiting the surface, the ridges are seen to have a pinnate arrangement, being directed obliquely on both sides towards a line running down the convex or dorsal side of the corallum. Calice (in our examples) imperfectly preserved, but always more or less oblique, and apparently of considerable comparative depth. Septa of two sizes, regularly alternating with one another, the total number varying in coralla of different sizes from seventy-four to one hundred, but being usually about eighty. No septal fossula. The secondary septa generally very short, and often inclined towards and fused with the

primary septa at their inner extremities. Curved dissepiments sparingly developed in the interseptal loculi. Towards their inner ends the longer septa become more or less freely united with one another and with a reticulate pseudo-columella, which occupies the axis of the visceral chamber, and projects into the bottom of the calice. Tabulæ sometimes close-set and nearly horizontal, sometimes directed obliquely upwards and anastomosing.

Obs.—The Craighead limestone has yielded to the researches of Mrs Gray a number of specimens of a *Streptelasma*, of which the above description gives the most salient characters, and which we hardly think can be specifically separated from *S. Europæum*, F. Roemer. It is true our examples show some points of difference, but the investigation of these ancient cup-corals is attended with great difficulties, and some discrepancy is to be expected in specimens from widely distant localities. Our specimens agree with *S. Europæum*, F. Roemer, in their general form, and are thus readily distinguished from the cylindrical *S. Cragiense*, M'Coy, sp., of the same beds. We have no specimens nearly so large as the largest figured by Roemer, but this is a matter of little importance. In its conical, turbinate form, *S. Europæum* very closely resembles *S. corniculum*, Hall; but if our specimens are rightly identified, it is separated from the latter (with which Schmidt placed it) by its uniformly smaller number of septa, and by the entire absence of a septal fossula. According to Roemer, *S. Europæum* possesses epithecal ridges which are directed in a pinnate manner along three lines, one dorsal and two lateral. Most of our examples have the surface much obscured by adherent matrix, or worn away, and we have only been able to detect a feather-like arrangement of the septal furrows on the dorsum of the coral. Again, the tabulæ are figured by Roemer as being nearly horizontal, close-set, or more or less freely anastomosing in *S. Europæum*, and our larger specimens sometimes show the same feature. On the other hand, in the smaller examples, the tabulæ are highly inclined, with their convexity upwards,

and they are rather remote. Upon the whole, however, we think we are safest in identifying the Craighead specimens with *S. Europæum.*

Though badly preserved as regards external characters, the internal structure of our specimens can be readily investigated by the usual means adopted by us. Cross-sections (Pl. VI., fig. 1 *b*) show the same general structure as in *S. Craigense*, M'Coy, sp. The false wall formed by the amalgamation of the bases of the septa is, however, much less developed than in the latter. The septa are alternately of two sizes, generally about forty of each dimension being present, the shorter ones being often united internally with the longer, and the interseptal spaces being crossed by remote curved dissepiments. At their internal extremities the primary septa are mostly united in groups of from three to five, and these, in turn, become connected with a highly-developed reticulate pseudo-columella, which occupies a considerable space in the centre of the corallum. Long sections exhibit the same general features as in *S. Craigense*, and we have not thought it worth while to figure one. We may observe, however, that the lattice-work of the columella is seen conspicuously to be composed of vertical calcareous rods, irregularly uniting with one another; that the columella forms a conspicuous fasciculate projection in the floor of the calice; and that in sections taken slightly out of the true line of the centre it appears simply as a series of short spines springing from the upper surfaces of the tabulæ. It is a section of this last kind that is figured by Roemer (*loc. cit.*, Pl. IV., fig. 1 *f*). As before remarked, however, long sections show a variable condition of the tabulæ. In old specimens, towards their calicine extremities, the tabulæ are nearly horizontal, and are placed close together. On the other hand, they are usually greatly curved, with their convexities upwards, and are then comparatively remote.

Form. and Loc.—Common in the Craighead limestone, near Girvan. (Gray collection.)

Streptelasma (?) æquisulcatum, M'Coy, *sp.*

(Pl. VI., fig. 3.)

Petraia æquisulcata, M'Coy, Ann. and Mag. Nat. Hist., ser. 2, vol. vi. p. 279, 1850.
„ „ M'Coy, Pal. Foss., p. 39, Pl. I. B, figs. 23 and 24, 1851.

Spec. char.—Corallum simple, conical, slightly curved, with an oblique calice, attaining an adult diameter of from one inch and a quarter to one inch and a half, with a length of two inches or more. Epitheca well developed, marked by strong, obtuse or flattened, longitudinal ridges, which correspond with the interseptal loculi, and of which about three occupy the space of one line. Septa apparently from sixty-five to eighty-five in number, alternately large and small, centrally more or less twisted, and sometimes inosculating with one another. Tabulæ unknown. Dissepiments very few and remote, curved, not forming an exterior vesicular zone. Calice deep, the septa in its upper portion merely marginal.

Obs.—We have a few specimens from Mulloch Hill which we can identify with entire certainty with M'Coy's *Petraia æquisulcata.* Some of our examples are in the condition of casts; others retain the calcareous skeleton; but our material is unfortunately insufficient to enable us to pronounce an opinion upon the true affinities of this well-marked coral. M'Coy refers it to *Petraia,* as defined by him, chiefly upon the ground of its twisted septa, and its supposed absence of tabulæ and dissepiments. We have been unable to obtain any longitudinal sections, and our transverse sections are from specimens in which the centre of the visceral chamber is more or less filled up with matrix, to the partial destruction of the calcareous framework of the coral. As to the presence or absence of tabulæ we can therefore say nothing. Cross-sections (Pl. VI., fig. 3) show the septa to be greatly twisted as they approach the centre; but this character, of itself, goes for little. Dissepiments, however, are seen to be undoubtedly present, though they are but very few in number, and irregular in their occurrence. Some of

the septa, however, inosculate with one another, and there are indications that the centre of the visceral chamber was really occupied by a trabecular columella. It is not uncommon in specimens of undoubted *Streptelasmæ* to find the loosely-compacted columella more or less broken down and replaced by the matrix; and we are at present inclined to believe that *Petraia æquisulcata*, M'Coy, is really a *Streptelasma*, though only longitudinal sections can set this point finally at rest. If our conjecture be correct, *Streptelasma* (?) *æquisulcatum* will stand very near to *S. Europæum*, Roemer, from which it will be distinguished principally by its more curved form, more broadly expanded shape, and very limited number of dissepiments. Milne-Edwards and Haime (Brit. Foss. Cor., p. 280) identify *Petraia æquisulcata* with *Aulacophyllum mitratum*, His.; but a careful microscopical examination of the latter has satisfied us that there is no sufficient ground for this identification.

Form. and Loc. — Mulloch Hill, near Girvan, in beds of Upper Silurian (? Upper Llandovery age). Gray collection.

Genus Lindströmia, Nich. and Thoms., 1876.

(Proc. Roy. Soc. Edin., vol. ix. No. 95, p. 149.)

Gen. char. — Corallum simple, conical or turbinate, the epitheca complete, with well-marked longitudinal ridges, fine encircling striæ, and low annulations of growth. Septa well developed, lamellar, equally developed or of two sizes, united inferiorly in the axis of the visceral chamber, and augmented by a secondary deposit of sclerenchyma, so as to form a comparatively enormous pseudo-columella, which projects into the floor of the calice. The lower portion of the visceral chamber often more or less completely filled up by the deposition within it of solid sclerenchyma. Interseptal loculi, usually crossed by a few strong and remote dissepiments; and the upper portion of the visceral chamber not uncommonly traversed by thick transverse plates of the nature of tabulæ, though at other times

these are not recognisable, or at any rate have not been clearly made out.

Obs.—The genus *Lindströmia* was founded by one of the present writers and Mr James Thomson (*loc. cit.*), for the reception of certain small corals from the Devonian formation of North America, the specific description of which is still unpublished. From its general characters, which we shall discuss immediately in a more detailed manner, it is clear that the genus belongs to the *Cyathaxonidæ*, and the type to which it is most nearly allied is *Cyathaxonia*, Michelin, itself. In this genus, however, if we take into consideration the type-species —viz., *C. cornu*, Mich.—we find that the columella is a solid rod extending from the bottom of the visceral chamber to the calice, that there are neither dissepiments nor tabulæ, and that there is a well-marked septal fossette (*see* De Koninck, Nouv. Recherches sur les An. Foss., Prem. partie, p. 108, 1872). In *Lindströmia*, however, as we shall see, there is no septal fossula; dissepiments are always present, and tabulæ sometimes; and the columella, or pseudo-columella, has an entirely peculiar structure; while there are other special structural features as well.

There is, however, one species of *Cyathaxonia*, so called—namely, *C. Dalmani*, Edw. and H.—which agrees in its internal structure with the forms here united under the name of *Lindströmia*. That this well-known Silurian form is not a true *Cyathaxonia* seems to have been recognised by De Koninck, who remarks that the species of this genus "probablement sont toutes carbonifères;" and it has certainly been determined by Lindström, to whose kindness we owe specimens of this species, accompanied by the remark that it is not a genuine *Cyathaxonia*, and that he proposes for it the generic name of *Centrotus*. We are not aware of this name having been published formally; but we are not able to accept it, partly because it is already preoccupied by a genus of insects, and partly because we find it to be covered by the published *Lindströmia*, and thus very appropriately designated already. The *Cyath-*

axonia Siluriensis of M'Coy (Brit. Pal. Foss., p. 36, Pl. I. C, fig. 11) is also clearly a *Lindströmia;* and we have determined the same to be the case with at least one of the forms included by M'Coy under the head of *Petraia.* All these forms, except *Cyathaxonia Siluriensis,* M'Coy, we have now carefully examined by means of thin sections, and we find them to agree with one another in the following general characters :—

They are all small corals, of a conical or turbinate shape, with a well-developed epitheca, which exhibits longitudinal ridges and encircling striæ. All have a deep calice, with the septa nearly obsolete at the margin, but gradually becoming more prominent as we approach the floor of the cup. Those in which the interior of the calice is fully known exhibit at the bottom a comparatively very large and projecting columellar mass, and those in which the interior of the calice has not been observed can be shown by sections to possess a similar structure. In all, the structure of this columella, or pseudo-columella, is quite peculiar, and can only be demonstrated by means of transparent horizontal and vertical sections. Even by this method of investigation, the subject is not without its difficulties, for the lower part of the visceral chamber seems to be usually, if not always, filled up in process of growth by a dense secondary deposit of sclerenchyma, so that transverse sections—which ought to be most instructive—vary in the appearances which they present, according as they are taken near the base of the corallum or near the floor of the calice. Combining together the numerous sections which we have made of different species of this singular genus, we find that the so-called columella is really to be regarded as formed by the fusion of the inner ends of the whole or a number of the septa, together with a larger or smaller amount of dense calcareous tissue, which is clearly of secondary and non-essential origin, since it often invades the interseptal loculi, and may entirely fill up the lower part of the visceral chamber. The upper surface of this pseudo-columella may be quite smooth and sharply defined (as in *Lindströmia Dalmani,* E. and H.), or it

may exhibit its real structure by presenting itself in the floor of the calice as a bundle of partially fused lamellæ. In any case, longitudinal sections of the corallum show that it is really formed in the manner above described,—namely, by the amalgamation of the inner ends of a larger or smaller number of the septa, this amalgamation taking place without any twisting of the septa, and being accompanied by a more or less copious secondary deposition of sclerenchyma. The only other noteworthy points in the structure of the corallum concern the presence of dissepiments and tabulæ. The former structures undoubtedly exist, though they are always few in number and remote in distance; and they can by no means be invariably demonstrated, especially in cross-sections taken near the base of the corallum. That they always are present, however, we feel tolerably certain. With regard to the existence of tabulæ, on the other hand, we cannot speak with the same confidence. Longitudinal sections of *Lindströmia* (*Cyathaxonia*) *Dalmani*, Edw. and H. (fig. 4), certainly show strong plates crossing the upper part of the visceral chamber transversely, and it is impossible to regard these as being anything else than tabulæ. Vertical sections of *Lindströmia* (*Petraia*), *subduplicata*, M'Coy, and of *L. lævis*, nobis, sometimes show the same thing in a less marked manner; but in these small forms it is not surprising that it is difficult to pronounce a positive opinion as to the presence or absence of tabulæ, seeing that the whole of the visceral chamber, up to the floor of the calice, is more or less completely occupied by a dense secondary deposit of sclerenchyma. Moreover, when dissepiments are only present in small number, and are at all exceptionally strong, it becomes impossible to know whether one is dealing with structures of this kind, or with that more developed stage of the same which we know as "tabulæ." Upon the whole, however, we think that the presence of ill-developed tabulæ may be regarded as the rule in the genus *Lindströmia*. In the annexed engraving (fig. 4) we have represented vertical and transverse sections of three forms of *Lindströmia* upon an enlarged scale.

Before leaving this subject, a few words may be said as to the genus *Petraia* of Münster, merely in so far as the forms at present under consideration are concerned. Palæontologists have at various times included under the name of *Petraia*

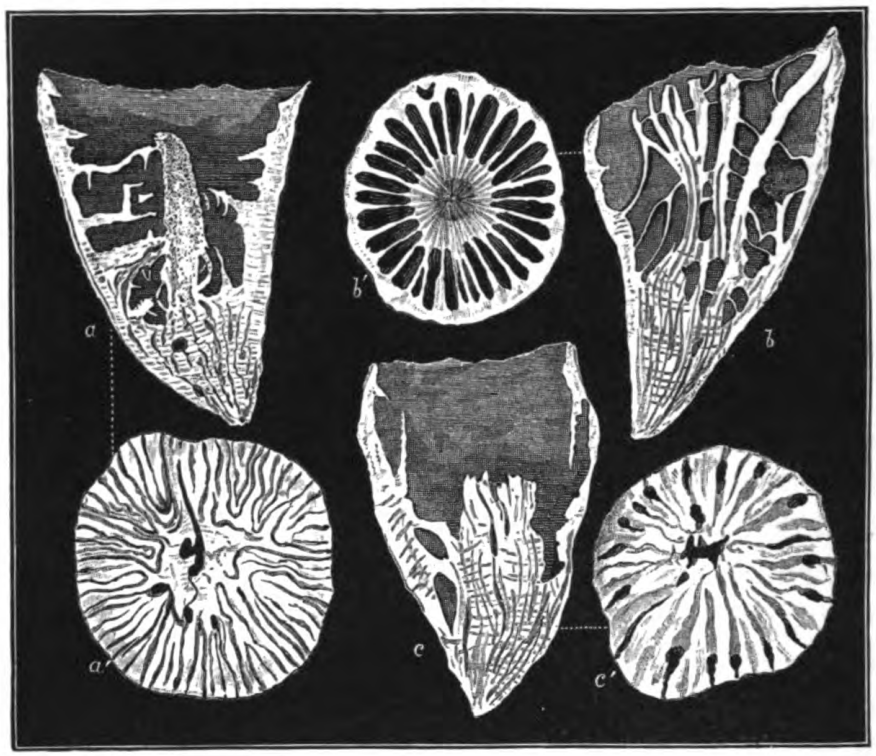


Fig. 4.—*a*, Vertical section of *Lindströmia* (*Cyathaxonia*) *Dalmani*, Edw. and H., enlarged two diameters, showing the dense infilling of the lower portion of the coral, the great columella, and the transverse plates or tabulæ; *a'*, Transverse section of the same, enlarged three times, showing the dense central mass, and the almost complete amalgamation of the septa by sclerenchyma. *b*, Vertical section of *Lindströmia columnaris*, Nich. and Thoms., enlarged three times, showing the filled-up base, the composition of the columellar mass of partially amalgamated vertical rods, and the imperfect tabulæ; *b'*, Transverse section of the same, similarly enlarged, showing the fusion of the septa by means of secondary sclerenchymatous deposit into a central columellar mass. *c*, Vertical section of *Lindströmia subduplicata*, M'Coy, sp., twice the natural size, showing the central fasciculate columellar mass, the deep calice, and the imperfect tabulæ; *c'*, Cross-section of the same, taken close to the base, enlarged five times, and showing the almost complete fusion of the septa by secondary deposit.

a number of small, simple, turbinate corals, of very varying structure, and, so far as known, of very different affinities; and perhaps the best course to adopt would be to entirely drop this title from our nomenclature. If this course be not followed, it will be necessary to restrict the name to some

one or other of the various types of structure which have been included under this name, since it does not appear to be known what was the true nature of the fossils originally placed here by Münster. From the definitions, however, of all later observers, it is evident that the essential features in the structure of *Petraia* are supposed to be the total want of *dissepiments*, *tabulæ*, and *columella*, conjoined with the presence of well-developed lamellar septa and a deep funnel-shaped calice. Our own personal investigations have not brought under our notice any Palæozoic corals in which we could assert positively that these features are present. Two or three small specimens from the curious fossiliferous ashes of Balcletchie, near Girvan, certainly *seem* to want both tabulæ and dissepiments, and to otherwise conform to the above definition; but our material is so scanty that we have held these forms over, in the hope of obtaining more light upon this subject at a later date. On the other hand, we are now able to speak positively as to the structure of at least one of the most typical of M'Coy's *Petraiæ*—viz., *Petraia subduplicata;* and we have been able to prove, as will subsequently appear, that this is a true *Lindströmia*, which in no way conforms to *Petraia* as ordinarily understood. The determination of the real structure of this well-known Silurian species may be regarded as probably settling the position of at any rate most of the small corals included by Phillips under the head of *Turbinolopsis* (Pal. Foss. of Cornwall, &c., p. 1). This name has been rightly regarded as a synonym of *Petraia*, in the usual acceptation of the latter; and it was founded, as is the case with many species of *Petraia*, upon *casts* of the interior of the corallum. These casts, as is well known, are abundant in the Devonian and Silurian rocks, and they are remarkable, as has been frequently noticed, for their being usually truncated below. This truncation of the cast, as noticed by M'Coy, is truly due to the fact that the lower portion of the visceral chamber was filled up with a dense secondary deposit of sclerenchyma, this being one of the characteristic features of *Lindströmia*.

In some cases, also, the lower end of the cast may be seen to present a depression in the centre, corresponding with the columella.[1] We need only add that it has seemed to us much the most preferable course not to attempt to retain the generic name of *Petraia* for *P. subduplicata*, M'Coy, and for those other forms which undoubtedly prove to be congeneric with this. It is true that these forms constitute the most typical section of the group which British palæontologists have usually understood by *Petraia*; but it seems clear that the name *Petraia* cannot be advantageously retained, unless it be strictly limited to forms which want dissepiments, tabulæ, and columella. Such forms have been described (*e.g.*, *P. Benediana*, De Koninck); but microscopic examination renders it certain that *P. subduplicata*, M'Coy, and its allies, must be placed in a totally different category.

Lindströmia subduplicata, M'Coy, *sp.*

(Fig. 4, and Pl. VI., figs. 2-2 *f*.)

Petraia subduplicata, M'Coy, Ann., and Mag. Nat. Hist., ser. 2, vol. vi. p. 279, 1850.
„ „ M'Coy, Pal. Foss., p. 40, 1851.
„ „ Salter, Quart. Journ. Geol. Soc., vol. vii. p. 171, Pl. IX., figs. 7 and 8, 1851.

Spec. char.—Corallum simple, small, conical, straight or slightly curved, averaging nine or ten lines in length, with a diameter at the larger extremity of six or seven lines. Epitheca well developed, marked with longitudinal ridges, corresponding with the interseptal loculi, of which about four occupy the space of one line. In well-preserved specimens fine encircling striæ are present as well, and there are shallow annulations of growth. The calice is deep, funnel-shaped, and oblique. The septa are well developed and lamellar, of two sizes, regularly alternating with one another, and varying from fifty to sixty in number in all. The secondary septa

[1] This feature is sometimes very marked. Compare the figure of the cast of *Petraia elongata*, Phill., given by Milne-Edwards and Haime in their Monograph (Brit. Foss. Cor., Pl. LXVI., figs. 6 and 6 *a*).

are short, and, near the base of the coral, may be unrecognisable. In the centre of the visceral chamber the primary septa unite with one another, and become more or less completely fused together by the deposition of a mass of secondary sclerenchyma, which more or less entirely fills up the lower portion of the corallum. Superiorly the central mass formed by the fusion of the inner ends of the septa, as afore-mentioned, is continued upwards as a large pseudo-columella, which projects to a greater or less extent into the floor of the calice. The interseptal loculi are crossed by a few remote and irregularly-developed dissepiments, and a few imperfect tabulæ can be occasionally detected. No septal fossula.

Obs. — The Gray collection contains a large number of specimens of this interesting little coral from the Craighead limestone, in which the original skeleton of the coral is preserved, and from thin sections of which we have been able to determine its structure in a satisfactory manner. Its general form is conical and nearly straight, the attenuated tip of the corallum being often slightly oblique, and its average dimensions are as above stated. Many individuals, however, are much smaller, and a few are larger. The epitheca is complete, with well-marked longitudinal rugæ, and, when perfectly preserved, with close-set, fine, encircling striæ. Annulations of growth, though present, are never a marked feature. In all our specimens the calice is filled up with the matrix, but it is seen in sections to be always deep, and more or less oblique, occupying one-half to two-thirds of the entire length of the corallum, the septa in its upper portion being merely marginal, and gradually becoming more developed as we descend towards the base. Longitudinal sections (fig. 4 *c*, and Pl. VI., figs. 2 *b* and 2 *c*) show the remarkable feature that the lower third or thereabouts of the visceral chamber is filled up by dense calcareous matter, which is really composed partly of the primary septa, and partly of a secondary deposit of sclerenchyma. In sections, taken accurately through the median line, this calcareous infilling is seen to be prolonged upwards

in the form of a large, apparently cylindrical pseudo-columella, which projects to a greater or less extent above the floor of the calice. In sections taken a little out of the median line, this columellar mass shows its true composition by its exhibiting more or less distinctly the projection into the calice of the cut edges of a number of the septa. The same fact can also be determined by microscopic examination, which shows that the essential elements of this mass are the inner ends of the septa. As regards the other points shown by long sections, we may notice the occasional occurrence of a few strong transverse or ascending plates, which we must regard as tabulæ, and which are most conspicuous in excentric sections. Transverse sections, again, enable us to considerably supplement the knowledge gained by means of vertical slices, but they differ greatly according to the height above the base at which they are taken. Sections taken close above the base (fig. 4 *c*) show that the apparently structureless and dense infilling of the lower part of the visceral chamber is really formed largely out of the primary septa, the interseptal loculi being occupied by a deposit of sclerenchyma, which is usually so far imperfect as to leave small interspaces between the outer ends of the septa. Sections taken at a higher level (Pl. VII., fig. 2 *d*) show the outer wall, the interseptal loculi, which may or may not be crossed by a few dissepiments, and a large central mass, which is formed by the union in the median line of the primary septa, together with structureless calcareous matter of secondary origin. Sections taken above the plane of the floor of the calice show the septa gradually to diminish in size, till they become almost obsolete. The number of primary septa which take part in the formation of the central pseudo-columella varies from twenty-five to twenty-eight; but between these there really exists a corresponding number of much shorter secondary septa. These latter, however, can often not be recognised — especially in sections taken close above the base; and even when present, they may appear to be absent in a variable number of the

interseptal loculi. Sometimes the development of the central pseudo-columellar mass is decidedly excentric, but in no case have we observed a regular septal fossula. As for *tabulæ*, they certainly are not present in a well-marked form. Longitudinal sections, however, often show—especially if excentric—ascending transverse plates, which we consider to be unquestionably imperfect structures of this nature.

Casts of *Lindströmia subduplicata* are not uncommon in the sandstones of Mulloch Hill, near Girvan, and their characters have been well described by M'Coy. As we can readily see from the structure of the corallum, as we now know it, these casts represent the filled-up vacuities of the *upper* portion of the corallum only. The cast is conical, truncated behind, of nearly equal width and length, marked externally with from twenty-four to thirty-two deep slits, which extend to near the centre, where they are slightly twisted. These slits represent the primary septa, and they are separated by an equal number of finer slits, which only extend a very short distance inwards, and which represent the short secondary septa. The radiating lamellæ of the cast, which separate and bound these slits, represent, of course, the filled-up interseptal loculi. The introduction of new septa was effected along the line of a principal interseptal space occupying the dorsal side of the corallum, giving rise to a pinnate arrangement of the sulci in the cast. We have also evidence that the septa within the calice were more or less markedly crenulated, ridged, or toothed on their sides. This is shown by the occurrence of grooves or pits upon the sides of the lamellæ which represent the filled-up interseptal loculi. In ordinary casts, this crenulation of the upper portions of the lamellæ just alluded to is not a marked feature, though usually to be detected with care. There are, however, other casts (Pl. VI., fig. 2 *f*) in which the crenulation of the upper parts of the lamellæ is extraordinarily conspicuous, the outer edge of each being cut into prominent teeth by deep and regular lateral grooves. These casts have been described and figured by M'Coy (Pal. Foss., p. 41, Pl. I. B, fig. 26 *b*),

and they are regarded by him, probably quite rightly, as merely a variety of *L. subduplicata*, to which he gives the title of *crenulata*.

Form. and Loc.—Common in the shales associated with the limestone at Craighead, near Girvan (Lower Silurian). Also not uncommon, though principally in the condition of casts, in the mudstones of Mulloch Hill, near Girvan, of Upper Silurian (? Upper Llandovery) age. A few individuals from the greenish mudstones of Penkill, near Girvan (? Upper Llandovery), also appear to belong to this species, though we have not examined them microscopically. (Gray collection.)

Lindströmia lævis, Nich. and Eth., jun., *sp. nov.*

(Pl. VI., figs. 4-4 *c*.)

Spec. char.—Corallum small, simple, expanding, and widely turbinate, slightly curved towards its smaller extremity. The width of the calice equal to or slightly larger than the total length of the corallum. Surface to the naked eye nearly or quite smooth, under the lens exhibiting fine and close-set encircling striæ, and obscure longitudinal ridges. Epitheca complete; wall thick. Generally one or two shallow annulations of growth near the calicine margin. Calice oblique, patulous, its interior unknown, but always deep, and having the septa obsolete, or nearly so, near its lip. From fifteen to twenty-three primary septa, at various diameters, becoming more or less united with one another below the floor of the calice, and fused by means of a secondary deposit of sclerenchyma, so as to form a central pseudo-columellar mass of large size, which projects to a greater or less extent into the bottom of the calice. Short secondary septa are probably present between the primary ones, but they have not been determined with certainty. Dissepiments unknown. Tabulæ apparently represented by a few remote and strong arched and ascending plates, which intersect the visceral chamber near the base, and take part in the formation of the pseudo-columella.

The smallest individuals observed are a line and a half long, with a width at the calice of a line and three quarters. Average examples are three lines long, and three and a half lines in their greatest diameter. Large individuals attain a length of six lines, with a calicine diameter of between six and seven lines.

Obs.—This pretty little species is abundant and well preserved in the mudstones of Penkill, near Girvan. It is by no means impossible that it may turn out to be really identical with *Petraia uniserialis*, M'Coy (Pal. Foss., p. 41, Pl. I. B, fig. 25); but as the latter is known only by *casts*, as our form is known only by the external and internal characters of the corallum itself, and as we have no means of connecting the two, we have thought it best to establish a new species for our examples. The external characters of *Lindströmia lævis* are very readily recognisable, and distinguish it at once from *L. subduplicata*, M'Coy. It is at once known by its short, curved, and very widely expanding corallum, and the apparent smoothness of the epitheca, the use of a lens at once showing that the surface is really covered with very fine and closely-arranged concentric striæ. Longitudinal ridges and annulations of growth are faintly marked or nearly obsolete. The calice is oblique, though not so markedly so as in *L. subduplicata;* but owing to the fact that it is filled up with the matrix in all our specimens, we can say nothing as to the condition of its interior. Long sections, however, show that it is deep and funnel-shaped, and the septa are also merely marginal ridges near its immediate lip.

As the corallum itself is preserved, thin sections enable us to study its internal structure quite satisfactorily, and it can be shown in this way to be a true *Lindströmia*, with closer affinities to *L.* (*Cyathaxonia*) *Dalmani*, E. and H., than is the case with *L. subduplicata*, M'Coy. Cross-sections, taken below the level of the calice, show that most or all of the primary septa become coalescent and embedded in secondary sclerenchymatous deposit, thus forming a comparatively immense pseudo-

columellar mass, which, in long sections, can be shown to project to a considerable height into the calice. We can also detect in vertical slices a few strong and arched transverse or ascending plates, which must be regarded as tabulæ, and which join the columella centrally. There are two points which we have been unable to determine with certainty—namely, the existence of dissepiments and of short secondary septa. There are indications of both, and, from the analogy of the other species of the genus, we may conclude that these structures were really present. That we should not have been able to detect them is probably due to the fact that the cavities of the wide and patulous corallum are generally filled with the matrix, fine structures being thus broken down, and microscopic examination considerably interfered with. The extreme base of the corallum is more or less completely solidified by a dense deposit of the sclerenchyma, though this is not so largely developed as in *L. subduplicata*, M'Coy.

Form. and Loc.—Common in the greenish mudstones (? Upper Llandovery) of Penkill, near Girvan. (Gray collection.)

GENERAL REMARKS UPON THE CORALS OF THE GIRVAN AREA.

Though we have now examined a very large number of corals from the Silurian rocks of the Girvan district, it remains clear that the materials at present to hand will be very considerably augmented by future researches. Up to this time, in fact, corals have been collected almost exclusively from some three or four horizons in the great and complicated series of the Ayrshire Silurians. Much, therefore, has yet to be done, as will be seen by a glance at the list of localities previously given, before we can give any complete *conspectus* of the coral-fauna of this region; and the time has not come at which it will be possible to enunciate positive conclusions as to the age of the deposits from fossils of this class. Nevertheless it may

be of advantage that we should make a few remarks as to the distribution and time-relations of the known corals of the region in question; and we may conveniently do so by reviewing briefly the chief horizons which, so far, have proved to be coralliferous.

I. The Craighead Limestone.—Up to the present time, the principal Silurian deposit in Ayrshire from which corals have been collected is the great limestone, which is best known as exposed in the quarries at Craighead, about three miles from the town of Girvan. As here seen, the limestone itself is generally more or less grey in colour, and compact or sub-crystalline in texture, but it varies much in different parts of its mass. Often it is greenish in colour, or mottled with lighter or darker green blotches, apparently from the presence of felspathic or serpentinous matter intimately mingled with it; and occasionally a well-marked oolitic structure is developed in it. This last feature, however, is much more conspicuous in the Tramitchell quarries, where the limestone is to a large extent a regular oolite, the component grains being of considerable size. Associated with the limestone at Craighead are also greenish shales, which have yielded a considerable number of fossils. Leaving out of sight some forms which our material has not allowed us to work out, the corals of the Craighead limestone and its associated shales, as at present known to us, are as follows :—

Lyopora favosa, M'Coy, *sp.*
Tetradium Peachii, Nich. and Eth., jun.
Favosites Girvanensis, Nich. and Eth., jun.
Fistulipora ? pilula, Nich. and Eth., jun.
Prasopora Grayæ, Nich. and Eth., jun.
Thecostegites ? Scoticus, Nich. and Eth., jun.
Heliolites Grayi, Edw. and Haime.
Stylaræa occidentalis, Nich. and Eth., jun.
Streptelasma Craigense, M'Coy, *sp.*
„ *Europæum*, Ferd. Roemer.
„ *aggregatum*, Nich. and Eth., jun.
Lindströmia subduplicata, M'Coy, *sp.*

So far as giving us a clue to the precise position in the Silurian series occupied by the Craighead limestone, the above twelve corals are clearly of limited value. The entire assemblage — which we feel certain will hereafter be considerably increased—is a most remarkable one, and admits of little comparison with the coral-fauna of any sub-group of the Silurian rocks known to us. *Lyopora favosa*, *Tetradium Peachii*, *Prasopora Grayæ*, *Streptelasma Craigense*, *S. Europæum*, *S. aggregatum*, and *Lindströmia subduplicata*, are the *common* forms of the Craighead limestone; and, with the exception of the last, they are not known to occur elsewhere in Britain. Moreover, *Lyopora* and *Prasopora* are special generic types, and *Streptelasma* and *Tetradium* have not been previously recognised in this country, though the former, at any rate, will doubtless be found to have a wide range. Of the remaining forms, *Stylaræa occidentalis* and *Thecostegites* (?) *Scoticus* both belong to generic types foreign to Britain, though the identification of the latter cannot be regarded as certain. Lastly, the only *specific* forms which are known to occur elsewhere in the British area are *Lindströmia subduplicata*, M'Coy, and *Heliolites Grayi*, Edw. and H., both of which occur in undoubted Upper Silurian deposits elsewhere.

That the Craighead limestone, however, is not of Upper Silurian age, may be considered as certain. The absence of the commoner massive species of *Favosites*,[1] *Alveolites*, and *Heliolites*, of *Cyathophyllum*, *Acervularia*, *Cystiphyllum*, *Halysites*, and *Omphyma*, together with the apparent total want of Stromatoporoids, would render this conclusion almost inevitable, even if we had nothing else to go by. The genera *Tetradium*, *Stylaræa*, and *Streptelasma* are, however, characteristically, or exclusively, found in deposits belonging to the Lower Silurian period. We also cannot avoid being greatly struck

[1] The *Favosites Girvanensis* of the Craighead limestone is a very diminutive form, and is a poor representative of the large and common *F. Gothlandica*, *F. Forbesi*, &c., of the Upper Silurian.

with the strongly *American facies* of the Craighead corals, and in particular their resemblance to those of the Trenton and Cincinnati groups. Thus *Tetradium*[1] is a common generic type in the Trenton limestone and Cincinnati formation in both the United States and Canada. *Streptelasma Europæum* is a close ally of the common *Streptelasma corniculum* of the same deposits. Our *Streptelasma aggregatum* belongs to the sub-generic group *Palæophyllum*, the only other members of which are found in the Trenton and Cincinnati formations. *Stylaræa occidentalis* may be taken as representative of the common *Protaræa vetusta* of the Cincinnati beds. Lastly, the nearest allies to the curious *Lyopora favosa* of Craighead are to be found in the so-called *Columnariæ* (not *Favistella*, Hall) of the Trenton limestone, and especially in such forms as *C. Goldfussi*, Bill. Upon the whole, therefore, we must conclude that the Craighead limestone is certainly of Lower Silurian age; and, if we judge only from the corals, we are led to conjecture that it occupies a tolerably low position in the Lower Silurian series, corresponding perhaps with the upper part of the Trenton limestone, or the base of the Cincinnati and Hudson River formations of North America.

II. Mulloch Hill Beds.—Mulloch Hill, near Dalquharran, has long been known as one of the most prolific localities for fossils in the Girvan district. M'Coy generally speaks of the rock here as a "quartzite" or "sandstone," but it contains no silica. It is a hard greenish mudstone, the colour of which, as seen in thin sections, appears to be due to the presence of numerous particles of serpentinous or felspathic matter. Owing to the absence of lime in these deposits, corals are, naturally, not abundant, and they occur commonly, though by no means exclusively, in the condition of casts. Disregarding two or three forms, which could not be determined with the material

[1] Since the above was written, our friend George J. Hinde, Esq., F.G.S., has shown us specimens which he has collected in the Trenton Limestone of Canada, which, so far as we can judge without microscopic sections, are specifically identical with our *Tetradium Peachii*.

at our command, we have recognised the following four corals in the Mulloch Hill beds :—

Heliolites interstincta, Wahl.
Pinacopora Grayi, Nich. and Eth., jun.
Favosites Mullochensis, Nich. and Eth., jun.
Lindströmia subduplicata, M'Coy, *sp.*

The last-named of the above is no test of age, as it occurs in rocks belonging to different periods; and *Pinacopora Grayi*, being both generically and specifically new, is also unavailable as a guide. The presence of *Heliolites interstincta*, however, together with a large-celled *Favosites* of the type of *F. Gothlandica* and *F. Forbesi*, would lead to the conclusion that the Mulloch Hill beds are certainly referable to the Upper Silurian. This conclusion is borne out by the nature of the associated fossils; and we may in the meanwhile consider this deposit as probably corresponding with the Upper Llandovery or May Hill sandstone of "Siluria."

III. Penkill Beds. — The rocks at Penkill, near Girvan, from which we possess corals, consist of a fine-grained grey or greenish-grey mudstone, and the number of corals is limited. From this horizon we have determined the following :—

Heliolites interstincta, Wahl.
Halysites catenularia, Linn.
Favosites Girvanensis, Nich. and Eth., jun.
Lindströmia subduplicata, M'Coy, *sp.*
„ *lævis*, Nich. and Eth., jun.
Calostylis Lindströmi, Nich. and Eth., jun.

The only species in this list which can be used as tests of age are *Heliolites interstincta* and *Halysites catenularia*, and these would go to prove that the beds here are of Upper Silurian age. The singular Perforate genus *Calostylis*, Lindstr., is likewise an Upper Silurian type, the only other known species of the genus being confined to the Wenlock limestone of Gotland. Such other evidence as we have points in the same direction, and we are probably right in concluding that the Pen-

kill beds must find their place towards the lower portion of the Upper Silurian series.

IV. Shalloch Mill Beds.—We are indebted to Mr Lapworth for specimens from a thin band of coralline limestone which crops out on the sea-shore, near a smithy not far from Shalloch Mill, about a mile and a quarter to the south of Girvan. The fossils appear to be tolerably plentiful, but they consist wholly of *Favosites Gothlandica*, Lam., and *Alveolites Labechei*, Edw. and H. The presence of these two well-known types would render it certain that the series of beds in which this limestone is intercalated must be of Upper Silurian age. Further along the shore, in beds considerably higher in position, Mr Lapworth has also detected the presence in calcareous nodules or "cement-stones" of *Halysites catenularia.*

V. Balcletchie Beds. — The last coralliferous horizon which we need notice is that of the Balcletchie beds, near Girvan. The beds in question, which are not the same as those from which we possess remains of Trilobites, consist of dark-green, coarse-grained volcanic ashes, and appear to be largely fossiliferous. The corals are few in number, and badly preserved; and the only form that we have been able to determine positively is *Fistulipora favosa*, nobis. We have also several small cup-corals, very fairly preserved, but our material is insufficient to allow of a thorough examination of these. There are two or three types, and one of them seems to conform to the definition of *Petraia*, which we have given in speaking of *Lindströmia*—that is to say, its interseptal loculi are open, and it shows no traces of dissepiments, tabulæ, or columella. It is much to be desired, however, that further collections should be made from this locality. The corals give us no clue to the age of the Balcletchie beds, but there is some reason to believe that they are low down in the Lower Silurian series—possibly near the horizon of the Craighead Limestone.

SUB-KINGDOM ANNULOSA.

CLASS CRUSTACEA.

Sub-class ENTOMOSTRACA.

Order TRILOBITA.

Genus PHACOPS, Emmrich, 1839.

(De Trilobitis, &c., p. 18.)

Section Phacops proper.

Phacops Stokesii, Milne-Edwards.

P. Stokesii (M.-Edwards), Salter, Mon. Brit. Trilobites, 1864, pt. 1, p. 21, t. 2, f. 1-6 (*for synonomy*).
„ „ Salter, Murchison's Siluria, 1867, 4th ed., t. 10, f. 6, t. 18, f. 6.
„ „ Bigsby, Thesaurus Sil., 1868, p. 64.
„ „ Woodward, Cat. Brit. Foss. Crustacea, 1877, p. 54.

Obs.—P. Stokesii was long ago recorded[1] as a Girvan species by the late Mr J. W. Salter, and a head and tail figured in the Appendix to Sir R. I. Murchison's paper "On the Silurian Rocks of the South of Scotland." We have not met with specimens.

Loc. and Horizon.—Mulloch Quarry, in shelly sandstone (*Salter*). Saugh Hill, in sandstone (*Salter*). Thrave.[2]

Phacops Downingiæ is stated to occur at Mulloch Quarry,[3] but we believe the next species has been mistaken for it.

[1] Quart. Jour. Geol. Soc., 1851, vii. pp. 171, 172.
[2] Cat. Foss. Mus. Pract. Geology, 1865, p. 12.
[3] Cat. W. Scot. Foss., 1876. p. 16.

Section Acaste, *Goldfuss.*

Phacops Brongniarti, Portlock.

(Pl. VII. figs. 1 and 2.)

P. (*Acaste*) *Brongniarti* (Portlock), Salter, Mon. Brit. Trilobites, 1864, pt. 1, p. 34, t. 1, f. 20-25 (*for synonomy*).
P. Brongniarti, Bigsby, Thesaurus Sil., 1868, p. 62.
„ „ Woodward, Cat. Brit. Foss. Crustacea, 1877, p. 50.

Obs.—After Mr Salter's clear and detailed description it is quite unnecessary for us to redescribe *P. Brongniarti*, which with its var. *Dalmani* was first met with in the Girvan district by the late Mr R. Gibbs, and determined by Mr R. Etheridge, F.R.S.[1] We give a figure taken from a cast of an exceedingly well-preserved mould in the Museum of Practical Geology; we are indebted to the authorities of that institution for the loan of it.

Loc. and Horizon.—Ardmillan-brae, in flagstones (*Etheridge*); Mulloch Hill quarry. (Gray Collection.)

Section Chasmops, *M'Coy.*

Phacops truncato-caudatus, Portlock (?).

(Pl. VII. figs. 3 and 4.)

P. (*Chasmops*) *truncato-caudatus* (Portlock), Salter, Mon. Brit. Trilobites, 1864, pt. 1, p. 42, t. 4, f. 13-15 (*for synonomy*).
P. truncato-caudatus, Bigsby, Thesaurus Sil., 1868, p. 64.
„ „ Woodward, Cat. Brit. Foss. Crustacea, 1877, p. 54.

Obs.—Our specimens are both unfortunately imperfect about the head, which necessitates a note of interrogation after the name of the species; otherwise, however, the characters of the specimens appear to accord perfectly with those given by Mr Salter as distinctive of the species. The sides of the axis of the thorax are conspicuously nodose, the axal furrows strong, and there is a strong node on the inner end of each pleura against the axis, a character upon which stress is laid by Mr Salter. Now these are all present in the specimens we refer

[1] Mem. Geol. Survey. Scot. Expl., No. 7, 1869, p. 10.

to *P. truncato-caudatus*; and in the absence of more negative evidence, we believe we are justified in referring them to that species. Moreover, one of the specimens shows that the head was granulated; and if we refer to Portlock's original figures,[1] we see a peculiar cross-puckering of the surface represented by vertical shading, a point exceedingly well marked in the Girvan individuals. In the determination of the latter we are happy to possess the support of Mr Etheridge, F.R.S. We think our specimens hardly possess as many segments in the pygidium as those figured by Mr Salter.

Loc. and Horizon. — Drummuck Quarry, in a compact greenish mudstone. (Gray collection.)

Genus CHEIRURUS, Beyrich, 1845.

(Ueber einige böhmische Trilobiten, p. 5.)

Cheirurus bimucronatus, Murchison.

C. bimucronatus (Murch.), Salter, Mon. Brit. Trilobites, 1864, pt. 1, p. 63, t. 5, f. 1-5, t. 6, f. 9-18 (*for synonomy*).
„ „ Bigsby, Thesaurus Sil., 1868, p. 44.
„ „ Woodward, Cat. Brit. Foss. Crustacea, 1877, p. 30.

Obs.—This species has been twice recorded by the late Mr Salter[2] as occurring at Girvan; but we have not seen specimens in any of the collections to which we have had access. We can only refer to its occurrence there, and hope that future observers will be more fortunate.

Loc. and Horizon.—Drummuck Quarry, in shaly beds; Mulloch Hill (*Salter*).

Cheirurus gelasinosus, Portlock.

(Pl. VII. figs. 5 and 6.)

C. gelasinosus (Portlock), Salter, Mon. Brit. Trilobites, 1864, pt. 1, p. 71, t. 5, f. 6-8 (*for synonomy*).
„ „ Bigsby, Thesaurus Sil., 1868, p. 44.
„ „ Woodward, Cat. Brit. Foss. Crustacea, 1877, p. 30.

Obs.—The specimens before us do not throw any further

[1] Geol. Report on Londonderry, &c., 1843, t. 2, f. 1-4.
[2] Quart. Jour. Geol. Soc., 1851, vii. p. 172; Monograph, p. 67.

light on the structure of this species, and as they are only badly preserved portions of the head, we refer the reader to Salter's description. Our chief reason for placing these fragments in this species rather than with *C. bimucronatus*, is the form of the forehead lobe of the glabella, which is about equal in breadth to the others, no wider, and does not overhang the other lobes on the sides, and in front is not produced, and, lastly, does not occupy all the margin, as in *C. bimucronatus*. The specimens are small, and in an unsatisfactory state of preservation, and further material is required for proper elucidation. We find *C. gelasinosus* was first mentioned as occurring at Girvan by Mr Salter,[1] who figured a portion of a fine head from that district.

Loc. and Horizon.—Craighead Quarry, in limestone (Salter, *Mus. Pract. Geol.*); Balcletchie, in a dark-green, slightly calcareous mudstone. (Gray collection.)

Cheirurus clavifrons, Dalman?

(Pl. VII. figs. 7 and 8.)

Calymene (?) *clavifrons*, Dalman, Vet. Akad. Handlingar, 1826, p. 260.
„ „ Dalman, Om. Palæaderna eller de sa Kallade Trilobiterna, 1827, p. 75 (*separate copies*).
„ „ Lovén, Öfv. K. Vet. Akad. Förhandlingar, 1844, No. 4, p. 63.
Cyrtometopus affinis, Angelin, Pal. Scandinavica, 1854, pt. 1, p. 77, t. 39, f. 10.
(Compare *Cheirurus octolobatus* (M'Coy), Salter, Mon. Brit. Trilobites, 1864, pt. 1, p. 69, t. 5, f. 13 and 14.)

Spec. char.—Glabella oval-oblong, blunt in front, regularly convex, most so in a line drawn across uniting the two foremost furrows—it is also broader at this point, slopes gradually off to the neck segment, and does not overhang the front margin. Frontal and ocular furrows moderately long and curved slightly backwards; basal furrows circumscribing the oval basal lobes, but faintly marked where they join the neck segment, otherwise they, and the frontal and ocular furrows, are deep; the distance

[1] Quart. Jour. Geol. Soc., 1851, vii. p. 170, t. 8, f. 1; Mems. Geol. Survey, Dec. vii., No. ii., p. 11; Monograph, p. 72.

between the ocular and basal furrows, on the one hand, and the ocular and frontals on the other, is about equal; the surface is microscopically granular. The fixed cheeks are rudely triangular, scrobiculate, and, like the glabella, microscopically granular or roughened; although not vertical, they are steeply inclined. Facial suture strongly marked, and in the first part of its course, starting from the external margin, is almost on a line with the ocular furrow. Frontal margin broad and distinct; axal furrows broad, deep, and well marked.

Obs.—The specimen we figure under this name, a glabella and one fixed cheek, has given us much trouble; neither do we yet feel satisfied that it is *C. clavifrons*, Dalman. This difficulty has arisen in a great measure from the want of a clear definition of what is *C. clavifrons*, Dal., accompanied by a good figure. It appears, from Angelin[1] and Salter's[2] account, that two distinct species were included by Dalman under this name, and placed in the Stockholm Museum: one of these has a narrow-fronted glabella, with parallel sides,[3] and for this Angelin retained the name *C. clavifrons;* the other, with a sub-clavate glabella, is more deserving of the name bestowed by Dalman. This, Professor Angelin has called *Cyrtometopus affinis.*[4] Had the name *clavifrons* been retained for the latter instead of the former, much confusion would have been prevented; and we quite agree with Salter's opinion—"We shall never have done with the confusion of these forms unless we restrict Dalman's name to the species called *Cyr. affinis* by Angelin."[5] Taking, therefore, *C. clavifrons*, Dal., as typified by *Cyrtometopus affinis*, Angelin, we may institute as close a comparison with our figured specimen as the side view of the head given by Angelin will permit. The form of the glabella in the two individuals is very much the same; in both, the basal lobe is completely circumscribed by the furrow; but in Angelin's figure the two anterior furrows are shorter than in the Girvan specimen. So far as the fixed cheek is preserved in the latter, there is a close

[1] Pal. Scand., p. 78. [2] Monograph, pt. 1, p. 68. [3] Pal. Scand., t. 39, f. 9.
[4] Pal. Scand., t. 39, f. 10. [5] Monograph, pt. 1, p. 68.

correspondence between the two; they are both scrobiculate; the position of the eye is much the same; and lastly, the facial suture, after leaving the external margin, proceeds in a direct line with the ocular furrow before turning off round the eye—a most important point of resemblance.

Amongst recognised British forms, we have to compare our specimen with *C. octolobatus* (M'Coy), Salter, and *C. juvenis*, Salter. Its resemblance to the former is, in some points, very striking: for instance, the circumscription of the basal lobes, length and direction of the ocular and frontal furrows, and form of the fixed cheeks, are similar; whilst, on the other hand, the elevation of the glabella above the front margin and the neck segment are not marked in our specimen as in *C. octolobatus*—neither does the glabella overhang the front margin. The form and ornamentation of the fixed cheeks is similar; and the facial suture, as in Angelin's figure, is directed towards the ocular furrow. On the whole, there appears to be such a dovetailing of characters between our Girvan form, *Cyrtometopus affinis*, Angelin, and *C. octolobatus*, M'Coy, as to strongly bear out Salter's view that the latter "will have to forego its baptismal privileges;" [1] and again, "our British name must give way to the prior one, for it seems to be really the long-contested *C. clavifrons* of Dalman." [2]

With regard to *C. affinis*, Salter,[3] the task of comparison is much easier: we have only to look at the position of the facial suture of this species in regard to its position with the ocular furrow, to see at once that it is quite distinct from the Girvan form. In *C. affinis* it is directed in a line with the basal instead of the ocular furrow, as in the others; although, so far as the form of the glabella only is concerned, that of *C. affinis* is perhaps more in accord with the Girvan specimen than are either *C. clavifrons*, Dal., or *C. octolobatus* (M'Coy), Salter.

The species now under consideration resembles *C. neglectus*, Barr,[4] but the form of the cheeks in the latter will enable the

[1] Monograph, pt. 1, p. 68. [2] Ibid., p. 70. [3] Ibid., t. 5, f. 9-12 (especially f. 11).
[4] Syst. Sil. Boh. Atlas, I., t. 40, f. 20 and 21.

two species to be distinguished. The form of the glabella and the very restricted circumscribed lobes in *C. gryphus*, Barr,[1] at once distinguish the latter from our *C. clavifrons* (?). A close comparison should also be instituted with *C. pectinifer*, Barr;[2] but it appears to us that the glabella of the latter is relatively too depressed.

In well-marked internal casts the basal lobes are found to be quite circumscribed; but in examples with the whole of the integument preserved, the basal furrows on nearing the neck furrow become much shallower, and in a specimen here and there would lead to the belief that they did not quite circumscribe the lobe.

We were at first inclined to regard the subject of fig. 9, Pl. VII., as distinct from *C. clavifrons*, Dal. (?). The specimen in question is certainly more depressed, and a little more acute in front; but the chief point of difference appeared to us to lie in the ornamentation—a microscopically granular surface with scattered pimples, prickles, or small tubercules. However, a further series of specimens has revealed to us the fact that the convexity of the glabella varies considerably; and one particularly good example, which we hope to figure in our second Fasciculus, shows an outer surface as described in our specific diagnosis, underlaid by a layer with the characters represented by fig. 9, Pl. VII., and just described. We hope to return to this subject at a later period.

Loc. and Horizon.—Drummuck, in a fine-grained mudstone (Gray collection). Thrave Glen, in a buff-coloured rock (Gray collection). Penwhapple, in greenish sandstone (*Salter*,[3] Coll. Brit. Mus., as *C. octolobatus*). *C. clavifrons* appears to have been first recorded as a Girvan fossil by Messrs Armstrong, Young, and Robertson;[4] if, however, *C. octolobatus* is identical, Dr H. Woodward first determined its existence in those rocks.

[1] *Loc cit.*, Supp. I., t. 3, f. 10-17.
[2] *Loc cit.*, t. 4, f. 16.
[3] Salter, Monograph, p. 70.
[4] Cat. W. Scot. Foss., 1876, p. 15.

Cheirurus trispinosus, Young.

(Pl. VII., figs. 10-17.)

C. trispinosus, Young, Proc. Nat. Hist. Soc. Glasgow, 1868, i., pt. 1, pp. 169-171, t. 1, f. 4, 6 *b*.
„ „ Etheridge, jun., Proc. R. Phys. Soc. Edinb., 1878, iv., pt. 3, p. 173.

Sp. char.—General form of the head probably semicircular; free cheek semilunate-triangular, with a rounded, broad, and entire free margin. Eye——? Facial suture cutting the outer margin in a line with the basal furrows of the glabella. Neck furrow deep and well marked. Glabella globular convex, dipping little towards the neck furrow, vertical and blunt in front, or slightly overhanging; frontal furrows short, shallow, sometimes quite inconspicuous and far forward; middle or ocular furrows longer than the frontal, more strongly marked, and inclined backwards; basal furrows the most conspicuous of all, deep, and curving inwards and backwards, uniting with the neck furrow, but faint at the point of union, enclosing prominent, well-marked basal lobes, bearing between them in the middle line a narrow neck. The fixed cheeks are equal in antero-posterior dimensions to the basal and cervical lobes; the anterior margins in a line with the posterior of the three furrows, and the gently arched surface well marked off from the prominent glabella by a slight longitudinal depression; the outer margins are not straight, but bend slightly inwards posteriorly, the greatest width is therefore where they join with the free cheeks; the posterior margins of the fixed cheeks slope obliquely outwards and backwards to the angles. The posterior angles are produced into long, tapering, genal spines, with a dorsal curvature, the apices not descending below the general level of the body. The neck lobe is prominent, thickened, and produced into a strong median spine curved in a similar manner to the others. The glabella, fixed and free cheeks, and the bases of the spines, are covered with large, coarse, and elongated tubercules, intermingled with finer ones,

and scattered without arrangement. The apices of the spines are delicately striate.

Obs.—After a lapse of nearly ten years since its original description by Prof. J. Young, M.D., we are able to add very little to the account of this interesting Trilobite. So far only the head of *C. trispinosus* has come to light, and, even in the case of specimens of this, always in a mutilated condition. The individuals present in the Gray Collection appear to exhibit the genal and cervical spines in a more satisfactory manner than those from which Prof. Young's description was made, now in the Hunterian Museum, Glasgow. In drawing up the above specific diagnosis we have availed ourselves of Prof. Young's description, and we have reproduced his outline drawing of the restored carapace (fig. 17).

C. trispinosus has the thickened neck segment seen in many species of the genus, and appears to be peculiar, so far as we have been able to ascertain from a comparison with a large number of specimens and figures, in the presence of the cervical spine, as Prof. Young originally pointed out. Many *Cheiruri*, as for instance *C. insignis*, Beyrich, *C. gibbus*, Beyrich, and *C. ornatus*, Dalman, have a small tubercule in the centre of the neck lobe, more or less developed according to species: may the cervical spine of *C. trispinosus* be a further development of this? Again, in some American species there is a median cephalic spine developed, as *C. Satyrus*, Billings, and *C. glaucus*, Billings,[1] but it arises from the posterior median portion of the glabella, and not from the neck lobe. Although placed in *Cheirurus*, Prof. Young remarks that it may "hereafter be found to form the type of a separate genus,"[2] but until the entire Trilobite can be described it is better where it is.

Loc. and Horizon.—Penkill, in greenish mudstone. (Gray collection.)

[1] Pal. Foss. Canada, i. pp. 323, 324, f. 308 and 309. [2] *Op. jam cit.*, p. 171.

Cheirurus, *sp. ind.*

(Pl. VII., fig. 18.)

Obs.—We illustrate a specimen consisting of six thoracic segments, which appears to be peculiar in the possession of a very broad axis in proportion to the width of the pleuræ. It has very much the character of the form called *C. octolobatus*, by M'Coy and Salter, only it tapers from before backwards much too rapidly for that species. So many *disjecta membra* require piecing together, especially in the present genus, that it becomes very difficult to determine a large number of fragments such as that now under discussion. The width of the axis cannot in itself be accepted as a distinctive character, so many species of *Cheirurus* possess it.

Loc. and Horizon.—Drummuck Quarry. (Gray collection.)

Cheirurus (?) *sp. ind.*

(Pl. VII., fig. 19.)

Obs.—Although minute and fragmentary, this specimen is worthy of a figure on account of the well-marked glabella furrows, also from the fact that the latter appear to be only two in number, and almost pass completely across the glabella. So far as preserved it is not unlike a species of *Amphion* (*A. pauper*, Salter).

Loc. and Horizon.—Balcletchie, in dark-green mudstone. (Gray collection.)

Genus SPHÆREXOCHUS, Beyrich, 1845.

(Ueber einige böhmische Trilobiten, p. 19.)

Sphærexochus mirus, Beyrich.

(Pl. VII., fig. 20.)

S. mirus (Beyrich), Salter, Mon. Brit. Trilobites, 1864, pt. 1, p. 76, t. 7, f. 1-6 (*for synonomy*).
„ „ Bigsby, Thesaurus Sil., 1868, p. 68.
„ „ F. Roemer, Lethæa Geog., 1877, Atlas, t. 17, f. 9.
„ „ Woodward, Cat. Brit. Crust., 1877, p. 58.

Obs.—We only possess one specimen of this peculiar Trilo-

bite, and so far as we recollect it has not hitherto been noticed as a Girvan species. It is an imperfect glabella, showing the strong basal glabella furrows and traces of the surface granulation.

Loc. and Horizon.—Dark-green coarse-grained ashes or ashy-conglomerate of Balcletchie. (Gray collection.)

Genus ENCRINURUS, Emmrich, 1845.

(N. Jahrbuch für Min., 1845, p. 42.)

Encrinurus punctatus, Brünnich.

E. punctatus (Brünnich), Salter, Mem. Geol. Survey, Dec. vii., 1853, No. 4, p. 6 (*for general synonomy*).

a. var. **calcareus,** Salter.

Encrinurus punctatus, Corda, Prodrom einer Monog. böhmischen Trilob., 1847, p. 91, t. 5, f. 55.
Cybele punctatus, Fletcher, Quart. Jour. Geol. Soc., 1850, vi., p. 403, t. 32, f. 15.
Encrinurus punctatus, M'Coy, Brit. Pal. Foss., 1851, fas. 1, p. 158.
E. punctatus, var. *calcareus*, Salter, Mem. Geol. Survey, Dec. vii., 1853, No. 4, p. 6, t. 4, f. 15.
Asaphus tuberculatus, Buckland, Bridg. Treatise, n. ed., 1858, ii., t. 64, f. 6.
E. punctatus, Salter and Woodward, Chart. Foss. Crustacea, 1865, p. 13, f. 52.
„ „ Baily, Char. Fossils, i., p. 67, t. 23, f. 2.
„ „ Salter, Murchison's Siluria, 1867, 4th ed., p. 235, foss. 65, f. 5.
„ „ Salter, Cat. Camb. Sil. Foss., Woodwardian Museum, Camb., 1873, p. 77.
„ „ Woodward, Cat. Foss. Crust., 1877, p. 37.

Obs.—Of Mr Salter's variety *calcareus* we have examined only two definite specimens from the Girvan district, both pygidia, and not in a good state of preservation. They do not call for further remark. We have given the synonomy of *E. punctatus* under the two varieties established by Mr Salter, and trust that this division will be found of service.

Hor. and Locality.—Penkill (Gray collection); burn passing Bargany Pond, near Dailly (*Coll. Geol. Survey, Scot.*, collected by Mr A. Macconochie).

b. var. **arenaceus**, Salter.

(Pl. VIII., figs. 1-4.)

Calymene variolaris, Brongniart, Hist. Nat. Crust. Foss., 1822, t. 1, f. 3 A.
„ *punctatus*, Dalman, Vet. Acad. Handlinger, 1826, p. 233, t. 2, f. 2, *a* and *b*.
„ „ Murchison, Sil. Syst., 1839, t. 23, f. 8.
Encrinurus punctatus, Salter, Quart. Jour. Geol. Soc., 1851, vii., pp. 170 and 172, t. 9, f. 4.
Cybele punctata, Hall, Pal. N. York, 1852, ii., p. 297, t. A. 61, f. 1, *g*, *h*, and *i*.
E. punctatus, var. *arenaceus*, Salter, Mem. Geol. Survey, Dec. vii., 1853, No. 4, p. 6.
„ „ Bronn, Lethæa Geognostica, 3d ed., 1851-56, i. p. 658, Atlas, t. 9^2, f. 24, a-c.
Asaphus tuberculatus, Buckland, Bdgw. Treatise, n. ed., 1858, ii., t. 64, f. 6.
E. Stokesii, M'Coy, Sil. Foss., Ireland, 1864, p. 46, t. 4, f. 15.
Cryptonemus punctatus, Angelin, Pal. Scandinavica, 1854, p. 3, t. 4, f. 4-8.
E. punctatus, Salter, Murchison's Siluria, 1867, 4th ed., p. 90, foss. 15, f. 10.
„ „ var. *arenaceus*, Bigsby, Thesaurus Sil., 1868, p. 51.
„ „ „ Salter, Cat. Camb. Sil. Foss. Woodwardian Mus., Cambg., 1873, p. 77.
E. punctatus, F. Roemer, Lethæa Geog., 1876, i., Th. Atlas, t. 17, f. 8, *a* and *b*.
„ „ var. *arenaceus*, Woodward, Cat. Brit. Foss. Crustacea, 1877, p. 36.

Obs.—The variety *arenaceus*, Salter, which has the termination of the pygidium deflexed and blunt, as distinguished from the produced mucro of *calcareus*, appears to be the predominating variety at Girvan. Nearly all the specimens are mere casts, usually of the pygidium only, sometimes the latter and a few of the thoracic segments united, and in one or two instances small casts of the entire Trilobite. As a rule, the pygidia, although casts, show traces of the characteristic tubercules on the axis and ribs to a greater or lesser extent; indeed the features of the tail in *E. punctatus* are so well marked and distinctive as to quite bear out Mr Salter's remark, when describing *E. variolaris*—viz., that "the characters of the tail are amply sufficient to separate the two common species."[1] However, to

[1] Mem. Geol. Survey, Dec. vii., No. 4, p. 7.

afford assistance to those not having ready access to books, we give the abbreviated characters of the tail in the three allied species, which may be used as distinctive ones, taken from the detailed descriptions of Messrs Fletcher[1] and Salter.[2]

Encrinurus punctatus.—Axis of about thirty segments, with the centre smooth, but having seven prominent and distinct tubercules, with an interval of four rings between every two tubercules. Lateral ribs eight in number, separated by deep furrows, and each with a tubercule at its proximal end.

E. variolaris.—Axis of ten rings, the first carrying a tubercule, the second a punctum between two tubercules. The succeeding five rings have a tubercule, and a punctum between two tubercules alternately; the three last have a tubercule only. There are seven lateral ribs, each with a tubercule at its proximal end.

E. sexcostatus.—Axis of twenty segments without tubercules. Lateral ribs six in number, strong, flattened, with obtuse tips, divided by narrow deep furrows. Surface of tail covered with a close scabrosity.

Loc. and Horizon. — Conglomerate of Cuddystone Glen (*Salter*); sandstones of Saugh hill (*Salter*); Craighead limestone (*Etheridge*,[3] Mus. Pract. Geol. Collection); Penwhapple (*Etheridge and Young*,[4] ibid.), all recorded simply as *E. punctatus*.

The variety *arenaceus* occurs at Craighead, in the limestone (Gray collection), and at Penkill in greenish mudstones (Gray collection.)

Genus CYBELE, Lovén, 1845.

Cybele, Lovén, Vet. Akad. Forhandlingar, 1845, No. 4, p. 110.
Zethus (pars), M'Coy, Brit. Pal. Foss., 1851, fos. 1, p. 156 (non Pander).
Cybele, Salter, Brit. Pal. Foss., 1851, App. A, p. iii.
„ Salter, Mem. Geol. Survey, 1864, iii., p. 324, note.

Obs.—We adopt the name *Cybele* as restricted by Salter, in contradistinction to the interpretation of Volborth, M'Coy, and others, who considered it identical with *Zethus*, Pander. Mr Salter states that *Zethus* was founded upon a fragment of a *Cheirurus*, and is altogether a doubtful and dubious genus.

[1] Quart. Jour. Geol. Soc., vi. pp. 403 and 405.
[2] Dec. vii., No. 4, p. 3.
[3] Mem. Geol. Survey Scot., Expl. 14, 1869, p. 9.
[4] Ibid., Expl. 3, 1873, pp. 31 and 32.

Cybele was placed by Salter as a sub-genus of *Encrinurus*, from which it is chiefly distinguished by the possession of twelve thoracic segments, usually produced into spines, the position of the facial suture, and some minor points.

Cybele verrucosa, Dalman.

(Fig. 5 *c.*)

Calymene (?) *verrucosa*, Dalman, Vet. Akad. Handlingar, 1826, p. 285.
„ „ „ Om Palæaderna, &c., 1827, p. 100.
„ „ „ Arsberättelse om nyare Zoologiska arbeten, &c., 1828, p. 134, Note 1.
„ „ „ in Férrussac's Bull. des Sciences, Nat., 1829, xix., p. 128.
Chaperon d'un Trilobite, Brongniart, Hist. Crust. Foss. 1822, p. 145, t. 4, f. 11.
Trilobites (*Calymene*) *verrucosa*, Lovén, Vet. Akad. Forhandlingar, 1845, No. 3, p. 52, t. 1, f. 5, *a-c.*
Cybele verrucosa, Lovén, *loc. cit.*, No. 4, p. 111.
Atractopyge verrucosa, Corda, Prodrom einer Mon. böhmischen Trilob., 1847, t. 5, f. 52.
Cybele sexcostata, Salter, Mem. Geol. Survey, 1848, ii., pt. i., t. 8, f. 9 (non f. 10).
„ *verrucosa*, Salter, *loc. cit.*, p. 343.
Zethus atractopyge, M'Coy, Brit. Pal. Foss., 1851, fas. 1, p. 156, t. 1 G., f. 1-5.
Cybele verrucosa, Salter, Mem. Geol. Survey, 1853, dic. vii., No. 4, p. 4.
„ „ Salter and Woodward, Chart Foss. Crustacea, p. 12, f. 48.
„ „ Morris, Cat. Brit. Foss., 1854, 2d ed., p. 103.
„ „ Salter, Mem. Geol. Survey, 1866, iii., p. 324, t. 19, f. 7.
„ „ Salter in Murchison's Siluria, 1867, 4th ed., p. 206, Foss. 48, f. 2.
„ „ Bigsby, Thesaurus Sil., 1868, p. 47.
„ „ Woodward, Cat. Brit. Foss. Crustacea, 1877, p. 33.

Obs.—We have seen several imperfectly-preserved examples of this species from the Girvan district, sufficiently well marked to make identification satisfactory.

Loc. and Horizon.—South side of Green-hill, Penwhapple Glen (*Coll. Mus. Pract. Geology*); Drummuck, in greenish-grey mudstone ? (Gray collection); Balcletchie, in dark-green mudstone (Gray collection). *C. verrucosa* appears to have been first collected in the Girvan neighbourhood by the late Mr Richard Gibbs, and the specimen identified by Mr R. Etheridge, F.R.S., and Dr J. Young, F.G.S.

Cybele rugosa, *Portlock.*

(Pl. VIII., figs. 5-7.)

Ogygia (?) *rugosa*, Portlock, Geol. Report, Londonderry, 1843, p. 302, t. 5, f. 10.
Cybele „ Salter in M'Coy's Brit. Pal. Foss., 1851, fas. 1. App. A., p. iii., t. i. G. f. 8.
„ „ Bigsby, Thesaurus Sil., 1868, p. 47.
„ „ Morris, Cat. Brit. Foss., 2d ed., 1854, p. 103.
„ „ Salter, Cat. Camb. Sil. Foss., Woodwardian Mus., Cambg., 1873, p. 51.
„ „ Woodward, Cat. Brit. Foss. Crust. 1877, p. 33.

Spec. char.—General form ovate-triangular, tapering rapidly towards the posterior. Head or carapace nearly semicircular; anterior margin strong, broad, vertical, and bent upwards in front of the glabella. Free cheeks very convex, unsymmetrically hatchet-shaped, and produced posteriorly into short, pointed, slightly curved, genal spines. Facial suture generally sigmoidal; posterior to the eye it curves outwards laterally until near the thickened margin, when a sudden downward curvature is taken, cutting the margin close to the genal spine; anterior to the eye the facial suture passes inwards towards the glabella, and in front of the latter some little distance above the front margin. Axal furrows broad and deep, well marked; marginal furrow distinct, but not deep; neck furrow rather broad and well defined, especially in the lateral portions. Neck segment or lobe strong. Glabella elongate, slightly clavate, attenuated posteriorly; frontal lobe expanded and overhanging the others, continuous with the main axis of the glabella; the three side lobes are club-shaped, connected with the axis by narrow necks, and so united with one another as to leave between them very shallow inconspicuous furrows and deep oval pits between the narrow necks; the upper or frontal furrows are directed obliquely forwards, the middle and basal are nearly at right angles to the glabella axis. The eyes are situated nearer to the glabella than to the lateral margins, a little behind the most convex part of the cheeks. Fixed cheeks

narrow and transversely elongated; general surface, except the anterior margin and genal spines, tuberculated.

Thoracic segments tapering rapidly towards the tail; axis about as broad as the pleuræ, with a single line of tubercules on each segment, and a few smaller ones scattered amongst them; pleuræ sharply divided longitudinally by a groove, near the anterior margin, into two very unequal parts, and produced distally into flat angulated curved spines. Pygidium long, triangular, gradually tapering to a point; axis less in width than the side lobes, of about twenty-eight coalesced rings, the divisions being visible only on the sides, leaving a clear, smooth, more or less longitudinal flattened space, unornamented and without tubercules; side lobes deflected, becoming strongly bent down towards the apex of the tail; the component pleuræ are five in number on each side, longitudinally curved when viewed laterally, and increasing in size outwards from the axis, each ornamented with a few tubercules; between the three upper ribs on each side an intermediate rugose small rib is interpolated; "the lateral ribs have terminal spines, but the four last ones are much longer; they are united for some distance, and then diverge to form the 4-5 serrate tip of the tail."

Obs.—With the exception of that of the tail, we are not acquainted with any further description of *Cybele rugosa;* it was therefore very gratifying to find two or three examples in Mrs Gray's collection, from which we have been able to draw up the above description, although some of the minor details, such as the ornamentation of the pleuræ and the full extent of the spines, still remain to be further elucidated.

From *Cybele bellatula*, Dalman, the present species is distinguished, as it also is from *C. verrucosa*, Dalman, by possessing much more decidedly hatchet-shaped free-cheeks, and by their greater posterior extension. From the first it is also distinguished by its highly ornate head, and from both by the production of the posterior angles into spines. So far we have no evidence of the two peculiar spines descending from

the sixth thoracic segment in *C. rugosa*, as in *C. bellatula*, neither is there any trace of the ornate anterior margin of *C. verrucosa*. The position of the eyes is also different in these species to what it is in *C. rugosa:* in *C. bellatula* the eyes are close to the glabella and far forward, judging from Angelin's figure;[1] whilst in *C. verrucosa* they are situated almost half-way between the glabella and the anterior lateral margin, and nearly opposite the frontal furrow. On the other hand, in *C. rugosa*, they are close to the lateral lobes of the glabella, and far back, approaching the posterior margin, and almost opposite the middle or ocular furrow. When we look at the tails of the respective species we see a still further and more decided difference. In the two Swedish species, which more or less resemble one another, we notice, in the first place, that the axis of the tail is more regularly segmented; in the second there is an absence of the deflection visible in *C. rugosa;* and, finally, the terminations of the lobes are free and not coalesced to form a spine.

Cybele dentata, Esmark,[2] and *C. brevicaudata*, Angelin,[3] are known only in the form of pygidia, and are easily distinguished from *C. rugosa* by similar characters to the preceding species.

Loc. and Horizon.—In the greenish-grey mudstone of Drummuck (*Gray Coll.*); Ladyburn, a little above Drummuck, in a similar matrix (*Geol. Survey Scot. Coll.*) We believe that *Cybele rugosa* was first indicated as a Girvan species by Mr John Young, F.G.S.[4]

Genus DINDYMENE, Corda, 1847.

Dindymene, Corda, Prodrom einer Mon. böhmischen Trilob., 1847, p. 119.
„ Barrande, Syst. Sil. Bohême, 1852, p. 816.

Obs.—The genus *Dindymene* was established by Dr Corda for a very peculiar trilobite devoid of eyes and facial suture,

[1] Pal. Scandinavica, t. 4, f. 1.
[2] Angelin's Pal. Scandinavica, t. 41, f. 12.
[3] Ibid., t. 41, f. 14.
[4] Proc. Nat. Hist. Soc. Glasgow, ii., pt. 2, p. 179.

and in which the glabella is unprovided with furrows.[1] The glabella is elevated somewhat above the cheeks, which are convex and sub-triangular. The thorax has ten segments, and its pleuræ have their extremities produced into oblique, free points or extremities, increasing in length posteriorly, and there inclined to become parallel to the axis. The axis of the pygidium is multi-segmentate. Upon each lateral lobe are two pleuræ, similar to those of the thorax, bent down nearly parallel to the axis, and terminating in similar points produced a short distance beyond its apex. We believe *Dindymene* has not hitherto been recognised as a British form, and we were for some time in much doubt to what genus to refer the fossils which follow. The descriptions of Corda and Barrande, however, are so clear, especially when used in conjunction with their admirable figures, that we think little doubt can be entertained as to the correctness of our determination.

Dindymene Cordai, Etheridge, jun., and Nicholson, *sp. nov.*

(Pl. VIII., fig. 8, and Fig. 5, A and B.)

Spec. char.—Outline of the head nearly semicircular; front margin somewhat bent up in the middle line, in front of the glabella. The latter is strongly pyriform, and very convex, widest at about, or a little less than, a third behind the anterior margin, then rapidly narrowing to the neck furrow. No lobes or furrows are present, and there is no point or occipital tubercule. Cheeks convex, prominent, and obtusely triangular. Axal furrows strong, deep, and wide; neck furrow well marked but not so strong as the axal furrows. Posterior angles produced into diverging spines. Entire thorax unknown; axis gradually tapering, moderately convex, the segments rounded, distinct, and prominent. The united portion of the pleuræ a little broader than the axis, the segments resembling those of the latter, slightly bent downwards, terminating in short free points,

[1] M. Barrande described a third species of this genus in the supplement to the first volume of his Bohemian work, which has glabella furrows,—so that this statement requires modification.

which become bent more and more parallel to the general axis of the trilobite as the posterior end is approached. Pygidium narrow; axis of many segments, about eight or ten (?), tapering to a fine point; the side lobes are very narrow and reduced, being composed of two pleuræ on each side, resembling those of the thorax, and given off from the two first segments of the axis; the inner of these are pressed quite close to the lateral margins of the axis, and both the inner and the outer terminate in similar points to the pleuræ of the thorax, the two inner by their extension beyond the apex of the tail forming a well-marked apical-notch. The surface of the glabella is ornamented with granules or small tubercules, and that of the segments of the body and tail is very minutely and inconspicuously granular.

Obs.—M. Barrande has described three species of this genus from the Silurian rocks of Bohemia, all of which differ from the present form. The markedly pyriform shape of the glabella separates *D. Cordai* from all the Bohemian species, and the

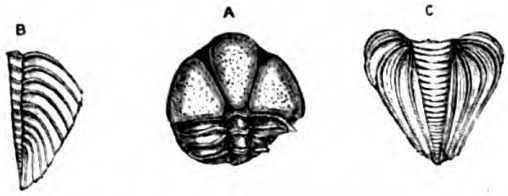


Fig. 5.—A, Head-shield of *Dindymene Cordai*, Eth. and Nich., without eyes or facial suture, but showing the granulated surface; Ladyburn, above Drummuck, enlarged twice. (*Coll. Geol. Survey Scot.*). B, Cast of pygidium accompanying the same, similarly enlarged. (Compare fig. 8, Pl. VIII.) C, Cast of pygidium of *Cybele verrucosa*, Dalm., similarly enlarged, from Balcletchie.

absence of any trace of lobation from *D. Bohemica*, Barr. in particular. In *D. Friderici-Augusti*, Corda, and *D. Haidingeri*, Barr., the glabella swells out anteriorly, tapering gradually towards the posterior, the axal grooves are somewhat curved, and there is a cephalic tubercule present. In *D. Cordai*, nobis, on the other hand, the axal grooves are straight, the glabella is quite pyriform, becoming very narrow at the neck furrow, and there is no trace of a cephalic tubercule. In the thorax of *D. Cordai* the axis narrows, and the segments are individually more rounded and projecting.

There is evidently a close resemblance between the tails in all the species of this genus, but in *D. Cordai*, nobis, the axal segments are more numerous than in *D. Friderici-Augusti*, Corda, and the free terminations of the lateral lobes are more widely separated. So far as we are aware, the biserial arrangement of the tubercules on the axes of the thorax and pygidium of the latter species does not exist in the Girvan form.

We were at first acquainted only with the tail of this species, and had provisionally placed it in *Cybele*, Lovén, but the accidental discovery of a head and tail (Fig. 5, A and B) on the same piece of matrix in the collection of the Geological Survey of Scotland gave us a further clue. The general features of this peculiar Tribolite are so marked, more especially those of the head and tail, that little doubt can exist of the relation of our fossil to those described by M. Barrande.

Loc. and Horizon.—Drummuck, in fine grey mudstone (*Gray Coll.*); Ladyburn, above Drummuck, in a hard mudstone; collected by Mr A. Macconochie (*Coll. Geol. Survey Scot.*)

Genus STAUROCEPHALUS, Barrande, 1846.

(Note Préliminaire, p. 52; Syst. Sil. Bohême, 1852, i., p. 810.)

Staurocephalus globiceps, Portlock.

St. globiceps (Portlock), Salter, Mon. Brit. Trilobites, 1865, pt. 2.
„ „ Bigsby, Thesaurus Sil., 1868, p. 68.
„ „ Woodward, Cat. Brit. Foss. Crustacea, 1877, p. 59.

Obs.—In his 'Monograph,' Mr Salter gave a woodcut[1] of a specimen of this species from Ayrshire, without defining any particular locality. We have been allowed to examine this example, now in the Museum of Practical Geology, and find that Salter's figure does more than justice to the specimen, and is greatly enlarged. The cheeks are much more convex than in *St.* (?) *unicus*, and this with the position of the eye appears to be a very good point of distinction between the two species.

Loc. and Horizon—Ardmillan Brae, in shale (*Etheridge*[2]).

[1] P. 86.
[2] Mem. Geol. Survey Scot., Expl. No. 7, 1869, p. 10; Expl. No. 3, 1873, p. 32.

Staurocephalus (?) unicus, Wyv. Thomson.

(Pl. VIII., figs. 9-16, and Fig. 6, A, B.)

Acidaspis unicus, Wyv. Thomson, Quart. Jour. Geol. Soc., 1857, xiii., p. 209, t. 6, f. 13 and 14.
St. (?) *unicus*, Salter, Mon. Brit. Tribolites, 1865, pt. 2, p. 86, t. 7, f. 22-24.
St. Maclareni (Wyv. Thomson, MS.), Salter, *loc. cit.*, p. 86.
St. unicus et *St. Maclareni*, Bigsby, Thesaurus Sil., 1868, p. 68.
„ „ Woodward, Cat. Brit. Foss. Crustacea, 1877, p. 59.

Spec. char.—General form of the body oblong, and sparingly ornamented with granules. Head broad, and rather long. Free cheeks very minute, with entire margins. Eyes very slightly, if at all, pedunculate, distinctly faceted, situated far forward, immediately under the swollen hemispherical glabella on each side. Neck furrow broad and strongly marked. Glabella more or less clavate, with the frontal lobe produced into a globular or somewhat more or less pyriform prominence, occupying almost, if not quite, two-thirds of the whole length of the entire glabella, much elevated above the general surface of the head, and projecting above the frontal margin. The two basal lobes bear no comparison to the frontal lobe, and are separated from it by a broad, distinct, and well-marked furrow. Cheeks broad, gently convex, and distinctly punctate, with a thickened margin produced anteriorly into two almost straight or slightly recurved spines, of variable length, but generally short; posterior angles produced into short recurved genal spines. Thorax of twelve (?) segments; axis convex, about half as broad as the pleuræ, or perhaps a little more; pleuræ horizontal, with a double ridge running along each, the two ridges coalescing at the distal extremity, and ending in a strong, long, reflexed spine. Tail broad and short; axis of two minute segments; pleuræ of the first tail segment spatulate, divided almost medianly by a shallow groove, and posteriorly bent almost at right angles to the axis, and continued backwards into two long spines. Ornamentation: thorax with

a double row of minute granules on each segment; pygidium granular; cheeks punctate; frontal lobe of the glabella minutely granular.

Obs.—This species was originally described by Sir Wyv. Thomson as an *Acidaspis*, but it was transferred to *Staurocephalus* by Mr Salter in his earlier description of it. Prof. Wyv. Thomson drew attention to the abnormal number of thoracic segments present in *St. unicus*, and to its position as a link between the *Acidaspidæ* and *Cheiruridæ*. Salter remarked: "If Prof. Thomson be correct in figuring twelve segments to the body, the species is abnormal for either *Acidaspis* or *Staurocephalus*. The shape of the head shows clearly enough that it is to *Staurocephalus*, or else to one of the sections of *Cheirurus*, that this bizarre fossil must be referred. *Cheirurus* often has twelve segments, *Acidaspis* nine or ten, *Staurocephalus* only ten. The grooved pleuræ are unlike *Staurocephalus*, but like the section *Eccoptochile* among the genus *Cheirurus*. But no *Cheirurus* has so clavate a glabella, though a tendency towards it is exhibited in some species, and *Sphærocoryphe* of Angelin is very near to our fossil." If the almost entire cast we figure (Pl. VIII.) as *St. unicus* is in reality that species, as we believe it to be, we think we are in a position to corroborate Sir Wyv. Thomson's view of the number of thoracic segments, for we are strongly under the impression that this cast possesses twelve. We are inclined to regard this as *St. unicus* and not *St. globiceps* from the less convexity of the cheeks, forward position of the eye, and spatulate appendages to the tail. Salter, who was the first to figure the glabella of *St. unicus*, represents the frontal lobe as much elongated or pyriform, and projecting far beyond the frontal margin. Salter's figure must represent an extreme variety of *St. unicus*, for not one of the numerous heads of this species we have examined, and which otherwise accord perfectly with the characters of *St. unicus*, possesses this extremely pyriform and projecting outline: on the contrary, they all more nearly resemble the form of frontal lobe seen in the other species of the genus.

The frontal lobes before us are hemispherical, or in one or two cases very slightly pyriform, and without the anteriorly elongated form of Salter's figure,[1] and quite accord with Barrande's generic description.[2] The outline of the former more nearly corresponds with Angelin's *Sphærocoryphe*, as displayed in the type species *S. dentata*, than any of its fellows. We much wish we possessed specimens of *Sphærocoryphe* for comparison with *Staurocephalus*, for we are quite convinced of the close relationship of the two genera. The position of the eyes in *St. unicus* appears to be a little different from that in either *S. Murchison*, Barr., *S. globiceps*, Portlock, or *S. clavifrons*, Angelin. In *St. unicus* the eyes are situated far forward, and as if sheltering themselves under the sides of the frontal lobe of the glabella; but in the three species just mentioned the eyes have a more posterio-central position on the lateral elements of the head. The bidentate character of the limb is a well-marked and distinctive point in *St. unicus;* but, strange to say, the same peculiarity is present in *Sphærocoryphe dentata*, Angelin.

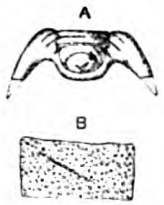


Fig. 6.—A, Pygidium of *Staurocephalus* (?) *unicus*, Wyville Thomson; possibly a variety of it, or a new species, of the natural size. B, Enlargement of the surface of the same. Shalloch Mill.

Sir Wyv. Thomson's manuscript species *S. Maclareni* was considered by Mr Salter identical with *St. unicus*. We have been favoured with the loan of specimens of the former from the Museum of Practical Geology, and can fully bear out Salter's statement. We give a figure of a somewhat peculiar pygidium (Fig. 6, A), from another locality, Shalloch Mill. It has the general character of that of *St. unicus*, but the surface, including that of the long spines, is scabrous (Fig. 6, B), instead of granular or tubercular. It may be specifically distinct, but the one specimen is all we have at present at our command. It is in a calcareous shale.

Loc. and Horizon.—Penwhapple Glen, in schists at the base of the Orthoceratite and Graptolite flags (*Wyv. Thomson*);

[1] Monograph, t. 7, f. 22[b].

[2] Syst. Sil. Bohm., i., p. 811.

Piedmont Glen[1] (as *S. Maclareni*, Wyv. T.); Balcletchie (*Gray Coll.*); Drummuck (*Coll. Geol. Survey Scotland*).

Staurocephalus nodulosus, Salter.

S. nodulosus, Salter (MS.), Mon. Brit. Foss., 1865, pt. 2, p. 87, t. 7, f. 25.
S. sp. ind., Woodward, Cat. Brit. Foss. Crustacea, 1877, p. 59.

Obs.—Under this name Salter figured two thoracic segments, "an imperfect fossil, but distinct from *St. unicus*. It has tuberculate pleuræ." The pleural spines appear to be bent down at a much more acute angle than in *St. unicus*. Nothing more appears to be known about this fossil.

Loc.—Ayrshire.

The peculiar and interesting Trilobite, *Deiphon Forbesii*, Barrande, is stated[2] to have been found at Balcletchie, but we have not met with any direct evidence of it. Hemispheric, disjointed glabellæ are common at that locality, but we see no reason to doubt their identity with the preceding species but one.

Genus ACIDASPIS, Murchison, 1839.

Acidaspis, Murchison, Sil. Syst., 1839, p. 638.
„ Salter, Mem. Geol. Survey, Dec. vii., 1853, No. 6., p. 1.
Odontopleura, Emmrich, de Trilobitis, 1839, p. 33.

Acidaspis Lalage, Wyv. Thomson.

(Pl. VIII., figs. 17-22.)

A. Lalage, Wyv. Thomson, Quart. Jour. Geol. Soc., 1857, XIII., p. 206, t. 6, f. 1-5.
„ „ Bigsby, Thesaurus Sil., 1868, p. 33.
„ „ Woodward, Cat. Brit. Foss. Crust., 1877, p. 19.

Spec. char.—General form oblong, inclined to square. Head or carapace roundly triangular, moderately convex, with the frontal margin rounded. Free cheeks small, fringed in front

[1] Cat. Foss. Mus. Pract. Geol., 1865, p. 6. [2] Cat. W. Scot. Fossils, 1876, p. 16.

with short, minute spines; posterior angles produced into short divergent genal spines. Eyes somewhat remote; ocular ridge distinct. Facial suture apparently cutting the posterior margin close to the base of the genal spines. Neck furrow strongly marked. Glabella triangular, moderately convex, with a distinct, broad, median lobe, and two pairs of oval convex lateral lobes entirely circumscribed, and of which the lower pair appear to be a little the larger; glabella furrows well marked and deep.

Fixed cheeks very gibbous, separated from the glabella by deep axal grooves. Neck segment convex and expanding posteriorly, produced into two divergent or slightly curved spines. Thorax square-oblong, horizontal, of nine or ten segments; axis narrow and prominent; pleuræ convex, divided by the pleural grooves into two ridges which coalesce at the distal extremities, and are produced as long diverging posteriorly directed spines. "Pygidium short, semicircular, of two short segments fringed with from twelve to fourteen long radiating equal spines; a ridge from the anterior axis-segment is continuous with the antepenultimate spine on either side." General surface tuberculate, the head more so than the body; tail reticulate.

Obs.—Our description is drawn up from several detached fragments of this species, as we have not seen a complete example; the characters of the tail are taken from Prof. Thomson's description. We are able to add one or two characters to the original general diagnosis of the Trilobite, which will serve to fix the species in a more satisfactory manner. The occurrence of the cheeks appears to be rare, for only in one example in the Gray collection is there any trace of them; indeed, information about the free cheeks and eyes is required before the above remarks relating to them can be considered as definite. The circumscribed lateral lobes of the glabella appear to be well-marked features of *A. Lalage*, so also do the gibbous fixed cheeks with their closely set tubercules. Another point to be noticed in the structure of this

species is the highly tuberculate head, as compared with the sparingly ornamented body and reticulate tail.

A. Lalage may be distinguished from its ally *A. hystrix*, Wyv. Thomson, by the more uniform character of the lateral lobes of the glabella, by its single, as compared with the double thoracic pleural spines of the latter, and by possessing a reticulate instead of a tuberculate surface to the pygidium. From *A. Grayæ*, R. Etheridge, which it resembles in the reticulate tail, *A. Lalage* may be distinguished by the simple nature of its spines, by the smaller and less developed condition of the spines of the last thoracic segment, and by a dissimilar number of spines fringing the pygidium.

Sir Wyv. Thomson says,[1] "The form of the tail of this species at once distinguishes it from all its British congeners, as indeed from all species hitherto described, with the exception of *A. radiata*, which it closely resembles. The tail-spines of the present species are longer than in *A. radiata*, and slightly curved." We may observe on this point that, according to Goldfuss's figure,[2] the posterior axis segment of the tail is represented by two nodes or elevations, which quite separates it from *A. Lalage*.

Loc. and Horizon.—Penwhapple Glen, in schists at base of the Graptolite and Orthoceratite flags (*Wyv. Thomson*). Balcletchie (*Gray Coll.*)

Acidaspis hystrix, Wyv. Thomson.

(Pl. VIII., figs. 23-25.)

A. hystrix, Wyv. Thomson, Quart. Jour. Geol. Soc., 1857, xiii., p. 207, t. 6, f. 6-10.
,, ,, Bigsby, Thesaurus Sil., 1868, p. 33.
,, ,, Woodward, Cat. Brit. Foss. Crustacea, 1877, p. 19.

Spec. char.—General form parallelogrammatic, slightly tapering posteriorly, densely fringed with spines. Head or carapace almost semicircular. Limb of the free cheek ornamented with a fringe of short simple spines, increasing in length backwards;

[1] Quart. Jour. Geol. Soc., xiii., p. 207.

[2] N. Jahrbuch, 1843, t. 4, f. 1.

posterior angles produced into curved genal spines extending backwards to the third thoracic segment, and so curved that the convexity is outward laterally from the body of the trilobite, when in its natural position. "Glabella broadly triangular, not very highly arched; middle lobe rather narrow; lateral lobes two, oval, separated by distinct grooves from the central lobe and from the cheek; basal lateral lobe fused with the neck segment. Portion of the cheek within the facial suture very gibbous, likewise confluent with the neck segment. Neck segment very prominent, separated from the middle lobe of the glabella by a shallow groove." Thorax of nine segments; axis narrow and prominent, rounded; pleuræ horizontal and convex, divided into an anterior and posterior portion by a groove which is placed somewhat nearer the anterior than the posterior margin of each pleura, so that the latter are divided longitudinally into two unequal portions; the anterior half terminates in a short pointed reflexed spine, the posterior on the other hand terminating in a long, simple, more acutely reflexed straight spine, very gradually tapering; the spines are so placed, with regard to one another, that the short anterior spine of one pleura passes under the posterior spine of the pleura next in front, the length of the former being such that in nearly every case two are overlaid by the same posterior long spine. Pygidium minute, short, and a little less than the width of the thorax; axis of two segments, the anterior giving off ridges on each side continuous with the antepenultimate spine of the tail on each side; limb produced into twelve nearly parallel or slightly radiating spines, graduating in length right and left from the two central ones, which are nearly equal. The spines of the last thoracic segment are more acutely bent down than any of the others of the thorax, and are extended backwards beyond the extremity of the longest tail-spines. Surface of the head, thorax, and pygidium densely granular, the granules on the thorax being arranged in two lines on each of the divisions of the pleuræ.

Obs.—The regular contour, long radiating spines, and highly granular surface give to this species a peculiarly graceful appearance. According to Sir Wyv. Thomson, *A. hystrix* somewhat resembles *A. Prevosti*, Barr.,[1] but the structure of the head, and the number and arrangement of the tail-spines (sixteen), distinguish it. The elongated large basal lateral lobes of the glabella will serve to distinguish the head of the present species from that of *A. Lalage;* whilst as regards the thorax, the profuse granulation and spines of two orders in *A. hystrix* will be sufficient. In the one the tail is reticulate, in the other tuberculate. The doubly-spined pleuræ and granular ornamentation separate *A. hystrix* from *A. Grayæ*, R. Eth., to say nothing of the denticulated spines of the latter form, but unfortunately we are unable to compare the heads of the two species. *Acidaspis Dufrenoyi*, Barr.,[2] resembles *A. hystrix* to a certain extent, but the distal ends of the pleuræ are produced into three spines each, one of them almost vertical, and the others sub-parallel, not passing under one another. Again, the thorax is ornamented with only one row of tubercules on the pleuræ, arranged vertically, and two on the axis, and the pygidium is plain except on the axis. In the double spines to the pleuræ, *A. hystrix* resembles *A. ovatus*, Emmrich,[3] but the arrangement is different.

Acidaspis callipareos, Wyv. Thomson.

A. callipareos, Wyv. Thomson, Quart. Jour. Geol. Soc., 1857, xiii., p. 208, t. 6, f. 11, 12.
„ „ Bigsby, Thesaurus Sil., 1868, p. 33.
„ „ Woodward, Cat. Brit. Foss. Crustacea, 1877, p. 18.

Obs.—Although we have not had the advantage of studying the original specimens upon which Sir Wyv. Thomson based his determinations, we are inclined to think that the head described in his interesting paper under the above name would have been more appropriately ascribed to the thorax and pygi-

[1] Syst. Sil. Bohm., i., p. 739, t. 39, f. 33-41. [2] Ibid., i. t. 38, f. 25.
[3] *Odontopleura*, Emmrich, Untersuch. über boh. trilob., 1846, p. 18, t. 3, f. 1.

dium [1] named by him *A. hystrix*—a view which is borne out by the highly ornate character of the test in the whole of the remains referred to. In the only specimen of *A. hystrix* in the Gray collection in which the head is shown it is unfortunately imperfect, and, so far as preserved, the distinctive characters assigned to it by Sir Wyv. Thomson cannot be satisfactorily made out, as they appear to be common throughout the genus. Of *A. hystrix*, Prof. Thomson remarked, "We have only one specimen of this species showing the head," whilst of *A. callipareos* only the head is known likewise. According to the descriptions of the two species, the heads chiefly differ in that of *A. hystrix* having the basal lateral lobes fused with the neck segment, and the fixed cheeks confluent with the neck segment. It is just possible that the imperfect state of the head of *A. hystrix* may have given rise to the appearance of characters which did not really exist; they are, however, said to be from different horizons.

Loc. and Horizon.—Sandstone of Mulloch Hill. (*Coll.*, Wyv. Thomson.)

Acidaspis Grayæ, R. Etheridge, jun.

(Pl. VIII., fig. 26: Pl. IX., figs. 1-6, and 7 (?); Fig. 7 B.)

A. Grayæ, Eth., jun., Proc. R. Physical Soc., Edinb., 1878, iv., pt. 3, p. 170, t. 2, f. 6-8.

Spec. char.—General form oblong-oval, depressed, bordered with a fringe of delicate, radiating spines. Head rounded, triangular convex; limb of the free cheek produced into a fringe of delicate, simple spines graduating and becoming longer from before backwards. Glabella apparently oval, convex, basal lobes oval, elongated, apparently quite circumscribed. Posterior angles produced into genal spines which extend backwards for about half the length of the thorax, and appear to be but little bent or curved; neck segment prominent and apparently non-spinous; surface of the glabella and lobes covered with scattered tubercules or granules. Thorax horizontal, square-

[1] *Loc. cit.*, t. 6, f. 7 and 8.

oblong, of ten segments; axis narrow and prominent, gradually decreasing in width towards the pygidium; pleuræ horizontal, traversed by a nearly central groove, and produced laterally into long, recurved, denticulated spines, those of the last segment (that next the pygidium) bent down almost in a parallel direction with the limb-spines of that division of the body—no trace of surface-ornamentation preserved. Pygidium short, semicircular, surface reticulate; axis of two segments; limb produced into fifteen sub-equal radiating denticulated spines; the anterior axis segment gives off a ridge on each side, continuous with the antepenultimate spines on each side the central one of the pygidium; the denticles are sub-alternate on each side of contiguous spines, and alternate on opposite sides of the same spine.

Obs.—All the specimens of this species contained in Mrs Gray's cabinet are more or less fragmentary, with the exception of that represented by Fig. 6, a cast; and even here the specimen is a good deal crushed, and the characters of the carapace obliterated. So far as present observation has enabled us to judge, the spines projecting from the anterior part of the carapace are simple, whilst those of the thorax and pygidium are unquestionably denticulated. The head is not in a good state of preservation, and little can be said about the characters of the glabella, its lobes and furrows, the facial suture, and the fixed and movable cheeks, except that the glabella and lobes appear to have been convex and prominent.

Amongst British species, *A. Grayæ* must be first compared with three species of *Acidaspis* from Girvan, described by Sir Wyville Thomson, F.R.S.[1] The form and general proportions of the thorax and pygidium closely resemble those of two of these—*A. Lalage* and *A. hystrix;* but the characters of the carapace, so far as they can be made out, do not correspond particularly, in the absence of any cervical spines in *A. Grayæ.* It undoubtedly differs from *A. Lalage* in its denticulated spines, those of the latter being quite simple and plain, both on the

[1] Quart. Jour. Geol. Soc., 1857, xiii., pp. 206-209.

pygidium and thorax. Similarly it is also distinguished from *A. hystrix*, Wyv. Thomson, and *A. Caractaci*, Salter; in the first of these each pleura terminates in two reflected spines, one passing under the other, and in the latter is bispinose, one spine being much longer than the other, but in neither case are the spines denticulated. Again, *A. Grayæ* does not appear to agree with any other described British species with which we are acquainted, either by specimens or figures, such as *A. Barrandei*, Fletcher; *A. bispinosa*, M'Coy; *A. Brightii*, Murchison; *A. coronatus*, Salter; *A. Jamesii*, Salter; or *A. Hughesii*, Salter. In fact, the increased number of spines round the pygidium separates *A. Grayæ* from all the foregoing forms, to say nothing of their denticulated character, except *A. Lalage* and *A. hystrix*, where the spines are twelve to fourteen in the one case, and twelve in the other, and apparently all simple. All the specimens of pygidia which we refer to *A. Grayæ* have constantly fifteen denticulated spines, except in one specimen where we counted sixteen.

Leaving British species and passing to Bohemian Silurian Trilobites, we find there are several with which a comparison may be made. M. Barrande has figured two species with the spines of the pleuræ denticulated—*Acidaspis Keyserlingi*, Barr.,[1] and *A. mira*, Barr.[2] In the first of these the spines in question are of a form totally different from those of *A. Grayæ*, and the thoracic axis is very much broader in proportion to the general size of the trilobite. In *A. mira* the spines of the pleuræ are of two kinds, one denticulated and the other not, both attached to the same pleura. In neither are the spines of the pygidium denticulated, but M. Barrande also figures at least five species in which these particular spines are so, viz.:—

1. A. Verneuilii, *Barr.*, loc. cit., t. 38, f. 1-9.
2. A. Portlockii, „ „ „ f. 10-12.
3. A. vesiculosa, „ „ „ f. 13-21.
4. A. tricornis, „ „ suppl., t. 8, f. 21.
5. A. rara, „ „ „ t. 12, f. 28.

[1] Système Sil. Boh., I., t. 36, f. 10-22.

[2] Ibid., t. 39, f. 1-11.

In the first three of these the form of the pygidium, and the number, form, and arrangement of the spines into which the limb of each is produced, are so different as to necessitate little or no comparison. The ornamentation of these trilobites consists of small granules or tubercules, both on the thorax and pygidium; on the other hand, on the only part of *A. Grayæ* where the ornamentation is preserved, it is seen to be reticulate, as in *A. Lalage.* In *A. tricornis*, Barr., the pygidium spines are only eight in number; finally, there are eight also in *A. mira*, but the arrangement of them is again different from any of the preceding.

A specimen of this species lately obtained by Mrs Gray leads us to think that the arrangement of the spines was even more complicated than at first supposed. It will be seen that in Fig. 7, A and B, two pleuræ taken from a larger specimen, the central portion of each pleura terminates in the long denticulated spine as described, and there appears to be anterior and posterior to this the broken bases of other supplementary spines: whether these were also denticulated we cannot say.

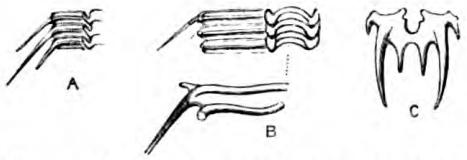


Fig. 7.—A, Part of one side of thorax of *Acidaspis*, sp., with long and slender spines, of the natural size, from Balcletchie. B, Part of one side of thorax of *Acidaspis Grayæ*, Eth., jun., enlarged twice, with one pleura enlarged still further. At the termination of the pleuræ is seen the central denticulated spine, along with the broken bases of the anterior and posterior spines of the same (from Balcletchie). C, Pygidium of *Acidaspis*, sp. ind., with six spines, enlarged twice (cast from Mulloch Hill).

Loc. and Horizon.—Balcletchie, in a fine, greenish mudstone (*Gray Coll.*)

Acidaspis, *sp. ind.*

(Fig. 7 C.)

(Compare *Acidaspis* (*Ceraurus*) *crenatus*, Emmrich, as figured by Lovén, Ofv. K. Vet. Akad. Förhandl., 1845, No. 3, p. 47, t. 1, f. 1, *a-f.*)

Obs.—The pygidium we represent in Fig. 7 C is quite different from any others which have come under our notice. The axal segments are not distinctly preserved, but they are apparently

two in number. As usual in this genus, from the anterior of the two proceed two ridges, which on reaching the margin are prolonged into straight, tapering, plain spines. Between these are two smaller and shorter ones, placed opposite the termination of the axis. External to the two principal spines are two small prolongations, almost proceeding from the angles of the pygidium, and the shortest of all those visible in the specimen. No traces of ornamentation are preserved.

This form of pygidium differs from all the other Girvan species here described, by the fact that the elongated spines, continuous with the ridges from the first axal segment, are separated by only two secondary spines proceeding from the limb of the pygidium, instead of three or more, as in *A. Lalage*, *A. hystrix*, or *A. Grayæ*, as the case may be; and that external to these primary spines, the secondary are reduced to one on each side. M. Barrande has figured several Bohemian forms in which a similar number and arrangement of spines is to be seen, as in the species under consideration, but in each case there is also present some other good distinctive character. Such are *A. Dormitzeri*, Barr.;[1] *A. Laportii*, Barr.;[2] *A. propinqua*, Barr.;[3] *A. Roemeri*, Barr.;[4] *A. Geinitziana*;[5] and *A. direlicta*, Barr.[6] Much nearer, however, than any of the foregoing is *A.* (*Ceraurus*) *crenatus*, Emmrich, as figured by Lovén. Here we find an exact representation of the spines seen in the Girvan fossil, except that in Lovén's figure the whole of the parts are on a much larger scale. We think it not at all improbable that it may be a small variety of *A. crenatus*, or else an undescribed form.

Loc. and Horizon.—Mulloch Hill (*Gray Coll.*)

Acidaspis (?) *sp. ind.*

(Fig. 7 A.)

Obs.—We figure this fragment of a thorax from the fact that it appears to differ in the length of its spines and other minor

[1] Syst. Sil. Boh. Atlas, I., t. 38, f. 22.
[2] *Loc. cit.*, t. 39, f. 23.
[3] *Loc. cit.*, t. 39, f. 25.
[4] *Loc. cit.*, t. 39, f. 29.
[5] *Loc. cit.*, t. 39, f. 49.
[6] *Loc. cit.*, Suppl. I., t. 7, f. 10, t. 9, f. 4.

characters from any of the other Girvan forms which have come under our noticc. We provisionally refer it to *Acidaspis*, although we quite admit that it may be a *Staurocephalus*, but probably the former. The central ridge of each pleura is minutely granulated, and is produced into a long, tapering, posteriorly-recurved, simple spine. The horizontal portions of the pleuræ appear to be unornamented.

Loc. and Horizon.—Balcletchie, in a fine-grained greenish mudstone (*Gray Coll.*)

Genus LICHAS, Dalman, 1826.

(Ofv. Vet. Akad. Handlingar för aar 1826, p. 93.)

Lichas laxatus, M'Coy.

Lichas laxatus (M'Coy), Salter, Mem. Geol. Survey, 1848, II., pt. 1, p. 340, t. 8, f. 4-6.
„ „ Salter, Quart. Jour. Geol. Soc., 1851, VII., p. 172, t. 9, f. 5.
„ „ Morris, Cat. Brit. Foss., 1854, 2d ed., p. 110.
„ „ M'Coy, Sil. Foss. Ireland, 1862, p. 51, t. 4, f. 9.
„ „ Salter, Mem. Geol. Survey., 1866, III., p. 324, t. 19, f. 1-3.
„ „ Salter, in Murchison's Siluria, 1867, 4th ed., p. 204, foss. 46, f. 5.
„ „ Bigsby, Thesaurus, Sil., 1868, p. 57.
„ „ Woodward, Cat. Brit. Foss. Crustacea, 1877, p. 43.

Obs.—We know this as a Girvan species only from the figure given by Mr Salter, representing a small glabella, showing very distinctly the narrow neck of the latter, and the circumscribed side-lobes, although it appears to us that these are represented in this figure as much more oval in outline than those of the later figures of the same author.

Loc. and Horizon.—Lower Thrave, in yellowish sandstone (Salter), on a similar horizon to the beds of Mulloch Hill quarry.

Lichas Barrandei, Fletcher (?).

(Pl. IX., fig. 8.)

L. Barrandei, Fletcher, Quart. Jour. Geol. Soc. 1850, vi., p. 238, t. 27. f. 10, t. 27 *bis*, f. 5.
,, ,, Morris, Cat. Brit. Foss., 1854, 2d ed., p. 110.
,, ,, Salter in Murchison's Siluria, 1867, 4th ed., p. 234, foss. 64, f. 3.
,, ,, Bigsby, Thesaurus Sil., 1868, p. 57.
,, ,, Woodward, Cat. Brit. Foss. Crustacea, 1877, p. 43.

Obs.—We are indebted to Mr R. Etheridge, F.R.S., for the loan of a pygidium of this species from the M.P.G. Collection, but as we are unable to add to Mr Fletcher's description, we content ourselves with simply giving a figure of the specimen. We have to observe, however, that, unlike Fletcher's example, the axis of ours is not wider than the side-lobes, scarcely so wide indeed. It will be seen by the figure that the projecting teeth of the broad foliaceous pleuræ are not visible, consequent upon the non-preservation of the margin. In this state some hesitation might be manifested whether to refer the specimen to *L. Barrandei*, Fl., or *L. laciniatus*, Dalman, and indeed it appears really to occupy an intermediate position between the two. In some respects the specimen approaches *L. Barrandei*, and in others equally so *L. laciniatus*. Unfortunately the matter is not simplified by the indefinite character of the margin of the Girvan specimen. However, it appears to possess the three-segmented axis, broad foliaceous pleuræ with their central division, the axal tubercle, and the rapidly attenuated posterior portion of the axis of both species, but the axis and the attenuation are relatively much narrower than in either of the above, but of the two it is probably nearer *L. Barrandei* than *L. laciniatus*. On the other hand, the outline of the margin, so far as it is preserved, assumes more the form of *L. laciniatus*, especially of Lovén's figure,[1] although there are at the extreme apex, we think, indications

[1] Öfv. Vet. Akad. Förhandl., 1845, No. 3, t. 1, f. 7, *a* and *b*.

of a notch, which would be a strong indication of alliance with *L. Barrandei.* This is only one of the many unsatisfactory points which have appeared during the examination of the present collection, and which can only be settled by the acquisition of further material. It is the *L. laxatus* of the Catalogue of Fossils in the Museum of Practical Geology,[1] quoted from Girvan, but not of M'Coy.

Loc. and Horizon.—Mulloch Hill (*Coll. Mus. Pract. Geol.*)

Lichas Hibernicus, Portlock.

(Pl. IX., figs. 9, 10.)

Nuttania Hibernica,		Portlock, Geol. Report, Londonderry, 1843, p. 274, t. 1, f. 1, t. 5, f. 1-3.
,,	,,	Morris, Cat. Brit. Foss., 1843, p. 75.
Lichas	,,	Beyrich, Ueber einige Böhm. Trilob., 1845, pp. 25, 29.
,,	,,	Bronn, Index Pal. Nomenclator, 1848, p. 641.
,,	,,	M'Coy, Sil. Foss. Ireland, 1862, p. 51.
,,	,,	Bigsby, Thesaurus Sil., 1868, p. 57.
,,	*sp.*	R. Etheridge, jun., Proc. R. Phys. Soc., 1878, iv. pt. 3, p. 169.

Spec. char.—Head obtusely semicircular or semi-oval, and gibbous in front. Glabella convex, broader in front than behind; forehead lobe continuous from the front margin backwards to the neck-segment, and not expanding posteriorly; anterior portion of the forehead-lobe expanding, and slightly overhanging the side-lobes; neck of the glabella rather broad, flattened, formed by its posterior prolongation to the neck segment. Side-lobes elongate, concavo-convex laterally, extending rather further back than the base of the glabella. Neck segment broad but not very convex. Surface covered with pustules of various sizes and irregular form, arranged without regard to order. Glabella furrows well marked.

Obs.—We are only acquainted with the glabella of this species from Girvan, but its characters are so essentially simple as compared with most other members of the genus, that it is easily recognised. The almost straight neck-lobe, with the

[1] 1865, p. 21.

oval side-lobes descending quite to the latter, without the intervention of any intermediate lobes, is very characteristic. It is the *Lichas avus* of the 'Catalogue of Western Scottish Fossils,' but not of M. Barrande. It certainly resembles the Bohemian form in the character of its ornamentation; otherwise it is totally different.

We have four specimens, all glabellæ, and only in one specimen are the accessory lobes preserved; the others consist merely of the forehead and side lobes. *L. macrocephala*, Eichwald, is another similar form.

Lichas ornatus, Angelin, closely resembles the Girvan species, and like it has the large side-lobes descending to the neck-furrow, giving it a bold and marked appearance.

Loc. and Horizon.—Craighead quarry, in limestone; Balcletchie, in fine-grained mudstone. (Gray collection.)

Lichas Grayii, Fletcher (?).

(Pl. IX., figs. 11, 12.)

Lichas Grayii, Fletcher, Quart. Jour. Geol. Soc., 1850, vi., p. 237, t. 27, f. 8, t. 27 *bis*, f. 3, *a* and *b*.
„ „ Morris, Cat. Brit. Foss. 2d. ed. 1854, p. 110.
„ „ Bigsby, Thesaurus Sil., 1868, p. 57.
„ „ Woodward, Cat. Brit. Foss. Crustacea, 1877, p. 43.

Spec. char. — Head nearly semicircular, gibbous in front. Glabella large, convex, as broad or broader anteriorly than posteriorly; forehead-lobe continuous from the front margin to the neck-segment, narrowing posteriorly till on a level with the base of the side-lobes, where it is marked by a slight constriction or transverse groove, then suddenly expanding at the base, with a slight prominence or node on each side. Upper lateral lobes oval, obtusely pointed, not extending to the neck-segment, but cut off by the posterior expansion of the forehead-lobe; lateral side-lobe more or less triangular. Neck-segment not prominent; glabella furrows well marked; surface covered with close-set granules.

Obs.—We refer this specimen to *L. Grayii* provisionally, as

we have not had the advantage of comparing it with any typical examples: it appears to agree better with this species, however, than with any other. The form of the side-lobes and the posterior expansion of the forehead-lobe separate our specimen from *Lichas Bucklandi*, M. Edw., and *L. Salteri*, Fletcher. From *L. laxatus*, M'Coy, and *L. verrucosus*, Eichwald, it is separated by the much greater width of the neck of the forehead-lobe, and the different form of the supplementary side-lobes. Its dissimilarity to *L. Hibernicus* is at once apparent.

Loc. and Horizon. — Drummuck, in fine-grained greenish mudstone. (Gray collection.)

Lichas, *sp. ind.*

(Pl. IX., figs. 13, 14.)

Obs.—This is in all probability a portion of the cephalic shield of a *Lichas*. We observe the fore part of the forehead-lobe, and a small portion of the right side-lobe, a portion of the eye-lobe, and the right eye with its facets, preserved. The lobes are all granulated. On the under side is visible the hypostome, of an oval or egg-shaped form, with one of its alar prolongations partially preserved. This fragment is interesting, from the forward position of the eye in relation to its position with the side-lobe, and its size.

Loc. and Horizon.—Drummuck. (Gray collection.)

END OF THE FIRST FASCICULUS.

PRINTED BY WILLIAM BLACKWOOD AND SONS.

A MONOGRAPH

OF THE

SILURIAN FOSSILS OF THE GIRVAN DISTRICT IN AYRSHIRE

WITH SPECIAL REFERENCE TO THOSE CONTAINED IN THE "GRAY COLLECTION"

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F.R.P.S. ED.

OF THE GEOLOGICAL DEPARTMENT OF THE BRITISH MUSEUM

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FASCICULUS II.

(TRILOBITA, PHYLLOPODA, CIRRIPEDIA AND OSTRACODA)

WILLIAM BLACKWOOD AND SONS

EDINBURGH AND LONDON

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PREFACE TO THE SECOND FASCICULUS.

THE present Fasciculus is occupied wholly with the Crustacea of the Silurian rocks of Girvan, and contains the Trilobita (continued from the First Fasciculus), the Phyllopoda, the Cirripedia, and the Ostracoda. We had originally hoped to include in the present part the *Polyzoa* of the area under consideration, but we have found this impossible, upon two grounds :—

In the first place, indisposition on the part of one of us has considerably interfered with the production of the present Fasciculus, and has compelled us to make it shorter than we would otherwise have done,—a deficiency which we trust to be able to compensate for in the Third Fasciculus.

In the second place, a new series of researches which have been carried out during the past summer by Mrs Gray in the Girvan district, to a large extent in localities not previously examined, has resulted in placing in our hands a very large mass of additional material relating to the Protozoa, Cœlenterata, and Crustacea ; and either embracing new forms, or in various respects adding to the already available information as to forms formerly described.

Under these circumstances, we have decided to publish in the Third Fasciculus an extended Supplement, dealing with

all the new material which we have obtained in connection with the groups of animals above mentioned. The amount and importance of the additional material in question would seem to render this a preferable course to that of waiting till we are enabled to publish a "General Supplement" at the end of the entire work. The preparation of the Third Fasciculus is now well advanced, and we shall include in it, not only the Supplement above spoken of, but, if space permits, also the section dealing with the Polyzoa.

In connection with the present Fasciculus, we have to express our gratitude to the Royal Society for further assistance from the Government grant. We have also to return our best thanks to our friends Dr Henry Woodward, F.R.S., and R. B. Newton, Esq., for assistance in working out the Trilobites; to Professor T. Rupert Jones, F.R.S., for his great kindness in supplying us with notes on the Ostracoda; and to T. W. Newton, Esq., for help in the verification of authorities and references.

We are greatly indebted and obliged to Professor Kjerulf for the loan of certain specimens for comparison from the Christiania Universitets Mineralkabinet, which were of the greatest use to us in our investigations of the genus *Ampyx*.

As in the case of the Trilobites dealt with in the First Fasciculus, the plates have been drawn and put upon the stone by our friend Mr Charles Berjeau, F.L.S.

United College, St Andrews, and
British Museum, London,
November 1879.

A MONOGRAPH

OF THE

SILURIAN FOSSILS OF THE GIRVAN DISTRICT.

CRUSTACEA (*Continued*).

Genus LICHAS, Dalman (*continued*).

Lichas Geikiei, Etheridge jun. and Nicholson, (*sp. nov.*)

(Pl. X., fig. 1.)

Spec. char.—General form oval, but wider in front than behind. Head irregularly semicircular, the anterior portion tumid and projecting in front, and divided into seven lobes; forehead-lobe expanded in front, overhanging the upper lateral lobes, contracting posteriorly to a narrow neck, and then expanding widely to a narrow base which is cut off by the neck-furrow; upper lateral lobes reniform, their inner margins, or those next the forehead-lobe, indented by a small notch (in casts); they do not extend posteriorly to the neck-furrow, being cut off by the expanded base of the aforesaid forehead-lobe; lower lateral lobes far apart, larger than the upper, and of a different shape; basal lobes oval, somewhat large and interrupting the neck-furrow. All the furrows separating the lobes are deep, wide, and well marked (in casts); the upper lateral lobes are almost

but not quite circumscribed, the furrows not quite meeting towards their lower portions; the basal lobes are deeply circumscribed below (in casts), but not so in their upper part. The neck-furrow in its central part is broad and shallow, but against the basal lobes becomes deep and well marked. Facial suture anterior to the eye gradually and gracefully curving outwards to the front margin; but posterior to the eye, it is, for a short distance, parallel to the neck-furrow, curving round the small scar representing the eye; again it turns parallel to its former course; and it cuts the posterior margin at about half-way between the basal lobe and the lateral margin of the head-shield. Free cheeks or wings of a peculiar antler-like elongated form, with a concentrically-striated broad front edge; genal angles rounded, not produced. Eyes not preserved, but represented by oval scars occupying the most elevated or convex portion of the free cheeks. Surface of the frontal lobe (and the others ?) with scattered tubercles.

Thorax of eleven somites, and, as preserved, devoid of ornamentation; the axis is about two lines wide, broad and convex; the pleuræ are about three lines, or a little more, in width, deeply grooved from the axis nearly to their distal ends, the extremity of each being slightly expanded and rounded.

Pygidium broadly oval and composed of four short coalescent rings; the axis gradually contracts to a bluntly-rounded posterior extremity, from which a small median ridge arises uniting it with the outer posterior border, which is finely lineate; the margin does not appear to have been ornamented with projecting spines.

Obs.—Our specimens are quite decorticated, so that the more or less granular ornamentation so characteristic of the genus *Lichas* is not to be detected save on the pygidium, and even there it is very ill preserved. The frontal portion of the glabella is very tumid, but the latter narrows rapidly as it recedes towards the posterior margin. The free cheeks have the usual rounded and broadly falcate form seen in *Lichas*.

We have carefully compared our specimens with the English species of *Lichas* (*L. anglicus*, *L. Barrandii*, *L. Grayii*, *L. Bucklandi*, *L. laxatus*, &c.), and with those from Sweden, figured by Angelin, and from Bohemia by Barrande.

The blunt axis and rounded entire margin of the pygidium at once distinguish this from all those species of *Lichas* with spinous tails. Of described forms, it otherwise approaches nearest to *L. laxatus*, M'Coy, and *L. verrucosus*, Eichwald; but in the former the eyes were evidently much larger. The nature of the tail forbids any reference to *L. Barrandii*, Fletcher, *L. hirsutus*, Fletcher, and *L. laciniatus*, Dalman; whilst the form of the head at once separates *L. Geikiei*, from *L. anglicus*, Beyrich.

The Swedish species *L. cicatricosus*, Lovén, appears somewhat near our specimens in the general form of the glabella; but the respective pygidia, again, show them to be very clearly distinct. This is also the case with *L. sexspinus*, Angelin.

None of the Bohemian species of *Lichas* approach this Girvan form, except, perhaps, *L. heteroclyta*, Barr,[1] which possesses a rounded limb to the pygidium without any extension into spines. It is, of course, just possible that small spines may have existed round the margin of the tail, and have been removed with the outer shell; but even supposing this to be the case, there are other points of difference which will, we think, separate this form as distinct. We are therefore led to the conclusion that our Girvan *Lichas* must be considered as specifically distinct from any which has been heretofore described, so far as we have been able to ascertain; and we therefore propose to associate with it the name of Professor A. Geikie, LL.D., F.R.S., to whom we are indebted for the loan of specimens from the Collection of the Geological Survey of Scotland.

Loc. and Horizon.—Drummuck, in a fine-grained, greenish sandstone or mudstone (*Coll. Geol. Survey, Scotland*). Collected by Mr A. Macconochie.

[1] Syst. Sil. Bohême, i., t. 28, f. 33.

Genus CYPHASPIS, Burmeister, 1843.

(Die Organ. der Trilobiten, p. 103.)

Cyphaspis megalops, M'Coy.

Harpes megalops, M'Coy, Sil. Foss., Ireland (1846), 1862, p. 54, t. 4, f. 5.
Harpidella megalops, M'Coy, Annals Nat. Hist., 1849, iv. p. 412.
,, ,, M'Coy, Brit. Pal. Foss., 1852, fas. 2, pp. 143-368.
Cyphaspis ,, Salter, Mem. Geol. Survey, Dec. vii., No. 5, p. 1, t. 5.
,, ,, Salter and Woodward, Chart. Foss. Crustacea, 1865, f. 104.
,, ,, Salter, in Murchison's Siluria, 1867, 4th ed., p. 235, foss. 65, f. 2.
,, ,, Bigsby, Thesaurus Sil., 1867, p. 49.
,, ,, Woodward, Cat. Brit. Foss. Crustacea, 1877, p. 34.

Obs.—Unfortunately we have not been able to obtain specimens of this interesting Trilobite from Girvan, although it is recorded from there by Professor M'Coy,[1] and Sir Wyv. Thomson.[2] Through the kindness of Professor T. M'K. Hughes, we have been able to examine the specimen in the Woodwardian Museum, and find it to be in a very unsatisfactory condition for exact determination. Sir Wyville Thomson's example we have not seen.

Loc.—Mulloch Quarry, near Girvan (*Woodwardian Museum*, and *Coll., Sir Wyv. Thomson*).

Genus CALYMENE, Brongniart, 1822.

(Hist. Nat. Crust. Foss., pp. 7 and 9.)

Calymene Blumenbachii, Brongniart.

(Pl. X., figs. 2-6.)

Calymene Blumenbachii, Brongniart, Hist. Nat. Crust. Foss., 1822, p. 11, t. 1, f. 1 *a-c.*

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[1] Brit. Pal. Foss., p. 368, as *Harpidella.*
[2] Quart. Jour. Geol. Soc., xiii. p. 209.

Entomolithus paradoxus, Linn., Act. Soc. Sci. Holmiensis, 1759, p. 22, t. 1, f. 3.
Trilobites Blumenbachii, Schlotheim, Nachrichten, 1823, ii. pp. 131-133.
Calymene „ Dalman, über die Palæaden, &c., 1828, p. 35, t. 1, f. 2 and 3.
„ „ Green, Monthly American Jour. Geol., i. 1832, No. 12, p. 558.
„ „ Bronn, Lethæa Geog. 1835, i. p. 110, t. 9, f. 3.
„ „ Hisinger, Lethæa Suecica, 1837, p. 10, t. 1, f. 3 and 4.
„ „ Emmrich, de Trilobitis, 1839, p. 39.
„ *senaria*, Conrad, Ann. Rep. Pal. N. York, 1841, p. 49.
„ *Blumenbachii*, Portlock, Geol. Report, Londonderry, 1843, p. 285, t. 3, f. 1*a*.
„ „ Mantell, Medals of Creation, 1844, ii. p. 555, p. 553, lign. 121, f. 3, 4, and 4^a.
„ „ Geinitz, Grundriss, 1846, p. 225, t. 9, f. 2 *a* and *b*.
„ „ Burmeister, Organ. Trilobites, 1846, p. 81, t. 2, f. 1-3 (English edition).
„ *senaria*, Hall, Pal. N. York, 1847, i. p. 238, t. 64, f. 3 *a-n*.
„ *Blumenbachii*, Mantell, Wonders of Geol., 1848, ii. p. 789, lign. 178.
„ „ Salter, Quart. Jour. Geol. Soc., 1851, vii. pp. 171, 172, t. 9, f. 1 *a* and *b*.
„ „ var. *niagarensis*, Hall, Pal. N. York, 1851, ii. p. 307, t. 67, f. 11 and 12.
„ „ F. Roemer, in Bronn's Lethæa Geog., 1851-1856, i. 2 Theil, p. 612, t. 9, f. 3, t. 9^1, f. 24 *a* and *b*, t. 9^2, f. 15.
„ „ Barrande, Syst. Sil. Boh., 1852, i. p. 566; Atlas, t. 19, f. 10, t. 43, f. 46-48; Supp. 1872, p. 36, t. 14, f. 33, t. 15, f. 15.
„ *spectabilis*, Angelin, Pal. Scandinavica, 1854, p. 28, t. 19. f. 5.
„ *Blumenbachii*, Morris, Cat. Brit. Foss., 1854, 2d ed., p. 102.
„ „ Buckland, Bridgewater Treatise, 2d ed., 1858, ii. t. 64, f. 1-3.
„ „ Eichwald, Lethæa Rossica, 1860, i. p. 1420.
„ „ F. Roemer, Sil. Fauna, W. Tennessee, 1860, p. 179, t. 5, f. 22.
„ „ Salter, Mon. Brit. Trilobites, 1865, pt. 2, p. 93, t. 8, f. 7-16, t. 9, f. 1 and 2.
„ „ Salter, Mem. Geol. Survey, 1866, iii. p. 326, t. 17, f. 1-7; and vars. t. 17, f. 9, 13 and 14.
„ „ Salter, in Murchison's Siluria, 1867, 4th ed., p. 68, foss. 13, f. 1, t. 17, f. 1, t. 18, f. 10.
„ „ Bigsby, Thesaurus Sil., 1868, p. 42.
„ „ Lyell, Students' Manual of Geology, 1871, p 450, f. 541.
„ *senaria*, Hall and Whitfield, Ohio Geol. Survey Report, i. pt. 2 1873, p. 173, t. 14, f. 14, *a-f*.

Calymene Blumenbachii, Dana, Manual of Geology, 2d ed., 1875, p. 120, f. 167, p. 202, f. 361.
" " Salter, Cat. Camb. Sil. Foss., Woodwardian Mus. Cambg., 1873, pp. 53, 77, 132, and 166.
" " Lyell, Students' Manual, 2d ed., 1874, p. 464, f. 530.
" " F. Roemer, Lethæa Geog., 1876, Atlas, t. 17, f. 15.
" " Woodward, Cat. Brit. Foss. Crustacea, 1877, p. 28.
" " de Koninck, Foss. Pal. Nouv. Galles du Sud., 1876, p. 55.
" *Niagarensis*, Miller, American Pal. Foss., 1877, p. 213.
" " Etheridge jun., Cat. Australian Foss., 1878, p. 15.

Obs.—The above synonomy may be considered as in a measure supplementary to that given by Mr Salter in his 'Monograph,' and embraces a number of important and selected references.

We do not think it necessary to redescribe this common, widespread, and well-marked Trilobite, as Salter's diagnosis will be found sufficient for all purposes of identification.

Calymene Blumenbachii occurs plentifully at one or two localities in the Girvan district, usually in the form of internal casts, but occasionally a specimen is found with portions of the integument remaining. When in the former state, the various glabella-furrows, as well as those of the thorax and pygidium, are, by removal of the old thick crust, exceedingly well marked, broad, and deep. This is especially to be noticed in the marginal furrow of the glabella in individuals from Drummuck, where the species occurs in the greatest profusion, and of the largest size. So very marked is this in some cases, as to cause the strong prominent margin to project sensibly forward, indicating a transition towards *Calymene tuberculosa*, Salter. Again, examples are not wanting in which the knots, or blunt tubercles, down the sides of the thoracic axis, are quite as well marked as in any of those examples figured by Mr Salter,[1] although not so prominent as in the var. *Allportiana* or *C. tuberculosa*. In all probability such a specimen caused one of us to record[2] the occurrence of *C. tuberculosa* at Girvan, although

[1] Monograph, t. 8, f. 12 and 15.
[2] Mem. Geol. Survey, Scot., Expl. 3, 1873, p. 31.

we cannot at the present moment refer to the fossil; so far, however, as the "Gray Collection" is concerned, we have not observed any *Calymene* in which the frontal margin is so projecting or snout-like as in the latter species. In only one specimen is the integument sufficiently well preserved to show the ornamentation, but in this particular instance there is an entire absence of the tubercles generally seen on *C. Blumenbachii*, and the surface is simply scabrous or microscopically granular, a feature met with in certain varieties of the latter, according to Salter, and also a character of *C. tuberculosa*, and to some extent of *C. senaria*, Conrad. The Collection of the Geological Survey of Scotland possesses an unusually well-preserved example, in which the whole of the head is after this pattern. In nearly all the examples of the pygidium of *C. Blumenbachii* from Girvan, the bifurcation of the pleuræ is well marked. There are, however, examples from Mulloch in which it is scarcely perceptible; this is especially the case in small specimens.

As regards the general outline of the Girvan form of *C. Blumenbachii*, it appears to us to approach nearer to that variety called by Salter *Caractaci*, than with the true "Dudley Trilobite." The length, as against the width, when compared with the measurements of the latter, accord better to our minds with those of the elongated body of the variety than with the squarer form figured by Salter as characteristic of the true species.

With the view of ascertaining to how many species the *Calymenæ* of Girvan may be referred, we have made a most careful comparison with the species of this genus represented in the collections of the British Museum and Museum of Practical Geology. Our investigations in this direction, and the material from Girvan at present in our possession, have led us to the conclusion that the true Dudley form of *C. Blumenbachii* either does not exist in that area, or is of only rare occurrence; at any rate we have not met with any examples.

On the other hand, we were at first inclined to refer the South

of Scotland forms to two species, but after mature consideration we think it best for the present to look upon the specimens as only referable to one. This, as before stated, resembles both *C. Blumenbachii*, var. *Caractaci*, and *C. senaria* in the elongated body; but so far as the first of these is concerned, the difference between it and ours consists in the much broader frontal lobe of the latter, especially in its most anterior part.

As to *C. senaria*, we would point out that the glabella, as bounded by the axal furrows, is of a much more triangular form than that seen in any of the Girvan fossils. Again, the fixed cheeks are of a different outline, assuming a more laterally elongated appearance in the latter than in the former. On the other hand, an undoubted approach to *C. senaria* is to be found in the ornamentation of the Girvan Trilobites, which is simply microscopically granular, but without the "larger and smaller tubercles" of *C. senaria;* nor is it "roughly tubercular," as in *C. Blumenbachii* proper.

Under all circumstances, therefore, we look upon the form now under description as a variety of *C. Blumenbachii*, intermediate in some of its characters between *Caractaci* and *C. senaria.* It is the var. *a* of Mr Salter.[1] The labrum of this species is occasionally met with in the Girvan beds. Mr Salter has already given a figure of one, and we now represent the impression of another *in situ* (Pl. X., fig. 3) in the Trilobite.

Loc. and Horizon.—Ladyburn, above Drummuck (Etheridge);[2] Ladyburn, opposite Thrave (Etheridge jun.);[3] Roughneuk quarry (Etheridge jun.);[4] Drummuck (Gray Collection, &c.), in a fine-grained liver-coloured rock; Mulloch Hill (Gray Collection), in a fine-grained dark sandstone (?). Chiefly as specimens with the integument removed.

In addition to the foregoing localities, a tail has been met with by Mrs Gray in the shale at Craighead Quarry, and portions of the body of two individuals in the greenish-grey mudstone of Penkill.

[1] Monograph, t. 9, f. 2.
[2] Mem. Geol. Survey Scot., Expl. 14, 1869, p. 9.
[3] Ibid., Expl. 3, 1873, p. 31.
[4] Ibid., p. 30.

A last fact worthy of notice is, that all the individuals from Mulloch Hill are much smaller than those from Drummuck; and it is just possible that if any specific separation is hereafter required, the respective forms met with at these two localities may represent the two species.

Genus REMOPLEURIDES, Portlock, 1843.

Remopleurides, Portlock, Geol. Report, Londonderry, 1843, p. 254.
Caphyra, Barrande, Notice Préliminaire, 1846, p. 32.
Remopleurides et Amphitryon, Corda, Prodrom einer böhmischen Trilob., 1847, pp. 111-113.
Remopleurides, Salter, Mem. Geol. Survey, Dec. vii., No. 8, 1853, p. 1.
,, Barrande, Syst. Sil. Boh., 1852, i. p. 356.

Obs. — The late Mr J. W. Salter proposed to subdivide *Remopleurides* into two sections, depending on the presence or absence of furrows on the glabella. For the latter section Portlock's original term was retained; whilst for the former Barrande's name, *Caphyra*, was used, being next in order of precedence. This appears to us to be a very natural division of the genus, and it affords us much pleasure to carry out Salter's proposal. If we pass in review the species of *Remopleurides* known to us, we find that they fall very naturally into one or other of these two sections, thus—

Section *Remopleurides.*	Section *Caphyra.*
R. affinis, Billings.	*R. quatuorlineatus*, Angelin.
R. Canadensis, do.	*R. radians*, Barrande.
R. Colbii, Portlock.	*R. Schlotheimi*, Billings.
R. dorsospinifer, do.	*R. sexlineatus*, Angelin.
R. laterispinifer, do.	
R. longiscostatus, do.	
R. obtusus, Salter.	
R. Panderi, Billings.	
R. platyceps, M'Coy.	

So far as we know, all the species hitherto described from British rocks belong to the section *Remopleurides*, with one exception, *R.* (*Caphyra*) *radians*, Barrande, which is found in

Wales. We have to introduce in succeeding pages another member of the latter section.

Section Remopleurides. The glabella devoid of furrows.

Remopleurides Colbii, Portlock (?).

(Pl. X., figs. 8-8 *a*.)

Remopleurides Colbii, Portlock, Geol. Report, 1843, p. 256, t. 1, f. 1.
„ *Kolbii*, Emmrich, N. Jahrbuch, 1845, p. 45.
„ *Colbii*, M'Coy, Sil. Foss., Ireland (1846), 1862, p. 43.
„ „ Salter, Mem. Geol. Survey, Dec. vii., 1863, No. 8, p. 1, t. 8, f. 1, *a-f*.
„ „ Morris, Cat. Brit. Foss., 1854, 2d. edit., p. 115.
„ „ Salter and Woodward, Chart Fossil Crustacea, 1865, f. 40.
„ „ Bigsby, Thesaurus Sil., 1868, p. 67.
„ „ Woodward, Cat. Brit. Foss. Crustacea, 1877, p. 57.

Spec. char.—Glabella, large, convex, anteriorly bent down, but flattened or gradually sloping off towards the posterior margin; sides arched outwards; without the anterior projection or lip the glabella is broad-oval—with it, it is strongly urceolate; the base is well indented by the eyes, and the posterior margin straight. Lip, tongue, or anterior projection bent down, becoming almost vertical in front, separated from the anterior portions of the eyes by deep notches (in casts). The axal furrows immediately bound the glabella, and on arriving at the anterior extremity of the eye, they become much deeper, broader, and (as before stated) notch-like. Then they are immediately bent down, following the outline of the tongue or lip, and on reaching, but without touching, the rostral suture, are bent inwards towards the centre of the tongue; here the two prolongations approach but do not meet, thus leaving a portion of the latter between them as a small prolongation. Eyes placed more or less in a vertical position, very large, semi-lunar, much wider anteriorly, but posteriorly indenting the base of the glabella, passing obliquely downwards and inwards, and facetting with the neck-

segment. The eyes, on their lower margins, are also bounded by grooves and narrow borders continuous with the rostral groove. The eye-lobes towards the anterior end are reduced to mere rims, but over the attenuated posterior portion of the eyes they expand horizontally and project; surface of the eyes microscopically reticulate, with innumerable lenses. Rostral shield well marked. Free cheeks small and triangular; posterior angles produced into spines; neck-furrow narrow and not particularly well marked, widening under the attenuated posterior ends of the eyes; neck-segment wider than the base of the glabella. Surface of the latter apparently unornamented. Of the thorax, only four segments are preserved; axis convex, wide, but not equal to the width of the glabella. Pleuræ short, falcate, directed backwards and downwards, and almost separated into two portions by a deep oblique furrow, which does not, however, pass quite to the acute apex in each pleura; the forward margin of each pleura is provided, just at its junction with the axis, with a projecting fulcral tubercle, and at a corresponding point on the posterior margin with a deep notch for the reception of the tubercle of the succeeding pleura, and with a raised border. The axis-segments are ornamented with transverse striæ and granules, and the posterior margin of each is pectinated by a row of projecting tubercles; the pleuræ are obliquely striated, the striæ distant from one another.

Obs.—The above characters are essentially those of the Girvan specimen, and are given at length in order to show how far it agrees with Salter's description of *R. Colbii*, and to what extent it differs. We are under obligations to the officers of the Museum of Practical Geology for permission to examine in detail the fine set of specimens of this genus under their charge; the types, in fact, figured by Portlock and Salter. Our Girvan specimen, a weathered internal cast, appears to agree with *R. Colbii* in almost every particular; it is, however, a little larger, and is not entire. The study of the above specimens quite enables us to appreciate the difficulty under which Mr

Salter laboured in arriving at a satisfactory conclusion relative to the specific value of the three names, *R. Colbii*, *R. lateri-spinifer*, and *R. dorsospinifer*, "except, of course, in the remarkable appendages to which the specific names refer," as he himself says.[1] As the Girvan form does not retain the afterpart of the thorax and the pygidium, we think it more prudent to place a note of interrogation after the name, although, in our minds, there exists very little doubt as to its identity with the first of the above species. It certainly does differ from *R. Colbii* in the proportions of the pleuræ to the remainder of the body; they here appear larger, and of a slightly different shape. According to Salter, the axis-segments of the thorax are crossed by transverse lines; but a close examination of the type-specimen has convinced us of more than this. To us the lines look like closely-applied sub-imbricating granular laminæ, tubercular on the hinder edge of the somite, and having very much the appearance, at first sight, presented by the body-segments of the Carboniferous *Eurypterus Scouleri*, Hibbert.

From *R. Panderi*, Billings,[2] the present species is easily distinguished by the peculiar single furrow on each side of the glabella of the former. In *R. Canadensis*, Billings,[3] there are again, obscure furrows present, and the form and length of the eyes are entirely different from that of *R. Colbii*. In *R. affinis*, Billings,[4] the general proportions are quite different, the glabella is not so broad or convex, the eyes are much longer, and the form is not the same. In *R. platyceps*, M'Coy,[5] the glabella is flattened and the eyes (described as cheeks) form a narrow semi-lunar margin, giving rise to quite a different arrangement to that seen in the present form.

Loc. and Horizon.—Drummuck, in a fine-grained mudstone (Gray Collection); so far as we are aware, this species has not hitherto been recognised as a Girvan form.

[1] Decade, vii. p. 6. [2] Canadian Pal. Foss., p. 293, f. 283. [3] Ibid., i. p. 182, f. 164.
[4] Ibid., p. 325, f. 313. [5] Sil. Foss., Ireland, p. 44.

Remopleurides laterispinifer, Portlock.

(Pl. X., figs. 10, 11; Pl. XI., fig. 15.)

Remo. laterispinifer, Portlock, Geol. Report, 1843, p. 256, t. 1, f. 2.
„ *laterispina*, Corda, Prod. Mon. böhm. Trilobiten, 1847, p. 113, t. 6, f. 59.
„ *laterispinifer*, Salter, Mem. Geol. Survey, Dec. vii., No. 8, p. 4, t. 8, f. 2-2 *c*.
„ „ Morris, Cat. Brit. Foss. 2d ed., 1854, p. 115.
„ „ M'Coy, Synop. Sil. Foss., Ireland (1846), 1862, p. 43.
„ „ Bigsby, Thesaurus Sil., 1868, p. 67.
„ „ Woodward, Cat. Brit. Foss. Crustacea, 1877, p. 57.

Obs.—We have before us several specimens, in two of which the peculiar development of the seventh pleura on each side is visible, and from which the form derives its name. In neither is the head or pygidium preserved. The segments of the thoracic axis are ornamented in a precisely similar manner to that seen in *R. Colbii*, except that the granules are arranged in a single row on the anterior part of each segment, and separated by a fine transverse line from the fringing tubercles on the posterior portion.

Loc. and Horizon.—Ardmillan Brae, in a fine-grained sandstone; shore at Ardwell, in a fine-grained sandstone.

Remopleurides, *sp. ind.* (*a*).

(Pl. X., figs. 9, 9 *a*.)

Obs.—We prefer to figure the fragmentary cast represented as above separately, because it may be different from either of the foregoing, though not sufficiently complete to enable us to say much about it. The specimen consists of a portion of a flattened glabella and one eye, with the remains of the axes of three thoracic somites. The former is ornamented with granules, the latter show very distinct traces of oblique, fine, sub-imbricating laminæ, and are sprinkled with granules; but, so far as we can make out, the posterior margin of each segment is not provided with projecting tubercles, or, at any rate, by no means

to such an extent as in *R. Colbii* or *R. laterispinifer*. It is just possible that this may be only a larger condition of the form which we have identified with *R. Colbii*, to which it approaches nearest; or it may be the large form, *R. longicostatus*, Portlock; only in this "species" the glabella and thoracic somites are lamellar-striate, whilst in the present instance they are both lamellar-striate and granular.

Loc. and Horizon.—Drummuck, in a fine-grained greenish mudstone. (Gray Collection.)

Remopleurides, *sp. ind.* (*b*).

(Pl. X., fig. 12.)

Obs.—We may advantageously conclude this section of the genus *Remopleurides* by giving a figure of a small and imperfect specimen in which the greater portion of the glabella is preserved, and a part of the thorax. There is no trace of ornamentation either on the glabella or segments; but the structure of the eye is particularly well shown. We leave its identity an open question.

Loc. and Horizon.—Balcletchie, in a fine-grained greenish mudstone. (Gray Collection.)

The following analysis of a few of the characters of the four species of *Remopleurides* named below, taken direct from the types in their present condition, may be found of service :—

R. Colbii, Portlock.—Glabella devoid of ornamentation; thoracic segments horizontally lamellar-striate and granular, with a prominent row of spinous projections on the posterior margin of each somite; pleuræ horizontally striate—*i.e.*, parallel with their longer axes.

R. laterispinifer, Portlock.—Head, thoracic appendages, and pleuræ *apparently* devoid of ornament.

R. dorsospinifer, Portlock.—Head and thoracic segments apparently plain; pleuræ vertically striate—*i.e.*, striated parallel to their shorter axes.

R. longicostatus, Portlock.—Glabella lamellar-striate; thoracic segments vertically striate; pleuræ striate vertically, and obliquely outwards from their posterior margins.

Section Caphyra. Glabella with three pairs of furrows, not inflated.

R. (Caphyra) Barrandii, Eth. jun., and Nich., (*sp. nov.*)

(Pl. X., figs. 13-16; Pl. XI., fig. 16.)

Spec. char.—Head semi-oval; glabella flattened, strongly urceolate, anteriorly produced into a prominent and well-marked tongue or lip, somewhat attenuated posteriorly and indented by the eyes. There are three pairs of furrows—the basal and middle pairs almost horizontal, and at about equal distances apart; the anterior pair take their origin immediately at the anterior termination of the eyes at the base of the lip or tongue, and are directed obliquely downwards and inwards. Eyes prominent, semi-annular, forming a narrow marginal band to the large expanded portion of the glabella, extending backwards to the neck-furrow, and indenting the posterior margins of the glabella; eye-lobes linear, very minute. Neck-furrow extending all across, a little bent up in the middle line at the base of the glabella; neck-segment rather broad, obliquely striated, and without a tubercle. Wings or free cheeks elongately triangular, extending round in front of the tongue or lip of the glabella, and bordered with a small striate front margin, which is produced at the posterior angles into small, fine, short, and delicate spines. Surface of the free cheeks and glabella minutely reticulate. Thorax and pygidium unknown.

Obs.—It affords us much pleasure to name this well-marked, although small species, in honour of the indefatigable author of the section into which it properly falls from the nature of its glabella-furrows. We have been at considerable trouble in working out the affinities of *R. Barrandii;* and having availed ourselves of the descriptions and figures of all the known species (at any rate so far as we are aware), we feel justified in introducing it as undescribed, as it does not agree with any of the recorded forms.

From the Swedish species, *R. quatuorlineatus*, Angelin, [1] and *R. sexlineatus*, Angelin,[2] it is distinguished by its much smaller glabella, and the very great difference in the size of the anterior tongue. In the two former species this is reduced to a mere point, and at the same time the eyes are proportionately elongated, and the general form of the glabella is much more rotund.

In *R. Schlotheimi*, Billings,[3] the eyes do not completely encircle the side portions of the glabella, and they do not join the neck-furrow; the direction of the glabella-furrows is also somewhat different from that seen in the Scotch form.

From *R. Panderi*, Billings,[4] *R. Barrandii* is at once separated by the reduction of the glabella-furrows to one pair, and those of a very peculiar nature.

In *R. Canadensis*, Billings,[5] the surface of the glabella is tubercular and not reticulate as in our form, and there is a tubercle present on the neck-segment. The position of the eyes much more closely resembles the arrangement seen in *R. Barrandii*, but the tongue is a much less marked and prominent character.

Unlike *R. Barrandii*, the Bohemian species, *R. radians*, Barr,[6] has the surface striated, the tongue is much smaller and more elongated for the size of the Trilobite generally, and the position of the furrows in the two species differs; in the Bohemian form they are much more obliquely inclined towards one another on each side than in our species, but the place of the latter is decidedly near that of *R. radians*. The absence of furrows renders it hardly necessary to make a comparison with *R. affinis*, Billings,[7] but the latter may be just referred to in passing, from the resemblance there is between the glabella in the two forms. We have examined a number of specimens of *R. Barrandii*, and find the characters to be constant, except

[1] Pal. Scandinavica, 1854, p. 13, f. 9, f. 8.
[2] Ibid., f. 7 and 7 a.
[3] Pal. Foss. Canada, i. p. 294, f. 284, *a* and *b*.
[4] Ibid., p. 293, f. 283.
[5] Ibid., p. 182, f. 164.
[6] Syst. Sil. Bohême, i. p. 359, Atlas, t. 43, f. 33-39.
[7] Pal. Foss. Canada, i. p. 335.

that in one or two individuals there is a tendency in the grooves to become faint.

Loc. and Horizon.—Balcletchie, in fine-grained greenish mudstone. (Gray Collection.)

Genus ASAPHUS, Brongniart,[1] 1822.

(Hist. Nat. des Crust. Foss., pp. 7 and 17.)

Section Basilicus, *Salter*, 1849.

Asaphus radiatus, Salter.

(Pl. X., fig. 17.)

Asaphus (*Basilicus?*) *radiatus*, Salter, Mon. Brit. Trilobites, 1866, pt. 3, p. 157, t. 18, f. 15 (*for synonomy*).
„ „ „ Bigsby, Thesaurus Sil., 1868, p. 39.
„ „ „ Woodward, Cat. Brit. Foss. Crust., 1877, p. 26.

Obs.—Our acquaintance with *A. radiatus* as a Girvan species depends solely on the remains of the fine pygidium given in Pl. X., fig. 17. From the label attached to it, it appears to have been collected by the late A. Macallum. The anterior segment is wanting, seven only being preserved in the specimen; the terminal body, however, is quite discernible.

Loc. and Horizon. — Penwhapple burn, in a fine-grained greenish mudstone (*Coll. Mus. Pract. Geology*). This is a typical Caradoc species.

Section Isotelus, *De Kay*, 1824.

Asaphus gigas, De Kay (?).

(Pl. X., figs. 18, 19.)

A. (*Isotelus*) *gigas*, (De Kay) Salter, Mon. Brit. Trilobites, 1866, pt. 3, p. 161, t. 24, f. 1-5, t. 25, f. 1 (*for synonomy*).
„ *sp.* Salter, Quart. Jour. Geol. Soc., 1851, vii. p. 170, t. 8, f. 2.
„ „ Salter, Mon. Brit. Trilobites, 1866, pt. 3, p. 168.

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[1] *Asaphus rectifrons* has been recorded (Mem. Geol. Survey, Scot. Expl., iii. 32) from Ardmillan Brae, but we have not been able to obtain evidence of this.

Asaphus gigas, Salter and Woodward, Chart Foss. Crustacea, f. 72.
Isotelus „ Bigsby, Thesaurus Sil., 1868, p. 56.
„ „ Woodward, Cat. Brit. Foss. Crustacea, 1877, p. 25.
„ „ Etheridge and Young, Mem. Geol. Survey, Scot., 1873, Expl. 3, p. 32.

Obs.—This species was probably first recorded as a Girvan form by Mr Salter, who mentioned the occurrence of an *Asaphus* of this section in the Girvan district contained in Sir R. Murchison's cabinet.[1] He again referred to it in his 'Monograph,' but without applying to it any distinctive name, although he considered the specimen "probably distinct from *I. gigas*."

The material at present at our disposal is meagre in the extreme—four specimens, and all in a miserable state of preservation. Having compared these with Mr Salter's figured examples of *A.* (*Isotelus*) *gigas*, we think that the interests of science will best be served, pending the arrival of fresh material, by considering the Girvan form of *Asaphus* as identical with *A.* (*Isotelus*) *gigas*. At any rate, we cannot detect any characters which would warrant more than a varietal separation being made at the best, especially with only badly-preserved material to work with. The only difference we can detect is a somewhat narrower axis to the pygidium, especially at the anterior end.

Fig. 20 (Pl. X.) is that of an *Asaphus* tail, in which the long slender axis, although much weathered, exhibits what appears to be a series of depressions on each side, in all probability resembling those represented by Mr Salter in the tail of *A. tyrranus*,[2] and considered by him to be internal glands.

Loc. and Horizon.—Ardmillan Brae, in a greenish mudstone (*Mus. Pract. Geology*); Balcletchie, in a similar rock. (Gray Collection.)

[1] Quart. Jour. Geol. Soc., vii. p. 170.
[2] Monograph, t. 22, f. 9.

Genus ILLÆNUS, Dalman, 1827.

(Palæad., p. 51).

Section Dysplanus, *Burmeister*, 1843.

Illænus Bowmani, Salter.

(Pl. XI., figs. 6-8.)

Illænus (*Dysp.*) *Bowmani*, Salter, Mon. Brit. Trilobites, 1867, pt. 4, p. 185, t. 28, f. 6-13, t. 30, f. 6 (*for synonomy*).
„ „ Bigsby, Thesaurus Sil., 1868, p. 54.
„ „ Woodward, Cat. Brit. Foss., Crustacea, 1877, p. 40.

Obs.—It is unnecessary for us to redescribe this species after the very full manner in which it has been illustrated by the late Mr Salter.

Although a frequent species at Girvan, entire specimens are rare; disjointed heads and tails are usually met with, occasionally in a fine state of preservation. We figure (Pl. XI., fig. 6) a very neat internal cast, contained in the Gray Collection, in which the distinguishing characters of the species, so admirably laid down by Mr Salter, are well shown—the backward position of the eyes, the almost vertical facial suture, the deep punctum at the base of each axal furrow, and the distinct linear neck-furrow, visible, however, only in casts. Mr Salter states that the latter is only seen beneath the cheeks, but we find that it extends regularly across the glabella from punctum to punctum. Specimens received from Balcletchie frequently have the integument preserved; at Penkill, *I. Bowmani* is almost always in the form of internal casts, whilst in the shale connected with the Craighead limestone it is usually crushed, but, as would naturally be expected, the outer covering is in a much more satisfactory state for examination.

One of Mrs Gray's examples of *I. Bowmani* exhibits the free cheek and eye in position, although the anterior portion of the head-shield is bent down (Pl. XI., fig. 7). The eye is very well preserved, provided with a very large number of minute lenses.

Mr Salter considered the *Illænus latus*, M'Coy,[1] from the Wrae limestone of Peeblesshire, as only a compressed form of this species. The specimen, originally in the Woodwardian Museum, appears to have been mislaid, otherwise we should like to have referred to it, for we have several such depressed individuals from the Girvan area, and do not feel at all satisfied as to their identification.

If *I. latus* should prove to be identical with *I. Bowmani*, Professor M'Coy[2] was the first observer to point out the existence of this characteristic Trilobite in the Girvan area, otherwise Mr Salter takes precedence in this discovery.[3]

Loc. and Horizon.—Drummuck, in shaly beds (*Salter*); Old Fort, Kirkhill, and Penwhapple Glen (*Etheridge*[4]); Ardmillan Brae (*Etheridge*[5]) in shaly beds; Balcletchie, in a hard greenish mudstone (Gray Collection); Craighead, in the limestone (Gray Collection); Penkill, in a greenish-grey mudstone (Gray Collection); (?) as *I. latus*, M'Coy, Knockdolian Mountain to the south of Girvan (*Woodwardian Museum*).

Illænus Thomsoni, Salter.

(Pl. XI., fig. 9.)

Illænus sp. ind., Salter, Quart. Jour. Geol. Soc., 1851, viii. p. 171, t. 9, f. 3.
Illænopsis Thomsoni, Salter, Mem. Geol. Survey, 1866, iii. p. 231 (name only), non. p. 316, t. 11, b. f. 1 and 2).
Illænus Thomsoni, Salter, ibid., p. 360 (name only).
„ (*Dysplanus*) *Thomsoni*, Salter, Mon. Brit. Trilobites, 1867, pt. 4, „ p. 188, t. 28, f. 2-4, t, 30, f. 8-10.
„ „ „ Bigsby, Thesaurus Sil., 1868, p. 56.
„ „ „ (pars.) Woodward, Cat. Brit. Foss. Crustacea, 1877, p. 42.

Obs.—We figure the cast of a large caudal shield, which will bear comparison with any of Mr Salter's figured specimens. The measurements of this fine example are, length two inches

[1] Monograph, t. 22, f. 9, p. 215. [2] Brit. Pal. Foss., p. 363.
[3] Quart. Jour. Geol. Soc., vii. 187.
[4] Mem. Geol. Survey, Scot., Expl. 3, 1873, pp. 30 and 32.
[5] Ibid., Expl. 7, 1869, p. 10.

six lines, and breadth two inches five lines. According to Salter, *Illænus Thomsoni* is abundant in the light-coloured sandstones of Mulloch Hill; but we have only seen a few examples, and these not in a good state of preservation. The most perfect is in the Museum of Practical Geology, and is that originally figured by Mr Salter in the Quarterly Journal of the Geological Society.

Loc. and Horizon.—Kirkhill and Girvan (*Etheridge*); Mulloch quarry (Gray Collection; *Mus. Pract. Geol.*, &c., &c.)

Illænus æmulus, Salter (?).

(Pl. XI., fig. 10; Pl. XII., figs. 12 and 13.)

Illænus (*Dysp.*) *æmulus*, Salter, Mon. Brit. Trilobites, 1867, pt. 4, p. 187, t. 28, f. 5.
„ „ „ Bigsby, Thesaurus Sil., 1868, p. 54.
„ „ „ Woodward, Cat. Brit. Foss. Crustacea, 1877, p. 40.

Obs.—The fossiliferous beds of Penkill have yielded two caudal shields and a glabella, which may belong to the form indicated by Salter under the above name. At any rate, certain of the characters assigned to *I. æmulus* are to be seen in the pygidia referred to, prominent amongst them being the strong sharp Λ-shaped plicæ, only perhaps closer and more acute than in *I. æmulus*, truncate angles, wide axal depressions, and in one of the specimens very faint indications of rings. We, however, fail to observe any trace of the posterior triangular extension of the axis. The smaller of the two specimens has attached to it nine flat thoracic rings. They may only be a variety of *I. Bowmani*, although we are induced to place them provisionally under the above, from the very marked character of the ornamentation.

The head of this species does not appear to have been described, and we therefore refer that in question to Salter's *I. æmulus* with some diffidence, chiefly on account of the presence of similar wavy imbricating undulations, although they have not the same Λ-shaped arrangement, but on the

contrary, have a more concentric appearance. The furrows were deep, and reached far forward, the glabella large and convex, the side-lobes likewise convex and somewhat arched.

Loc. and Horizon.—Penkill, in a light-coloured mudstone. (Gray Collection.)

Illænus nexilis, Salter.

(Pl. XI., figs. 11-13.)

Illænus nexilis, Salter, Mon. Brit. Trilobites, 1867, pt. 4, p. 190, t. 30, f. 4 and 5.
„ „ Bigsby, Thesaurus Sil., 1868, p. 55.
„ „ Woodward, Cat. Brit. Foss. Crustacea, 1877, p. 41.

Obs.—This species was established by Mr Salter for forms of *Illænus* intermediate between *I. Bowmani* and *I. Thomsoni*, and at the time he wrote, was believed to be exclusively confined to the Girvan area; we do not know if it has been met with elsewhere, neither have we seen any specimens which we could with entire satisfaction to ourselves refer to it. We give a figure of a specimen communicated to us by Mrs Gray on behalf of a friend, which we think may be *I. nexilis*, although it is just possible *I. Bowmani* would be a more correct determination.

In his 'Monograph,' Mr Salter gave a figure[1] of a broad epistome from the cabinet of the late Lieut. Wyatt-Edgell, which he considered to be that of *I. nexilis*. Of such an epistome we give two figures (Pl. XI., figs. 12 and 13), one much larger than the other, both from Girvan. They appear to be of an elongated shuttle-like form, and to have strong, coarse, and distant transverse ridges, with deep valleys between. That they are the epistome of *I. nexilis* we do not assert, but assuming Mr Salter's figure to represent this portion of that Trilobite, the presence in Girvan beds of these shuttle-shaped epistomes lends colour to our previous determination.

[1] T. 30, f. 5 (upper figure).

Loc. and Horizon.—Mulloch quarry (*Salter*); ? Penkill, as epistomes (Gray Collection), in light-coloured mudstone.

Section Illænus proper.

Illænus Davisii, Salter.

Illænus (*Ill.*) *Davisii*, Salter, Mon. Brit. Trilobites, 1867, pt. 4, p. 194, t. 29, f. 10-16 (*for synonomy*).
„ „ Bigsby, Thesaurus Sil., 1868, p. 55.
„ „ Woodward, Cat. Brit. Foss. Crustacea, 1877, p. 41.

Obs.—*Illænus Davisii* was recorded many years ago as a Girvan species by Mr Salter,[1] who recognised it in a collection made by Mr Carrick Moore from the Stinchar river. We are not acquainted with any more recent notice of its discovery, and as the determination was made only on portions of a few body-segments, the occurrence of this species in the district under review requires confirmation.

Loc.—Stinchar river, in limestone.

Illænus Rosenbergii, Eichwald (?).

(Pl. XI., fig. 14.)

Illænus Rosenbergii (Eichw.), Salter, Mon. Brit. Trilobites, 1867, pt. 4, p. 199, t. 29, f. 2-6 (*for synonomy*).

Obs.—This Trilobite was stated to occur at the Mulloch quarry by Professor M'Coy,[2] but upon applying to our friend Professor Hughes, we were sorry to learn that the specimen could not then be found.

The Hunterian Museum has communicated to us, through Mrs Gray, two tails, presented by her to that institution, which we believe to be this species, and enable us to confirm Professor M'Coy's statement that *I. Rosenbergii* occurs at Girvan.

One of the pygidia in question is of an elongately oval form,

[1] Quart. Jour. Geol. Soc., v. p. 15; Decade, ii. No. 2, p. 3.
[2] Brit. Pal. Foss., p. 368.

with the anterior margins near the facets broken away. Mr Salter states that in the figured specimen of *I. Rosenbergii* in the Woodwardian Museum, the pygidium has "a narrow axis, defined by broad and rather deep axal furrows, which extend, however, but a short distance, and do not converge."[1] The characters of the axal furrows here described by Salter are quite those of the tail, which we think may belong to this species, now before us. On the other hand, there is no trace of the four annulations on the axis which Mr Salter states to exist in *I. Rosenbergii.* Again, the cast, according to the same authority, is marked all over "with short wavy impressed lines and puncta." In our specimen, which is also a cast, the lines are absent, but the puncta are present in quantity and well marked. On the whole, therefore, if the identification with the Trilobite, which Salter referred to *I. Rosenbergii*, Eichwald, is not as close as it might be, nevertheless we have the remains of an individual partaking of many of its characters, and probably indicating an allied species at least.

The Craighead limestone has furnished us with a glabella, which appears to be of too elongated and oval a form to be that of *I. Bowmani*, and may, perhaps, be the head of the species whose tail has just been described. We cannot detect any trace of the characteristic neck-groove and depressions at the base of the glabella-furrows of the former species.

Loc. and Horizon.—Mulloch quarry (*M'Coy, Woodwardian Museum*). ? Craighead, in the limestone. (Gray Collection.)

Illænus crassicauda, Wahlenberg (?).

Ill. crassicauda (Wahl. ?), Salter, Mon. Brit. Trilobites, 1867, pt. 4, p. 215, f. 56.

Obs.—Both Professor M'Coy[2] and Mr Salter refer to this as a Girvan species, but the latter with doubt; we are not able to afford any further information.

Loc.—Knockdolian, south of Girvan (*Woodwardian Museum*).

[1] Monograph, p. 200. [2] Brit. Pal. Foss., p. 354.

Illænus Murchisoni, Salter (?).

(Pl. XII., fig. 1.)

Ill. Murchisoni, Salter, Mon. Brit. Trilobites, 1867, pt. 4, p. 201, t. 26, f. 1, t. 30, f. 7.
„ Bigsby, Thesaurus Sil., 1868, p. 55.
„ Woodward, Cat. Brit. Foss. Crustacea, 1877, p. 41.

Obs.—The evidently rare occurrence of a very large Trilobite at Girvan has induced us to figure the imperfect tail represented on Pl. XII., fig. 1. It measures two inches one line in one direction, by three inches in the other; and is an internal cast with the whole of the integument removed except at one or two spots on the surface. The caudal fascia is moderately broad and prominent, and marked with strong, coarse, imbricating ridges, which in casts show well upon the abruptly bent down margin.

We are quite unable to refer this fine specimen to any other species than *Illænus Murchisoni.* It will be observed that the anterior part of the axis and the pleural facets have been broken off, which gives it a rather deceptive appearance; but when we take into consideration the characters previously mentioned, and compare them with Mr Salter's figure, the resemblance is seen to be very close. Mr Salter mentions that the fascia in *I. Murchisoni* is narrow; this must be an oversight, because in his figure it is represented as anything but in this condition.

A second pygidium from the same locality as the foregoing may perhaps be referable to this species also, but of this we are not so confident. It is much compressed, the fascia is not well seen, and the pleural facets are perhaps too obliquely reflected. On the other hand the surface of the cast is granular, a character assigned by Salter to *I. Murchisoni.*

Loc. and Horizon.—Penkill, in a fine light-coloured mudstone. (Gray Collection.)

Illænus Macallumi, Salter.

(Pl. XII., fig. 2.)

Illænus Macallumi, Salter, Mon. Brit. Trilobites, 1867, pt. iv. p. 210, t. 28, f. 1, t. 30, f. 2 and 3.

Obs.—We figure a cast of a tail of this species from the typical locality, but are otherwise unable to advance the description of the species as a whole. The general convexity, prominent fulcra, and recurved margin, are well shown in this example.

There is also a head which may be that of this species, as it possesses a blunt front-edge, the furrows apparently curving round the eyes, and a central glabella-ridge; but as it is very imperfect and appears to have been more or less crushed, we leave its position an open question.

Loc. and Horizon.—Mulloch Hill in a dark-greenish mudstone or fine sandstone (Gray Coll.); Kirkhill (*Coll. Mus. Pract. Geol.*)[1]

Genus Bronteus, Goldfuss, 1839.

(Nova. Act. Phys. Med. Acad. Cæsareæ Leop.-Carol. Nat. Curios, xix. pt. 1, p. 360.)

Bronteus Andersoni, Etheridge jun., and Nicholson (*sp. nov.*)

(Pl. XII., figs. 3-5.)

Spec. char.—Head (so far as preserved) depressed; glabella strongly club-shaped; frontal lobe overhanging the others; axal furrows well marked, biconcave towards one another; fixed cheeks not well preserved; anterior margin small but prominent, ornamentation consisting of faint partially imbricating (?) concentric lines.

The thoracic axis is rounded and convex; the pleuræ hori-

[1] Cat. Camb. and Sil. Foss. Mus. Pract. Geol., 1878, p. 63. (The specimen figured by Salter, Monograph, t. 28, f. 1.)

zontal and flattened, their terminal portions deflected, wrinkled transversely; ten or eleven segments.

Pygidium more or less semi-oval, longer than wide, not much attenuated posteriorly, surface a little vaulted. Axis well marked, consisting of an inner and two small side-lobes, separated by longitudinal faint grooves; it is as a whole very small for the size of the tail, and short as compared with the length of the latter; the central lobe is subdivided by seven (?) transverse grooves, whilst the side-lobes are small and linear. The lateral portions of the tail are subdivided into seven sharp, angular, radiating ridges on each side, corresponding with the subdivisions of the central lobe of the axis. The median line of the tail, forming the posterior continuation of the latter, consists of a sharp, angular, undivided ridge. The general surface is depressed, and for about one-half its width round the axis is flat, thence to the margin slightly and feebly concave. When the integument is removed, this concavity is seen to be ornamented by close, undulating, concentric, and imbricating (?) striæ, or laminæ, which became less undulating as the margin is receded from.

Obs.—Unfortunately we are not able to give the characters of the head and thorax with as much detail as those of the tail, the preponderance of the remains of the latter over those of the former being something remarkable. It is by no means an uncommon species at one locality. The segmentation of the central lobe of the pygidium in the genus *Bronteus* appears to be confined to a few species, and the discovery of a form possessing this character in the Girvan rocks is interesting. This axal segmentation is discernible only in a few specimens, the nature of the matrix being such that the finer and more delicate characters are obliterated, but in one or two of the specimens in question it is distinctly exhibited. The ornamentation of the tail is a very well-marked feature in this species; but all the *Brontei* so closely resemble one another in this respect that it is of less importance.

In comparing *B. Andersoni* with other species we shall con-

fine ourselves to those in which the central lobe of the axis is segmented, a proceeding which will lessen in a great degree the difficulties of identification and place the matter within a tolerably narrow compass.

The specific numerical strength of the genus *Bronteus* in British rocks is very limited. We have *B. Hibernicus*, Portlock; *B. signatus*, Phill; *B. laticauda*, Wahlenberg; and *B. flabellifer*, Goldfuss. With the two last-named we do not consider it necessary to compare our Girvan form. As regards *B. Hibernicus*, so little has been written that we hardly know how to enter on a comparison, Portlock's figures being undoubtedly those of imperfect specimens; but of *B. signatus* a more definite opinion can be expressed. In the type-specimen of the former, now in the Museum of Practical Geology, the axis of the tail is unsegmented. This, if a permanent character, would at once distinguish it from the Girvan individuals. Again, the lobes are very indistinctly marked, and it is of much greater size than *B. Andersoni*, which, amongst a large number of specimens, retains the same proportions with great regularity, and is, also, not tuberculated.

With regard to *B. signatus* of the Devonian rocks, we find that it possesses a much less number of radiating costæ, and the trilobation and segmentation of the axis are again very indistinct. By some authors this species is considered identical with *Bronteus laticauda*, Wahlenberg.

Of the large number of species of *Bronteus* described by M. Barrande, in the 'Système Sil. de la Centre de la Bohême,' only two require detailed consideration at our hands: these are *B. planus*[1] and *B. simulans*.[2] In the first, the central lobe of the axis of the pygidium has from three to four transverse grooves, whilst in the second there are four or five. A reference to our specific description will at once show the difference which exists between *B. Andersoni*, (*nobis*), and the two species just mentioned. In the Girvan form, there are seven distinct segments present, which we consider a suffi-

[1] *Loc. cit.*, i., Atlas, t. 42, f. 34. [2] Ibid., t. 48, f. 33.

ciently well-marked difference to warrant us in separating it from the foregoing.

In *B. Barrandii*, Hall,[1] the axis of the tail is transversely subdivided by two distinct articulations, and the same number is recognisable in that of *B. occasus*, Winchell and Marcy.[2]

We have expended some time in referring to all the descriptions of *Brontei* within our reach, but we have not met with any one with which our species could be satisfactorily identified: those just cited are the nearest.

It affords us much pleasure to name this species in honour of the late Mr Thomas Anderson of Girvan, an intelligent and enthusiastic collector, whose assistance in the collection of the material for this 'Monograph' we desire to acknowledge.

Loc. and Horizon.—Tolerably abundant in the greenish-grey mudstones of Penkill (Gray Collection); Ardmillan Brae as *Bronteus hibernicus.* (*Coll. Mus. Pract. Geol.*)[3]

Bronteus, *sp. ind.* (*a*).

(Pl. XII., fig. 6.)

Obs.—The limestone of Craighead has yielded a single specimen of a large species of *Bronteus*, clearly distinct from the last. When complete, the pygidium was probably of an oval form, and had narrow, rounded, and prominent or cord-like radiating ridges on the side-lobes, leaving between them broad, flat, or very slightly concave interspaces. The concentric striæ, almost partaking of the nature of imbrications, are not undulate, but, apparently, regular and direct. Of the form and characters of the axal lobe, we are quite ignorant. In size, strength of the radiating ridges, width of the interspaces, and general appearance, this fragmentary fossil very closely resembles the type-specimen of *Bronteus hibernicus*, Portlock.

[1] Pal. N. York, iii., Atlas, t. 73, f. 1-4.

[2] 'Enumeration of Fossils collected in the Niagara Limestone at Chicago,' Mem. Boston Soc. Nat. Hist., i. p. 104, t. 3, f. 11.

[3] Mem. Geol. Survey Scotland, Expl. No. vii. p. 32. We have examined the specimen upon which this determination was made.

Loc. and Horizon.—Limestone at Craighead. (Gray Collection.)

Bronteus, *sp. ind.* (*b*).

Obs.—A small pygidium, of which we possess only two specimens, deserves notice, as it appears to be different from either *B. Andersoni* or the species indicated above. In form the tail is semicircular, gently convex over the whole surface, and the lateral ridges almost obliterated. We hope to obtain further material.

Loc. and Horizon. — The limestone of Craighead. (Gray Collection.)

Genus Bronteopsis, Wyv. Thomson, 1857. (*Gen. nov.*)

Bronteopsis, Wyv. Thomson, 1857, MS. (*fide* Salter).
„ Salter, 1866, Mon. Brit. Trilobites, pt. 3, p. 143.
„ „ 1867, Ibid., pt. 4, p. 216.

Obs.—In describing *Barrandia Cordai*, M'Coy, the late Mr J. W. Salter wrote as follows : "The passage from the *Ogygides* to the *Bronteidæ* is rendered still more easy by a MSS. genus, *Bronteopsis*, distinguished so far back as 1857 by my friend Prof. Wyville Thomson, who was at that time carefully studying the Caradoc fossils of the Girvan district. The genus is a very remarkable one, having all the characters of the Bronteidæ, and will be described under that family. But the crust appears to have been thin, not calcareous; and the habit of the tail is so much that of *Barrandia*, that it might well be mistaken for an extreme member of the group we are describing." We have had the good fortune to discover in the private portion of the collection of the Museum of Practical Geology, specimens bearing the label, "*Bronteopsis Scotica*, Salter MS.," and collected in the Girvan district by the late Mr R. Gibbs. We have no reason to doubt that these are the original specimens used by Mr Salter, in conjunction with those in Sir Wyville Thomson's Cabinet, at the time he wrote the above passage.

They have enabled us to name correctly a numerous suite of specimens in the "Gray Collection," which we should otherwise have referred to *Barrandia* with doubt,—an excusable error after Mr Salter's remark above quoted.

The only other information relating to *Bronteopsis*, given by Mr Salter, are a few remarks contained in his introductory notice to the family *Bronteidæ*. He says, speaking of the pygidium: "This is not usually a part of much consequence in classification; but by tracing the variation of the tail-piece in *Bronteus*, through *Bronteopsis* to *Barrandia*, the relations of the group to *Ogygia* are clearly seen." Again, he adds, "The shape and lobes of the glabella are much like those in *Barrandia;* and, as before said, the shortened tail-axis of the last genus points to the still shorter axis in *Bronteopsis*, and the almost obsolete one in *Bronteus*." We refrain from giving a concise generic definition of *Bronteopsis* at once, and content ourselves with as full a description as possible of the only species at present known,—since the former can be added when we are better acquainted with the characters of a more extended series of species.

Bronteopsis Scotica, Salter (*sp. nov.*)

(Pl. X., figs. 21 and 22; Pl. XI., figs. 1-5.)

B. Scotica, Salter, MS., Coll. Mus. Pract. Geology.

Spec. char.—Entire head unknown. Glabella clavate, triangular; forehead-lobe insensibly expanded in front towards the front margin, which is bordered by a striated rim; the glabella is narrowed behind, and within the posterior half is a central obtuse median ridge; on each side of the latter are three circular shallow depressions, arranged in opposite pairs and answering to the facial grooves; axal furrows well marked in their posterior course, but gradually becoming obsolete towards the anterior margin of the head. Cheeks narrow, with an outer sigmoidal margin. Neck-furrow shallow and inconspicuous; neck-segment narrow, angular, but little raised above the general surface. Facial suture elongately-sigmoidal, terminating at a

point on the posterior margin almost opposite that at which it cuts the anterior margin. Anterior part of the forehead-lobe delicately lineate; epistome, or rostral shield, longitudinally imbricate-striate; labrum convex, wide on the side of attachment, narrow and round towards the posterior, concentrically lineate.

Thorax of seven or eight segments, of much less width than the tail; axis convex, of nearly equal width to the pleuræ. The latter are horizontal, without grooves, but each with a central angular ridge dividing it into two almost equal portions.

Pygidium large, semicircular, with the angles rounded, but at the same time faceted, and a shallow, concavely-flattened limb. Axis flattened, narrow and very short, of five small segments, and a large projecting terminal appendage. Side-lobes gently rounded, with five or six indistinct rounded pleuræ on each side, which extend as far as the termination of the declivity, but do not impinge on the limb; the four anterior ribs always more distinctly marked; fulcra rather prominent. General crust very thin.

Obs.—The structure of the glabella-grooves, or furrows, represented in *Bronteopsis* by the shallow pits along the sides of the glabella, indicates a transition towards *Ogygia*. This resemblance is, however, not borne out by the few-ringed thorax with its grooveless pleuræ, nor by the very short axis of the pygidium, and the entire pleuræ or side-lobes of the former. The characters of the tail are more those of *Barrandia*, with a tendency towards *Bronteus;* but, again, the grooved thoracic pleuræ of the former separate it quite from *Bronteopsis*.

The form of the glabella, course of the facial suture, and number of thoracic somites, the grooveless pleuræ, and the abbreviated axis of the pygidium, clearly separate *Bronteopsis* from *Asaphus*.

On the other hand, the broad large forehead-lobe, the position of the pits on the sides of the glabella, the narrow fixed cheek, the grooveless pleuræ, and the large semicircular

tail, with its abbreviated axis, clearly justified Mr Salter in placing this genus near *Bronteus*. It must, however, be borne in mind that we have only, at present, been able to ascertain the existence of seven or eight, instead of ten, thoracic somites, and we know nothing about the eyes.

The free cheeks are unknown to us with any certainty, although we have from the same bed yielding the other portions of *B. Scotica*, a fragment which may represent the part in question.

Occurring with the remains of *Bronteopsis Scotica* are several small pygidia, which, when we know more of the genus, it may be necessary to separate as a species distinct from the type; for the present, however, we prefer to regard them as the young condition of the same. (Pl. XI., fig. 5.)

We question if the small specimens in the Museum of Practical Geology, on which the occurrence of *Stygina latifrons* in the Girvan district has been based, are more than badly-preserved examples of the young form just referred to.

Loc. and Horizon.—Penwhapple Glen, in a greenish fine-grained mudstone (*Mus. Pract. Geology*); Balcletchie, in a similar rock. (Gray Collection.)[1]

Genus PROETUS, *Steininger*, 1831.

Section *Forbesia*, M'Coy (1846), 1862.

(Glabella-furrows present; neck-segment terminated on each side by a tubercle or small node; and posterior angles of the cephalic shield produced into spines.)

Proetus Girvanensis, Eth. jun., and Nicholson (*sp. nov.*)

(Pl. XII., figs. 7-10.)

Spec. char.—Oblong-oval, robust, the anterior and posterior

[1] It is probable that these two localities are one and the same.

extremities rounded; general axis prominent, gradually tapering towards the posterior margin. Cephalic shield semicircular, being the most convex portion of the body; longer than the tail, but of less length than the thorax; the glabella and cheeks when in apposition forming a well-marked arch. Glabella short, almost square, with the angles rounded off, a little broader behind than in front, lateral margins but very little concave; very blunt in front, not quite reaching the anterior margin; of equal width with the cheeks. Front margin concave, bent up in front, not impinged on by the glabella; when seen in internal casts, with the integument removed, the concave margin is delicately striate as far back as the posterior angles. Furrows of the glabella very indistinctly marked. Neck-furrow broad, and deep at the base of the glabella, as broad but shallower below the free cheeks. Neck-segment broad, and well marked, with a central papilla; the lateral tubercles flattened and somewhat elongated in outline, inconspicuous. Fixed cheeks small and linear. Eye-lobe projecting from the small fixed cheeks. Free cheeks obtusely triangular, produced posteriorly into short, tapering, pointed, genal spines, extending as far as the third, or perhaps the fourth, thoracic somite. Eyes close to the sides of the glabella, small and very prominent, subreniform or almost rotund, microscopically faceted (in internal casts). Facial sutures in front of the eyes, curving gradually, bent outwards; behind the eyes, almost vertical till near the neck-margin, when they turn sharply outwards for a short distance, and cut the posterior margin. Surface of the glabella concentrically lined. Thorax of ten segments, one and a quarter as long as the head. Axis quite as broad as the pleuræ, convex, rounded, gradually tapering; marginal tubercles moderately well developed, although not very prominent. Pleuræ throughout their course preserving about the same convexity as the free cheeks. The axis-segments are ornamented with a row of papillæ, or minute tubercles on each, in the central line, and are always obliquely striated.

Pygidium about half the length of the thorax, broad-oval;

axis convex, well marked, not reaching to the posterior margin or limb, but connected with it by a slight ridge; of five segments and a broader terminal process. Side-lobes flattened, the segments four or five in number, much more indistinctly marked than on any other part of the body; limb striated concentrically (in casts).

Ornamentation of the whole test or integument not preserved, but on the internal casts of the cheeks there is a microscopic pitting or reticulation present.

Obs.—The present species occurs somewhat plentifully at Drummuck, numerous well-preserved internal casts, and here and there a specimen with the test remaining, being in the collections of Mrs Gray, the Museum of Practical Geology, and the Geological Survey of Scotland. Notwithstanding the large number of *Proeti* which have been described from the Palæozoic rocks generally of the European and American continents, we believe we are justified in regarding the present one as new.

From *Proetus* (*Forbesia*) *latifrons*, M'Coy,[1] it is distinguished (1) by the difference in the form of the glabella, the latter being in the Girvan form relatively much shorter in proportion to its breadth, with less indented lateral margins, wider base, and much less attenuated anterior extremity; (2) by a lessening of the space between the glabella and the anterior margin of the head-shield; (3) by the smaller, more prominent, and less reniform eyes; (4) by the absence of the notch in the front margin of the head-shield; (5) by the proportionately wider, but shorter, and more triangular cheeks; (6) by the much greater disproportion between the sizes of the head, thorax, and pygidium (in *P. latifrons*, the head and body are equal, while here the body is nearly the width of three segments longer than the head); (7) by the diminished number of segments on the axis of the tail and side-lobes.

Proetus Stokesii, Murchison,[2] has a much more pointed cephalic shield, and the genal spines appear to extend back-

[1] Synop. Sil. Foss., Ireland, p. 49, t. 4, f. 11. [2] Sil. System, t. 14, f. 6.

wards to the commencement of the pygidium, characters at once quite sufficient to separate it from *P. Girvanensis*.

Of the many forms of *Proetus* described by Barrande from the Silurian rocks of Bohemia, our species does not appear to be identical with one. In some one, or perhaps two or three characters, it agrees with several of the latter, but there exist in conjunction strong points of departure from any one of these. *P. Girvanensis* differs from some of the Bohemian species in the form and size of the glabella; the distance of the front of the latter from the anterior margin; the size, shape, and position of the eyes; the width of the thorax and the degree of segmentation of the tail; the nature of the limb of the latter; and the number of the thoracic somites. As examples of the manner in which our species differs in the form and size of the glabella, and its distance from the front margin, we may mention *Proetus superstes*, Barr; *P. Ryckholtii*, Barr; *P. unguloides*, Barr; *P. micropygus*, Barr; *B. ascanius*, Barr; and many others.[1] As regards the size, shape, and position of the eyes, *P. myops*, Barr,[2] may be taken as illustrating the difference which exists between the eyes of our form and the majority of the Bohemian species. The dissimilarities present in the limb of the tail and in the nature of the pleuræ are exhibited by *P. Archiaci*, Barr;[3] *P. striatus*, Barr;[4] and *P. Lovéni*, Barr,[5] respectively. Several of the Bohemian species have the peculiar ridge extending from the last axis-segment of the pygidium to the limb, as *P. venustus*, Barr; *P. decorus*, Barr; and *P. natator*, Barr. On the whole, we can merely say that there is a general resemblance to many of the Bohemian forms, especially of the type with a broad-fronted glabella, such as *P. Bohemicus*, Barr, without any absolute identity,—indeed in nearly every case there is to be found some strong point of divergence. We have compared our specimens with examples of *P. Bohemicus*, Barr, in the British Museum, and we find that in this species the glabella is proportionately

[1] Syst. Sil. Bohême., i. t. 15. [2] *Loc. cit.*, t. 15.
[3] Ibid., t. 17, f. 42. [4] Ibid., t. 17, f. 46. [5] Ibid., t. 17, f. *a* and *b*.

narrower in front, and wants the wide anterior margin in front of it.

From the Swedish species *P.* (*Calymene*) *concinnus*, Dalman,[1] the Girvan form is easily distinguished by the outline of the glabella and cheeks, and the form and position of the eyes. In addition to the foregoing comparisons, we have referred to the descriptions of a large number of American species described by various authors. With the *P. corycœus*, Hall,[2] and *P. protuberans*, Hall,[3] *P. Girvanensis* has no characters of importance in common, whilst the general outline, and brevity of the cephalic spines, distinguish it from *P. Spurlockii*, Meek.[4] Two species have been described from Missouri, by Professor Shumard,[5] *P. Swallovii*, and *P. Missouriensis*. The first has no cephalic spines, and the general form of the head and glabella is different; whilst in the second, although the squarer form of the glabella reminds us of the structure of the Girvan species, there are large basal lobes present, which point more towards the genus *Cyphaspis*, and which are not present in our form.

In the "Fifteenth Annual Report" on the State Cabinet of Natural History of New York, Professor James Hall has described no less than fifteen American species of this genus, many of them undescribed at the time he wrote. We have carefully studied these descriptions, but as they are unaccompanied by figures it is almost impossible to definitely point out how they differ from our species, especially in a genus like *Proetus*, where the species all closely run into one another, although we are strongly convinced that *P. Girvanensis* is distinct from them all.

We have reserved until the last any remarks upon several indicated although unnamed species by the late Mr Salter, more especially as it is to one or other of these that our

[1] Öf Vet. Akad. Handl., 1826, t. 1, f. 5 and 6.
[2] Hall. Pal. N. York, ii. t. 67, f. 15.
[3] Ibid., iii. t. 73, f. 5-8.
[4] Ohio Geol. Report, i. pt. 2, t. 14, f. 12.
[5] 1st and 2d Ann. Report, Geol. Survey, Missouri, 1855, t. 13, f. 12 and 13.

Girvan form is most nearly allied. The anterior third of one of the species in question, from the Wenlock limestone, has been beautifully figured in the Memoirs of the Geological Survey,[1] and in the quadrate form of the glabella is undoubtedly a close ally of our examples from Girvan. It is, however, to be remarked that in this form, which is a small one, the eyes are unusually large for its size, and the neck-tubercles are very pronounced, as against the small eyes and ill-defined tubercles in *P. Girvanensis.*

In the Woodwardian Museum Catalogue of Cambrian and Silurian Fossils,[2] Mr Salter gave figures of one or two species of undescribed *Proetus* which, to a certain extent, resemble our *P. Girvanensis;* but there is, again, noticeable the very marked difference in the form and size of the free cheeks.

In the figures we give of this species may be noticed a slight variation in one or two of the characters which distinguish it. Thus, fig. 7 is of a somewhat more oval form than the others; again, in fig. 7, the free cheek appears to be a shade wider than in figs. 9 or 10; but beyond such trivial points there appears to be little or no reason for considering all of them as other than one species.

Loc. and Horizon.—Drummuck, in a fine greenish sandstone or mudstone (Gray Collection; *Mus. Pract. Geol.; Coll. Geol. Survey, Scot.*); Lady Burn, above Drummuck (*Mus. Pract. Geol.*)

Proetus procerus, Etheridge jun., and Nicholson (*sp. nov.*)

(Pl. XII., fig. 11.)

Spec. char.—Elongately oval, slender, gradually tapering towards the posterior margin; head and thorax equal in length; tail less than half the length of either. Cephalic shield semi-oval, breadth a little exceeding the length; glabella square-oval, longer than broad, a little wider behind than before; axal furrows well marked, slightly concave at the sides of the

[1] Vol. ii. pt. i. pl. 6, f. 2.

[2] Cambridge, 1873, pp. 133, 134, &c.

glabella; furrows not visible; surface gently convex, most so immediately in front of the neck-furrow; front margin as wide or wider than the neck-furrow and segment combined. Fixed cheeks inconspicuous, the eyes situated close to the axal furrows in the before-mentioned concavities of the latter. Facial suture sharply deflected outwards in front of the eye, behind it almost vertical for a short distance, then gradually turning outwards at an obtuse angle to cut the posterior margin at a point nearer the genal angles than the axal furrows. Eye small, projecting but very little outwards laterally, and not extending either backwards or forwards to any great extent. Neck-furrow well marked, not as broad as the segment; basal lobes inconspicuous. Free cheek irregularly triangular; genal angles produced into spines, extending as far back as the third thoracic somite.

Thorax of ten somites, gradually tapering posteriorly; axis very coarse and round, separated from the pleuræ by strong axal furrows (in the cast), and wider than the pleuræ; the latter are arched in the middle line and sharply bent down distally.

Pygidium small, with a tapering, convex, raised axis of five segments and a terminal appendage. On the side-lobes the pleuræ are almost obsolete, being represented by a few faint radiating markings.

Obs.—The small eye, large free cheek, and prominent axis of the thorax in *P. procerus* closely ally it to *P. Girvanensis;* but when the slender elongated form of the one is compared with the robust and round outline of the other, we do not see how it would be possible to unite the two forms under one specific name. Furthermore, in *P. Girvanensis* the axis and pleuræ of the thorax are of the same breadth, whereas in *P. procerus* the axis is wider than the pleuræ. Neither can the present species be referred to either of the British described *Proeti, P. latifrons,* M'Coy, or *P. Stokesii,* Murchison, from both of which it differs in many essential particulars, chiefly, however, in the size of the eye and the slender elongated form.

So far as we have been able to make an examination, it is not identical either with any of the numerous manuscript species which have crept into print from time to time. We do not think it necessary to enter into details of comparison with the array of species noticed under the description of *P. Girvanensis*, for almost the same characters mentioned as separating the latter from these species will suffice in the present instance, except, of course, those points just now indicated as marking the line of demarcation between *P. procerus* and *P. Girvanensis*.

Loc. and Horizon.—Drummuck, in a fine-grained greenish sand or mudstone. (Gray Collection.)

Genus Ampyx, Dalman, 1827.

(Kongl. Vet. Acad. Handlingar för år 1826, p. 252.)

Obs.—Dalman proposed the name *Ampyx* as a section of *Asaphus*, but as M. Barrande has remarked, its "characters are so distinct from those of *Asaphus*, that the generality of palæontologists who have followed have not hesitated to consider this type as separate."[1] The characters assigned by Dalman to *Ampyx* were the absence of eyes, large triangular head, non-lobate prominent glabella, 6-segmented thorax, and distinct undivided pygidium.

In 1849 Professor Ed. Forbes[2] proposed the subdivision of *Ampyx* into two provisional sections :—

1. *Ampyx* proper, with the head long, and five somites to the thorax.
2. *Brachampyx*, Forbes, 1849, with the head short and round, and six somites to the thorax.

Following Professor Forbes, Dr Angelin, in 1854,[3] proposed the subdivision of his family *Raphiophoridæ* into three genera :—

[1] Syst. Sil. Bohême., i. p. 632.
[2] Mem. Geol. Survey Gt. Brit., Dec. 2, pt. 10, p. 3.
[3] Pal. Scandinavia, p. 80.

1. *Lonchodomus*, Angelin, 1854, with a lanceolate glabella, terminating in an elongated prismatic spine. Type, *L.* (*Ampyx*) *rostratus*, Sars.
2. *Ampyx*, Dalman, with an oval glabella, terminating in a round spine; six thoracic somites. Type, *A. costatus*, Boeck.
3. *Raphiophorus*, Angelin, 1854, with an obovate glabella, having an abrupt apical spine; five thoracic segments. Type, *R. setirostris*, Angelin.

In 1852, M. Barrande,[1] writing anteriorly to Dr Angelin, subdivided *Ampyx* into three groups, but he did not assign names to them. *Group* 1, with six thoraic segments; *Group* 2, with five thoracic segments; *Group* 3, thorax unknown.

If we now compare the subdivisions proposed by Forbes and Angelin, we at once meet with a slight overlapping in their respective sectional names. Angelin retained the term *Ampyx* almost in the sense of its originator, Dalman, for types with six thoracic segments, his two other sections differing from this in possessing five such somites, but unlike one another in the form of the head. We feel that this will be looked upon as a sound and philosophical course on the part of Dr Angelin. On the other hand, Professor Forbes proposed his provisional *Brachampyx* also for forms with six body-rings, from which it becomes evident that *Brachampyx*, Forbes, is equivalent to, at least, *Ampyx*, Angelin. Now, as we consider, in this matter of creating sub-genera or sections of genera, that the section represented by the original name of the author should correspond as nearly as possible to that author's definition, it seems to us that the term *Brachampyx* is altogether misplaced and should be abandoned; on the ground that, although anterior in date to the section *Ampyx*, Angelin, the latter is essentially *Ampyx*, Dalman. In this case Forbes's first section, or *Ampyx*, Forbes, is equivalent to *Lonchodomus*, Angelin, or *Raphiophorus*, Angelin, or perhaps to both combined, and also to Group 2 of M. Barrande.

In the succeeding pages we shall adopt the genera of Angelin's *Raphiophoridæ* in the sectional sense, as used by Mr Salter throughout his 'Monograph.'

[1] Syst. Sil. Bohême, i. p. 636.

Section *Lonchodomus*, Angelin, 1854.

Ampyx rostratus, Sars.

(Pl. XII., figs. 14 and 15; Pl. XII., figs. 1-3.)

Ampyx rostratus, Sars, Oken's Isis., 1835, heft 4, p. 334, t. 8, f. 3 *a e*.
„ „ M. Edwards, Hist. Nat. Crust., 1840, iii. p. 296.
„ *Sarsii*, Portlock, Geol. Report, Londonderry, &c., 1843, p. 260, t. 1, f. 9 and 10.
„ *rostratus*, Bronn, Index Pal. Nomen., 1849, p. 69.
„ „ Morris, Cat. Brit. Foss., 1854, 2d ed. p. 99.
Lonchodomus rostratus, Angelin, Pal. Scand., 1854, p. 82, t. 40, f. 11 *a-d*.
Ampyx rostratus, Bigsby, Thes. Sil., 1868, p. 36.
„ „ Steinhardt, Beitr. Naturk. Preus. Physik-Œkonomischen, Gesellsch, Königsberg, 1874, 3, p. 39, t. 4, f. 10, ? t. 5, f. 7.
Lonchodomus rostratus, Lindström, in Angelin's Pal. Scand., 2d ed., 1878, p. 82, t. 40, f. 11.

Spec. char.—General form oval, produced anteriorly. Cephalic shield triangular; glabella long, oval, diamond-shaped, contracted anteriorly and posteriorly; widest and most convex about the middle, the anterior extremity terminating in a long spine, the posterior margin reaching quite to the neck-furrow, the anterior third projecting freely from the remainder of the head, and snout-like; in some individuals the central line of the glabella is ridge-like or occupied by a narrow, elongated, flattened area. Glabella-furrows represented by pits along the posterior lateral margins of the glabella. Two of these are situated at the base on opposite sides, a little in front of the neck-furrow, and in a measure mark off the base of the glabella as an indistinct lobe, their longer axes being transverse to that of the glabella; two others, having an oblique inclination, are situated at the anterior ends of the axal furrows, at the anterior junction of the outline of the glabella and fixed cheeks; two more, one on each side, are placed a little above these, but with their longer axes parallel to that of the glabella. Free cheeks triangular, with the outer margins more or less sigmoidal. Axal furrows not strongly marked. Neck-furrow faint, except at the outward termination of the fixed cheeks, where it is deeper on each

side; hardly perceptible under the base of the glabella. Free cheeks small, their outer margins rounded, the inner sigmoidal, terminating posteriorly in inwardly-curved produced spines. The anterior and genal spines are prismatic in section, with the four faces more or less concave; the former projects from the head almost in the same plane with the body, or is parallel to its longer axis. Facial suture elongately sigmoidal, cutting the anterior margin about half-way between the axal furrows and the genal angles, and the posterior margin close to the latter. Rostral shield, and incurved under margin, widely V-shaped; the latter is concave with ridge-like borders. Surface of head (in casts) punctate. Thorax short and broad. The axis is equal in length to the pygidium, but much less than the glabella; wider than the pleuræ, slightly convex. Pleuræ flattened.

Pygidium semicircular, with a broad, bevelled, and striated limb. Axis faintly segmented, with a row of tubercles on each side, with the exception of the first segment which is distinct; lateral lobes undivided, except for an anterior furrow on each side corresponding to the anterior somite of the axis.

Obs.—The above are the characters of the British specimens referred to *A. rostratus*, Sars. The latter and Milne-Edwards describe the axis of the pygidium as possessing six rows of tubercles. This is quite possible, because the tails which have come under our notice are casts, and not in a good state of preservation, although we have one example in which five are visible on one side, and this character might easily be obliterated.

The pits along the sides of the glabella which we have described above, are not visible in all the specimens before us, but are particularly well seen in one which we figure. In all, however, there is more or less a trace of them to be found, and especially of the most anterior and lowest pairs.

The form of the head in this species is very characteristic, and were the sides prolonged from the genal angles to the base of the rostral spine, an almost equilateral triangle would be

formed. As a British species, the occurrence of *Ampyx rostratus* is limited; as we are acquainted only with specimens from the typical Irish locality, a very doubtful specimen from Garn in Wales, referable to the Llandeilo, examples probably belonging to this form from the Coniston Limestone of Keisley, Westmorland, and the present examples from Girvan.

Loc. and Horizon.—Drummuck, in a fine-grained greenish sandstone or mudstone (Gray Collection; and *Mus. Pract. Geology*); Lady Burn above Drummuck (*Mus. Pract. Geol.*); Littleburn, south-west of High Mains (ibid.)

Ampyx Macallumi, Salter (*sp. nov.*)

(Pl. XII., figs. 9-12.)

A. Macallumi, Salter, MS., Cat. Foss. Mus. Pract. Geol., 1865, p. 18.

Spec. char.—Cephalic shield almost an equilateral triangle. Glabella lanceolate-triangular, arched, with a sharp dorsal ridge which terminates anteriorly in an attenuated spine; backwards the glabella terminates against the neck-furrow with a narrow truncated base; furrows or depressions not visible, except the anterior pair, which are situated exactly at the middle angles of the glabella. Fixed cheeks acutely triangular, their outer margins extending from the neck to the anterior end of the glabella, or, as it might be termed, the narrow neck of the spine, and so enclosing the whole of the former within their boundaries; surface slightly convex or almost flat in those portions next the glabella, becoming a little bent down towards the facial sutures. Glabella-spine short, spine-like, prismatic, or triangular (?), grooved. Neck-furrow linear, only an impressed line, inconspicuous below the glabella. Neck-segment broad, sloping inwards towards the head. Free cheeks unknown. Facial sutures direct, a little indented about the middle of their course. Ornamentation none.

Thoracic somites, five in number, short and broad; axis very gently convex, pleuræ flat; axal grooves faintly marked. Each pleura is unequally divided into an anterior and posterior

portion, the former being the largest, by a shallow pleural groove, which, commencing at the distal or outer end of the pleuræ, gradually dies out before reaching the axis, in a very marked manner.

Pygidium semicircular, with a striated or slightly-bevelled limb; axis very gently convex, with the first segment strongly differentiated; side-lobes flat, and partially segmented—*i.e.*, the four or five segments are indicated by shallow grooves commencing at the outer margin, as in the pleuræ of the thorax, and extending inwards towards the axis but a short distance, and terminating without reaching the latter, giving to the margin of the tail a more or less feebly crenulated appearance; the first of these grooves is the best marked.

Obs.—The occurrence of *Ampyx rostratus*, Sars, in the Girvan series and the fact that this, like the form now under description, is a species of the section *Lonchodomus*, render it necessary that a minute comparison should be entered into between the two to show in how far they differ.

In the course of the description of *A. Macallumi*, just given, we have shown that the glabella, as far as the base of the spine, is contained *within* the equilateral triangle forming the general outline of the head. On the other hand, if reference is made to our description of *A. rostratus*, it will be at once seen that to all intents and purposes only half the glabella is so contained, and that to convert the head in this species into an equilateral triangle, lines would have to be drawn from the base of the spine to the genal angles. It may be thought that this merely results from the absence of the free cheeks; it is, however, not so; for in our fig. 14 (Pl. XII.), representing a view of *Ampyx rostratus*, the free cheeks are plainly visible, occupying only the lower half of the head and, of course, coinciding with the fixed cheeks—whereas in *A. Macallumi* (Pl. XII., figs. 9 and 10), we suspect the free cheeks would occupy the whole length of the side of the head. We imagine such differences as these will be quite sufficient to separate the two species, presuming others to be absent; to show that other

points can be indicated, however, we would only refer to the pleural grooves on the thorax, the characteristic segmentation of the tail in each, and the absence of tubercles or nodes on the tail-axis of *A. Macallumi*.

We have not yet obtained a specimen of the species exhibiting the genal spines *in situ*, but there are in the same bed at Balcletchie isolated examples of the frontal margins of a Trilobite, with genal spines attached (Pl. XIII., fig. 11) which may belong to it. The spines are prismatic, with prominent edges, a central groove on each face, and delicate striæ.

As regards the vexed question of identification, we are unable to satisfactorily place this form under any species of which a description is within our reach, and we have been at some trouble to make ourselves acquainted with the characters of as many forms of *Ampyx* as possible. It will not do for either of Sars's species; none of those so beautifully illustrated by Angelin will contain our form, so far as we can judge by the figures; it certainly is neither of the Bohemian forms described by M. Barrande,[1] and nearly the same points relied on for separating the heads of *A. rostratus* and *A. Macallumi* will also suffice to mark a division between the latter and *A. Brückneri*, Boll.[2]

The form of the glabella is sufficient to distinguish *A. Macallumi* from *A. nasutus*, Dalman,[3] and the same may be said of *A. parvulus*, Forbes,[4] *A. prænuntius*, Salter,[5] and *A. tumidus*, Forbes.[6] No distinct alliance exists with any of the species described by the late Mr Billings, with the exception of *A. normalis*,[7] which appears to come nearer to our form than any other we are acquainted with. The glabella appears to bear furrows which are not present in *A. Macallumi*, and the tail has not those peculiarities noticed in the foregoing description of the latter. In *A. nasutus*, Dalman, the pygidium is smooth

[1] Syst. Sil. Bohême, i. t. 30. [2] Palæontographica, i. t. 17, f. 8.
[3] Vet. Acad. Handlingar, 1826, p. 253, t. 5, f. 3.
[4] Mem. Geol. Survey, ii. pt. 1, p. 10.
[5] Ibid., iii. t. 8, f. 5. [6] Ibid., iii. t. 23, f. 6.
[7] Pal. Foss. Canada, i. p. 295.

and the segments of the thorax are represented by pits or punctæ on the surface of the latter. In *A. Macallumi*, on the contrary, the side-lobes are segmented partially, and the axis regularly so.

We have much pleasure in adopting the MS. name applied to specimens now in the Museum of Practical Geology, by the late Mr Salter, who evidently regarded it as a new form.

Loc. and Horizon.—Balcletchie, in a fine-grained green mudstone (Gray Collection); Penwhapple Glen (*Mus. Pract. Geol.*),[1] and as *Ampyx nasutus*, Dalman (ibid.)

Ampyx (?) Macconochiei, Etheridge jun., and Nicholson (*sp. nov.*)

(Pl. XIV., fig. 1.)

Spec. char.—General form almost round, with the rotundity interrupted only by the produced glabella. The glabella and lateral lobes of the head-shield convex; the former apparently pyriform, enlarged forwards, and without any anterior spine; surface of the glabella and side-lobes (fixed cheeks) minutely punctate, the punctæ being arranged in concentric and slightly inosculating lines.

Thorax of five rings; axis very narrow as compared with the whole width of the thorax, convex; pleuræ horizontal, visibly grooved, much wider than the thoracic axis.

Pygidium small, widely semicircular; axis of apparently four or five rings, gradually tapering, convex; side-lobes of apparently four radiating subdivisions on each side, strong, and well marked; limb broad for size of the body, a little bevelled, and concentrically lineate. Surface of the thorax and pygidium punctate, but the punctæ coarser and stronger than on the head-shield.

Obs.—We were for some time inclined to regard this peculiar little Trilobite as a *Trinucleus*, but acting on the advice of our friend, Dr H. Woodward, we have provisionally referred it to *Ampyx*. The head-shield in several species of both these genera is punctate, but we are not acquainted with any in which

[1] Cat. Foss. M.P.G., 1865, p. 18.

the whole surface is so, as in the present instance; and, again, as regards a reference to *Trinucleus*, we have not seen a trace of the punctate-fringe in any of the specimens before us. The chance of its being an immature form has also been considered by us, but without any satisfactory result.

We are unacquainted with any species to which this could be referred, and therefore take the opportunity of associating with it the name of Mr A. Macconochie, of H.M. Geological Survey, who has collected largely in the Girvan district.

Loc. and Horizon.—Balcletchie, in a greenish fine-grained mudstone. (Gray Collection.)

Ampyx Hornei, Etheridge jun., and Nicholson (*sp. nov.*)

(Pl. XIII., figs. 4-8.)

Spec. char.—Cephalic shield semicircular, the margin truncated and curved upwards anterior to the glabella. Glabella, taken as a whole, somewhat pyriform, with a prominent, gibbous, mammillary, blunt, and upwardly-projecting frontal lobe, extending to the anterior margin, but not projecting beyond it, and terminating in an apical tubercle; the basal contracted portion of the glabella bears, on each side, two elongated, obliquely and outwardly directed furrows, and faint indications of a third near the neck, the glabella being contracted backwards between the grooves in the form of a rounded blunt ridge. Neck-furrow well marked, rather broad, extending the whole transverse length of the shield; neck-segment narrow, projecting backwards in the middle line. Fixed cheeks broad and wing-like, flat, or a little convex, traversed diagonally from about the middle of the frontal lobe of the glabella, by a series of radiating lines or ridges, of which two are usually more strongly marked than the others, and are sometimes the only ones visible; these ridges start from a common base, represented by a small irregularly-rounded elevation, having much the appearance of an eye-spot. Facial suture obliquely elongated and undulated. Free cheeks not preserved, but probably elongated and linear, and terminating posteriorly in genal

correct separation has been made. After all, it is just possible it may be a question of sex, but as it is almost next to impossible to indicate what were or were not sexual characters in certain extinct groups of fossils, the only other course open to the palæontologist is to consider such forms from a specific point of view.

We are extremely indebted and obliged to Professor Kjerulf, Director of the Christiania University Museum, for the loan of authenticated specimens of *A. mammillatus*, Sars, and *A. costatus*, Boeck, kindly forwarded to us by Conservator W. C. Brögger, also of the above institution, by means of which we have been able to work out the above subject, and compare with them our Girvan forms.

Passing now to the latter (Pl. XIII., f. 4-8) we would point out that they approach nearest to *A. mammillatus*, Sars, as restricted,[1] in the presence of a truncated anterior margin to the cephalic shield, blunt glabella terminating in a tubercle, and not a spine, and strong neck-segment. On the other hand, if the glabella-furrows in Sars's figure are correctly drawn, a point upon which we have some doubt, then there is here a marked difference between the Swedish and Scotch forms. In addition to this, there is in the latter a backward prolongation of the neck-segment which does not appear to exist to any extent in the restricted *A. mammillatus*, although it is more marked in that figure of *A. costatus*[2] with the non-produced glabella. Setting aside these discrepancies, however, there is a much more important one to be mentioned. In our specific diagnosis we described a series of ridges radiating from a defined point across the cheeks of *A. Hornei.* Now, neither in the figures of Sars or Angelin, nor yet on the actual specimens forwarded to us from Sweden, is there the slightest trace of such ridges. It affords us much pleasure to state that our friend Dr H. Woodward, F.R.S., is quite at one with us in regarding this as a sufficiently important structural difference between the Scotch and Swedish fossils to warrant a specific separation.

[1] Isis., t. 835, t. 8, f. 4^c.

[2] *Loc. cit.*, f. 4^a.

One other point in connection with this requires to be noticed. Colonel Portlock described an Irish species as *Ampyx Austinii*,[1] which has hitherto been regarded as a synonym of *A. mammillatus*, Sars (restricted). As in the case of Sars's species, there is here no mention made, or trace in the figure, of radiating cheek-ridges; and we can therefore only conclude that *A. Austinii* did not possess such, and is in consequence quite distinct from our *A. Hornei*.

In describing the other species of *Ampyx* from Girvan, we placed them under and made use of the subdivisions of the genus proposed by Angelin. We cannot at the present moment recall any other species of this genus possessing similar cheek-ridges, and we consider this character of sufficient importance in itself to indicate *A. Hornei* as worthy of separation from the typical *Ampyx* in an equal degree with the other species referred to.

Locality and Horizon.—Balcletchie, in a fine-grained greenish mudstone (Gray Collection); Penwhapple Glen, in a similar matrix (*Coll. Mus. Pract. Geology*).

Genus Trinucleus, Lhwyd, 1699.

(Lith. Brit. Ichnographia, p. 97.)

Obs.—In 1849,[2] and again in 1851,[3] Professor M'Coy proposed the subdivision of the genus *Trinucleus* into two sections or genera—*Trinucleus* proper and *Tretaspis* M'Coy,—depending on the presence in the latter of five thoracic segments, two furrows on each side of the base of the glabella, a diagonal eye-line crossing the cheeks, occupying the position of the facial suture more or less, and usually a small apical or culminating tubercle ocular (?) in character.

This subdivision was adopted by the late Mr Salter in 1853,[4] who thus defines *Tretaspis*, M'Coy: "Ocular tubercle dis-

[1] Geol. Report, p. 261, t. 1, B. f. 1 and 2. [2] Annals Nat. Hist., 1849, iv. p. 410.
[3] Brit. Pal. Foss., fas. 1. p. 146. [4] Mem. Geol. Survey, Dec. vii., No. 7, p. 7.

tinct; eye-line cutting the posterior margin, but the head not separable at the sutures; glabella lobed."

It will be observed that the character of the five-segmented thorax of M'Coy is here abandoned, consequent upon the discovery of a metamorphosis in *Trinucleus* by M. Barrande.

Against this subdivision M. Barrande has strongly protested,[1] and on the following grounds. He observes that, 1st, the "eye-line" is not distinct and sharp, as is usually the case with a facial suture; 2d, it is a simple nervure, and as such is visible in many other Trilobites, as, for instance, *Conocephalites Sulzeri*, without any trace of facial suture, whilst in another species, *C. striatus*, it coexists with that structure; 3d, in *T. seticornis* and its allies the cheeks are constantly found attached to the head; 4th, *T. Bucklandi*, Barr., placed by M'Coy as one of the types of his *Tretaspis*, never possesses any real suture, or an eye-line similar to that of *T. seticornis*, whether British or Swedish forms are selected for illustration. We would observe that this view was expressed by M. Barrande after an inspection of the specimens in the Woodwardian Museum used by M'Coy.

In another place,[2] M. Barrande again returns to this subject, and further shows that,—1st, the 5-segmented thorax is of no moment, consequent on the metamorphosis which is undergone by *Trinucleus;* 2d, the two grooves on each side of the base of the glabella are, from their presence in *T. Bucklandi*, as much a character of specimens with a 6- as a 5-segmented thorax; 3d, the "ocular" tubercle occurs as frequently in *T. seticornis*, His., *sp.*, or *T. Bucklandi*, with six segments to the thorax, as it does in M'Coy's forms with only five.

In the views thus elaborated we entirely concur with M. Barrande, and we are now able to demonstrate the accuracy of his conclusions. We have examined more than fifty specimens of a species, hereafter described in detail as referable to *T. seticornis*, var., and all of which are British. Some of these have five segments to the thorax, two well-

[1] Syst. Sil. Bohême, i. p. 617. [2] Ibid., p. 620.

marked grooves at the base of the glabella on each side, and no cheek-tubercles; others, again, possess a 6-segmented thorax in combination with the characters just mentioned; again, there are other conditions in which may be seen a 6-segmented thorax, two glabella-furrows on each side, and apical or culminating tubercles present on the cheeks, while the latter are crossed by the so-called eye-line; and lastly, we have before us a beautifully-preserved cephalic shield from Pomeroy in Ireland, in the Museum of Practical Geology, possessing all the essential characters of *T. seticornis*, and of M'Coy's *Tretaspis, with a tubercle on each cheek*, and with the basal constrictions to the glabella, but *without the slightest vestige of an "eye-line"* crossing the cheeks. We think this conclusively proves the correctness of M. Barrande's reasoning.

Notwithstanding the fact that *Tretaspis*, either as proposed by M'Coy, or as defined by Salter, will not stand, it becomes a question with us whether the name may not advantageously be retained, as a section, for those *Trinuclei* with a lobed glabella, in contradistinction to those in which it is entire, or more or less entire at any rate.

Trinucleus seticornis, Hisinger, *sp.*, var. Bucklandi, *Barrande.*

(Pl. XIII., figs. 13-20.)

(*Asaphus seticornis et A. cyllarus*, His., Leth. Suecica., 2d Suppl., p. 3, t. 37, f. 23; *Trinucleus*, Lovén, Öfv. K. Vet. Akad. Förhandl., 1845, No. 4, p. 107, t. 2, f. 1, *a-g.*)

Trinucleus seticornis, Portlock, Geol. Report 1843, p. 263, t. 1, B. f. 8, *a-c.*

„ *Bucklandi*, Barrande, Note Prélim., 1846, p. 31.

„ *seticornis*, M'Coy, Synop. Sil. Foss., Ireland (1846), 1862, p. 56.

„ *Bucklandi*, Corda, Prod. Mon. Böhm. Trilob., 1847, p. 39.

Tretaspis seticornis, M'Coy, Brit. Pal. Foss., 1851, fas. 1, p. 47.

Trinucleus Bucklandi, Barrande, Syst. Sil. Bohême, 1852, i. p. 621, t. 29, f. 10-17.

„ (*Tretaspis*) *seticornis*, Salter, Mem. Geol. Survey, Dec. vii., 1853, No. 7, p. 7.

„ *seticornis*, Salter, in Murchison's Siluria, 1867, 4th ed., p. 69, Foss. 14, f. 1 and 1.

Spec. char. — General outline oval, with the head much

elevated above the level of the body; the thorax and pygidium are about equal in length, but the cephalic shield is much longer than either, semicircular in form, and most convex exactly in the median line. Glabella pyriform, with the anterior portion much inflated, spherical, and very convex, rising high above the cheeks, and gradually attenuated posteriorly to a more or less depressed, elongated, narrow neck, and having its apex, or culminating point, occupied by a persistent tubercle; the neck bears on each side two deep, laterally-elongated pits or fossæ, of which the anterior pair are the larger, and take the place of regular glabella-grooves; axal furrows surrounding the glabella, broad and well-marked in their posterior parts, gradually decreasing in depth and width towards the anterior margin, terminating on each side of the glabella, immediately behind the punctate fringe, in a circular pit or foramen, which is deep in young, but becomes almost imperceptible in old, individuals; half-way between these pits and the anterior pair of glabella-furrows on each side is situated another similar but shallower and larger depression, which, instead of interrupting the course of the axal furrows, is excavated in the lateral margins of the glabella itself; they are less perceptible in the young than in the old state. Cheeks subtriangular, strongly convex, situated at a much lower level than the glabella, graduating outwards towards their exterior margins, but abrupt next the body; each cheek provided with an apical or culminating tubercle, which may be very prominent or depressed, but is always stronger than that on the glabella, and is always present in the young state, although absent in the old condition; there is usually an "eye-line" extending across the cheeks from the punctum on the side of the glabella, passing through the cheek-tubercles and terminating at each posterior lateral angle, but it is not always present. The neck-furrow is broad, although not deep, and constricts the base of the glabella, giving rise to the appearance of a third pair of furrows. Neck-segment narrow. Surface of the glabella reticulate. The prominent and well-

marked limb in front of the glabella is inclined at an angle of about 85°; but more posteriorly, at the sides of the cheeks, and where continued to the thorax, it is almost vertical. In front of the cheeks and glabella the limb is at first convex, it then becomes concave, and gradually turns upwards and outwards, being bordered by an inwardly bevelled and striated margin; in the vertical portion at the sides of the head the concavity is lost, and the prominent front margin gradually extending backwards is produced into long, tapering, striated, genal spines, which reach some distance beyond the posterior margin of the pygidium. In the young condition the convex part of the limb in front of the head is occupied by three concentric rows of circular, funnel-shaped holes or punctures, the concavity and the upwardly-turned margin exhibiting a row of transversely-elongated depressions, each of which really contains two of the previously-mentioned holes, placed one in front of the other. The adult condition only differs from this in the increased number of the concentric rows of holes on the convex portion, the result being that the limb, anterior to the head, has the circular depressions arranged in both a concentric and radiating manner. In both young and old, increase in the number of the rows takes place by interpolation, so that at whatever point the punctæ are counted vertically, the number in each row increases more and more as the posterior margin is approached. In young individuals a row taken immediately below the posterior angles of the cheeks would number from five to six holes, a row at the posterior termination of the fringe numbering seven to nine along the incurved margin of the limb; whilst in adults the posterior margin will have against it from ten to fourteen holes; and in the vertical portion of the fringe the perforations lose both their radiate and concentric arrangement in a great measure. When the integument is removed from the limb, the concavity is seen to be occupied by a narrow zone, or broad groove, extending from one end to the other, concentrically striated, and devoid of any trace of the perforations which

appear when the integument is preserved; at the same time the upturned edge of the front margin is occupied by a single line of punctæ, which increases to two lines towards the posterior angles.

The thorax consists of six segments; the axis is convex, but of less width than the lateral lobes or pleuræ; it tapers gradually, and each segment is transversely striated; the distal portions of the segments are separated from one another, from front to back, by deep depressions on each side, especially in casts; axal grooves shallow. Pleuræ horizontal, flat; pleural grooves extending nearly the whole breadth of the pleuræ; the backwardly-directed facet-portion of each is longitudinally striated.

Pygidium semicircular; axis gradually tapering to an acute apex in the old condition, broader in the young, and composed of six, seven, or nine rings, which are similar in character to those of the thorax; lateral lobes indistinctly marked, with a varying number of indistinct subdivisions. Surface of pygidium apparently unornamented.

Possessed the power of rolling up.

Obs.—After describing the beautiful Trilobite named by him *Trinucleus Bucklandi*, M. Barrande, on the one hand, enters into a minute comparison between it and typical specimens of *T. seticornis*, Hisinger, from Sweden; and, on the other, compares examples of the latter species from Ireland with *T. Bucklandi*, with the view of showing the close identity existing between the three forms.

M. Barrande finds that adult specimens of *T. seticornis*, His., from Sweden differ from his Bohemian species: 1st, by the form of the punctate limb, which does not extend in the former beyond the head, and is not applied to the sides of the thorax; 2d, in the axis of the pygidium, which thoughout its course is identical in size with that of the thorax, and has a truncated posterior end, in place of a gradually-narrowed axis terminating in a more or less acute point, as in *T. Bucklandi;* 3d, by the persistence of the tubercles on the cheeks. The author

then proceeds to observe that these differences gradually disappear if we look upon the form of *T. seticornis*, His., figured by Lovén as representing only the young or medium age. In other words, says M. Barrande, young Bohemian specimens of *T. Bucklandi* agree in every particular with Swedish examples of *T. seticornis;* and the species only differ, as above pointed out, when adult forms of the Bohemian species are examined. From these facts M. Barrande is disposed to regard his *T. Bucklandi* as identical with *T. seticornis;* but the question is left an open one for other palæontologists, particularly those of Sweden, to decide.

The remarks on the Irish examples of *T. seticornis* by the learned Bohemian naturalist, are equally to the point. He observes that, so far as such are known to him, they appear identical with the young condition of his *T. Bucklandi*, except in the eye-line described by Professor M'Coy on the cheeks of the former which is never seen on those of the latter. Further, M. Barrande states that the late Mr Salter discovered the characteristic reticulation visible on the glabella of young *T. Bucklandi* on British specimens referred to *T. seticornis*, His. He had, moreover, personally seen similar ornamentation on examples from Tyrone which agreed in size with the middle age of *T. Bucklandi*, likewise possessing the limb applied to the sides of the thorax and nearly vertical in position. These and other points mentioned evidently lead M. Barrande to the provisional conclusion that little difference will ultimately be found to exist between *T. seticornis*, His., from Sweden, the British Trilobites referred to this species, and his *T. Bucklandi.*

It affords us much pleasure to be able to clear up, to a certain extent at least, the relation existing between the foregoing forms. With this view we think we cannot do better than in the first place show how our British examples of *T. seticornis* agree with *T. Bucklandi*, Barr., merely stating that the specific description just given is drawn up from specimens derived from Irish, Welsh, and Scotch rocks; the examples of the former

being in the Museum of Practical Geology, of the latter in the "Gray Collection." After all, perhaps, a special verbal comparison is almost superfluous when a perusal of the respective specific descriptions by M. Barrande and ourselves, and a glance at the figures in the plates of both, should be sufficient to show that we undoubtedly possess *Trinucleus Bucklandi* in our British rocks. However, it may be at once stated that the form of the body (Pl. XIII., figs. 13 and 15) is in both cases the same,[1] the arrangement and backward extension of the punctate fringe are similar, as also is its stopping in the young state a little behind the cheek-angles (Pl. XIII., figs. 15 and 15^a), but increasing and becoming applied against the thoracic segments with age (Pl. XIII., fig. 13). The glabella is as spherical in our specimens, or perhaps a little more so, and invariably has the culminating tubercle both in the young and old condition. Further, we figure (Pl. XIII., fig. 17) its reticulate surface, a character already noticed in British specimens by Mr Salter and M. Barrande himself. As in Bohemian examples, so in ours, the culminating or apical tubercles on the cheeks are always present in the young, but never in the adult state. The young of the British examples usually possess the "eye-line," a phenomenon which Barrande says is never to be seen in Bohemian specimens, either old or young. It certainly does not occur in our aged examples and not always in the young condition. We give an exceedingly beautiful illustration of this (Pl. XIII., figs. 14 and 20); and we might, if necessary, continue the comparison with an examination of the glabella-furrows (even to the presence of the deep pit at the anterior end of the axal grooves of the glabella), the genal spines, and the characters of the thorax or pygidium, the result in all cases tending to show the identity of *T. Bucklandi*, Barr., with both the old and young stages of those Trilobites usually referred by British palæontologists to *T. seticornis*, Hisinger. In the collection furnished by M. Barrande to the British Museum

[1] Compare Barrande's figures, Syst. Sil. Boh. Atlas, t. i. pl. 29.

are several examples of the young and middle age of *T. Bucklandi*, with which we have compared the British specimens, and we are quite satisfied as to their identity.

Passing on to a consideration of the resemblance, or otherwise, existing between the British and Swedish forms, we would point out that, so far as we know, the fullest and most detailed description of *T. seticornis*, His., *sp.*, with which we are acquainted, is that by Lovén,[1] who, in his synonomy, admits the figures of Irish specimens of that species by Portlock; specimens presumed to be the originals of those we have been fortunate enough to study. A fact, moreover, which must not be overlooked, is that Portlock figured[2] the reticulate structure of the head in British specimens before it was noticed either by Salter or Barrande.

We hoped to have been able to compare authenticated Swedish examples with our British fossils; but we have been unable to meet with these, and must wholly rely, therefore, on figures. We see by those of Lovén and Angelin that the form of the head and body closely corresponds in both; the spherical glabella and convex cheeks are identical, and there are similar furrows. In the side view of the head given by Angelin,[3] the glabella appears too long for either *T. Bucklandi* or our specimens — the spines are decidedly much longer. Both these authors represent the cheek-tubercles present in their figures, which are of the natural size, and larger than the largest of our full-grown examples. Again, on the other hand, Angelin's side view of the head shows a similar bent down fringe, turned up in front, vertical behind; whilst in an enlargement[4] by the same author, we observe the striated space round the fringe devoid of perforations, where the integument is removed, which quite corresponds with the figure we give (Pl. XIII., fig. 19). In other words, the Swedish *T. seticornis* appears to differ from the British fossils of the same name in exactly the same features as it does from the Bohemian *T. Bucklandi*, Barr.—viz., in the

[1] Öfv. Vet. Akad., 1845, No. 4, t. 2, f. 1, *a-g*.
[2] Geol. Report, t. 1, B. f. 8*c*.
[3] Pal. Scand., t. 40, fig. 19*a*.
[4] Ibid., fig. 19*c*.

restriction of the punctate fringe to the head, and its non-application backwards to the sides of the thorax; in the non-attenuation of the axis of the pygidium; and by the presence of the cheek-tubercles in what appears to be an adult form. If, therefore, these points are to be considered of specific importance, then our British *T. seticornis* has more affinity with *T. Bucklandi*, Barr., than with the true *T. seticornis*, His., and should be united with the former. But, on the other hand, if we admit with M. Barrande that the differences thus apparent are only those of age, we then have the adult Swedish form of *T. seticornis* equal to the young and middle age of the Bohemian and British forms. This we at present believe to be the safest and best course, especially as, 1st, Lovén admits Portlock's figures into his synonomy of *T. seticornis*, His., *sp.*; 2d, Salter, who had opportunities of examining Swedish examples, considers the British fossils to be identical with these; 3d, the same author places *T. Bucklandi* as a synonym of *T. seticornis*, His., *sp.* We entertain, therefore, little doubt of the identity, speaking in a broad sense, of all these forms, notwithstanding the trivial differences which appear to separate them.

Under these circumstances, we propose to consider the Bohemian and British fossils as a variety of the true species of Hisinger, as *T. seticornis*, His., *sp.*, var. *Bucklandi.*

We find that the structure of the punctate fringe in our specimens is of a very interesting character. In an exceedingly well preserved specimen, we notice that the funnel-shaped perforation, or punctum, is closed by a diaphragm, which, in its turn, is pierced by a small pore (Pl. XIII., fig. 15^{b}). This is to a certain extent figured by Lovén,[1] but our specimens show it in a marked degree.

Loc. and Horizon.—Drummuck, in a fine-grained greenish mud or sandstone (*Coll. Mus. Pract. Geol.*; Gray Collection, &c., &c.)

[1] Öfv. Vet. Akad. Förhandl., 1845, t. 2.

Trinucleus concentricus (Eaton), Salter.

T. concentricus (Eaton), Salter.
„ Salter, Mon. Brit. Trilobites, pt. 4, 1867, p. 211.

Obs.—In giving the locality of his *Illænus Macallumi*, the late Mr Salter casually mentions that *Trinucleus concentricus* occurs "in the same deposit of hard yellow sandstone and grit" with *Illænus Thomsoni* and *Atrypa hemisphærica* at Mulloch Hill. For our own part, we have not met with this species at the locality mentioned; but fragments of a punctate fringe occur at Shalloch Mill, not at all unlike that of the species in question.

Loc.—Mulloch, in sandstone. (Salter).

Trinucleus, *sp. ind.*

(Pl. XIV., figs. 2-4.)

Obs.—Another form of *Trinucleus* is found at Shalloch Mill, chiefly as fragments of the punctate limb; but we have an entire tail, and portions of a head which may belong to the same species. The fringe (Pl. XIV., fig. 3) appears to have been a horizontal one, little or not at all bent down, and the cheeks highly scrobiculate; the posterior angles terminated in small spines.

The pygidium (Pl. XIV., fig. 4) associated with these remains is of a widely triangular form, sharp at the lateral angles and apex; the axis is multisegmentate, of ten or more rings, and the lateral lobes are crossed by a much less number of wide flat segments; the limb was longitudinally striated.

We are unable to determine with any certainty to what species these remains are referable. The punctate limb (Pl. XIV., fig. 3) has somewhat the aspect of that of *T. concentricus*, Eaton; but the pygidium, although similar in appearance, is too decidedly triangular.

Loc. and Horizon.—Shalloch Mill, in an argillaceous shale containing a good deal of lime. (Gray Collection.)

Genus SALTERIA, Wyv. Thomson, 1864.

(Mem. Geol. Survey, Dec. xi., No. 6, 1864, p. 1.)

Salteria primæva, Wyv. Thomson.

(Pl. XIV., fig. 5.)

S. primæva, Wyv. Thomson, *loc. cit.*, t. 6.
„ Bigsby, Thes. Sil., 1868, p. 67.
„ R. Etheridge, jun., Proc. R. Phys. Soc. Edinb., 1878, iv. p. 170.

Obs.—We have little to add to the description of this Trilobite given by Sir Wyville Thomson; but we are able, through the zealous collecting of Mrs Gray, to give a figure (Pl. XIV., fig. 5) of a more perfectly preserved specimen now in the Hunterian Museum.

In addition to the description above referred to, we may state that the base of the glabella, where it cuts off the neck-segment, is very delicately striated like the former, on which the striæ inosculate.

The thorax consists of at least six somites; the axis is slightly convex, and the segments striated parallel to the longer axis. The pleuræ are horizontal and obliquely striated, although one or two of the most anterior appear to be ornamented like the rings of the axis.

The central lobe of the tail has at least eight rings. We are not acquainted with either the free cheek or eye; in fact, we doubt if the latter exists in this genus.

Loc. and Horizon.—Balcletchie, in a fine-grained greenish mudstone (*Coll. Mus. Pract. Geol.;* Gray Collection; *Hunterian Museum;* "Graptolite and Orthoceratite flags," Penwhapple Glen, Wyv. Thomson).

Genus AGNOSTUS, Brongniart, 1822.

(Hist. Nat. Crust. Foss., 1822, pp. 8 and 38).

Agnostus agnostiformis, M'Coy.

(Pl. XIV. fig. 6.)

Trinodus agnostiformis, M'Coy, Sil. Foss., Ireland, 1846, p. 57, t. 4, f. 3.
Agnostus convexus, Salter, Mem. Geol. Survey, 1848, ii., pt. 1, p. 351, t. 8, f. 12 and 13 (*non.* f. 11).
Trinodus agnostiformis, M'Coy, Brit. Pal. Foss., 1851, fas. 1, p. 141, t. 1, E., f. 10.
„ *tardus*, M'Coy, *loc. cit.*, p. 142, t. 1, E., f. 9 (*non.* Barrande).
Agnostus trinodus, Morris, Cat. Brit. Foss., 1854, 2d ed., p. 99.
„ „ Salter, Mem. Geol. Survey, Dec. xi., pt. 1, p. 8, t. 1, f. 8-10.
„ „ Salter, Mem. Geol. Survey, 1866, iii., p. 297, t. 19, f. 8.
„ „ Salter, Murchison's Siluria, 1867, 4th ed., p. 204, Foss., 46, 6.
„ „ Bigsby, Thes. Sil., 1868, p. 36.
„ „ Salter, Cat. Camb. Sil. Foss., Woodwardian Mus., Cambg., 1873, p. 48.
„ „ Woodward, Cat. Brit. Foss., Crustacea, 1877, p. 22.
„ „ R. Etheridge, jun., Proc. R. Phys. Soc. Edinb., 1878, iv. p. 173.

Obs.—We are unable to supplement Mr Salter's description of this species beyond stating that we have observed traces of the thoracic somites. In some specimens the mucronate posterior angles of the head are visible, and the short spines on the limb of the tail.

This species was originally described by Professor M'Coy as *Trinodus agnostiformis*, but from the non-adoption by palæontologists of the term *Trinodus* in a generic sense, it was transferred to *Agnostus* by Salter. We presume Mr Salter changed the specific name given by M'Coy from, as he considered, a too close resemblance to the generic name, and as having little or no meaning from a precise specific point of view. For our part, we maintain that, a name once given, without it can be shown to be preoccupied, should be adopted, although it may at first sight appear peculiar from its resemblance to the generic term. Those working at the subject would be quite as well

able to understand the meaning of *Agnostus agnostiformis* as of *Agnostus trinodus*, especially if the term *Trinodus* be applied in a sectional sense, as is done through his 'Monograph' by Mr Salter. The name would then be written *Ag.* (*Trinodus*) *agnostiformis;* and viewing it in this way, we fail to see why M'Coy's name should be relegated to the synonomic list.

If *Dendrophyllia dendrophylloides*, Lonsdale, a Bracklesham Coral, be admitted to be rightly designated—and it is so by Messrs Milne-Edwards and Haime[1]—we fail to see why the name here in question should not be preserved also; and we think that the practice of changing a specific or generic name for the sake of euphony, or because of some slight defect in its composition, is one which should not be followed except under special and aggravated circumstances.

Loc. and Horizon.—Balcletchie, in a fine-grained green mudstone (Gray Collection); Penwhapple Burn (*Mus. Pract. Geology*);[2] Piedmont Glen (*Mus. Pract. Geol.*)[3]

Addenda (Trilobites).

Phacops Brongniarti, Portlock.[4]

(Pl. XIV., figs. 7 and 8.)

Obs.—We give a supplementary figure of a very large decorticated example of this species, which has, unluckily, been subjected to pressure and distortion to some slight extent. The characteristic sutures of the glabella are quite visible on one side of the head, and a part of the eye on the other. The pleuræ of the thorax in *P. Brongniarti* appear to be of a very well marked character, much bent down, with oval partially free distal terminations, and strong central grooves. We also figure another head in which the glabella-grooves are particularly well shown.

[1] Brit. Foss. Corals, p. 36.
[2] Salter, Decade, xi., No. 1, p. 9.
[3] Cat. Foss. M.P.G., 1865, pp. 4 and 7.
[4] See p. 99.

Locality.—Drummuck (*Coll. Geological Survey of Scotland*), collected by Mr A. Macconochie; Ardmillan (Gray Collection).

Cheirurus bimucronatus, Murchison.[1]

(Pl. XIV., fig. 9.)

Obs.—In our First Fasciculus we mentioned the occurrence of this species on the authority of the late Mr Salter. Shortly after going to press our attention was called to the fine thoracic fragment represented as above.

The specimen is a well-marked internal cast, measuring as now preserved one inch eight lines long, by two inches four lines wide, the rings of the axis measuring on an average one inch wide by four lines long. From the axal groove to the broad side-groove is exactly half an inch; the side flaps or outer portions of the pleuræ at their broadest point are three lines wide from front to back; they bend more or less to the rear, and consist of a nodular end gradually decreasing outwards to a flat, elongated, blade-like expansion, terminating in an acute point. This external portion of each pleura is separated from the inner by a constriction, the series of constrictions forming a groove, parallel with the thoracic axal furrows. The inner portion of each pleura is the shortest, and most convex, and is divided into two elongated triangles by a narrow, deep, oblique groove, forming a diagonal, with an average length of five lines, which, in fact, unites the axal groove and the second groove parallel to it. The tubercles present on this part of the thorax are well described by Mr Salter.[2]

Locality.—Burn passing Bargany Pond, near New Dailly (*Coll. Geological Survey of Scotland*), collected by Mr A. Macconochie.

Cheirurus clavifrons, Dalman (?).[3]

(Pl. XIV., fig. 10.)

Obs.—In our First Fasciculus we gave a figure of a por-

[1] See p. 100. [2] Monograph, p. 66. [3] See p. 101.

tion of the cephalic shield of a *Cheirurus* which we at one time thought might be distinct from the above.[1] The ornamentation consisted of a microscopically granular surface, with scattered pimples or small tubercles, and differed from the specimens referred to *C. clavifrons* in the possession of the latter character. We now take the opportunity of figuring, as previously promised, another specimen in which both styles of ornamentation are combined in the one example. At one point on the right-hand side of the figure a small fragment of the external crust may be observed, with a microscopically granular or frosted appearance, whilst over the general surface of the glabella may be seen a similar ornamentation, but also with the additional scattered small tubercles. This specimen clearly proves the identity of the subjects of our figs. 7 and 9, Pl. VII.

Locality.—Drummuck. (Gray Collection.)

Cheirurus (?) *sp. ind.* (*a.*)

(Pl. XIV., fig. 11.)

Obs.—We have before us three specimens of a small pygidium which may be that of a species of this genus. So far as preserved, it appears to be oval in form, with a narrow convex axis of five segments, more or less horizontal side-lobes, each traversed by two, or perhaps three, ridges, which extend to the posterior margin of the tail, and probably, though we are not sure on this point, extended beyond in the form of free spines.

Loc.—Balcletchie. (Gray Collection.)

Cheirurus (?) *sp. ind.* (*b.*)

(Pl. XIV., fig. 12.)

Obs.—We desire to call particular attention to the peculiar head represented on Pl. XIV., fig. 12. It appears to us to be a *Cheirurus* allied to the British species *C. gelasinosus*, Portlock. The frontal lobe and three lateral lobes on each side are

[1] Ibid., p. 104, t. 7, f. 9.

very well preserved, the former being strongly triangular, and the surface sparsely covered with tubercles; the central line of the glabella is somewhat carinate. Neck-groove well marked and broad; cheeks scrobiculate. A small pointed appendage in front of the truncated anterior end of the glabella. We are in doubt as to the position of the facial suture, and on this, in a great measure, depends the specific determination of the fossil. The only lines on the face of the cheek preserved are irregular cracks in addition to a diagonal ridge; none of these can represent the suture, so that we are at present compelled to look upon the curved lines joining the glabella on a line with the anterior pair of furrows as representing the facial suture. If this be so, it will at once separate our fossil from *C. gelasinosus*, Portlock, or *C. bimucronatus*, Murchison, in both of which the facial sutures below the eye run on a level with the first pair of glabella-furrows, and their course is quite different to that here exemplified.

In some *Cheiruri* the fixed cheeks are very broad, and the facial sutures have a very forward position, quite on a level with the anterior pair of glabella-furrows, as in our specimen. Such are *C. Hawlei*, Barr.,[1] and *C. vinculum*, Barr.,[2] so that it is just possible the anterior curved line in our figure may represent the facial suture. We at first thought that the anterior projection in front of the glabella was a part of the labrum forced up from its natural position; but our friend Dr Woodward, who has been kind enough to closely study this specimen, believes it to be truly *in situ* and to the remains of a forward projection of the frontal lobe of the glabella, or perhaps an anterior spine, such as is sometimes seen in species of *Phacops*, for instance, *P. longicaudatus*. Another important point in this specimen is the diagonal ridge passing across the fixed cheek from the anterior furrow in the direction of the eye. We have only one specimen.

Loc.—Balcletchie. (Gray Collection.)

[1] Syst. Sil. Bohême, i. t. 42, f. 6. [2] Ibid., Suppl. i. t. 12, f. 4.

Encrinurus punctatus, var. **calcareus**, Salter.

(Pl. X., f. 7.)

Obs.—In our First Fasciculus,[1] we alluded to the apparently rare occurrence of this variety of *Encrinurus punctatus* in the Girvan beds. Additional researches in that district have enabled Mrs Gray to add many interesting fossils to the list; one of them is the cast of the var. *calcareus* now figured (Pl. X., fig. 7), a tail, in which the extended mucro is broken off short.

Loc. and Horizon.—Penkill, in a fine-grained light-coloured mudstone. (Gray Collection.)

Cybele rugosa, Portlock.[2]

(Pl. XIV., fig. 13.)

Obs.—Dr J. G. O. Linnarsson has called our attention, since the publication of the First Fasciculus, to a paper by himself on Swedish Trilobites,[3] of the existence of which we were previously not aware, and to the resemblance borne by our figures of *C. rugosa* to a form described by him as *C. Lovéni*.[4] The resemblance is certainly very strong, but as we at present see no reason to doubt the accuracy of our reference of the Girvan specimens to *C. rugosa*, Portlock, we refrain from making any alteration in the name. Our command of a language so little used in this country as Swedish, is, unfortunately, limited; but so far as we can judge from Dr Linnarsson's figure, probably a very excellent one by the by, we should think it not improbable that *C. rugosa*, Portlock, and *Lovéni*, Linnars., may be identical, although the structure of the tail appears to be somewhat different in the two forms. The solution of this question can hardly resolve itself into a question of opinion—it must await the full description of *C. rugosa* from typical Irish examples, and the discovery at

[1] P. 108.

[2] See *ante*, p. 112, t. 8, f. 5-7.

[3] "Om Vestergötlands Cambriska och Siluriska Aflagringar."—Kongl. Svenska Vetenskaps-Akad. Handlingar, B. 8, No. 2.

[4] *Loc. cit.*, t. 1, f. 14.

Girvan of specimens having still more complete tails than possessed by those before us. In one of our former illustrations of this species, the cephalic and thoracic spines were inadvertently omitted. We now repair this omission by giving a more accurate figure. (Pl. XIV., fig. 13.)

Acidaspis, *sp. ind.*

(Pl. XIV., fig. 14.)

Obs.—A figure of this little Trilobite is given more with the view of showing the hypostome in position than as a detailed figure of the form in question. The thorax was narrow and convex, the proximal portion of the pleuræ horizontal, the distal portion sharply bent down; general surface of the cast punctate. From a portion of another example on the same piece of matrix we learn that the truncated posterior margin of the tail was produced into six spines, the two outermost being the largest.

Loc. — Burn passing Bargany Pond, near New Dailly (*Coll. Geological Survey of Scotland*), collected by Mr A. Macconochie.

Proetus (?) or **Acidaspis** (?) *sp. ind.*

(Pl. XIV., fig. 15.)

The subject of fig. 15, Pl. XIV., is probably a small *Proetus* or *Acidaspis*, but we cannot at present do more than give a figure of the one specimen in our possession, which is quite decorticated.

Loc.—Burn passing Bargany Pond, near New Dailly (*Coll. Geological Survey of Scotland*), collected by Mr A. Macconochie.

Ampyx (?) *sp. ind.*

(Pl. XIV., fig. 16.)

Obs.—With the view of drawing attention to a peculiar head-shield, we have given the above figure, being that of an

only specimen. It has the appearance, to some extent, of both an *Ampyx* and a *Trinucleus*, but from the produced nature of the glabella, were it wholly preserved, with seemingly greater affinities to the former. The centre of the glabella and the outer halves of the fixed cheeks are granulated in a characteristic manner, so that we may hope in the future to receive further specimens. It may be provisionally regarded as an *Ampyx*.

Loc.—Balcletchie. (Gray Collection.)

Order PHYLLOPODA.

Genus SOLENOCARIS, J. Young, 1868.

(Proc. Nat. Hist. Soc. Glasgow, i. p. 171.)

Solenocaris solenoides, J. Young.

S. solenoides, J. Young, *loc. cit.*, pp. 171-173, t. 1, f. 7, *a* and *b*.
„ R. Etheridge, jun., Proc. R. Phys. Soc. Edin., 1878, iv. p. 167.

Obs.—Several fragments of this peculiar Crustacean are in the cabinet of Mrs Gray, by whom it was originally discovered. They do not, however, throw any additional light upon its structure. For a detailed account of this fossil we must refer the reader to Professor Young's description.

Solenocaris solenoides appears to have quite escaped the notice of all recent cataloguers of fossils, as we do not find it noticed by any recent writers. It must not be confounded with the later *Solenocaris*, Meek, which must be abandoned and another name proposed in its place.

Loc.—Balcletchie (*Hunterian Museum;* Gray Collection).

Genus PINNOCARIS, R. Etheridge, jun., 1878.

Pinnocaris, Etheridge, jun., Proc. R. Phys. Soc., 1878, iv. p. 167.

Gen. char.—Carapace bivalve, bent along the middle line; each half is pinna-form, much attenuated towards one ex-

tremity; dorsal margin almost straight, but rising at a little less than a third from the rounded end into a kind of false umbo; ventral (? lateral) margin elongately sigmoidal; the expanded end of the carapace is broadly but gradually rounded; attenuated end produced into a long, narrow rostrum or beak, truncated at its extremity; substance probably very thin; surface striated parallel to the curved margins.

Obs.—The above name was proposed for a very peculiar fossil in Mrs Gray's cabinet, from the resemblance each half of the specimens bore to the recent genus *Pinna*—so much so, indeed, that much doubt was felt whether to regard them as a species of Pelecypoda (Lamellibranchiata) near the genera *Pinna*, *Pteronites*, or *Aviculopinna*, or as the carapace of a Phyllopodous Crustacean, allied to *Ceratiocaris*, *Discinocaris*, and other like forms. In their present state the specimens appear as black, flattened, shining bodies, the produced and truncated end retaining more of the original convexity than the other portions. On analysing the various characters of these fossils, for, or against their crustacean nature, we find that in support of the latter view we have the absence of any definite separation into anterior and posterior ends, as in a bivalve shell; secondly, the nature of the projecting part of the dorsal margin, here called the false umbo, which in no way appears to partake of the characters of the umbo in the Pelecypoda; thirdly, the presence of the object, indicated at *a*, fig. 17 (Pl. XIV.), which, although without organic connection with the carapace near it, is, we believe, one of the telson-spines, similar to those of *Ceratiocaris*, and other genera; fourthly, the lines of growth, instead of graduating outwards from the projecting point of the dorsal margin, as the similar striæ do on the valve of a shell (bearing in mind that the umbo of a bivalve is its "initial point"), appear to us to be much more regularly concentric (or as we see them, semi-concentric) round a central point or apex, as would be the case if both valves were spread out, as occurs in the genera *Discinocaris* or *Peltocaris*. On the other hand, in support of the molluscan affinities of these fossils, we have the

general *pinna* or *pteronites*-like form, although the larger end is more obliquely rounded than is usually met with in these genera, and the entire absence of the characteristic punctate ornamentation seen on the carapace of many Crustacea, combined with the absence of all trace of the eye-spot. It appears to us that the balance of evidence is at present in favour of the Crustacean affinities of these fossils, and that they cannot be placed in any of the genera known to us, such as *Ceratiocaris*, M'Coy; *Hymenocaris* (*Saccocaris*), Salter; *Physocaris*, Salter; *Peltocaris*, Salter; *Dictyocaris*, Salter; *Dithyrocaris*, Scouler; *Myocaris*, Salter; *Discinocaris*, Woodward; *Solenocaris*, Young; *Lingulocaris*, Salter; *Caryocaris*, Salter; *Aptychopsis*, Barrande; *Solenocaris*, Meek (*non* Young); *Colpocaris*, Meek; *Archæocaris*, Meek; *Cryptocaris*, Barrande; and *Pterocaris*, Barr. As none of the specimens to which we have access have the valves spread out, it is impossible to say with certainty whether *Pinnocaris* had a dorsal furrow along the back, like *Peltocaris*, or was devoid of one, as in *Discinocaris*.

Since the above facts were first brought forward by one of us, we have not seen any reason to modify or alter them; on the contrary, the increased number of specimens at present in Mrs Gray's cabinet tend to make our conviction of the crustaceous nature of these fossils still stronger.

In Pl. XIV., fig. 17, a small spine-like body is seen in contiguity to one of the valves. It was at one time thought this might be a small *Theca;* but the general appearance, similarity in structure to the valves of *Pinnocaris*, and resemblance to the tail-spines of this order of Crustacea, lead us to the opinion that in all probability we have here one of the spines of the present species.

Many of the examples before us exhibit a groove, or rather impressed mark, as if the surface had somewhat given way, and proceeded obliquely downwards from the prominence on the dorsal line.

Pinnocaris Lapworthi, R. Etheridge, jun.

(Pl. XIV., figs. 17-20.)

P. Lapworthi, Etheridge, jun., Proc. R. Phys. Soc. Edin., 1878, iv. p. 169, t. 2, f. 3-5.

Spec. char.—Identical with those of the genus; the greatest breadth is at a little less than the middle of the valve; concentric lines fine and close.

Obs.—The species was named in honour of Mr C. Lapworth, F.G.S., to whom we have been on several occasions indebted for the communication of specimens.

Loc. and Horizon. — Balcletchie, in a fine-grained, dark-greenish mudstone (Gray Collection; *Mus. Practical Geology; Mus. Science and Art*, &c.)

Genus PELTOCARIS, Salter, 1863.

(Quart. Jour. Geol. Soc., xix. p. 87.)

Obs.—It affords us much pleasure to be the means of communicating the following note by our friend Dr H. Woodward, F.R.S., on the subject of the genera *Peltocaris*, *Discinocaris*, and *Aptychopsis*:—

"Among the numerous forms of Phyllopod Crustaceans whose carapaces have been met with in rocks of palæozoic age in this country, three genera are specially remarkable from the fact that they have a nearly circular or disc-shaped shield, not a bivalved carapace, as is commonly the case with the members of this order.

"The first of these genera, named *Peltocaris*, was described and figured by the late Mr J. W. Salter, in 1863 (Quart. Jour. Geol. Soc., vol. xix. p. 88), and was designed to contain certain flat circular shields composed of three parts—namely, two principal lateral valves united along the mesial line by a straight suture, and one anterior or rostral valve separated from the

lateral valves by a rostral furrow or suture, which, in this genus, forms a parabolic curve.

"The second genus, named *Discinocaris*, was proposed in 1866 by H. Woodward (Quart. Jour. Geol. Soc., vol. xxii. p. 504) for certain circular, slightly conical shields composed of two parts only—namely, a small triangular-shaped anterior valve separated from the rest of the carapace (which consists of but one piece) by a straight rostral suture.

"The third genus, named *Aptychopsis*, was founded by M. Barrande in 1872 (Supplément au vol. i. Syst. Silur. Bohême, p. 455, Pl. 33) to contain flat sub-circular carapaces composed of three valves—namely, two lateral or principal valves united by a straight suture or hinge-line, and one anterior or rostral valve, forming an isosceles triangle the sides of which are equally straight.

"In 1871, a new Phyllopod shield labelled '*Aptychoides, gen. nov.*,' was presented by Mr A. Michie of Hawick to the British Museum. This specimen was obtained from the Middle Silurian of Yad's Lynn, near Hawick, and was named by H. Woodward, in August 1872, *Aptychopsis Wilsoni*. Two other species previously received from Mr C. Lapworth, from the same horizon and locality, were also named by H. Woodward at that time as *A. glabra* and *A. Lapworthi* (Brit. Assoc. Reports for August 1872, and Geol. Mag., 1872, vol. ix. p. 565).

"Mr Woodward was then quite unaware that the generic name *Aptychopsis* had already been published by M. Barrande for similar forms of shield found in the lowest division (e 1) of the Upper Silurian of Bohemia. Of course, the genus is *Aptychopsis* of Barrande, *not* of H. Woodward, as erroneously printed in Messrs Armstrong and Young's 'Catalogue of the Western Scottish Fossils,' 1876, p. 7, and in Woodward's 'Catalogue of British Fossil Crustacea,' 1877, p. 69."

Peltocaris (?), *sp. ind.*

(Pl. XIV., fig. 21.)

Obs.—The specimens agree in size with Salter's *Peltocaris aptychoides*,[1] being eleven millimetres in longest diameter: the rostral suture was possibly more angular than in *Peltocaris;* but as the specimens are both distorted and separated down the dorsal suture, it is somewhat uncertain what was the exact form of the rostral valve.

Under these circumstances it would be unwise to speak decidedly on this point, as it is to be hoped that other and better specimens will be found from this locality. M. Barrande remarks that the only ornamentation these flat Phyllopod shields present is a series of concentric and radiating striæ, observable on their inner surface, and seen on the casts of the English specimens. There seems good reason to conclude, from an examination of a large number of specimens, that these thin chitinous valves were ornamented by raised lines upon their outer surface, as are the valves of the modern *Estheria.*

Loc. and Horizon.—Penwhapple Burn, at bend below Penkill Castle (*Coll. Geol. Survey Scot.*); collected by Mr A. Macconochie.

Genus Dictyocaris, Salter, 1860.

(Annals Nat. Hist., 1860, v. p. 161.)

Dictyocaris (?), *sp. ind.*

Dictyocaris, sp., Etheridge jun., Mem. Geol. Survey Scot., Expl. 3, 1873, p. 34.

Obs.—The occurrence of this genus at Girvan depends upon the determination by one of us of a specimen which appeared to possess the peculiar sculpture described by Mr Salter. It is not now available, and the determination requires confirmation.

[1] Quart. Jour. Geol. Soc., 1863, xix. p. 88, woodcut.

Loc.—Quarry near Knockgardner, about ten miles north-east of Girvan (*Coll. Geol. Survey of Scotland*); collected by Mr A. Macconochie.

Sub-class CIRRIPEDIA.

Order THORACICA.

Genus TURRILEPAS, H. Woodward, 1865.

Plumulites, Barrande (MS.), in Reuss, Sitz. Berichte d. K. Akad. d. Wissensch. 1864, xlix. p. 215 (note 2).
Turrilepas, H. Woodward, 1865, Quart. Jour. Geol. Soc., xxi. p. 486.
Plumulites, Barrande, 1872, Syst. Sil. Boh., i., Suppl., p. 565.
Oploscolex, Salter, 1873, Cat. Camb. and Sil. Foss. Woodwardian Mus. Camb., p. 129 (*fide* Morris).
Turrilepas, H. Woodward, 1877, Cat. Brit. Foss. Crust., p. 143.
„ R. Etheridge, jun., 1878, Proc. R. Phys. Soc. Edin., iv. p. 164.

Obs.—A short time ago one of us wrote as follows regarding this genus :—

"The genus *Turrilepas* was established by Dr H. Woodward, F.R.S., for certain peculiar ovate triangular plates from the Dudley limestone, previously known under the name of *Chiton Wrightianus*, de Koninck. Dr Woodward satisfactorily showed that these plates were more properly referable to a form of *Cirripedia* allied to the recent *Loricula*, and for which he proposed the name *Turrilepas*, than to *Chiton*, or to any other Mollusc. Priority is claimed by M. Barrande for his term, on the plea of previous publication. For my own part, I hardly think the facts support M. Barrande's claim. Dr Woodward's name was both proposed and published in 1865; and although the genus was certainly not defined in so many words, it was nevertheless founded on a well-known and perfectly-defined fossil, and what is more, was copiously illustrated. I take this to be satisfactory publication. It appears that M. Barrande had discovered similar plates in the Silurian rocks of Bohemia, and applied to them the name *Plumulites*,—a fact which was communicated by Professor Reuss to the Imperial Academy of Science of Vienna at their meeting of 18th February 1864, and

was published in a paper of the latter,[1] but unaccompanied either by description or figure. The plates in question were referred by M. Barrande to the *Cirripedia*, and their alliance to *Loricula* pointed out; but so far as I understand the question, no description or figure was furnished by the latter until the appearance in 1872 of the supplement to the first volume of his magnificent work on the 'Silurian System of Bohemia.'[2] I think, under these circumstances, that strict impartiality requires the adoption of Dr Woodward's *Turrilepas*. Again, Messrs Hall and Whitfield[3] adopt *Plumulites* in preference to *Turrilepas*, on the ground that the latter was never characterised; but my previous remarks equally apply in this case."

Turrilepas Scotica, R. Etheridge, jun.

(Pl. XIV., figs. 22-27.)

T. Scotica, Eth. jr., Proc. R. Phys. Soc. Edin., 1878, iv. p. 166, t. 2, f. 1 and 2.

Spec. char.—General form elegantly kite-shaped, curved; superior end curved and much attenuated, produced into a fine needle-point; inferior margin slightly convex, and a little concave in the middle; lateral margins, one convex throughout the whole of its length, the other and opposite one convex in the lower part gradually becoming concave towards the finely drawn out superior end; lobation very indistinct, only traceable through the curvature of the transverse striæ; a median, ridge-like, sharp, and narrow keel, dividing the plate into two sub-equal parts, passes from the central concavity of the inferior margin to the sharp superior extremity—the latter is, in fact, formed by the extension of this central keel, the plate on each side of it becoming abortive; surface ornamented with a very large number of transverse imbricating striæ, which in the central lobe are parallel to the inferior margin, and on the lateral lobes are bent down parallel to the lateral margins.

[1] Sitz. Berichte d. K. Akad. d. Wissensch, xlix. p. 215.
[2] Système Silurien du Centre de la Bohême, Supp. vol. i., 1872, p. 565.
[3] Ohio Geol. Report, ii. pt. 2, p. 106.

Obs.—*T. Scotica* differs from the Dudley *T. Wrightii*, de Koninck, in form and proportion, in the much augmented number of concentric striæ, and particularly in the extended superior extremity. The same characters also appear to separate it from all the species described by M. Barrande.

That our figures do not represent merely one form of plate out of the several which occur in the body of *Turrilepas*, is, we think, proved by a specimen in the collection, which shows a number of them associated together, after the manner of Dr Woodward's fig. 1^c,[1] and all retaining the outline and characters above described. Out of the three-and-twenty individual specimens before us, all, with the exception of five, assume the elongate form we figure. Of the latter, two (Pl. XIV., figs. 25 and 26) approach much nearer in form to the typical outline of the plates of *T. Wrightii*,[2] and had a wavy inferior margin, indicated by the lines on the surface, as in de Koninck's species. The third example (Pl. XIV., fig. 27) corresponds with those pieces in the economy of *Turrilepas* described by M. Barrande as the "cancellated plate" (*valve fénestrée*),[3] and in which the apex is rounded and depressed, the surface concentrically ornamented, and the outline of the plate somewhat wedge-shaped. The fourth and fifth plates differ somewhat in form from the two previously noticed, but correspond in every way to those denominated by M. Barrande the "large valve" (*valve large*).[4]

Whether figs. 24-27, Pl. XIV., are plates in the test of our species *T. Scotica*, we are at present uncertain, but in all probability the "cancellated plate" is so. In the Museum of Practical Geology are some "cancellated plates" from the Deerhope Burn, Pentland Hills, which closely resemble that from Girvan. To these Mr Salter applied the MS. name *T. Haswelli.*

Loc. and Horizon.—Balcletchie, in a fine-grained greenish mudstone. (Gray Collection.)

[1] *Loc. cit.*, t. 14.
Syst. Sil. Boh., i., Suppl., p. 567.

[2] Ibid., f. $1^{i,k,l}$.

[3] Ibid., Atlas, t. 20, f. 4^a and 5^b.

Order OSTRACODA.

We are indebted to Professor T. Rupert Jones, F.R.S., F.G.S., &c., for the following notes on the Silurian Ostracoda which have been met with in the Girvan area up to the present time.

Genus CYTHERE, O. F. Müller, 1785.

(Entomostraca, seu Insecta Test., pp. 34 and 63.)

Cythere aldensis, M'Coy.

(Pl. XV., figs. 1-3.)

Cytheropsis aldensis, M'Coy, Annals Nat. Hist., 1851, viii. p. 387.
Cythere aldensis, Jones and Holl, Annals Nat. Hist., 1868, ii. p. 60, t. 7, f. 12. (*For synonomy.*)
Cytheropsis aldensis, Bigsby, Thes. Siluricus, 1868, p. 74.
„ „ Woodward, Cat. Brit. Foss. Crust., 1877, p. 114.

Spec. char.—Carapace haricot-shaped, thin at the edges; rather wider at one end than the other; hinge on the convex edge, marked by a simple apposition of the edges of the valves. The surface roughened by partial dissolution; but a roughish circular elevation is sometimes apparent in the anterior third, as is seen also in Professor M'Coy's first sketch.[1] This comes rather far forward, but may be the usual muscle-spot.

Loc. and Horizon. — Plentiful in the greenish-black and black limestone of Aldens; (?) in the fine-grained greenish sandstone of Thrave Glen. (Gray Collection; *Mus. Pract. Geology; Woodwardian Mus. Cambridge*, &c. &c.)

C. aldensis (M'Coy), var. *major*, Jones.

(Pl. XV., fig. 4.)

Obs.—This agrees with the foregoing in the general shape of the carapace-valves, but is larger, and may be a sex variety.

[1] Brit. Pal. Foss., t. 1, L. f. 2.

The relative convexity of the sides cannot be determined, for the valves of our specimens are more or less cracked by pressure, and partially crushed.

Loc. and Horizon.—Aldens, in greenish-black limestone. (Gray Collection.)

Cythere Grayana, Jones (*sp. nov.*)

(Pl. XV., figs. 5-5^b and 6-6^b.)

Spec. char.—Valves nearly oblong, with rounded, nearly equal ends, and very slightly arched dorsal, and faintly incurved ventral, edge. Surface highly convex; a faint submedian circumscribed elevation (muscle-spot), with a very shallow transverse furrow in front of it, occurs on one specimen. The furrow is much more thoroughly impressed on the internal casts of the valves.

Obs.—Although somewhat obscure, as are many of the Palæozoic Entomostraca, this form appears to be sufficiently distinct from others to require a classificatory appellation, and we propose to associate it with the name of Mrs Robert Gray, to whose labours in the geology and palæontology of Girvan these pages owe their origin.

Loc. and Horizon.—Aldens, in black and greenish-black limestone. (Gray Collection.)

Cythere Wrightiana, Jones and Holl.

(Pl. XV., figs. 7-7^b.)

C. Wrightiana, J. and H., Annals Nat. Hist., 1868, ii. p. 57, t. 7, f. 5.
„ „ Woodward, Cat. Brit. Foss. Crustacea, 1877, p. 108.

Obs.—This has more equal ends than *C. aldensis* possesses, is less convex on the sides, and more parallel above and below.

Loc. and Horizon.—Rare in the greenish-black pyritous limestone of Aldens. (Gray Collection.)

Genus BEYRICHIA, M'Coy, 1846.

(Sil. Foss. Ireland, p. 57; Brit. Pal. Foss., 1851, fas. 1, p. 135.)

Beyrichia Klœdeni, M'Coy.

(Pl. XV., figs. 8-8*b*.)

B. Klœdeni, M'Coy, Sil. Foss. Ireland, 1846, p. 58, woodcuts.
,, M'Coy, Brit. Pal. Foss., 1851, fas. 1, p. 135, t. 1, E. f. 2.
B. tuberculata, Salter, Mem. Geol. Survey, 1848, ii. pt. 1, p. 352, t. 8, f. 14, 15.
B. Klœdeni (granulated var.) Jones, Annals Nat. Hist., 1855, xvi. p. 166, t. 6, f. 7, 9.
,, *et varr.*, Jones, Proc. Geol. Assoc., 1869, pp. 11 and 14, woodcuts.
,, H. Woodward, Cat. Brit. Foss. Crust., 1877, p. 84.

Spec. char.—Surface of valves three-lobed, bordered anteriorly, ventrally, and posteriorly by a marginal rim. The hind and front lobes are large and pyriform; the centre lobe is ovate, more or less closely united by a peduncle with the upcurved end of the posterior lobe. The valleys and lobes are variable in depth and breadth, and the lobes also are divided in some cases into lobules; the surface is often granulated.

Obs.—This Upper Silurian species is represented in Mrs Gray's collection by one hollow mould of the external surface, in the greenish fine-grained sandstone of Thrave Glen; it corresponds especially with M'Coy's figured variety.[1] *B. Klœdeni* was first met with in the Girvan district by Mr A. Macconochie, of the Geological Survey of Scotland.

Loc. and Horizon.—Thrave Glen, as above (Gray Collection); Hillside, near Blair Farm, about 8½ miles north-east of Girvan,[2] and a variety at a quarry on the roadside at Knockgardner, about ten miles north-east of Girvan (*Coll. Geol. Survey of Scotland*).[3]

[1] Brit. Pal. Foss., t. 1, E. f. 2.
[2] Mem. Geol. Survey Scotl. Expl. 3, 1873, p. 34. [3] Ibid.

Beyrichia impendens, Jones.

(Pl. XV., figs. 10-10^c.)

B. impendens, Jones, Palæoz. Biv. Entom. (Proc. Geol. Assoc.), 1869, p. 11, figs. 4*a*, 4*b*.
„ Proc. Edinburgh Geol. Soc., vol. ii. pt. 3, 1874, p. 322.
„ Geol. Mag., 1874, ser. 2, vol i. p. 511, figs. 2*a*, 2*b*.

Spec. char.—A small variable *Beyrichia*, known from casts and impressions; rarely from well-preserved, mostly from squeezed and distorted, individuals. The surface of the valves has a large pyriform posterior, and a much smaller anterior lobe, with a very small subcentral lobe in the broad median valley, but usually lying against the inside edge of the front lobe. In these features it approaches both *B. Salteriana* and *B. Klædeni;* but the neatness, ornamentation, and rim of the former are distinctive; and in the old condition (with antero-ventral additional lobe) the latter and *B. impendens* have different shapes (*see* Pal. Biv. Entom., *supra cit.*, figs. 4 *b* and 6 *b*).

Obs.—This weak little *Beyrichia* is very much altered in the schistose state, in which it is usually found; the central sulcus and its little tubercle having been squeezed fore and aft, and sometimes crumpled so as to give two tubercles. As variation of growth may have had to do with some of these differences, the form with two little knobs has been termed var. *tuberosa* (*see* Proc. Edin. Geol. Soc. and Geol. Mag., *locc. citt.*)

Loc.—*B. impendens* has been found by Mr A. Macconochie at the Hillside, opposite Blair Farm, about 8½ miles north-east of Girvan (*Coll. Geol. Survey of Scotland*).

Beyrichia comma, Jones (*sp. nov.*)

(Pl. XV., figs. 9-9^c.)

Spec. char.—Valves straight on the dorsal edge, obliquely elliptical on the ventral edge; much flatter and wider at one

end than the other. On the middle third of the surface is a semicircular ridge-like lobe, convex downwards, having one of its horns thicker than the other, and curved and rounded with a knob against the hinge-line. Ventral aspect of the closed carapace broad-lance-shaped; end view of the thickest and narrowest portion (? anterior) sub-cordate.

In other words, the surface may be described as being impressed with three cross valleys,—one long, and sloping from the posterior (?) dorsal region forwards to the ventral border; the second, medial, shorter, and deeper, curving rapidly forwards; and the third, on the most convex (anterior ?) third of the valve, is quite forward and shallow, and curves backward.

Obs.—We do not know any *Beyrichia* like this; but possibly *B. venusta*, Billings, from Anticosti, may be somewhat similar, judging only from the description given in the 'Catalog. Silur. Foss. Anticosti,' p. 68. A figure of a *Beyrichia* in Haswell's 'Geology of the Pentland Hills,' 1865, Pl. 3, fig. 12, has at first sight some resemblance to our species; but it is really intended for *B. Klædeni*.

Loc. and Horizon.—*B. comma* is represented by several specimens crowded together in a little nest-like group, with a *Cythere* (somewhat like *C. aldensis*), in the greenish fine-grained sandstone of Thrave Glen. (Gray Collection.)

Genus PRIMITIA, Jones and Holl, 1865.

(Annals Nat. Hist., 1865, xvi. p. 415.)

Primitia Barrandiana, Jones (*sp. nov.*)

(Pl. XV., figs. 11-11*f*.)

Spec. char.—Valves oblong-ovate, straight on the hinge-line, well rounded fore and aft and below. Surface of shell more convex on one half than on the other, and undulating with three obscure depressions—one on each third of the surface. The middle valley is deepest, and is marked by a faintly-raised

spot. The cast of the inside of the valve is far more deeply furrowed by a decided sulcus, from the hinge-line to the middle of the valve; and there is a very faint trace of a more anterior depression.

There are some individuals larger than the others, and they show only a feeble middle dorsal depression; but their internal casts show it more strongly.

Obs.—It is very difficult to correlate these simple *Primitiæ*, for the individuals among a large number vary very much.

These *Primitiæ* from Girvan evidently belong to the same set as those enumerated at p. 223, Ann. Mag. Nat. Hist., ser. 4, vol. iii., as Lower Silurian forms; and, of course, to the similar series from the 'Faune Silurienne, No. II.,' in M. Barrande's 'Syst. Silur. Bohême' (Suppl. to vol. i., 1872, p. 542). Similar forms occur also in North America (Newfoundland and Ohio). It is difficult, however, to fix an exact relationship between the Girvan specimens and any of those alluded to above. Looking at those species which are well known by their valves, or by impressions of their valves (not by internal casts only), we find many gradations in shape, from semicircular to oblong, and from a sulcated to an even or but slightly undulated surface. We may note that the surface may be nearly even, and yet a sulcus may appear on the internal cast. Smoothness, or a pitting of the surface, and the presence or absence of a marginal rim, are other and more definite characteristics.

The neat and almost Leperditioid outline, the smooth, undulated surface, with its minute median knoblet, and the definite dorsal transverse sulcus on the cast (due to a thickening of the middle of the valve), are characters which we do not find together in any named *Primitia*.

Barrande's *P. prunella* is not far removed; but it has an external sulcus and pitted surface; and so has *P. Logani*, Jones. *P. simplex*, Jones, is not sufficiently oblong; its external aspect is not well known, and the sulcus on the cast is not neatly defined. *P. mundula*, Jones, is nearly oblong;

but it is punctate, margined, and sulcated externally. *P. renulina*, Jones and Holl, is oblong, smooth, margined, and strongly notched. *P. Beyrichiana*, Jones and Holl, is oblong, smooth, and very faintly marked by the sulcus; but it is broadly margined with an ornamented ventral rim. *P. matutina*, Jones and Holl, is too long and smooth; *P. pusilla*, Jones and Holl, too circular and flat, though somewhat undulate. *P. obsoleta*, Jones and Holl, is nearer in its relative convexity; but it is semicircular and rimmed. Others disagree in form or other feature; and, since we have both the valves and the inner cast to give us as clear a knowledge as we are likely to get of this *Primitia*, we propose to give it a name (*P. Barrandiana*), associating it with the distinguished palæontologist of Bohemia, M. Joachim Barrande, who has elucidated so very many of its congeners.

At p. 221, 'Ann. Nat. Hist.,' ser. 4, vol. iii., are figured some casts of *Primitiæ* from the Shineton shales of Shropshire; and one of these, fig. 7, resembles in outline our *P. Barrandiana*, from Aldens, and may, indeed, be a poor representative of this species. Further, Dr C. Callaway has submitted for examination some specimens from the same shales, and these correspond generally with the same form; and though the transverse furrow is absent in one, it is represented by a mere dot in another, and by a definite sulcus in a third. These are mere flattened casts of outspread pairs of valves, which, varying in the semicircularity of their outlines, range between the shapes of figs. 6 and 7 ('Ann. Nat. Hist.,' *loc. cit.*); indeed, specimens like fig. 7 occur with them. They are alluded to by Dr Callaway in his paper in the 'Quart. Journ. Geol. Soc.,' 1877, vol. xxxiii. p. 670, where he refers these shales to the horizon of the "Lingula-flags." We may regard these little *Primitiæ* as small, modified, and crushed individuals, belonging to *P. Barrandiana*.

Loc. and Horizon.—P. Barrandiana occurs in the greenish-black pyritous limestone, and the black, friable, slickensided limestone of Aldens. In some pieces it is abundant, with

but few *Cytheræ;* in others, scattered in company with many individuals of *Cythere Aldensis*, &c. (Gray Collection.)

Genus ENTOMIS, Jones, 1861.

(Mem. Geol. Survey Scotl., No. 32, p. 137.)

Entomis globulosa, Jones (*sp. nov.*)

(Pl. XV., figs. 12*a* and *b*.)

Obs.—The subconical or nearly hemispherical fossil, with a somewhat oval base-line ($\frac{1}{8} + \frac{1}{12}$ inch), here figured, is an internal cast (in mudstone) of a tent-like shell, carapace, or valve, of doubtful relationship. I believe it to be an Entomostracan valve. It is referred to in the 'Mem. Geol. Surv. Scotland; Explan. Sheet 3, Western Wigtonshire,' 1873, p. 34, as having been found (about 1872) in the soft grey micaceous mudstone (weathering rusty) of the "Hillside opposite Blair Farm, about eight and a half miles north east of Girvan," and as having an analogue in some better preserved specimens from the Pentland Hills.

In the Girvan specimen, which is in the Collection of the Geol. Surv. Scotl. and marked "M. 1920," an apical depression, not quite central, is continued a little way on the longer axis of the cast by a tapering furrow. Studied in the light given by some other Entomides, this appears to me to be the cast of a valve of a very globose *Entomis;* and that it has been squeezed from end to end, so that the long and short axes have been mutually interchanged. The better specimens are considered as typical of a new species, *Entomis globulosa.*

GENERAL REMARKS UPON THE CRUSTACEA OF THE GIRVAN AREA.

In our First Fasciculus we gave, after the description of the Corals, a few general remarks on the stratigraphical relations of the species as a whole, more especially in regard to the

evidence furnished by them of the age of the beds in which they occur.

We now purpose supplementing this by a few remarks on the evidence afforded by the Trilobites and other Crustacea, and contrasting it with that deduced from our study of the Coral fauna.

The first point which strikes the observer is the increase in the number of localities yielding Trilobites, or other orders of Crustacea, over those from which Corals have been obtained. Whether this will maintain itself after the additional researches amongst the Girvan Corals, upon which we are at present engaged, remains to be seen. It is, however, noteworthy, that at certain localities where the Coral fauna has been found to be copious, the Crustacea were correspondingly scarce, and *vice versâ*.

So far as possible, we take the localities in the order in which they are considered in our previous notes.

I. Craighead Limestone and Shale.—These distinct and interesting beds have yielded the following Trilobites :—

Calymene Blumenbachii, Brong.
Bronteus (large sp.)
Cheirurus gelasinosus, Portlock.
Encrinurus punctatus, Brünn., var. *arenaceus*, Salter.
Illænus Bowmani, Salter.
„ *Rosenbergi*, Eichwald (?).
Lichas Hibernicus, Portlock.

We have here seven species, appertaining to six genera. Now, one of these is rather a doubtful determination, and on it we would not place too much reliance, although we believe the species to be identical with that known as *Illænus Rosenbergii* in this country. To resume, then, we have two, out of the four satisfactory species, which are essentially Caradoc—viz., *Ch. gelasinosus* and *Lichas Hibernicus*. In *Ill. Bowmani*, on the other hand, we have a Trilobite with an extended range in time, as it is said to occur as high as the Upper Ludlow, although its culminating point may be said to be in the Caradoc,

or Llandovery rocks. The late Mr Salter remarked, "This species never occurs in Wenlock rocks, and but rarely so high as the May Hill Sandstone." [1] Evidence derived, however, since Salter wrote, appears to demand a modification of this statement to some slight extent. In the presence of the var. *arenaceus* of *E. punctatus*, we have a form regarded as truly typical of Llandovery rocks,[2] although it ranges as high as the Wenlock. On this point we cannot do better than again quote Mr Salter, who says that it occurs in the Upper Caradoc in great abundance, and is again common in the *Pentamerus* limestone.[3]

Thus, we have in the Craighead limestone and associated shale two species typically Caradoc, another which has its culminating point at or about that horizon, a third species which appears to be a representative of a somewhat higher zone, and if the doubtful species is taken into account, yet another form restricted in its range to the Caradoc.

To a certain extent this evidence bears out our previously expressed opinion, that the Craighead limestone is not of Upper Silurian age, although it scarcely assigns to this stratum so low a position as that derived from a study of the Corals.

II. Mulloch Hill Beds.—The Trilobites from the deposits at this locality rarely ever have the true integument preserved, but, like the Corals, are usually in the state of casts. In the following list of species, four are inserted on the authority of Messrs Salter and M'Coy—viz., *Acidaspis callipareos*, *Phacops Stokesii*, *Cyphaspis megalops*, and *Trinucleus concentricus;* of actual specimens of these we have not seen definite evidence. The full list is as follows :—

Acidaspis callipareos, Wyv. Thomson.
Calymene Blumenbachii, Brong. *var.*
Cheirurus bimucronatus, Murchison.
Cyphaspis megalops, M'Coy.
Illænus Macallumi, Salter.
,, *nexilis*, Salter.

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[1] Monograph, p. 187. [2] Siluria, p. 90. [3] Decade vii. No. 4, p. 7.

Illænus Rosenbergi, Eichwald (?).
„ *Thomsoni*, Salter.
Lichas Barrandei, Fletcher (?).
Phacops Brongniarti, Portlock.
„ *Stokesii*, M. Edwards.
Trinucleus concentricus, Eaton.

Omitting the four species above mentioned, we have to take into consideration the remaining eight forms, of which two are doubtful determinations—viz., *Illænus Rosenbergi* and *Lichas Barrandei*. Amongst the others is a typical Caradoc form—viz., *Phacops Brongniarti;* whilst *Calymene Blumenbachii*, from its extended range, might at first be regarded as of little value, but it is to be remarked that its range as a Caradoc fossil is limited, whilst in the Lower Llandovery and May Hill beds its occurrence is much more extended, and it culminates in the Wenlock shale and limestone, of which it is very characteristic. *Illænus Thomsoni* is a Llandovery species, both upper and lower; but *I. nexilis* can scarcely be considered as of much value in a stratigraphical sense, as it is a purely local form. *Illænus Macallumi* was considered by Mr Salter to be indicative of Lower Llandovery age.[1] Of the four species recorded from the Mulloch Hill beds, which we have not seen, *Phacops Stokesii* commences its range in the Llandovery and passes upwards; *Acidaspis callipareos*, although a local species, is said to be of a Caradoc facies; *Cyphaspis megalops* makes its first appearance in the Caradoc, occurs in the Upper Llandovery, and passes up; whilst *Trinucleus concentricus* is both Caradoc and Upper Llandovery. Taking, therefore, the general facies of the whole Trilobite fauna of the Mulloch Hill beds, the expression made use of by us in referring to the Corals of this locality almost equally applies to the present class, "that the Mulloch Hill beds are certainly referable to the Upper Silurian." Further than this, it is very probable that either the Lower or Upper Llandovery has the strongest claim. Mr Salter placed them with the former, from the absence of *Pentamerus*.

[1] Monograph, p. 211.

III. PENKILL BEDS.—From the greenish-grey mudstone of Penkill we possess eight species—

Calymene Blumenbachii, Brong. (?).
Cheirurus trispinosus, Young.
Bronteus Andersoni, Eth. jun. and Nich.
Encrinurus punctatus, var. *calcareus*, Salter.
„ „ „ *arenaceus*, Salter.
Illænus æmulus, Salter.
„ *Bowmani*, Salter.
„ *Murchisoni*, Salter.
„ *nexilis*, Salter (?).

The Corals of the Penkill beds tended to prove the deposit in question to be situated towards the lower part of the Upper Silurian. Beyond the evidence afforded by the genera, the species *Cheirurus trispinosus* and *Bronteus Andersoni* cannot be said to prove anything, being peculiar to the beds; and the same may be said of *Illænus nexilis*. The variety *calcareus* of *Encrinurus punctatus* is very characteristic of the Wenlock limestone, whilst *Illænus æmulus* is essentially an Upper Llandovery species. The fourth species of *Illænus*, *I. Murchisoni*, is stated by Mr Salter to be almost confined to rocks of Caradoc age in Wales. Lastly, we have the evidence of the genus *Bronteus*—a very characteristic one of the Penkill beds, and which, with few exceptions, is an Upper Silurian genus.

We have, then, in these greenish mudstones, a mingling of species—some found high up in the Silurian series, but the majority indicating the lower part of the Upper Silurian, such as the Upper Llandovery or May Hill Sandstone, as the probable horizon to which the Penkill beds should be assigned.

IV. BALCLETCHIE.—At this locality two deposits of a different nature occur, yielding Trilobites and other Crustacea: (*a*) a coarse, volcanic, greenish-coloured ash; and (*b*) a dark-greenish mudstone.

(*a*) In the former, three species of Trilobites have been met with: one a widely-spread and very characteristic Caradoc species, *Sphærexochus mirus*, Beyr.; and two others peculiar to the district under description—viz., *Staurocephalus* (?) *unicus*

and *Acidaspis Lalage*. Both the latter are said by our best authorities also to have a Caradoc facies.

(*b*) In the Balcletchie mudstone we have, without doubt, the most copious Trilobite fauna of the Girvan area, so far as our present researches have gone, comprising in all fourteen species, viz.:—

Acidaspis Grayæ, Eth. jun.
„ *hystrix*, Wyv. Thomson.
Ampyx Hornei, Eth. jun. and Nich.
„ *Macallumi*, Salter.
„ (?) *Macconochiei*, Eth. jun. and Nich.
Agnostus agnostiformis, M'Coy.
Asaphus gigas, De Kay (?).
Bronteopsis Scotica, Salter.
Cheirurus gelasinosus, Portlock.
Cybele verrucosa, Dalman.
Illænus Bowmani, Salter.
Lichas Hibernicus, Portlock.
Remopleurides Barrandei, Eth. jun. and Nich.
Salteria primæva, Wyv. Thomson.

And of other Crustacean groups—

Pinnocaris Lapworthi, Eth. jun.
Turrilepas Scotica, Eth. jun.

Seven of the above Trilobites are species unknown elsewhere than in the Girvan area, and from a specific point of view will be of little service in determining the age of the beds in question, except in so far as pointing to allied species elsewhere. Irrespective of these, we have, first, four typically Caradoc species—viz., *Cheirurus gelasinosus*, *Lichas Hibernicus*, *Asaphus gigas*, and *Agnostus agnostiformis*. In company with these we find a Caradoc and Llandovery form, *Cybele verrucosa*, the ever-occurring *Ill. Bowmani*, and *Salteria primæva*, a Llandeilo species. The *Remopleurides*, although a new species, is one worthy of much consideration, for throughout the whole of the British Silurian rocks all the species of *Remopleurides* are Caradoc, and Caradoc only.

With regard to the other new species, we have this evidence: The genus *Ampyx*, with *very* few exceptions, is one confined to the Lower Silurian, and is either Llandeilo or

Caradoc; whilst *Acidaspis* ranges higher, and is stronger in species in the higher portions of the Silurian system. On the other hand, the new genus *Bronteopsis*, from its relation to *Barrandia* and its connection with the Ogygidæ, may be considered rather a low type. Another interesting fact in connection with the Balcletchie fauna must not be overlooked—the occurrence amongst so many Caradoc forms of that very characteristically Upper Silurian fossil, *Turrilepas*. In the Silurian rocks of our own country it is a Wenlock species, the type *T. Wrightii* being found at Dudley; whilst an undescribed species, probably not far removed from *T. Scotica*, is met with at about a similar horizon in the Pentland Hills. In Bohemia, where the genus is far more largely represented than here, both as regards individuals and species, it is met with in Barrande's 'Étages,' D. 1, D. 4, and D. 5, or beds about equivalent to our Tremadoc, Caradoc, and Llandovery respectively.

Now, from the Balcletchie mudstone we have few or no Corals of any importance, and those from the ash or fine conglomerate scarcely give a clue to the age of the deposit. Looking, however, at the above Trilobite fauna as a whole, one cannot but be struck with the strong Caradoc facies presented by it, though, at the same time, this is tempered by the presence of a few forms equally typical of other horizons.

V. Ardmillan Brae.—This locality has yielded—

Asaphus gigas, De Kay (?).
Bronteus Andersoni, Eth. jun. and Nich.
Illænus Bowmani, Salter.
Phacops Brongniarti, Portlock.
Remopleurides laterispinifer, Portlock.
Staurocephalus globiceps, Portlock.

Little need be said about these Trilobites, as they almost speak for themselves. The first and three last are, as we have before had occasion to remark, typically Caradoc; the third has a lengthened range; whilst on the presence of the *Bronteus* we do not put great reliance, the specimen obtained by the Geological Survey being a single one.

VI. PENWHAPPLE.—The matrix at this locality more or less resembles that at Balcletchie. The following species have been met with here :—

Acidaspis Lalage, Wyv. Thomson.
Agnostus agnostiformis, M'Coy.
Ampyx Macallumi, Salter.
Asaphus radiatus, Salter.
Bronteopsis Scotica, Salter.
Cheirurus clavifrons, Dalman.
Cybele verrucosa, Dalman.
Encrinurus punctatus, var. *arenaceus*, Salter.
Illænus Bowmani, Salter.
Salteria primæva, Wyv. Thomson.
Staurocephalus (?) *unicus*, Wyv. Thomson.

Our remarks on the Balcletchie fauna almost equally apply here. The Caradoc forms are *Cheirurus clavifrons*, *Staurocephalus* (?) *unicus*, *Asaphus radiatus*, *Agnostus agnostiformis*; whilst *Acidaspis Lalage* and *Bronteopsis Scotica* are probably also indicative of the same age.

VII. DRUMMUCK.—Without doubt this is the second most prolific locality for Trilobites in the Girvan district, for we have examined no less than sixteen species, viz. :—

Ampyx rostratus, Sars.
Calymene Blumenbachii, Brong.
Cheirurus bimucronatus, Murchison.
„ *clavifrons*, Dalman (?).
Cybele rugosa, Portlock.
„ *verrucosa*, Dalman.
Dindymene Cordai, Eth. jun. and Nich.
Illænus Bowmani, Salter.
Lichas Geikiei, Eth. jun. and Nich.
„ *Grayi*, Fletcher.
Phacops Brongniarti, Portlock.
Proetus Girvanensis, Eth. jun. and Nich.
„ *procerus*, Eth. jun. and Nich.
Remopleurides Colbii, Portlock.
Staurocephalus (?) *unicus*, Wyv. Thomson.
Trinucleus seticornis, var. *Bucklandi*, Barrande.

The first point which strikes us in connection with this list of species is the presence of so few forms indicative of an

absolutely low horizon in the Lower Silurian, and the preponderance of those species occurring in and about the Caradoc and Llandovery rocks. Thus, for instance, *Calymene Blumenbachii*, *Illænus Bowmani*, and *Ampyx rostratus* are the only species which are found as low as the Llandeilo, whilst they all three occur in the Caradoc with *Cheirurus clavifrons* (?), *Cybele rugosa*, *Staurocephalus* (?) *unicus*, *Remopleurides Colbii* (?), *Phacops Brongniarti*, and *Trinucleus seticornis*, which are all exclusively Caradoc. Of the other species, *Cheirurus bimucronatus* ranges from the Caradoc to the Aymestry beds; *Cybele verrucosa* is both Caradoc and Lower Llandovery; *Lichas Grayi*, a doubtful determination, is confined to the Wenlock elsewhere; whilst *Calymene Blumenbachii*, although possessing an extended range, is, as we have before observed, particularly characteristic of the Lower Llandovery and May Hill Sandstone.

We now come to the genus *Proetus*, which, although represented by new species, is of some importance as a test of the age of the Drummuck beds; because, with us, it has been found to be either an Upper Llandovery or Wenlock genus—perhaps more characteristic of the latter than the former. The deposit has, as yet, yielded two species of *Lichas*—a genus occurring in British Silurian rocks, chiefly in the subdivisions of the Caradoc and Wenlock; but here, again, numerically stronger, as to species, in the Upper than the Lower Silurian.

The curious genus *Dindymene*, which has not hitherto been recorded as British, is Lower Silurian in character. The form which we referred to *Phacops truncato-caudatus*, in our First Fasciculus, our friend Mr C. Lapworth thinks may turn out to be a *Dionide*. Circumstances have prevented our going into this question again as yet; but if it should prove to be so, it will add another Lower Silurian genus to the Drummuck fauna.

On the whole, it appears to us—taking a broad view of the question—that the Drummuck beds will probably turn out to be of Lower or Upper Llandovery age—speaking simply from

the evidence afforded by the Trilobites,—a question, however, which will in a great measure be dominated or modified by the Mollusca found in company with them.

VIII. THRAVE GLEN.—The following Crustacea have been here met with :—

Cheirurus clavifrons, Dalman (?).
Lichas laxatus, M'Coy.
Beyrichia comma, Jones.
,, *Klœdeni*, M'Coy.
Cythere Aldensis, M'Coy (?).

The first of the Trilobites mentioned is a Caradoc species; the second occurs in the Caradoc, and both the Lower and Upper Llandovery. *Beyrichia comma* is a new species, and not of much moment in determining the age of the beds; but *B. Klœdeni* is a well-known form, and ranges from the Llandovery upwards. But if we may judge from its rarity at this locality, its occurrence would probably indicate Llandovery beds rather than those above.

IX. ALDENS.—The black or dark-coloured limestone of Aldens had, up to the time Mrs Gray commenced her researches at Girvan, yielded only one Ostracode—*Cythere* or *Cytheropsis Aldensis*, M'Coy. In the blocks of limestone forwarded to Professor T. Rupert Jones, F.R.S., the latter has now been able to recognise a well-marked variety, and three other species, of which descriptions have been previously given. The full list is as follows :—

Cythere Aldensis, M' Coy.
,, ,, var. *major*, Jones.
,, *Grayana*, Jones.
,, *Wrightiana*, Jones.
Primitia Barrandiana, Jones.

The Aldens limestone was considered by Professor M'Coy to be of Lower Bala age,[1] and the number of species of the genus *Cythere* which Professor Jones has been able to detect, will go far to support this view; for the genus appears to be,

[1] Brit. Pal. Foss., p. 351.

in Silurian rocks, essentially characteristic of the Lower Silurian series.[1] The only other fossil at present published from this limestone is a *Maclurea*, again a low form, and affording still further support to M'Coy's view.

X. Hillside, near Blair Farm.—Mr A. Macconochie, of H.M. Geological Survey, has collected a few Ostracoda at this locality, which Professor T. R. Jones was kind enough to determine as—

Beyrichia Klœdeni, M'Coy.
,, *impendens*, Jones.

Although only two in number, the above species are important, and for this reason: *B. Klœdeni* is exceedingly characteristic of the Lesmahagow beds, high in the Upper Silurian series, whilst the other species is equally distinctive of similar beds in the Pentland Hills. Add to this, that they are accompanied by a *Retiolites*, amongst other fossils, and we have in all probability presumptive evidence of beds higher in the Silurian series than any we have yet had to consider.

XI. Kirkhill.—Three species only have been obtained here, viz. :—

Illænus Bowmani, Salter.
,, *Macallumi*, ,,
,, *Thomsoni*, ,,

The two last both occur at Mulloch Hill, and in all probability the Kirkhill beds are about the same horizon as those at the former locality.

The following table shows the geographical distribution, in the Girvan district, of the whole of the Crustacea occurring there, with which we are at present acquainted. The genera and species are arranged alphabetically.

[1] Bigsby's Thes. Siluricus, p. 73.

GEOGRAPHICAL DISTRIBUTION OF THE CRUSTACEA IN THE GIRVAN DISTRICT.

GENERA AND SPECIES.	Drummuck.	Mulloch Hill.	Lady Burn.	High Mains.	Kirk Hill.	Rough Neuk.	Thrave Glen.	Craighead Quar.	Penwhapple Burn.	Balcletchie.	Piedmont Glen.	Ardmillan Brae.	Penkill.	Ardwell.	Aldens.	Shalloch Mill.	Blair Farm.	Bargany Pond.	Stinchar River.	Knockdolian.	Saugh Hill.	Cuddystone Glen.	Knockgardner.
Trilobita—																							
Acidaspis calipareos. *Wyv. Thomson*,	...	×	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
,, Grayæ. *Eth. jun.*,	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...	...
,, hystrix. *Wyv. Thomson*,	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...	...	...	..	...
,, Lalage. *Wyv. Thomson*,	...	...	...	...	...	...	...	...	×	×	...	...	...	...	...	...	...	...	...	...	...	...	...
,, sp. ind. (1),	...	×	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
,, ,, (2),	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...	...
,, ,, (3),	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	×	...	...	...	..	...
Agnostus agnostiformis. *M'Coy*,	...	...	...	...	...	...	...	...	×	×	...	...	...	...	...	...	...	...	...	...	...	...	...
Ampyx Hornei. *E. & N.*,	...	...	...	...	...	...	...	...	×	×	...	...	...	...	...	...	...	...	...	...	...	...	...
,, Macallumi. *Salter*,	...	...	...	...	...	...	...	...	×	×	...	...	...	...	...	...	...	...	...	...	...	...	...
,, ? Macconochei. *E. & N.*,	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...	...
,, rostratus. *Sars*,	×	...	×	×	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
,, ? sp. ind.	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...	...
Asaphus gigas. *De Kay?*	...	...	...	...	...	...	...	...	...	×	...	×	...	...	...	...	...	...	...	...	...	...	...
,, radiatus. *Salter*,	...	...	...	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Bronteopsis Scotica. *Salter*,	...	...	...	...	...	...	...	...	×	×	...	...	...	...	...	...	...	...	...	...	...	...	...
Bronteus Andersoni. *E. & N.*,	...	...	...	...	...	...	...	...	...	...	...	×	×	...	...	...	...	...	...	...	...	...	...
,, sp. ind. (1),	...	...	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
,, ,, (2),	...	...	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Calymene Blumenbachii. *Brong.*,	×	×	×	...	...	×	...	×	...	...	...	...	×	...	...	...	...	...	...	...	...	...	...
Cheirurus bimucronatus. *Murch.*,	×	×	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...
,, clavifrons. *Dalman?*	×	...	...	...	...	...	×	...	×	...	...	...	...	...	...	...	...	...	...	...	...	...	...
,, gelasinosus. *Portlock*	...	...	...	...	...	...	...	×	×	×	...	...	...	...	...	...	...	...	...	...	...	...	...

A MONOGRAPH

OF THE

SILURIAN FOSSILS OF THE GIRVAN DISTRICT IN AYRSHIRE

WITH SPECIAL REFERENCE TO THOSE CONTAINED IN THE "GRAY COLLECTION"

BY

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FASCICULUS III.

(THE ANNELIDA AND ECHINODERMATA, WITH SUPPLEMENTS ON THE PROTOZOA, CŒLENTERATA, AND CRUSTACEA)

WILLIAM BLACKWOOD AND SONS
EDINBURGH AND LONDON
MDCCCLXXX

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PREFACE TO THE THIRD FASCICULUS.

SINCE the present work was originally undertaken by us, fresh explorations in the richly fossiliferous Silurian area of Girvan, by Mrs Robert Gray and others, have brought to light a very large amount of additional material. Under these circumstances, as stated in the Preface to the Second Fasciculus, we decided to publish at once short Supplements dealing with the new material obtained in the departments of the Protozoa, Cœlenterata, and Crustacea, rather than to wait till the completion of the entire work might enable us to issue a "General Supplement."

This intention we have now carried out, and the present Fasciculus will be found to contain the above-mentioned Supplements, in so far as it was found practicable to prepare them. We have, however, allowed the Graptolites to stand over in the meanwhile, and we have also found it necessary to restrict the Supplement dealing with the Actinozoa to those forms only which would ordinarily be understood as "Tabulate Corals." We found it, in fact, impossible to include the Rugose Corals in the present Supplement, partly on account of the large amount of new material available in this group, and partly on account of the great labour attending the satisfactory investigation of this difficult division of the Palæozoic Corals.

In addition, moreover, to the above-mentioned Supplements, the present Fasciculus contains descriptions of the Annelides and Echinoderms, which are known to us as occurring in the area under consideration. The plates which illustrate the text have, as before, been put upon the stone by our friend Mr Charles Berjeau, F.L.S., who has also drawn all except those dealing with the Corals and Protozoa; and we desire to take this opportunity of recording our gratitude to him for the care and skill which he has shown in the execution of his task. We may add that the present Fasciculus completes the first volume of the Monograph, and that we have therefore judged it expedient to append an Index of the forms which we have so far dealt with.

We have to express again our sincere thanks to the Royal Society for assistance from the Government grant—assistance without which it would be impossible for us to continue our work. We are also again much indebted to the authorities of the Museum of Practical Geology for the ready access to their unrivalled collection of British Fossils, which has been always granted us for purposes of comparison and study.

United College, St Andrews,
and Museum of Natural History, London,
October 1880.

A MONOGRAPH

OF THE

SILURIAN FOSSILS OF THE GIRVAN DISTRICT.

SUB-KINGDOM PROTOZOA (*Continued*).

CLASS RHIZOPODA (*Continued*).

(See *Fasciculus I.* p. 10.)

Genus CLATHRODICTYON, Nich. and Murie.

(Journ. Linn. Soc., vol. xiv. 1878.)

Gen. char.—"Skeleton ('sarcodeme') massive, closely resembling *Stromatopora* in superficial aspect and general appearance and structure, but differing in the fact that the concentric laminæ are minutely undulated, and inflected at short intervals, so as to give rise to successive layers of oval or rounded cells or vesicles, which are usually distinct, but at other times open into one another by the imperfection of their lateral boundaries. There are thus no 'radial pillars,' as independent structures; but their place is taken by partial or complete inflections of the horizontal laminæ bounding the interlaminar spaces, which are bent in such a way as to divide the space into complete or incomplete oval compartments.

Horizontal section simply reticulate. Surface tuberculate. (Nicholson and Murie, *op. cit.*)

Clathrodictyon vesiculosum, Nich. and Murie.

(Pl. XIX., fig. 2.)

Clathrodictyon vesiculosum, Nich. and Murie, Jour. Linn. Soc., vol. xiv. p. 220, Pl. II., figs. 11-13.

Spec. char.—Skeleton in the form of cake-like expansions, from about an inch to a foot in diameter, and from half an inch to two inches in thickness in the centre, but thinning out towards the circumference. Young specimens sometimes encrusting foreign bodies, but the unattached portions of the under surface being otherwise covered with a concentrically striated epitheca. Upper surface irregularly undulating and exfoliating concentrically round the elevated points. Surface smooth, not tuberculated. Internal structure of exceedingly fine and close-set horizontal or slightly undulating laminæ, of which about twenty occupy the space of 1-10th of an inch (counting in the interlaminar spaces as well). The horizontal laminæ are undulated and inflected at short intervals, so as to divide the interlaminar spaces into a series of minute lenticular vesicles or cells which often communicate laterally by imperfection of their boundaries.

Obs.—We have no reason to doubt the entire identity of the Girvan Stromatoporoids here described with those originally described by Dr Murie and one of the present writers, from the Clinton and Niagara formations of North America. The specimens which we possess from the Girvan area—the first Stromatoporoids which have been detected in the Silurian rocks of Scotland—are, it is true, smaller than the examples which we possess from America, and they appear to have been in general encrusting, rather than to have been attached by a pedicle and to have had a large part of the under surface free and epithecate. This difference is, however, almost certainly

to be ascribed to nothing more than difference of age or station in the two sets of specimens, and their internal structure is precisely the same.

Clathrodictyon vesiculosum is easily distinguished from the forms of *Stromatopora* proper by its want of any regular system of vertically disposed radial pillars, and by the resolution of the interlaminar spaces into a series of minute lenticular vesicles produced by often incomplete inflections of the undulated horizontal laminæ at short intervals. The great closeness of the horizontal laminæ at once separates the species from its ally, the *C. cellulosum,* Nich. and Murie, of the Devonian of North America.

Loc. and Horizon.—Not uncommon in the greenish mudstones (Upper Silurian) of Woodland Point, near Girvan. (Gray Collection.)

Genus HYALONEMA, Gray, 1835.

(Proc. Zool. Soc. III., p. 63.)

Hyalonema? Girvanense, Nich. and Eth. jun. (*sp. nov.*)

(Pl. XIX., figs. 1-1 *b.*)

Spec. char.—Rope of long cylindrical siliceous spicules of unknown length and very variable diameter, the largest being about 1-25th of an inch in thickness, while the smallest are 1-100th of an inch or less in diameter. The fibres, where well preserved, are traversed by a delicate axial canal, and are crossed at irregular intervals by horizontal or slightly curved transverse partitions. Terminations of the spicules, as well as the true skeleton-spicules and flesh-spicules, unknown.

Obs.—We propose the above name for a fossil from the Silurian rocks of Ayrshire, which we cannot doubt to be the siliceous rope of a sponge, more or less nearly allied to the recent *Hyalonema.* Our single specimen is a mere fragment of the rock, originally about three inches in length, enclosing

a portion of the rope, the component spicules of which are now no longer in contact, and are more or less widely distributed through the enveloping matrix. The spicules resemble those of the Carboniferous *Hyalonema* (*Hyalostelia*, Zittel) *parallelum*, M'Coy, sp., in being of very unequal sizes, as was pointed out in the case of the latter species by Professor Young and Mr John Young (Ann. and Mag. Nat. Hist., ser. 4, vol. xx., Pl. XIV., figs. 2 and 3). They show no traces of any diminution of their diameter (the long section figured in Pl. XIX., fig. 1 *b*, cuts the spicules somewhat *obliquely*, and therefore makes them appear to be fusiform); nor have we been able to find their terminal extremities. A careful microscopic examination has also failed to reveal the existence of any of the flesh-spicules, or of the proper spicules of the skeleton. The point by which the present species seems to differ more especially from *H. parallelum*, M'Coy, sp., is the presence in all the larger and in some of the smaller spicules of straight or slightly curved horizontal partitions; and it is on account of this peculiarity, principally, that we have separated it as a distinct species.

Our knowledge of this form is too scanty to allow us to affirm that it is really referable to *Hyalonema*, Gray; and it is simply as a provisional arrangement that we have placed it in this genus. When *Pyritonema*, M'Coy (Brit. Pal. Foss., p. 10), and *Acestra*, Roemer (Sil. Fauna von Sadewitz, Pl. VII., fig. 7 *a*, p. 55), come to be more fully understood, it is quite probable that our present form may prove to be congeneric with one or other of these imperfectly-worked-out types; but it would be useless at present to attempt any comparison.

Loc. and Horizon.—From a light grey limestone (of Lower Silurian age), Knockgeeran, near Girvan. (*Coll.*, Mr Charles Lapworth.)

SUB-KINGDOM CŒLENTERATA—(*Continued*).

CLASS ACTINOZOA—(*Continued*).

(See *Fasciculus I.* p. 25.)

Genus HELIOLITES, Dana, 1846.

(See *Fasciculus I.* p. 57.)

Gen. char.—"Corallum spheroidal, pyriform, hemispherical, or rarely ramose, composed of numerous closely contiguous corallites, which are divisible into two distinct series. The larger corallites are cylindrical, comparatively few in number, and furnished with twelve lamellar infoldings of the wall, of the nature of pseudo-septa, which fall short of the axis of the visceral chamber. Small corallites completely investing the larger ones, more or less regularly polygonal in form, provided with distinct walls, which are completely amalgamated with one another and with the walls of the larger tubes, and which are not known to be provided with any apertures allowing lateral communication. The small tubes have no septa, but have numerous straight and complete tabulæ, similar but somewhat less numerous structures existing in the large tubes. No columella." (Nicholson, Pal. Tabulate Cor., p. 243.)

Obs.—To the above generic diagnosis of *Heliolites*, we have nothing to add except as regards the condition of the septa. These structures are certainly normally lamellar, as above stated; and they vary much in their development, being sometimes quite marginal and rudimentary (*e.g.*, in *H. megastoma*, M'Coy, and in one of the forms ordinarily included under the name of *H. interstincta*, Linn.), while at other times they extend inwards for a distance of from one-half to two-thirds or more of the total distance between the wall and the axis of the visceral chamber. In the investigations which we have recently carried out as to the minute structure of a number of species of *Heliolites*, we have found that there is at least one

form—in other respects entirely agreeing in its characters with *H. interstincta*, Linn.—in which the septa are continued inwards to meet centrally in a more or less highly developed median reticulation, which might be regarded as a kind of trabecular pseudo-columella. We shall notice this feature more fully in speaking of the minute characters of *H. interstincta*, and need, therefore, say nothing further on this head at present. The only other point we have to notice is one concerning the possible existence of the septa as rows of spines, instead of as distinct lamellæ, as is normally the case in the genus. Thus, Dr Rominger (Foss. Cor. of Michigan, p. 10, 1876) describes a form of *Heliolites* which he terms *H. pyriformis*, Hall, in which the septa have the condition of vertical rows of spinules, thus resembling these organs in most of the *Favositidæ*. We have not ourselves found any undoubted form of *Heliolites* to possess spiniform septa; but the septa in certain species of *Plasmopora* (*e.g.*, *P. scita*, E. and H.) are composed of vertical rows of spines, which have a marked upward inclination, and are fused into lamellæ towards their bases. We have also examined a specimen from the Coniston Limestone of Westmorland which would seem to be referable to *Heliolites*, in which the free edges of the septa are terminated by a row of spines directed upwards.

In the First Fasciculus of the present work (p. 57) we have recorded the occurrence of *H. interstincta*, Linn., and of *H. Grayi*, E. and H., within the Girvan area. Since that was written, however, a number of specimens of *Heliolites* have been collected by Mrs Gray from the Silurian rocks of this region, and some of these present points of considerable interest. As the species of the genus are remarkably similar in internal structure, and differ principally in points relating to the proportionate size of the large corallites and the extent to which the small corallites are developed, we have found it necessary in the determination of these to institute a very careful comparative examination of a large number of forms. It may therefore be of advantage to students if we present

here a brief synopsis of the recorded species of the genus, so far as known to us, accompanying this with any observations to which our late researches have given origin.

1. HELIOLITES INTERSTINCTA, Linn.—Corallum discoidal or hemispherical, the large corallites about 1-17th of an inch (or two-thirds of a line) in diameter, and from half a line to a line apart. Small corallites polygonal, in from three to five rows. Condition of the septa variable.

We purpose giving a tolerably full description of this species, so need add nothing here to the above brief definition.

2. HELIOLITES SUBTUBULATA, M'Coy. — Corallum massive, the large corallites thick-walled and cylindrical, about half a line in diameter, and "generally more than their diameter apart." Small corallites very numerous, polygonal. Septa "small and indistinctly marked." (See *Palæopora interstincta* var. *subtubulata*, M'Coy, Brit. Pal. Foss., p. 16, Pl. I. C., fig. 2.)

Milne-Edwards and Haime (Brit. Foss. Cor., p. 250) identify this with their previously described *H. Murchisoni*, with which it agrees in the size of the large corallites. M'Coy's language as to the width of the intervals occupied by the small tubes is, however, so ambiguous, that it is difficult to judge if his form presents the wide interspaces so characteristic of *H. Murchisoni*, E. and H. The figures which he gives would make the intervals about equal to the large tubes in diameter. In view of this fact, and in our ignorance of the original types of M'Coy, we do not feel able to assert positively that *H. subtubulata* may not prove to be a good species. We should add that Dr Rominger has described a form from the Upper Silurian of North America under the name of *H. subtubulatus* (?) M'Coy, but he gives a very brief description of this, and states that the larger corallites are "only a half a millimeter wide," being thus considerably smaller than the corresponding tubes in M'Coy's species (*see* Foss. Cor of Michigan, p. 12). *H. subtubulata*, M'Coy, is stated to occur in the Coniston Limestone (Lower Silurian) and in the Wenlock Limestone.

3. HELIOLITES MURCHISONI, E. and H.—We have examined specimens of this form from the Wenlock Limestone, both macroscopically and microscopically, and we find typical examples to possess the following characters: The corallum is discoidal when young, or subhemispherical when adult, its size being moderate (rarely over two inches in diameter). Under surface epithecate. Large corallites between 1-26th and 1-34th inch in diameter (between one-third and one-half line), separated by interspaces, which vary in diameter from 1-34th to 1-15th inch, but average about 1-20th inch. The small corallites are polygonal, thin-walled, in from three to six or nine rows, their diameter about 1-100th inch, more or less. The tabulæ of the large tubes are straight, and about 1-100th of an inch apart; those of the small tubes are horizontal, and vary from 1-100th to 1-200th inch apart. The calices of the large corallites are markedly circular, not exsert, thin-walled, and hardly crenulated by the minute septa.

The most marked features in this species are the small, round larger corallites, placed at distances which vary much in the same specimen, but which are almost always wider than the large tubes themselves; while the septa are very minute, and the small corallites are polygonal and very numerous. Upon the whole, we are disposed to consider that Milne-Edwards and Haime were correct in regarding *H. subtubulata*, M'Coy, as a synonym of the present species; though, for reasons previously given, we keep the latter distinct in the meanwhile. The Upper Silurian, *H. micropora*, Eichw., has calices in general smaller, and always more closely set, though it is otherwise nearly allied to this species; while *H. porosa*, Goldf., of the Devonian, has calices of decidedly larger size than in *H. Murchisoni*, but mostly less closely set, and having slightly exsert margins and strongly developed septa. Lastly, *H. tenuis*, Bill., from the Upper Silurian of Anticosti, would seem to be separated sufficiently from the present form by its much more closely approximated large corallites.

4. HELIOLITES POROSA, Goldf.—In this well-known Devon-

ian species the corallum is hemispherical, pyriform, globular, or irregular in shape, often attaining a large size. The large corallites are about 1-17th inch (= 2-3ds of a line) in diameter, and are separated by intervals of varying width, ranging from 1-100th inch up to 1-17th or 1-10th of an inch, or sometimes even more. The small corallites are polygonal, thin-walled, often with slightly thickened nodes at their angles of junction, in from one to six rows, their size varying, but averaging about 1-80th to 1-100th inch in diameter. The calices of the large corallites are approximately circular, slightly exsert, with remarkably well-defined crenulated walls. The septa are twelve in number, very well developed, but not reaching the centre. The tabulæ of the large corallites are horizontal, and from 1-20th to 1-10th inch apart; those of the small tubes are likewise straight, and are from 1-40th to 1-60th inch apart.

The above brief description is taken from examples of this species from the Devonian of the Eifel, and the minute measurements are from thin sections. We have, however, examined specimens from the Devonian of Devonshire and of Australia, and we find them to differ in no material respect from the above.

H. porosa, Goldf., is perhaps most nearly allied to the Upper Silurian *H. Murchisoni*, E. and H.; but the large tubes are, on the whole, very decidedly larger, and less closely disposed, while the calices project somewhat, and the septa are very well developed. From *H. interstincta*, Linn., the present species is distinguished chiefly by the much wider and more variable intervals which separate the large corallites.

5. HELIOLITES MICROPORA, Eichw. (Leth. Ross., p. 454, Pl. XXV., fig. 7).—The only example of this species which we have seen is one kindly given to us by Dr Lindström, from the Upper Silurian of Gotland. This we have submitted to a careful microscopic examination, with the following results: The corallum is in the form of an irregular lobate mass, the upper, as well as most of the under, surface of which is covered by the calices. The large corallites are rather more than 1-30th

inch in diameter (between one-half and one-third line), and are separated by intervals of from 1-50th to 1-30th inch, or rarely 1-20th inch. The small corallites are polygonal, thin-walled, in from three to five rows. The calices of the large tubes are not at all prominent, with twelve very short and delicate septa. The tabulæ of the large corallites are horizontal, about 1-25th inch apart; those of the small tubes being also horizontal, and about 1-50th inch apart.

There can be no doubt as to the close relationship which subsists between this form and the *H. Murchisoni* of Edwards and Haime. Upon the whole, however, the large corallites of *H. micropora*, Eichw., are decidedly and uniformly more closely set than in *H. Murchisoni*, and they are separated by a smaller number of small corallites. The septa in the former species are, moreover, better developed, and the tabulæ decidedly wider apart, than in *H. Murchisoni*, while its corallum is expanded and lobate, and not discoid. Nevertheless, it is questionable if these two forms are more than mere variations of a single species, or if their differences are not due to age or locality.

6. HELIOLITES PYRIFORMIS, Hall. — The name of *H. pyriformis* was given by Hall to a species of this genus from the Upper Silurian deposits of North America (Pal. N. Y., vol. iii. p. 133, Pl. XXXVI. A., fig. 1, 1852), which was regarded by Edwards and Haime as identical with *H. interstincta*, Linn. (Brit. Foss. Cor., p. 249). Recently, however, Dr Rominger (Foss. Cor. of Michigan, p. 10, Pl. I., fig. 2) has described specimens from the Niagara Limestone of Drummond Island to which he gives the name of *H. pyriformis*, Hall, and to which he ascribes the following characters: Corallum subglobular in form, the large corallites being "about one millimeter" in width, separated by intervals of similar or somewhat greater breadth. Small corallites minute and numerous; the septa of the large tubes spinulose, arranged in twelve cycles, fused with the tabulæ into a cellular mass.

Accepting the accuracy of Rominger's description, and the

correctness of his reference of his specimens to *H. pyriformis*, Hall, it seems clear that this form cannot be regarded as identical with *H. interstincta*, Linn. At any rate, it possesses large corallites of a decidedly smaller size, while its septa, if really spiniform, differ materially from the lamellar septa of the latter species.

7. HELIOLITES TENUIS, Billings (Can. Nat., ser. 2, vol. ii. p. 248, and Cat. Sil. Foss., Anticosti, p. 32).—The late Mr Billings has given this name to a species of *Heliolites* from the Upper Silurian rocks of Anticosti, the general form and dimensions of the corallum of which are not stated. The large corallites are said to be mostly a little less than half a line in diameter, and a quarter of a line distant from one another, with "excessively thin and rarely distinguishable" walls. The small corallites are minute and polygonal. Mr Billings says that this species may, perhaps, be a *Protaræa*, but as we have seen no specimens which we could refer to it, and as no figures accompany the brief published description, we can offer no opinion upon its affinities.

8. HELIOLITES PARVISTELLA, F. Roemer (Sil. Fauna von Sadewitz, p. 25, Pl. IV., figs. 6 *a*, 6 *b*, 1861).—The corallum of this form is large and globular, or hemispheric in form. The large corallites are from 1-6th to 1-4th line in diameter, with almost superficial calices, and with no clear walls, the interspaces between them being from one-third to one-half line. The small corallites are polygonal in shape, and are in eight or ten rows between any given pair of large tubes. The septa in the large corallites reach nearly to the centre of the visceral chamber. The species is from the Upper Silurian.

We have not had access to any specimens of this singular form, and can add nothing to the above digest of its principal characters. It differs in some respects from the type of the genus, but, if rightly referred here, it is clearly distinct from all the other recorded species of *Heliolites*.

9. HELIOLITES MEGASTOMA, M'Coy (*Palæopora megastoma*, M'Coy, Brit. Pal. Foss., p. 16, Pl. I. C, figs. 4-4 *b*).—The speci-

mens upon which Professor M'Coy established this species seem to have been derived from the Coniston Limestone of the North of England, and there is room for considerable doubt as to whether they are really identical with the form which has been always recognised by this title by subsequent writers. We have no means at present of resolving this doubt, but such specimens of *H. megastoma* as we have seen from the Coniston Limestone are remarkable for their well-developed and spiniform septa, whereas the forms from the Wenlock Limestone usually known under this name have the septa quite rudimentary and lamellar. We subjoin here the principal characters of the species as derived from Upper Silurian examples.

Corallum subhemispheric or globular; the large corallites circular, with crenulated walls, and rudimentary or almost obsolete septa. Calices not exsert. Large corallites from 1-10th to 1-12th inch in diameter (M'Coy says from one and a half to nearly two lines), separated by intervals which usually vary from 1-20th to 1-12th of an inch. Small corallites in from two to six rows, from 1-50th to 1-60th inch in diameter. Tabulæ of the large tubes from 1-40th to 1-25th inch apart, those of the small tubes from 1-60th to 1-80th inch apart, in both sets of tubes straight and nearly horizontal.

This species is distinguished from *H. interstincta*, Linn., its nearest ally, by the greater size of the large corallites, and the smaller proportionate width of the interspaces occupied by the smaller tubes.

10. HELIOLITES PLACENTA, Goldf. (*see* Milne-Edwards and Haime, Pol. Foss. des Terr. Pal., p. 219).—This species is described by Edwards and Haime as possessing a large, thin, subcircular corallum, which is covered inferiorly by a strong epitheca. The large corallites have very thin walls, are about one line in diameter, are nearly equidistant, and are separated by intervals of rather more than half a line. The septa are in twelve rows; and the small corallites are polygonal, and apparently between 1-70th and 1-80th inch in diameter.

This species is imperfectly known, and we are not acquainted

with any specimen of it. If it be really a *Heliolites*, it would appear to be sufficiently separated from the recorded species of the genus by the peculiar form of the corallum, and the large and close-set calices. The species is Devonian.

11. HELIOLITES SPARSUS, Billings (Can. Nat., ser. 2, vol. ii. p. 428, and Cat. Sil. Foss. of Anticosti, p. 31).—The large corallites in this species are said to vary from one-half to one line in diameter, and to be separated by interspaces of from one to three lines. The septa are greatly developed, and sometimes meet in the centre of the visceral chamber. The small corallites are stated to be sometimes traversed by straight tabulæ, but at other times to be occupied by vesicular tabulæ, both conditions being present in a single specimen. The examples of the species are from the Upper Silurian rocks of Anticosti.

This species is imperfectly defined, and we have seen no example of it, nor have any figures of it been published. Judging from the description given by Mr Billings, we should imagine it to be really a *Plasmopora*, since the occasional and partial presence of horizontal tabulæ in the smaller corallites is not altogether unknown in this genus, while no undoubted species of *Heliolites* has been shown to possess vesicular tabulæ in the small tubes.

12. HELIOLITES PLASMOPOROIDES, Eth. jun., and Nich. (Ann. and Mag. Nat. Hist., ser. 5, vol. iv. p. 225, Pl. XIV., figs. 2-2 *b*).—The corallum in this species is massive and subhemispherical; the large corallites are about 1-10th to 1-8th inch in diameter, and are separated by intervals of mostly about half a line. The septa are marginal and rudimentary. The small corallites are very irregular in form, mostly in a single row only between any given pair of large tubes, and they are crossed by numerous straight tabulæ of the type of these structures in *Heliolites* generally.

This species is from the Devonian deposits of Queensland, and is distinguished by its curious combination of the characters of *Heliolites* with those of *Plasmopora*. Thus, it resembles

Plasmopora in the circular or oval, closely approximated large corallites, and in the irregular form of the small tubes which separate these, while it agrees with *Heliolites* proper in the important structural character that the small corallites have distinct and well-developed walls, and possesses straight and horizontal, instead of vesicular, tabulæ.

13. HELIOLITES DAINTREEI, Eth. jun., and Nich. (Ann. and Mag. Nat. Hist., ser. 5, vol. iv. p. 224, Pl. XIV., figs. 3-3 *a*).—Corallum massive, discoidal, with a slightly convex upper surface, often attaining a large size. The large corallites from 1-16th to 1-12th inch in diameter, with intervals mostly less than their own diameter. Small corallites polygonal, thin-walled, generally in only two rows between any pair of large tubes. Calices deeply crenulated by the well-developed septa.

This species is from the Devonian of Queensland, Australia, and most nearly resembles *H. megastoma*, M'Coy, from which it differs in the greater development of the septa, and the generally smaller and more closely set large corallites, as well as in some other less important characters.

14. HELIOLITES DUBIA, Fr. Schmidt (Silur. Form. in Ehstland, p. 228).—Corallum like that of *Monticulipora petropolitana*, Pand., in form—*i. e.*, hemispherical or discoid, with a flat or concave base. Large corallites circular, with an extreme diameter of 1-48th of an inch (a quarter of a line), separated by excessively narrow interspaces, occupied by minute polygonal corallites. Septa rudimentary. Internal structure unknown.

The best description, and the only figures, of this species with which we are acquainted, is one given by Ferd. Roemer (Sil. Fauna von Sadewitz, p. 26, Pl. IV., figs. 5 *a*, 5 *b*). If truly a *Heliolites*, there can be no question as to its entire distinctness from all the other recorded species of the genus; but its minute structure is unknown, and it is quite possible that this curious form may turn out to be a *Propora*. It differs from the normal forms of *Heliolites* in its excessively close-set large corallites. The species is Silurian in its range.

15. HELIOLITES EXIGUUS, Billings (Cat. Sil. Foss. of Anticosti,

p. 31, fig. 14).—Corallum massive, the large corallites about half a line in diameter, with intervals of rather more than half a line. Septa not determined. "Cœnenchyma minutely vesicular." Upper Silurian of Anticosti.

This species is described from a single specimen, and is only incompletely known. If it be truly a *Heliolites*, it will be difficult or impossible to separate it from *H. Murchisoni*, E. and H.; but if the "cœnenchyma" be really vesicular (a point upon which Mr Billings is not quite positive), then the species would have to be referred to *Plasmopora* or *Propora*.

16. HELIOLITES SPECIOSUS, Billings (Can. Nat., ser. 2, vol. ii. p. 426, and Cat. Sil. Foss. of Anticosti, p. 30, fig. 13).—Corallum massive, clavate, or pyriform. The large corallites rather more than one line in diameter, sometimes two lines; and usually about half a line apart, more or less, being sometimes in contact. Calices exsert, crenulated, with twelve rudimentary septa; the intervening surface being "covered with small rough tubercles." Interspaces between the large corallites occupied by "small vesicular cells, from one-sixth to one-third of a line in diameter." Upper Silurian, Anticosti.

In the absence of any sufficient information as to the internal structure of this form, it is useless to speculate as to its true position. If it be a *Heliolites*, it would doubtless be a good species, unless it proved to be identical with *H. macrostylus*, Hall. Judging, however, from the description given by Mr Billings, we should be disposed to think that it is really referable to *Plasmopora*, or, if the latter genus be ultimately retained, to *Lyellia*.

17. HELIOLITES AFFINIS, Billings (Can. Nat., ser. 2, vol. ii. p. 427, and Cat. Sil. Foss. Anticosti, pp. 5 and 30, fig. 12).—Corallum globular, hemispherical, or pyriform, sometimes encrusting. The large corallites from one-half of a line to one line in diameter, in contact, or barely separate, with exsert calices. The small corallites ("cœnenchyma") rudimentary, vesicular. Septa in the large tubes rudimentary, twelve in number. Upper Silurian, Anticosti.

There can be no doubt that this is not a true species of *Heliolites*. Dr Lindström (Öfversigt af Kongl. Vetenskaps-Akad., Förhandl., 1873) refers the species to *Plasmopora*, and his opinion is founded upon specimens sent to him by Mr Billings. Judging from the description and figure given by Mr Billings, we should be disposed to regard it as belonging to that section of *Plasmopora* separated by the name of *Propora*, E. and H., and we should doubt if it were specifically separable from the well-known *P. tubulata*, Lonsd.

18. HELIOLITES MACROSTYLUS, Hall (Pal. N. Y., vol. ii. p. 135, Pl. XXXVI. A, fig. 2).—This form was originally described from the Upper Silurian (Niagara Limestone), but the description given offers no points upon which any conclusion as to the validity of the species could be founded. Milne-Edwards and Haime (Brit. Foss. Cor., p. 251) regard the species as a synonym of *H. megastoma*, M'Coy. The few specimens which we have seen (from the Niagara Limestone of Manitoulin Island, Ontario) are, unfortunately, much altered by silicification, and we cannot fully make out their internal structure; but they appear to us to differ from *H. megastoma*, M'Coy, in several points, and especially in their strongly developed septa. The small corallites, also, *appear* to have vesicular tabulæ, which would remove the species from *Heliolites* altogether, though on the existence of this character we cannot speak with absolute certainty. Recently, Dr Rominger (Foss. Cor. of Michigan, p. 14) has placed *H. macrostylus*, Hall, as a mere synonym of *Lyellia Americana*, E. and H., the type of the genus *Lyellia*. If this determination be accepted as correct, then it will become a question if there be any character of generic value by which *Lyellia*, E. and H., could be separated from *Plasmopora*, E. and H. The definition of *Lyellia* given by Rominger (*loc. cit.*) certainly gives no indication of such a character; but in the absence of sufficient material, we refrain from pronouncing any positive opinion upon this point.

19. HELIOLITES GRAYI, Edw. and Haime (Pol. Foss. des Terr. Pal., p. 217).—Corallum dendroid, of flattened branches,

or sublobate, the large corallites from one-third to one-half line in diameter, with variable interspaces (most usually from one-third to one-half line). The small corallites are irregular in shape, thick-walled, usually in four or five rows between each pair of large corallites. Septa thick and unequal, extending far into the visceral chambers.

This species occurs in the Wenlock Limestone, and we have described it as occurring in the Lower Silurian (Craighead Limestone) of the Girvan area (*see* Fasciculus, I., p. 58). It is sufficiently distinguished from all the ordinary species of *Heliolites* by its mode of growth; while it differs from *H. inordinata*, Lonsd.—its nearest ally—in the flattened form and greater size of its branches, and its generally smaller and more closely set large corallites.

20. HELIOLITES INORDINATA, Lonsd. (Sil. Syst., p. 687, Pl. XVI., *bis.* fig. 12).—Corallum dendroid, composed of slender, rounded branches, from one to one and a half line in diameter. Large corallites, half a line in diameter, placed at variable intervals. Small corallites polygonal, irregular in shape. Septa twelve, unequal.

We have not had the opportunity of examining examples of this species, and can give no details as to its minute structure. It appears to be sufficiently separated from *H. Grayi*, E. and H., by the fact that the corallum is composed of slender and rounded branches, while the large corallites are, upon the whole, larger in size than in the latter species, and also more irregularly distributed. It is a Lower Silurian form.

21. HELIOLITES (PALÆOPORA) SUBTILIS, M'Coy (Ann. and Mag. Nat. Hist., ser. 2, vol. vi., 1850; and Brit. Pal. Foss., p. 17).—This form is described by M'Coy as possessing a dendroid corallum, of cylindrical branches, usually from one and a half to two lines in diameter. The large corallites are "about one-sixth of a line in diameter, and a little more or less than their diameter apart." The small corallites are polygonal, "about thirty in the space of one line," or usually in five rows between any given pair of large tubes.

Milne-Edwards and Haime (Brit. Foss. Cor., p. 253), with some little doubt, identify *H. subtilis*, M'Coy, with the previously described *H. inordinata*, Lonsd. If, however, M'Coy's description of *H. subtilis* be accurate, then it cannot possibly be identical with Lonsdale's species, as the larger corallites are stated to be only one-sixth of a line in diameter, whereas they are half a line in diameter in *H. inordinata*. Similarly, the large corallites are much smaller than in *H. Grayi*, E. and H., the only other recorded species of *Heliolites* in which the corallum has a ramose habit of growth. In the absence of any direct knowledge of the original specimens upon which M'Coy founded his species, we should not, therefore, regard ourselves as justified in denying its validity. On the other hand, Prof. M'Coy gives no other locality for *H. subtilis* than Mulloch, near Girvan, where he states it to be "very common." The collections made by Mrs Gray from this region contain, however, absolutely no examples which we could possibly refer to *H. subtilis*; and when we consider the extent of these collections, and the great care and thoroughness with which they have been assembled, we can hardly avoid the conclusion that Prof. M'Coy must have been under some misapprehension as to the locality whence his specimens were derived.

Heliolites interstincta, Linn.

(Pl. XVI., figs. 1-4.)

Obs.—In the First Fasciculus of this work (p. 57), we noticed the occurrence of examples of this species from the Upper Silurian strata of Mulloch Hill and Penkill, near Girvan. Since the publication of this notice, as before remarked, we have had occasion to very carefully investigate the minute structure of many species of *Heliolites*, and particularly of *Heliolites interstincta*, as ordinarily understood. This species has usually been defined principally by the absolute and relative dimensions of the large corallites and of the intervals occupied by the small corallites, and, in a general way, all specimens agreeing in these

dimensions with *H. interstincta*, as defined by Edwards and Haime, would be unhesitatingly referred to this species. We have made a large series of thin sections of a number of such specimens, and with a view of bringing out the real characters of this species, we subjoin here brief notes on the structure of four examples from different localities, but all from strata of Upper Silurian age.

(1.) *A specimen from the Wenlock Limestone of Gotland* (kindly given us by Dr Lindström). — Corallum discoid, epithecate below, about two inches in diameter, and half an inch in height. Large corallites 1-17th inch (= about two-thirds of a line) in diameter; intervals between the large corallites 1-20th to 1-12th inch in diameter; small corallites, in from three to five rows, from 1-60th to 1-100th inch in diameter. The large calices are circular, not exsert, with slightly crenulated walls, the septa being very imperfectly developed, and having the form of twelve rudimentary marginal lamellæ (Pl. XVI., fig. 3). The small corallites thin-walled, polygonal. Tabulæ of large tubes (Pl. XVI., fig. 3 *a*) usually about 1-50th inch apart, but sometimes 1-100th inch apart, and, to some extent, coalescent. Tabulæ of small corallites from 1-80th to 1-100th inch apart, horizontal.

(2.) *Specimen from the Wenlock Limestone of Stoke-Edith.*— Corallum large and massive, imperfect, but about four inches in width, and over two inches in height. Large corallites 1-20th inch (or less than two-thirds of a line) in diameter; intervals between the large corallites from 1-30th to 1-20th inch in diameter; small corallites in from three to five rows, from 1-60th to 1-90th inch in diameter. Large calices circular, not exsert, with slightly crenulated walls, and twelve marginal and quite rudimentary septal ridges (Pl. XVI., fig. 4). Small corallites polygonal, with horizontal tabulæ placed about 1-100th inch apart. Tabulæ of large corallites about 1-60th inch apart in general (Pl. XVI., fig. 4 *a*).

(3.) *A second specimen from the Wenlock Limestone of Dornington, Stoke-Edith.*—Corallum in the form of a large irregular

expansion, epithecate below. Large corallites from 1-17th to 1-18th inch in diameter; intervals between the large corallites varying from 1-50th to 1-17th inch, but averaging 1-30th inch in diameter; small corallites in three, four, or more rows, about 1-50th inch in diameter. Large calices circular, not exsert, with strongly folded and crenulated walls. Septa twelve in number, lamellar, strongly developed, extending far into the visceral chamber, and often uniting centrally into a loose and irregular trabecular axis or pseudo-columella (Pl. XVI., figs. 2-2 *b*). Small tubes polygonal, with horizontal tabulæ placed at intervals of from 1-80th to 1-120th inch apart. Tabulæ of large tubes from 1-60th to 1-120th inch apart.

(4.) *Specimen from the Upper Silurian of Woodland Point, Girvan*, (Pl. XVI., figs. 1-1 *b*).—Corallum pyriform (in some cases globular or hemispherical), of small size (average specimens are about one inch in height, and the same or less in greatest width). Large corallites 1-17th inch (about two-thirds of a line) in diameter; intervals between the large corallites from 1-30th to 1-15th inch in diameter; small corallites in from two to five rows, from 1-60th to 1-80th in diameter, irregularly polygonal in their shape. Large calices circular, not exsert, with crenulated and inflected walls. The septa, twelve in number, extending far into the visceral chamber, with partial and occasional traces of an actual central union. Tabulæ of large tubes from 1-20th to 1-60th inch apart, uniformly and deeply bent downwards in the centre of the visceral chamber, so as to be concave above. Tabulæ of the small corallites from 1-40th to 1-80th inch apart.

We have selected the above four specimens as excellent examples of the coral ordinarily known as *Heliolites interstincta*, Linn., to which they would unhesitatingly be referred by an examination of their external characters. They do not, in fact, differ from one another superficially—leaving their size and form out of consideration—except in trivial features, which may well be included within the limits of specific variation. In internal structure, however, they present certain differences, by

means of which they may be clearly divided into two groups, in accordance with the condition of the septa. To the first of these groups belong specimens 1 and 2, which may be regarded as types of an immense number of specimens from the Wenlock Limestone of Britain, and indeed of Europe generally. These specimens have the dimensions of the large tubes, and the other general characters of *H. interstincta*, Linn.; but their septa are quite rudimentary, being never more than mere marginal ridges, and being often recognisable only by the slight crenulations in the walls of the large corallites. On the other hand, specimen 3 is an example of another series of specimens, also very abundant in the Wenlock Limestone of Britain, and also with the general characters of *H. interstincta*, in which the septa are extremely well developed, and have the form of twelve strong lamellæ, which always extend for a long distance into the visceral chamber. Very commonly, the septa meet centrally, and give rise to a median reticulated or trabecular pseudo-columella. When this occurs, it is not uncommon to find this central reticulation in the large corallites so greatly developed, that tangential sections of the corallum appear under the microscope as if completely made up of cellular tissue, and the outlines of the large corallites can only be detected with great difficulty. In long sections, also, the central reticulation of the septa in the axis of the large tubes can readily be detected, and its appearances are very similar to those presented in vertical sections by the very similar reticulated pseudo-columella of *Streptelasma*. It should be added, that though well-preserved specimens demonstrate the existence of this central reticulation beyond the possibility of doubt, it is very common to find that in certain of the tubes, or in all of them, the delicate septa have been partially disintegrated or broken up, though the remains of the structure in question can always be detected.

It appears from the above, that among the specimens from the Wenlock Limestone which, from the dimensions of their tubes, the relative distance of their large corallites, and their

other general characters, would usually be included under the name of *H. interstincta*, Linn., there are really included two distinct groups. In the one of these groups the septa are marginal and quite rudimentary; in the other the septa are extremely well developed, and often anastomose centrally. In the latter, moreover, the large tubes are slightly smaller, and the intervals between them are decidedly narrower than in the first group, while the corallum is usually larger and more widely expanded. We have no means of finally deciding whether these two groups are merely composed of the varietal forms of a single species, or whether they are really distinct species; but they differ from one another more fundamentally than is usual in the species of *Heliolites*, and we should be inclined to separate them by titles of at least varietal value, if we had any means of ascertaining which was the original type of *Heliolites interstincta*, Linn. On this point, we have nothing to guide us but the statement of Milne-Edwards and Haime (Pol. Foss. des Terr. Pal., p. 214) that the septa in *H. interstincta* are "assez bien développées," from which we should conclude that it is the forms of the second of these groups which these authors had in view in their description of this species.

Finally, we have to briefly notice the specimens from Woodland Point, Girvan, of which we have above given a description from a typical example. Mrs Gray's recent collections from Girvan, comprise a number of specimens from this locality, which agree with one another in their small size and pyriform or subglobular shape, and which have all the general characters of *H. interstincta*. As regards the condition of the septa, these specimens belong upon the whole to the second group of forms which we have seen to be included under the head of *H. interstincta*. The septa, namely, are exceedingly well developed, and always extend to near the axis of the visceral chamber. There are, however, only imperfect and not universal traces of a central reticulation formed by the septa; the small tubes, though polygonal, are not so

geometric or regular in form as is usual in *H. interstincta;* and, so far as we have observed, there is the constant feature that the tabulæ of the large corallites are very deeply concave or bent downwards in the axis of the visceral chamber. It would not appear, however, that these differences alone should outweigh the general points of agreement between these specimens and the ordinary examples of *H. interstincta* from the Wenlock Limestone.

Formation and Locality.—Not unfrequent in a greenish-grey mudstone, of Upper Silurian age, from Woodland Point, near Girvan. (Gray Collection.)

Heliolites ? parasitica, Nich. and Eth. jun. (*sp. nov.*)

(Pl. XVI., figs. 5-5 *b.*)

Spec. char.—Corallum in the form of a thin parasitic crust, completely enveloping the shells of Gasteropods, and consisting of a single layer of corallites, from 1-24th to 1-15th inch in thickness. The large corallites vary from 1-20th to 1-18th of an inch in diameter, and are separated by intervals of from 1-50th to 1-70th inch or less. When the interspaces are below 1-70th of an inch in width, then the large corallites are in actual contact; when above this, the latter are separated by a single row of small corallites, which may become doubled at the angles of junction of the larger tubes. Large corallites, with about twelve triangular, or apparently trabecular septa, which have broad bases, and extend inwards to about a half of the distance between the wall and the centre of the visceral chamber. Small corallites thick-walled, irregular in shape, destitute of septa. In vertical sections no tabulæ can be detected, but the entire colony seems to be formed simply of a loosely trabecular or reticulate sclerenchyma, and the calices of the large corallites seem to be quite superficial.

Obs.—We have little to add to the above brief specific diagnosis of this curious coral, of which we have a number of speci-

mens from the "Gray Collection," and which appears to be quite constant in its habit and mode of growth. It occurs both as thin and well-preserved crusts, covering the exterior of the shells of Gasteropods, and also as *casts* lining the hollows left by the removal of such shells. We have never seen it growing upon any other organisms than spiral Gasteropods, and we have observed no specimens in which the characters of the *surface*—owing to the adherent matrix—could be examined.

We know of no species of *Heliolites* with which it is necessary to compare this, its peculiar habit, the trabecular or reticulate structure of the corallum, and the apparent absence of tabulæ, removing it widely from all the ordinary forms of this genus. It most closely resembles, in habit and general appearance, the parasitic *Protaræa vetusta*, Hall, of the Lower Silurian, from which it is separated by the undoubted possession of a set of small corallites intervening between the larger tubes. Owing to the tenuity of the corallum, and also to its being invariably attached to curved surfaces, it is very difficult to prepare satisfactory thin sections, and especially sections tangential to the surface. Tangential sections (Pl. XVI., fig. 5 *a*) would show it to be a *Heliolites*, with a remarkably ill developed series of small corallites. These sections also show that the large tubes are provided with septa, which are wanting in the small tubes. In vertical sections (Pl. XVI., fig. 5 *b*), the structure of the corallum seems to be simply reticulate, no distinction can be observed between the larger and smaller corallites save just at and below the surface, and no tabulæ can be detected. The absence of these structures may, however, be simply due to the extreme shortness of the corallites. There is also the peculiar feature that in all the sections the entire corallum seems to be composed of a loosely compacted and minutely porous sclerenchyma. In casts of the surface of the corallum, as seen in the hollows left by the removal of the shell upon which the colony grew, the large septate corallites, and the comparatively few small corallites intervening between these, can be recognised with the greatest distinctness.

Loc. and Horizon.—Not uncommon at Mulloch Hill, Girvan. (Gray Collection.)

Heliolites foliacea, Nich. and Eth. jun. (*sp. nov.*)

(Pl. XVI., fig. 6, and Pl. XVII., figs. 1-1 *b*.)

Spec. char.—Corallum in the form of thin, extended, undulated, sometimes folded, but apparently non-parasitic laminæ, which often have a considerable horizontal extension, and which vary from a fifteenth to about an eighth of an inch in thickness. Under surface not observed, but apparently epithecate. Large corallites about 1-24th of an inch in diameter, circular, with very slightly exsert calices, separated by intervals which vary from 1-50th to 1-24th of an inch, and are usually about the latter measurement. Small corallites numerous, with excessively thickened walls, and very contracted apertures, in from three to five or more rows. Septa in the large tubes broad and triangular, about twelve in number, extending inwards about one-third or one-half of the distance between the wall and the centre of the visceral chamber, wanting in the small tubes. In vertical sections, the distinction between the large and small corallites cannot be clearly made out, owing to the thickening of the tissues beneath the immediate surface by sclerenchymatous deposit, and also to mineralisation. The walls of the small tubes can, however, be seen to be excessively thick, and their cavities can be observed, under favourable circumstances, to be crossed by well-marked horizontal tabulæ.

Obs.—No species of *Heliolites* hitherto recorded is at all closely comparable with this. In its internal structure, and in the dimensions of the large corallites, and of the interspaces between these, the present form approaches more nearly to *H. Grayi*, E. and H., than to any other described form; but it differs from this, among other characters, by its peculiar mode of growth. Thus *H. Grayi*, E. and H., presents itself in the form of flattened or sublobate branches; whereas *H. foliacea*, nobis, has invariably the quite unique form, in this genus, of

large undulated laminæ, averaging about one line in thickness. The under surface, owing to the uniformly adherent matrix, cannot be observed; but there is no evidence whatever of the corallum having been parasitically attached to foreign bodies (except, doubtless, at some one point), and the general inferior surface would seem to be quite free, and probably covered with an epitheca. From all other species of the genus, save *H. Grayi*, E. and H., the present form is distinguished not only by its mode of growth, but equally by the excessively thickened walls of the small corallites (Pl. XVII., fig. 1 *a*). The result of this is that the visceral chambers of the small tubes appear in tangential sections merely as small round or oval apertures. The surface is often very well preserved (Pl. XVI., fig. 1); and an examination of this leaves no doubt as to the propriety of referring the species to *Heliolites*. In thin vertical sections (Pl. XVII., fig. 1 *b*) the internal structure can often be made out with difficulty, or not at all, and the large corallites cannot be separated from the small ones. This is apparently due partly to mineralisation, and partly to the secondary filling-up of the visceral chambers, as well as, to some extent, to the shortness of the corallites. From *H.? parasitica*, nobis, the present species is distinguished by its non-parasitic habit, the extensive development of the small corallites, and the fact that the general tissue of the corallum is not openly reticulate, but is regularly tubular.

Loc. and Horizon.—Apparently not very rare, in the Upper Silurian Mudstones of Woodland Point, Girvan. (Gray Collection.) All the specimens observed are more or less fragmentary, but the largest measured over three inches in length by about two inches in width; and its horizontal expansion would be much more than these measurements would indicate, as it is much folded upon itself.

Genus PLASMOPORA, Edwards and Haime, 1849.

(Compt. Rend., t. xxix. p. 262.)

Gen. char.—"Corallum discoidal when young, but becoming hemispherical or spheroidal when adult, its lower surface covered by a concentrically striated epitheca, while the upper surface carries the calices. Corallites in complete contact throughout, divisible into two distinct series. The larger tubes are comparatively few in number, and possess twelve lamellar septa, formed by infoldings of the wall, and extending but a short distance into the visceral chamber; while they are crossed by horizontal, complete, and comparatively remote tabulæ. The smaller tubes are devoid of septa, are comparatively irregular in form, and only possess distinctly differentiated walls when young. In their adult state their walls become amalgamated with the convex and anastomosing tabulæ by which their cavities are intersected, in such a manner that they can no longer be recognised as distinct structures, and the interspaces between the larger corallites become filled up with a loose tissue composed of irregular lenticular vesicles." (Nicholson, Pal. Tabulate Cor., p. 245.)

Obs.—The above definition may be taken as adequately characterising the species of *Plasmopora* proper, in the sense in which the genus was understood by Milne-Edwards and Haime. It has, however, been pointed out by Dr Lindström (Ann. Nat. Hist., ser. 4, vol. xviii. p. 16), as well as by one of ourselves (*loc. cit.*, p. 247), that the genus *Propora*, E. and H., can hardly be considered as separable from *Plasmopora* by any characters of a truly generic value. The recent collections made by Mrs Gray from the Girvan area have likewise brought to light a number of excellently preserved specimens of a new species of *Pinacopora*, nobis, the examination of which has led us to believe that this genus also is in reality very closely allied to *Plasmopora*, or rather to *Propora*. Upon

the whole, therefore, we are inclined to think that we may regard *Propora*, E. and H., and *Pinacopora*, nobis, as subgenera, or sections, of *Plasmopora*, E. and H., sufficiently distinct from the type-forms of this last to deservedly retain their special designations, but nevertheless not entitled, from a theoretical point of view, to take rank as independent genera. We propose, therefore, to define *Plasmopora*, and its sections *Propora* and *Pinacopora*, as follows :—

1. PLASMOPORA, E. and H.—Corallum discoid when young, hemispheric, subglobular, or pyriform in shape when adult. Large corallites with walls folded to correspond with a series of well-developed septa, which may be lamellar, or may be composed of vertical rows of closely approximated, upwardly directed spinules. Small corallites abundantly developed, separating the large tubes to a considerable distance from one another, and mostly in several (two to five) rows between any given pair of large corallites. Walls of the small corallites imperfect or obsolete, their tabulæ coalescing to form a vesicular tissue of lenticular cells. Calices not elevated above the general surface, in typical forms of the group, but in some cases distinctly exsert.

2. PROPORA, E. and H.—Corallum discoidal, hemispherical, or irregularly pyriform, or spheroidal. Large corallites circular, with comparatively ill developed septa, which are sometimes quite obsolete. The large tubes are close-set, much more nearly approximated than in *Plasmopora* proper, there being a corresponding diminution in the number of the small corallites. Usually only one row, rarely two rows, of small corallites between any given pair of large tubes. Walls of the small corallites incomplete or obsolete, their tabulæ anastomosing to form a vesicular tissue of lenticular cells. The calices, as a rule, more or less exsert.

3. PINACOPORA, Nich. and Eth. jun. — Corallum free, discoid or coin-shaped, very thin, epithecate below. Corallites excessively short; the large tubes with rudimentary or marginal septa, very closely arranged, with rarely, and only par-

tially, more than a single row of small tubes between any given pair of the former. Small corallites sometimes with complete walls and horizontal tabulæ, sometimes with more or less extensively obsolete walls, and with the tabulæ coalescent and giving rise to a vesicular tissue of lenticular cells. Calices not exsert.

Speaking in a general way, the species of *Plasmopora* proper are distinguished by the comparative abundance of the small corallites and the correspondingly wide intervals which separate the large tubes; by the strongly folded walls and well-developed septa of the larger corallites; and by the fact that the large calices are, typically, not exsert. The species of *Propora*, again, are recognised by their exsert calices; by the comparatively close-set corallites, and the correspondingly limited development of the small tubes; and by the fact that the septa are very short or obsolete, and the walls of the large tubes only faintly crenulated. Lastly, the species of *Pinacopora* are distinguished by the extraordinarily thin leaf-like corallum and the corresponding shortness of the corallites, the large tubes being close-set and with marginal septa, but wanting the exsert calices of *Propora;* while the small corallites may or may not possess vesicular tabulæ, these structures being in the type-species horizontal.

If typical examples of these three groups be selected, they can be distinguished from one another with the greatest ease, and they might with good reason be regarded as really representing three sections of generic value. It must be admitted, however, that there are forms which, with the exsert calices of *Propora*, possess the comparatively numerous small tubes and the well-developed septa of *Plasmopora* proper, and which might thus indifferently be placed under either of these sections; while we have now to describe a new species of *Pinacopora*, which, with the general features of this section, exhibits a more or less completely vesicular condition of the tabulæ of the smaller corallites, and thus closely approximates to the type of *Propora*.

The richly fossiliferous beds of Woodland Point, near Girvan, have yielded to the recent researches of Mrs Gray a new species of each of these three sections, which we shall now proceed to describe. In so doing, however, we shall have occasion to refer at some length to the structure of previously known forms of this group, which we have had occasion to examine minutely during the course of the present inquiry; and we take this opportunity, also, of appending a description of an extra-limital species of *Plasmopora*, which appears to be new, and the structure of which may be usefully compared with that of the other species here described.

Plasmopora Girvanensis, Nich. and Eth. jun. (*sp. nov.*)

(Pl. XVII., figs. 2-2 *b*.)

Spec. char. — Corallum pyriform or clavate in shape, the largest specimen examined having a height of about two inches, by a width at the top of an inch and a half. Large corallites close-set, with circular or ovate, very slightly exsert calices, from 1-10th to 1-13th of an inch in diameter, separated by intervals of from 1-20th to 1-12th of an inch in diameter, the widest intervals corresponding with the vertical axis of the corallum. The walls of the large corallites are thick, very strongly crenulated, and furnished internally with strong upwardly directed spiniform septa arranged in vertical rows, and having their chambers crossed by strong horizontal tabulæ at intervals of from 1-20th to 1-30th inch. The small corallites of the colony are exceedingly irregular in shape and size, from one to three rows existing between any neighbouring pair of large tubes. Their walls, also, are imperfectly developed, and the tabulæ are convex, and anastomose laterally, so as to give rise to a series of lenticular vesicles occupying the interspaces between the large tubes.

Obs.—When we come to compare the present form with the previously described species of *Plasmopora*, we find that it is readily separated from the *P. petaliformis*, Lonsd., by the

generally larger size of the large corallites, and by the much smaller width of the intervals occupied by the small tubes. Thus, in transverse sections of the latter species (fig. 8, A) the large corallites are seen to be usually about a line in diameter, sometimes rather less; while they are separated by intervals of from one to as much as two lines. On the other hand, in the present species, the large tubes are separated by intervals usually considerably less than their own diameter;

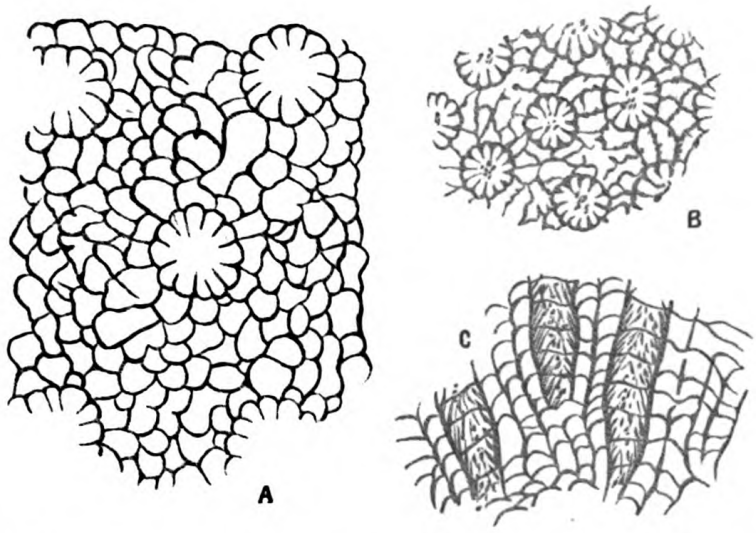


Fig. 8.—A, Transverse section of a specimen of *Plasmopora petaliformis*, Lonsd., from the Wenlock Limestone of Gotland, enlarged five times. B, Transverse section of *Plasmopora scita*, E. and H., from the Wenlock Limestone of Gotland, enlarged five times. C, Vertical section of the same specimen, similarly enlarged.

and there is the additional character that the small tubes are more irregular, and proportionately much larger than in *P. petaliformis.*

A microscopic examination, again, of *Plasmopora scita*, E. and H., shows that the large corallites (fig. 8, B) are circular or oval in shape, about 1-20th inch in diameter, and separated by intervals of from 1-30th to 1-60th inch. The large tubes, further, have well-developed crenulated walls, with twelve rows of strong septal spines, which have a marked upward direction, and extend to near the centre of the visceral chamber. The small corallites have imperfect walls, and form

irregular angular cells between the large tubes. The tabulæ of the large tubes (fig. 8, C) are complete and horizontal, while those of the small tubes are convex and commonly anastomose with one another, though this anastomosis does not take place to the extent of completely obliterating the walls of the small corallites. Upon the whole, *P. scita*, E. and H., is at once separated from *P. Girvanensis*, nobis, by the much smaller size of the large corallites.

Plasmopora follis, E. and H., and *P. micropora*, Goldf., are unknown to us, so far as microscopical examination goes; but the small size of the large corallites in both species is sufficient, of itself, to distinguish them from *P. Girvanensis*. The *Heliolites affinis* of Billings, from the Lower Silurian of Anticosti, is stated (Cat. Foss. Anticosti, p. 5, fig. 12) to have a vesicular "cœnenchyma;" and Lindström is therefore probably correct (Förteckning på svenska undersiluriska koraller; Öfversigt af Kongl. Vetenskaps-Akad. Förhandl., 1873) when he refers it to the genus *Plasmopora*. It is, however, sufficiently distinguished from the species now under consideration by the fact that the large corallites are mostly only about two-thirds of a line in diameter, and are "in contact with one another or barely separate" (Billings). Lindström is also probably correct (*loc. cit.*) in referring the *Propora conferta* of Edwards and Haime (Pol. Foss. des Terr. Pal., p. 225) to the genus *Plasmopora;* but this form, likewise, is readily distinguished from *P. Girvanensis* by the smaller size of the large corallites, and their much closer approximation to one another.

A closer resemblance, on the other hand, exists between *Plasmopora Girvanensis*, nobis, and the *Lyellia Americana*, E. and H. (? *Heliolites macrostylus*, Hall), of the Upper Silurian of North America. The few specimens, however, which we possess of this latter form are so highly silicified as to render it impossible to make out their minute structure; and we are therefore unable to say how far the general external likeness between these two forms may, or may not, be founded upon a real agreement in their internal conformation.

Loc. and Horizon. — In the Upper Silurian mudstone of Woodland Point, near Girvan. Also in the mudstones of Penkill, near Girvan. (Gray Collection.)

Plasmopora exserta, Nich. and Eth. jun.

(Pl. XVII., figs. 4, 4 *a*.)

Spec. char.—Corallum in the only specimen examined, forming a thin circular expansion with a convex upper surface, about three inches in diameter, and about one-third of an inch in thickness; its under surface being unknown. The large tubes are circular, with crenulated walls, and markedly exsert calices, about 1-33d inch in diameter (rather over one-third of a line), and separated by intervals of from 1-15th to 1-30th inch. They are furnished with well-developed spiniform septa, arranged in twelve rows, having an upward direction, and extending a considerable distance inwards. The small corallites are irregularly polygonal in shape, often with imperfect walls, allowing of lateral communication, and mostly only in two rows between any given pair of large tubes. In long sections (Pl. XVII., fig. 4 *a*) the tabulæ of the large corallites are seen to be horizontal, from 1-30th to 1-20th inch apart; while the small tubes have their walls largely obsolete, their tabulæ being convex, and uniting with one another to give rise to a tissue of variably-sized lenticular vesicles.

Obs.—Though this species is properly an extra-limital one, we have introduced a short description of it here, in consequence of its exhibiting a curious union of the characters of *Plasmopora* proper and *Propora.* A mere external examination of its surface would have certainly led us to refer it to *Propora*, as it possesses conspicuously exsert calices to the larger tubes. On the other hand, an investigation of its internal structure shows that it possesses the strongly crenulated walls to the larger tubes and the well-developed septa of *Plasmopora;* while

the walls of the smaller corallites are never so completely obliterated by the anastomosis of the tabulæ as is the case in *Propora*; so that we have little hesitation in referring it to the former genus.

In whatever genus it be placed, however, its specific distinctness seems to be sufficiently established by its minute structure; and the only two forms which it need be compared with are *Plasmopora scita*, E. and H., and *P. follis*, E. and H. Both of the forms just mentioned have the calices of the larger tubes flush with the general surface, and both possess a pyriform or spheroidal corallum; while in both the large corallites are of a decidedly greater size than is the case in the present species. These characters appear to be constant, and they are sufficient to separate these forms of *Plasmopora* from the species now under consideration. Upon the supposition that it really belonged to *Propora*, the present species would be most nearly related to *P. Edwardsii*, nobis, to be subsequently described; but the latter differs materially in the proportions of its corallites, while the corallum is pyriform, and the tabulæ of the small tubes are so completely vesicular as to obliterate the walls, the septa being at the same time obsolete.

Loc. and Horizon.—In the Wenlock Limestone of Dudley. (*Coll.*, H. A. Nicholson.)

Genus PROPORA, Edw. and Haime, 1849.

(Comptes Rendus, xxix. p. 262.)

Propora Edwardsii, Nich. and Eth. jun.

(Pl. XVII., figs. 3-3 *b*.)

Spec. char.—Corallum pyriform or subglobular, an average specimen being about an inch in height and an inch and a half in greatest width. Upper surface convex or flat. Large corallites about 1-20th inch in diameter, circular, their calices very slightly exsert, separated by intervals of from 1-70th to 1-25th

inch, but mostly about 1-60th inch apart. The walls of the large corallites are not crenulated, and the septa are entirely obsolete; while the visceral chamber is crossed by deeply-concave complete tabulæ, placed at about 1-80th inch apart. The small corallites are mostly in a single row (rarely in a double row here and there) between the large tubes, and are irregular in shape and size, though mostly distinctly angular. The tabulæ of the small tubes are convex or nearly straight, often uniting with one another to give rise to a vesicular tissue of lenticular cells, which largely or entirely obliterates the walls of the tubes.

Obs.—That the present species is properly referred to *Propora*, as here restricted, is placed beyond a doubt by the proportionate reduction of the small corallites and their angular form, by the circular non-crenulated large corallites, and by the total absence of the septa. It is nearly allied, in its general form and structure, to the well-known *P. tubulata*, Lonsd.; but the latter (Pl. XVII., fig. 5) differs materially from *P. Edwardsii* in the proportions of its corallites, the large tubes being mostly about three-fourths of a line in diameter, while they are separated by intervals of from 1-100th to 1-70th inch. The large corallites of *P. Edwardsii* are thus decidedly smaller than in *P. tubulata*, and, at the same time, proportionately more distant. Moreover, the tabulæ of the large tubes of *P. Edwardsii* are deeply and uniformly concave; while those of the small tubes, though commonly vesicular, are sometimes horizontal, and leave the walls of the interstitial corallites unaffected, single specimens showing both these conditions in different parts.

We have named this species in honour of M. Milne-Edwards, to whose labours amongst the living and fossil corals palæontologists are so greatly indebted.

Loc. and Horizon.—In the Upper Silurian mudstones of Woodland Point, Girvan. (Gray Collection.)

Genus PINACOPORA, N. and E.

(See *Fasciculus I.* p. 52.)

Pinacopora Andersoni, Nich. and Eth. jun.

(Pl. XVII., fig. 6, and Pl. XVIII., figs. 1-1 *e*.)

Spec. char.—Corallum free, discoid, coin-shaped, with a convex upper and concave lower surface, the former carrying the calices, while the latter is covered by a concentrically striated epitheca. Large specimens have a diameter of over two inches, with a thickness centrally of three lines, while young examples are only six or seven lines in diameter, with a thickness in the centre of a line or more. The large corallites are arranged in regular diagonal lines, being about 1-18th inch in diameter, and separated by intervals of about 1-25th of an inch. Their walls are faintly crenulated, and there are rudimentary septa, while the visceral cavity is crossed by complete horizontal tabulæ, placed at about 1-40th inch apart. The tabulæ cease to be developed in the upper part of the tubes, so as to leave proportionately deep calices. The small corallites are angular, a single row existing between any given pair of the larger tubes, and they are tabulate up to close to their mouths, and therefore to a higher level than is the case in the large tubes. The tabulæ are numerous, sometimes horizontal, but at other times convex, and anastomosing so as to give rise to a vesicular tissue of lenticular cells.

Obs.—The present species is very nearly allied to the form which we described from the Mulloch beds near Girvan (Mon. Sil. Foss., Girvan, Fasc. I., p. 54) under the name of *P. Grayi*, of which it may ultimately prove to be only a well-marked variety. It agrees with *P. Grayi* entirely in the form of the corallum, in its general aspect, and in the arrangement and relations of the corallites. It attains, however, a much greater size, and a greater proportionate thickness, specimens of *P. Grayi* having only a thickness of about one line at a diameter of sixteen

lines, whereas the same thickness is reached in *P. Andersoni* at a diameter of six lines, and fully grown specimens of the latter may have a thickness of three lines or more. There is, further, a constant difference in the tabulation of the two forms, to which we feel constrained, in the meanwhile, to attach a specific value. In both forms alike, there is the peculiar feature that the smaller tubes are tabulate to a much higher level (*i. e.*, to a point much nearer the surface) than is the case with the large tubes; but with this agreement their tabulation is otherwise importantly different. Thus, in *P. Grayi* the large corallites are so short that there is only room below the deep calice for one, two, or three tabulæ; while the tabulæ in the small tubes, though more numerous, are always complete, and approximately horizontal. On the other hand, in *P. Andersoni* the length of the large corallites is sufficient to allow of the development of a considerable number of tabulæ; while the tabulæ of the smaller tubes, though sometimes horizontal, are generally convex, and anastomose to form as regular and complete a vesicular tissue as is seen in corresponding parts of the corallum in the species of *Propora* or *Plasmopora.* These differences in the form and disposition of the tabulæ will be at once evident by comparing Pl. III., figs. 3 *i*, 3 *e*, with Pl. XVIII., figs. 3 *d* and 3 *e;* and, as before said, they seem to be constant, and to be of specific value.

We have named the present species after the late Mr Thomas Anderson of Girvan, who was well known to Scotch geologists as having made extensive collections of the fossils of the Girvan area.

Loc. and Horizon.—Not uncommon in the Upper Silurian mudstones of Woodland Point, near Girvan. (Gray Collection.)

Genus Halysites, Fischer, 1813.

(Zoognosia, 3d ed., t. i. p. 387.)

Catenipora, Lamarck, Hist. des An. sans Vert., t. ii. p. 205, 1816.

Gen. char.—Corallum fasciculate and reticulate, composed of long tubular cylindrical corallites, which are placed side by side in intersecting and anastomosing laminæ or lines, any given corallite being united with its neighbours to the right and left along its whole length, and each lamina of the corallum consisting of no more than a single linear series of tubes. Each tube is enclosed in a strong imperforate wall, surrounded on its free sides by a thick epitheca; and there may be a distinct division of the corallites into two series of different sizes, in which case a single small tube is placed between each pair of the larger tubes. In other cases all the tubes are similar in size and structure. Septa may be wanting, and, when present, have the form of vertically disposed rows of spines, in cycles of twelve. The tabulæ are complete, horizontal, or slightly concave, not vesicular, the smaller corallites (when present) being much more closely tabulate than the larger ones.

Obs.—The general confirmation and external characters of the corallum in the genus *Halysites* are so closely similar in all the known forms of this type, that the determination of the different species is a matter of extreme difficulty. Hence some high authorities have admitted only one or two species; while others (such as Fischer and Eichwald) have considered quite a large number of forms to be so far distinct as to deserve separate specific names. In almost all cases, however, the older observers have based their determinations of the species of this genus upon such obvious external characters as the size of the individual corallites, or the dimensions of the meshes of the network formed by the anastomosis of the laminæ of the corallum; and it cannot be denied that these, in the nature of things, must be to a greater or less extent variable and uncer-

tain characters, and characters especially liable to vary with age. On the other hand, it has been shown that there are in some cases important structural differences between different specimens of *Halysites* which at first sight appear to be the same, these differences affecting in the first place the condition of the septa, and, in the second place, the comparative size of the corallites of any given individual, and the development or non-development of a special series of small corallites. Thus, in some forms (such as the typical examples of *H. escharoides*, Lam., fig. 9 A) there exists a well-developed series of spiniform septa, arranged in twelve cycles; whereas such septa are wanting in other types (such as the typical examples of *H. catenularia*, Linn., fig. 9 B). Again, in some forms, such

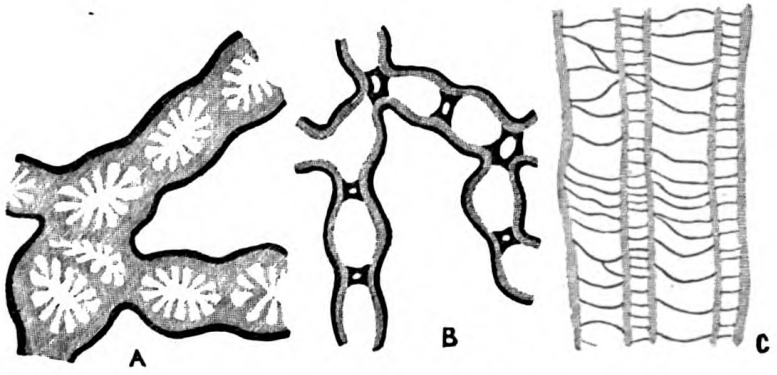


Fig. 9.—A, Transverse section of *Halysites escharoides*, Lam., from the Upper Silurian of Gotland, enlarged ten times, showing the spiniform septa, and the absence of a series of small corallites. B, Transverse section of *Halysites catenularia*, Linn., from the Wenlock Limestone of Dudley, enlarged five times, showing the absence of septa, and the presence of a series of small corallites. C, Vertical section of a few corallites of the last specimen, enlarged five times, showing the large and small corallites, and the difference in the tabulation of these.

as the typical *H. catenularia* of the Upper Silurian, there is the very important feature that there exists a special series of small corallites, which are more closely tabulate than the large tubes, and one of which is intercalated between each pair of the normal corallites (fig. 9, B and C). Other specimens, however, which in general appearance are not distinguishable from *H. catenularia*, do not exhibit upon minute examination these small corallites; while this series of tubes appears to

be also wanting uniformly in all specimens of the type of *H. escharoides*, Lam.

Taking the above almost inexplicable differences into consideration, we hardly think that it is at present possible to define with certainty the different species of the genus *Halysites*. A very vast mass of material will have to be submitted to microscopic examination before it will be possible for the observer to assert positively whether the above-mentioned important structural differences are *constant, and of specific value*, or whether they are not merely due to individual variation, or referable to other causes, such as the influence of sex, the temporary condition of the corallum as to the production of ova, or the actual dimorphism or polymorphism of the species. At any rate, it is clear that any attempt to finally determine the limits of any of the species of *Halysites* would be futile unless it were prefaced by an examination into the minute structure of the numerous forms of the genus which have been described under separate names by Fischer, Eichwald, and other palæontologists. In the absence of such an examination, it is useless to speculate as to how far differences in the size of the corallites or in the dimensions of the meshes of the corallum are associated with constant peculiarities in such important matters as the development of septal spines or the presence of a special series of small tubes; and it is therefore useless to attempt to define the species of the genus. Under these circumstances, we shall content ourselves with giving a description of the internal structure and general characters of three forms of *Halysites* which we have met with in the Girvan area, without referring these definitely to any previously named species, while at the same time noting the occurrence of what appears to be the normal form of *H. catenularia*, Linn.

Halysites catenularia, Linn.

Tubipora catenularia, Linné, Syst. Nat., ed. xii., p. 1270, 1767.
„ *catenulata*, Gmelin, Linné, Syst. Nat., ed. xiii., p. 3753, 1789.

[For the reasons above given, it is impossible to give any synonymy of this species which would be of any real value. We may say, however, that in the synonymy given in a previous portion of this work (Fasc. I., p. 49), we have united *H. escharoides*, Lam., with *H. catenularia*, Linn., but that we are now disposed to regard these forms as being specifically distinct; though a more extensive examination will be required before it will be possible to speak positively as to the relations between these forms.]

Obs.—In attempting to elucidate the real characters of this species we have, of course, been compelled to choose some form which we can reasonably suppose to be identical with the Linnean type; and we have selected the well-known Chain-coral of the Wenlock Limestone of Dudley, which palæontologists have always recognised as *H. catenularia.* This form, as previously shown by one of us (Pal. Tab. Corals, p. 228), is peculiar in apparently being constantly devoid of septal spines, and also in the fact that there exists a series of specially modified small corallites. One of these small tubes (fig. 9, B and C) is placed between every pair of the normal corallites, and not only is their size different, but they possess much more closely set tabulæ than is the case in the larger tubes. Milne-Edwards and Haime describe septal spines as present; but we have not been able to detect these in any of the thin sections we have prepared. The large corallites are oval, from about 1-20th to 1-15th inch in their long diameter; the small corallites are subquadrate, and about 1-60th inch in diameter. The tabulæ in both sets of corallites are complete, and mostly do not anastomose to any degree. The meshes formed of the laminæ of the corallum are mostly irregular and sinuous in outline, elongated, with a long diameter of from a quarter of an inch to an inch, and mostly having from three to six of the larger tubes in any one of the sides of the mesh.

Accepting the above as the principal characters of the Dud-

ley specimens of *H. catenularia*, Linn., we find among the many examples of this genus recently collected by Mrs Gray from the Upper Silurian rocks of Girvan, a few specimens which possess precisely similar features, and which we, therefore, refer to the same species. They agree, at any rate, with the Dudley examples not only in the size of the large corallites, and the general conformation of the corallum, but also in the much more important points that there appear to be no septa, while there is a well-developed series of small corallites separating the larger ones.

Form. and Loc.—Woodland Point, Girvan (in mudstones of Upper Silurian age). (Gray Collection.)

Halysites, sp.

(Pl. XVIII., fig. 2.)

Obs. — Among the specimens from the above-mentioned locality, we have various other examples, which resemble the Dudley form of *H. catenularia* in general characters, and especially in such superficial points as the size of the corallites and of the meshes of the corallum, but which differ in their internal structure to an important extent. The ordinary corallites are oval, with a long diameter in general of from 1-15th to 1-12th inch, thus rather exceeding in size the corallites of the Dudley form; and, as in the latter, no traces of septal spines can be detected. There is, however, the singular and important difference that in the examples now under consideration (Pl. XVIII., fig. 2) we find no indication whatever of the existence of a series of small corallites. On the contrary, the large tubes are placed directly against one another, without the intervention of any small tubes. The longitudinal section, therefore, simply exhibits the large, uniformly tabulate corallites.

How far the difference here noted can be regarded as of specific value, or to what extent it is possible that we have to deal simply with a difference due to dimorphism of a single species, is a question which we have no data to decide. Of

the reality of this difference there can be no doubt; and it seems impossible, in the meanwhile, to unite under the same specific name two forms presenting such a fundamental difference in their internal structure, however close their agreement may be in general form.

Form. and Loc.—Not uncommon in the Upper Silurian mudstones of Woodland Point, Girvan. (Gray Collection.)

Halysites, sp.

(Pl. XVIII., figs. 3, 3 *a*).

Obs.—Another form of *Halysites* which is very abundant at the locality just noted is very similar in its general configuration to *H. escharoides*, Lam., as usually understood. We have examined microscopically what we may regard as typical examples of *H. escharoides*, Lam., from the Wenlock Limestone of Gotland, and we find this type to be characterised by the possession of corallites of a single kind, interstitial small tubes being always absent; while there exists in all cases a well-developed system of spiniform septa, arranged in twelve vertical rows (fig. 9, A). The corallites are oval, and about 1-24th or 1-25th inch in their long diameter; and the meshes, which are formed by the laminæ of the corallum, are small (from one-fifth to one-third or more of an inch in long diameter), and have their sides formed of two, three, four, or five corallites.

The Girvan specimens, which have a general resemblance to the above, possess small uniformly-sized corallites, arranged in a close network, each side of any given mesh being formed by from one to three, four, or five corallites. There are no small tubes, and there are usually small septal spines, disposed in vertical rows and markedly directed upwards (Pl. XVIII., figs. 3, 3 *a*). In vertical sections (Pl. XVIII., fig. 3 *a*) these spines are cut across above their bases, and often look like so many rows of small pores in the wall. The septa, however, do not reach the same development as is seen in

typical examples of *H. escharoides*, Lam.; while the corallites are decidedly smaller, their long diameter being as a rule from 1-30th to 1-35th inch in length. The corallum has the general form characteristic of the species of *Halysites*, but is apparently usually of comparatively small size. Whether or not the differences above mentioned are sufficient to specifically separate this form from *H. escharoides*, Lam., and whether or not it is identical with any of the numerous species of the genus which have been described by Fischer and others, are questions which we have at present no means of deciding.

Loc. and Horizon.—Not uncommon in the Upper Silurian mudstones of Woodland Point, Girvan. (Gray Collection.)

Halysites, sp.

(Pl. XVIII., fig. 4.)

Obs.—In a fourth form of *Halysites* from the Girvan area, we have another type which in many respects resembles the *H. escharoides* of Lamarck, though it is in other respects peculiar. It resembles typical examples of *H. escharoides* from Gotland in the absence of small corallites, in the excellent development of twelve vertical rows of spiniform septa, and in the thickness of the walls of the corallites, resulting in a corresponding reduction in the calibre of the visceral chambers (Pl. XVIII., fig. 4). On the other hand, it much more closely resembles *H. catenularia*, Linn., in its general proportions, the corallites being from 1-18th to 1-12th inch in their long diameter, and the meshes formed by the laminæ of the corallum being comparatively large and elongated in form. As in the preceding cases, we must leave the specific position of this form at present an open question.

Loc. and Horizon.—In the cement-stones of Shalloch Mill, near Girvan. (*Coll.*, Charles Lapworth.) This form was noted, but not described or figured, in the First Fasciculus of this work, p. 49, under the name of *H. catenularia*, Linn.

Genus FAVOSITES, Lamarck.

(See *Fasciculus I.* p. 34.)

Favosites Mullochensis, Nich. and Eth. jun.

(Pl. XVIII., figs. 5-5 *b*.)

Favosites Mullochensis, Nich. and Eth. jun. Mon. Sil. Foss. Girvan, Fasc. I. p. 36, Pl. II., figs. 2-2 *b*, 1878.

Spec. char.—Corallum pyriform or more commonly spheroidal in shape, mostly from half an inch to an inch in diameter, but sometimes attaining a diameter of over three inches by a height of more than two inches. Corallites prismatic, often pentagonal, mostly with gently rounded angles, and with thin, often wavy, walls. The majority of the tubes are of large size, from half a line to about a line in diameter, but there always exist very much smaller corallites placed at the angles of junction of the larger tubes. Mural pores large, placed close to the angle formed by any two of the prismatic faces of the tubes, these angles being sharply undulated. Septa wanting. Tabulæ few, delicate, remote, from half a line to a line apart, often represented by short spines or laminæ springing from the undulated walls of the tubes.

Obs.—This species was originally described by us from a small number of examples from the Upper Silurian of Mulloch Hill, near Girvan (*loc. cit.*) Since that time Mrs Gray has obtained a very large number of specimens from the Upper Silurian mudstones of Woodland Point, Girvan; and we are therefore able not only to confirm our previously expressed opinion as to the specific distinctness of this form, but also to give some important additional information as to its internal structure. All our fresh specimens, both small and large, exhibit the mixture of small and large tubes, the rounded angles of the corallites, and the wavy walls, with the spiniform condition of many of the tabulæ, which first induced us to separate this form as a distinct species of *Favosites.* Not only do we find that the characters which we originally relied upon in

founding this species are constant; but we find the additional important point, that the mural pores have a position unusual among the species of *Favosites*, and only shared by very few forms. *F. Mullochensis*, in fact, agrees with *F. alveolaris*, Goldf., and *F. aspera*, D'Orb., in having the mural pores placed at, or close to, the angles of the prismatic corallites, instead of being situated, as is usual, on the flat faces of the same. The corallites (Pl. XVIII., fig. 5 *a*) have their walls strongly corrugated by transverse undulations, which are most marked at their angles, and the mural pores are placed close to the latter, and generally so as to alternate on the opposite sides of the line marking the angle. This peculiarity is, of itself, quite sufficient to separate *F. Mullochensis* from all the ordinary species of the genus, except the two forms above mentioned, in which a similar disposition of the mural pores is stated to obtain. Our species is, as a rule at any rate, of much smaller dimensions than either *F. alveolaris*, Goldf., or *F. aspera*, D'Orb., while its corallites are of decidedly smaller size, rarely exceeding three-fourths of a line in diameter. On the other hand, *F. alveolaris* and *F. aspera* are large and massive species of the genus, with a subplane upper surface, while the corallites are from a line and a quarter to a line and a half in diameter. It does not appear, also, that either of the above-mentioned species is distinguished by the same inequality in the size of the tubes as obtains in *F. Mullochensis*, and the form of their corallites is very regularly angular and prismatic. The marginal depressions of the tabulæ, which are stated to occur in *F. alveolaris* and *F. aspera*, and the number of which is supposed by Milne-Edwards and Haime to specifically separate these two forms, cannot be recognised in any of our specimens, though it is quite possible that they really exist. In any case, we cannot regard them as constituting a character of specific value.

Loc. and Horizon.—Abundant in the Upper Silurian mudstones of Woodland Point, Girvan. Also not uncommon in the dark-green Upper Silurian mudstones of Mulloch Hill, Girvan. (Gray Collection.)

SUPPLEMENT TO THE CRUSTACEA.

Order TRILOBITA.

(Continued from *Fasciculus II.* p. 207.)

Genus STAUROCEPHALUS, Barrande.

(See *Fasciculus I.* p. 117.)

Staurocephalus (?) *sp. ind.*

(Pl. XIX., fig. 3.)

Obs.—We can do little more than figure this fragmentary Trilobite, with a view to future identification, adopting the view of our friend Dr H. Woodward, and placing it provisionally in the above genus, with which it appears to have most in common. One of the chief peculiarities of the form appears to lie in the enlargement of the pleural spines after their extension beyond the lateral margins of the thorax. The cheeks are punctate, and each thoracic pleura is ornamented with a row of small but prominent granules.

Loc. and Horizon.—Whitehouse Bay, Ardmillan.

Genus CYCLOPYGE, Hawle and Corda, 1847.

Egle, Barrande, Notice Préliminaire, 1846, p. 34.
Cyclopyge, Hawle and Corda, Prodrom einer Monog. böh. Trilob., 1847, p. 64.
Æglina, Barrande, Syst. Sil. Bohême, 1852, i. p. 663.

Obs.—M. Barrande proposed the name *Egle* for the present group in 1846, apparently overlooking the fact that the term, either as *Egle* or *Ægle*, had already been used no less than four times—viz.,

Ægle, Oken, 1815,	as a genus of	Mollusca;
„ Hübner, 1816,	„	„	Lepidoptera;
Egle, Robineau, 1830,	„	„	Diptera;
Ægle, De Haan, 1835,	„	„	Crustacea;

and once, at least, in Botany.

Hawle and Corda proposed their name in 1847; and as we are unaware that it had been made use of previous to this, it appears to us only reasonable and fair that it should be adopted in place of Barrande's still later name, *Æglina*, which has been usually preferred before Hawle and Corda's.

Cyclopyge rediviva, Barrande.

(Pl. XIX., fig. 4.)

Egle rediviva, Barr., Notice Prélim., 1846, p. 34.
Cyclopyge megacephala, Corda, Prodrom Mon. böhmischen Trilob., 1847, p. 64, t. 4, f. 32.
Æglina rediviva, Barr., Syst. Sil. Bohême, i. p. 665, t. 34, f. 3-13.
„ „ Bigsby, Thes. Siluricus, 1868, p. 35.

Spec. char.—Body subrectangular, rounded at both extremities; trilobation, to any extent, only visible on the thorax. Cephalic shield occupying nearly half the entire length of the body (the other portion being equally divided between the thorax and pygidium), truncated at the posterior margin, no subdivision into glabella and other parts. The grooves of the glabella are reduced to two, being thus represented by two faintly marked, hollow depressions, placed a little in advance of the posterior margin, and directed outwards.

Thorax of four segments; axis flatly convex, defined by strong axal furrows, wider than the side-lobes or pleuræ, attenuated posteriorly. Pleuræ somewhat bent down laterally, increasing in breadth in an inverse ratio to those of the axis—*i.e.*, the first succeeding the shield is the narrowest from side to side, and the last, next the pygidium, the broadest—in other words, the lateral lobes are attenuated towards the anterior instead of towards the posterior end of the body.

Pygidium semicircular, slightly convex; axis convex, of three rapidly attenuated subdivisions, extending backwards scarcely half the length of the whole tail; the two anterior segments are the broadest, the third or terminal one forming a somewhat more prominent body. Two faintly marked grooves are visible

on each of the lateral lobes of the tail, near to its anterior end, the remainder of the pygidium being smooth, devoid of grooves or furrows, and forming a gentle convex expansion. The united axes of the thorax and pygidium may be described as connate.

Obs.—This neat little Trilobite does not correspond with any one of the British species of *Cyclopyge*, but appears to possess in general the characters of *C. rediviva*, Barr. The eyes in our specimen and the lateral margins of the Trilobite are to a great extent hid by matrix, which from its nature does not admit of ready removal. The glabella grooves are only faintly visible, but the other characters are of too marked a nature to admit of much doubt of its identity. A metamorphosis has been shown to exist in *C. rediviva*, by M. Barrande, by which an increase in the number of thoracic somites takes place from four to six, and a corresponding diminution in those of the pygidium as maturity and full growth is approached. The form now described from Girvan corresponds to one of the younger stages found in Bohemia, in which there are four segments of the thorax developed,[1] but with the difference that in the Bohemian specimen the four-segmented thorax is accompanied by three subdivisions on the antero-lateral portions of the pygidium, whilst in the Girvan form the latter are only two in number.

The foregoing description is exclusively taken from the Girvan specimen, and is in no way a complete diagnosis of the species—this will be found in M. Barrande's work.

Loc. and Horizon.—Shore at Whitehouse, near Girvan, in a dark-grey, hackly-fractured, hard, calcareous shale, full of comminuted organic remains of Lower Silurian age. (Gray Collection.)

In Bohemia it is characteristic of the *Étage des Quartzites.* D (Faune seconde.)

As this is an additional locality, only lately collected from by Mrs Gray, and not given in the list of localities at the

[1] Barrande, *loc. cit.*, t. 34, f. 5.

beginning of this 'Monograph,'[1] we may state that it is situated between three and four miles south of Girvan.

Cyclopyge armata, Barrande.

(Pl. XIX., fig. 5-8.)

Æglina armata, Barr., Syst. Sil. Bohême, i., Suppl., p. 59; Suppl., Atlas, t. 3. f. 1-14, t. 15, f. 16-19.
„ „ Bigsby, Thes. Siluricus, 1868, p. 34.

Spec. char. — Glabella prôduced, oval, gently convex, continued anteriorly into a frontal spine; posterior margin straight, more or less truncated; surface bearing two pairs of similar horizontal, or very slightly arched, grooves, or shallow depressions; the more advanced pair are situated at a little less than half-way between the anterior and posterior margins, and nearer to the latter; the second, or posterior pair, lie between the latter and the posterior margin of the shield. Frontal spine in fully grown specimens somewhat elongated, small and tapering to a fine point, round in section; anterior portion of glabella and base of spine ornamented with fine anastomosing raised lines. Eyes of large size, cushion-shaped, uniting in front of and below the glabella to form one continuous convex optical organ. The epistome is of the usual form seen in this genus, ornamented with rather distant, occasionally anastomosing, fine ridges.

Obs.—Amongst the Girvan specimens we have not met with either a perfect head-shield, a thorax, or pygidium, although we do not doubt but that our figures will quite bear out the reference to Barrande's abnormal and peculiar species. We have before us five examples of the glabella; in no case are the eyes actually attached, but are chiefly preserved as fragments lying around and about the glabellæ. In two instances, also, more perfect examples with the epistome attached are present, quite corresponding with Barrande's description and figures, so that there can be little doubt we now possess this

[1] Fascic. I. p. 7.

additional and interesting species in our British rocks. The first identification of *C. armata* in the latter is due to Mrs Gray, who forwarded the specimens to us bearing this name attached to them.

It results from the form of the united eyes, that the epistome will be considerably lowered in position, or placed much further under the head than is usually the case in the other species of *Cyclopyge*, except perhaps in *C. mirabilis*, Forbes, to which it is most nearly allied, and in which the eyes are likewise united; but so far as present researches have gone, this species has not been shown to possess a frontal spine.

The knowledge acquired by M. Barrande of the structure of *Cyclopyge* enables us to subdivide the genus into three well-marked sections, which may at some future date be designated by distinct names. They are :—

a. *Cyclopyge* proper. Forms having the anterior margin of the glabella intact, *i.e.*, not produced into a frontal spine; eyes lateral in position to a greater or less extent, and not united in front; type, *C. rediviva*, Barr.

b. Forms with a similar anterior margin to the glabella; eyes much enlarged, extending forward, and united in front of the head to form one large optical organ; type, *C. mirabilis*, Forbes.

c. Forms with the anterior part of the glabella produced into a frontal spine, and the eyes as in section *b*; type, *C. armata*, Barr.

We shall look forward with much interest to further discoveries of *Cyclopyge* in the Girvan district. A foreshadowing, as it were, of this genus has at present only presented itself.

Loc. and Horizon.—Shore at Whitehouse, near Girvan, in a dark-grey, hackly-fractured, hard, calcareous shale, of Lower Silurian age. (Gray Collection.)

In Bohemia, *C. armata* occurs in the Band D 5, of the *Étage des Quartzites*, D, equivalent to portions of our Lower Llandovery, and Upper Caradoc rocks.

Genus, TRINUCLEUS, Lhwyd.

(See *Fasciculus II.* p. 188.)

Trinucleus Macconochiei, Eth. jun., and Nich.

(Pl. XIX., fig. 9.)

Ampyx (?) Macconochiei, Eth. and Nich. This work, Fasciculus II. p. 183, t. 14, f. 1.

Obs.—After several attempts we have succeeded in obtaining a satisfactory cast in relief of this little Trilobite, which pretty conclusively proves our first impression of its generic affinities to be the correct one. Fig. 9, Pl. XIX., shows this cast in wax. It is unnecessary to redescribe it, as our former diagnosis remains good; we have only to add, as further information, that the constricted base of the glabella, with the deep pit-like furrows below it, taken in conjunction with the previously described features, clearly indicate *Trinucleus* as the proper genus, to which it should be referred. The only portion now wanting is the fringe. The ornamented condition of the head-shield is not abnormal, for it is met with in *T. ornatus*, Sternb.

The full number of thoracic somites in *Trinucleus* is six, but during the metamorphosis this number varies from none to six. In the present instance there are five segments, and we must therefore look upon this as an immature form, contrary to our former opinion, although it is difficult to believe this to be so, when, so far as our researches have at present gone, no other form of *Trinucleus* is met with in the Balcletchie beds.

The last-mentioned fact has determined us in retaining the above name in the meantime, leaving the solution of the difficulty for the future.

Trinucleus, *sp. ind.*

(Pl. XIX., fig. 10.)

Obs.—An additional *Trinucleus* has been found by Mrs Gray, but, unfortunately, in so fragmentary a state, that pre-

cise identification is nearly impossible. The glabella and one cheek are preserved, with a portion of the fringe. The latter, as in many species of *Trinucleus*, is more or less in the same plane with the remainder of the cephalic shield. Presuming this to be its normal condition in this instance, and not in any way due to contortion or displacement, we are at once provided with a very good character by which this fragment may be distinguished from *T. seticornis*, var. *Bucklandi*, to the fringe of which there is some resemblance in the form and arrangement of the perforations. The fringe itself in that species is, as we have before described it, much bent down, and, speaking generally, may be said to be placed at an angle of 85° with the plane of the head.

The glabella and cheek of the form now under description are covered with a well-defined reticulation.

Loc. and Horizon.—Shore at Whitehouse, near Girvan, in a dark-grey to blue, hackly-fractured, calcareous shale, probably of Lower Silurian age. (Gray Collection.)

Genus Dionide, Barrande, 1847.

Dione, Barrande, Notice Préliminaire, 1846, p. 33.
Dionide, „ N. Jahrbuch, 1847, heft. 4, p. 391.
Polytomurus, Corda, Prodrom Mon. böhmischen Trilob., 1847, p. 37.

Obs.—This very interesting genus is represented throughout the Silurian rocks of the world by a limited number of species, according to the enumeration given in Dr Bigsby's 'Thesaurus Siluricus.'[1] Of the four there recorded, only one is British, *D. atra*, Salter. The Silurian rocks of Girvan have yielded altogether five individuals of the genus *Dionide* to Mrs Gray's researches. The fragmentary and disconnected condition of these has caused us much perplexity in the limitation of species. On the one hand, we have before us the chance of combining under one name portions perhaps of two separate species, on the other, the almost equally fatal error of establishing unneces-

[1] P. 50.

sary species. This results from the absence of a sufficient number of specimens of each, by which it might be ascertained how far variation proceeds. As the object of the present work is not the mere coining of specific names, we shall content ourselves with creating only one name for the most perfect of the examples before us, and describing the others simply as indicated species, leaving for future observation the determination of how far the remains are related to one another.

Dionide Lapworthi, Eth. jun., and Nich. (*sp. nov.*)

(Pl. XX., fig. 1.)

Spec. char.—Body elongated, almost roundly wedge-shaped, attenuated posteriorly, dilated in front, its lateral margins appearing to have little convexity. Cephalic shield broadly semicircular, or broadly crescentiform, the convexity of the front margin more or less flattened, with the posterior margin truncate and almost straight. Glabella oval, probably convex, rounded in front, truncated behind, well defined from the remainder of the head-shield by the axal grooves, which indent the latter near the middle of the lateral margins of the glabella. From these indentations proceed oblique forwardly directed furrows; central protuberance of the glabella not visible. Neck-segment indistinctly preserved, but less in width than any of the thoracic somites. Cheeks not defined, but the remainder of the head-shield occupied by the flattened limb, entirely covered with small close non-perforating depressions or pits. The shield on each side of the glabella is crossed diagonally by two ridges or "eye-lines," from the genal angles to the indentations of the axal grooves at the sides of the glabella; each pair of ridges on leaving the genal angles are united, they then separate and diverge from one another, and ultimately again unite close under the glabella. Shield bordered by a strong thickened border, which terminates on each side at the genal angles; genal spines long and tapering, extending as far as the posterior termination of the body, and probably further.

Axis of the thorax slightly convex, tapering, a little less in width than the lateral lobes, well defined by the axal furrows; each ring consists of three more or less separated nodes, a central, and two lateral ones, the last being placed exactly at the outward terminations of the segment. Pleuræ broad, as measured from the anterior to the posterior margins; divided by an obliquely curved groove into two unequal portions, the anterior being the larger, and being punctate like the limb of the head-shield; the pleural grooves obliquely curved from before backwards.

Pygidium very long, attenuating to a more or less blunt point, and consisting of many coalesced rings or segments—sixteen at least, and perhaps more;—possessing all the characters of the thoracic somites, and becoming much deflected backwards as the anterior margin is receded from.

Obs.—The specimen of this remarkable form has undergone pressure in an oblique direction, giving to it the semblance of cleavage, although the absence of any such phenomenon in the matrix renders the latter explanation unlikely. The result of this oblique pressure has, in all probability, been to distort some of the characters, so that our description must, to a certain extent, be accepted as provisional, although we believe it to be correct in the main. One curious result of this oblique pressure has been to unduly expand the lateral portions of the cephalic shield, so that it projects beyond the boundaries of the thoracic segments, giving to the general outline a most peculiar appearance; at any rate, if this is the real condition of this Trilobite, it is a most abnormal one in the group.

It appears to us that, after allowing for this oblique pressure, we have in *D. Lapworthi* a *Dionide* in which the front margin of the head is broadly convex, the posterior margin truncate, and the body much elongated.

The four species of *Dionide* known to us are: *D. formosa*, Barr.,[1] from the Silurian rocks of Bohemia; *D. atra*, Salter,[2]

[1] Syst. Sil. Bohême, i. p. 641, t. 42, f. 24-28.
[2] Mem. Geol. Survey, iii. p. 321, t. 11 *a*, f. 9 and 9 *a*.

the British species; *D. euglypta*, Angelin,[1] from Sweden; and *D.* (?) *perplexa*, described by the late Mr Billings from the Anticosti Island group.[2]

From *D. formosa* our species is distinguished by its much more elongated body, more truncated posterior margin of the head, broader thoracic somites, and weaker genal spines. From *D. euglypta* the same characters will suffice for separation, except that here the general form of the body is more analogous to that of our species, whilst an additional point of departure presents itself in the absence of the cephalic diagonal ridges in Angelin's species, and in its very short spines. The pygidium is much nearer that of *D. Lapworthi* than is that of *D. formosa*. With a figure of *D.* (?) *perplexa* we are not acquainted, but, so far as an opinion can be formed from Billings's description, the two species are distinct.

Unfortunately *D. atra* is known only as a pygidium, and as in the case of *D. euglypta*, this portion of the body approaches that of our species more nearly than does that of *D. formosa*. The proportions taken from Salter's figure will not, however, permit us to include our form in the Welsh species, in the absence of any details of the head.

Our next figure (Pl. XX., fig. 2) represents a small (or portion of a small?) pygidium found in the same bed with *D. Lapworthi*, and possibly identical with it, since the direction and length of the pleural grooves in both specimens coincide; unfortunately, however, the lower portion of the tail of the latter has been injured. Fig. 2 (Pl. XX.) differs no more from the posterior portion of fig. 1, of the same plate, than does the isolated pygidium of *Dionide formosa* given by Barrande,[3] from that of his complete figure[4] of the same species. This pygidium is broader along the line of fracture from its anterior portion, now lost, than is that of *D. Lapworthi* at a corresponding point, measured from its posterior margin, and the axis is certainly narrower. This specimen is one of the debatable

[1] Pal. Suecica, t. 9, f. 6.
[2] Cat. Sil. Foss., Anticosti, p. 67.
[3] *Loc. cit.*, t. 42, f. 25.
[4] Ibid., f. 24.

forms which we must leave for future research to decide upon.

We have much pleasure in naming this species after our friend Mr Charles Lapworth, who has been long engaged in investigating the Silurian rocks of the Girvan area, and who, we believe, found the specimens.

Loc. and Horizon.—Whitehouse Bay, near Girvan, in a thin, dark-coloured, flaggy shale, of Lower Silurian age. (Gray Collection.)

Dionide, *sp. ind.* (*a.*)

Phacops truncato-caudatus, Eth. jun., and Nich. This work, Fasciculus I. p. 99, t. 7, f. 3 and 4 (*non.* Portlock).

Obs.—Misled by certain deceptive appearances, we described this Trilobite, in our First Fasciculus, under the above name. We are indebted to Mr Charles Lapworth for pointing out to us our mistake, and now repair our error.

It is without doubt a well-marked form of *Dionide*, and had the head been more fully preserved we should not have hesitated to apply a specific name to the specimens. Both the nodular axis, and the divided pleuræ are exceedingly well marked, the latter being almost twice the width of the thorax. The punctæ usually seen on the fore half of each pleura in *Dionide* are here replaced by vertical striæ or small ridges.

The pygidium is rather small, and consists of fourteen coalesced segments at least, with almost the same marked characters as are displayed by those of the thorax.

This form probably comes nearer to *Dionide formosa*, Barr., than any other of the Girvan species, although we believe it to be distinct. We hope further material may reach us eventually.

Loc. and Horizon.—Drummuck Quarry, neary Girvan. (Gray Collection.)

Dionide, *sp. ind.* (*b.*)

(Pl. XX., fig. 3.)

Obs.—The portion of a *Dionide* we now figure is, in many points, a very peculiar one. There are in all twenty-two segments preserved, apparently all coalesced, and without any sign of free terminations to the pleuræ. If this appearance is not deceptive, we are here dealing with a much elongated pygidium, and not a combination of coalesced tail-segments with free thoracic rings, in which case the specimen is quite distinct from either of the preceding forms. It appears to be nearest to our *D. Lapworthi*, but if only a pygidium, is much longer than that portion of the latter, and also less in width. The pleural grooves and ornamentation are, however, similar. If this represents a combined thorax and pygidium, in which the free ends of the former have become obliterated, there would then, allowing the six most anterior somites to the thorax, be sixteen in the pygidium, a similar number to that possessed by *D. Lapworthi*, so far as we are able to count them in the somewhat damaged specimen of the latter species. In the elongated form there is a certain resemblance to *D. atra*, Salter,[1] but the relative sizes of the axes, as compared with the pleuræ, differ. It is possible this may be only a condition of our *D. Lapworthi*, but for the present we prefer to keep them separate.

Loc. and Horizon.—Whitehouse Bay, near Girvan, as before. (Gray Collection.)

Dionide (?) *sp. ind.* (*c.*)

(Pl. XX., fig. 4.)

Obs.—This peculiar little tail we refer to *Dionide* with doubt. It consists, as preserved, of six segments and a long terminal appendage to the axis, reaching to the posterior margin. The divisions of the side-lobes are six or eight, and each bears

[1] Mem. Geol. Survey, iii. t. 11[a], f. 9 and 9[a].

an oblique pleural groove, without ornamentation. It has an oblong, or almost square form.

Loc. and Horizon.—Whitehouse Bay, near Girvan, in a thin flaggy shale of Lower Silurian age. (Gray Collection.)

Dionide, *sp. ind.* (*d.*), immature form.

(Pl. XX., fig. 5.)

Spec. char.—Body small, oval. Head-shield semicircular; posterior margin curved, not truncate; glabella indistinctly preserved, reaching almost to the front margin of the shield; lateral portions of shield finely punctate, but without diagonal ridges; shield produced backwards at the angles into genal spines, which reach as far behind as the commencement of the pygidium. Thorax of four segments; axis narrow in proportion to the width of the pleuræ, nodular as usual; pleuræ distinctly divided by the groove, and with faint traces of ornamentation on the fore part of each. Pygidium semicircular, consisting of nine thoracic and eight pleural coalesced segments, coinciding more or less in character with those of the thorax.

Obs.—M. Barrande has shown that *Dionide*, amongst other genera, underwent a metamorphosis. He gives a figure of the young condition of *D. formosa*,[1] with four free thoracic somites and eight or nine coalesced pygidium segments, possessing in every respect a very close resemblance to the little fossil now under description. The latter, however, appears to be proportionately longer in all its parts, and the cephalic spines extend backwards only to the pygidium, although it is a question if they have not been shortened by fracture, instead of being extended beyond the body as in the former case. It is impossible, in the absence of intermediate examples, to indicate in what relation this little *Dionide* stands to any of the foregoing described forms. The four-segmented thorax shows it

[1] Syst. Sil. Bohême, i., Suppl., t. 1, f. 18 *a* and *b*.

to be an immature specimen, and we must in consequence withhold an opinion on its identity for the present.

Loc. and Horizon.—Whitehouse Bay, in a dark flaggy shale of Lower Silurian age. (Gray Collection.)

It will perhaps be better to at once refer to some further remains of Trilobites, which appear to be referable to *Dionide*, rather than to describe these as merely indicated species. This is the more necessary on account of the difference which has been shown to exist by M. Barrande between the young and mature conditions of the type-species, *D. formosa*.

In fig. 2, Pl. XX., is represented a small pygidium having the many-segmented axis of *Dionide*, and with the divided and bent-down terminal pleuræ of that genus; the ornamentation is not preserved. It is possible this may be the tail only of the foregoing species, under a somewhat different aspect of pressure, but as preserved, it is in proportion much broader than that of *D. Lapworthi*, much less in length from before backwards (if wholly preserved), and apparently with a narrower axis. M. Barrande, however, gives two forms of tail to *Dionide formosa*, one[1] with the longer axis from before backwards, the other with the distance between the lateral margins representing the longer axis.[2] Fig. 2, Pl. XX., may be simply the latter condition of our *D. Lapworthi*. We leave its exact identification an open question for the present.

Loc.—Whitehouse Bay.

Genus AGNOSTUS, Brongniart, 1822.

(See *Fasciculus II.* p. 200.)

Agnostus perrugatus, Barrande?

(Pl. XX., figs. 6-7.)

A. perrugatus, Barr., Syst. Sil. Bohême, i., Suppl., p. 143, t. 14, f. 14-16.

Spec. char.—Head-shield more or less trapeziform, the long base corresponding to the front margin, concentric limb en-

[1] Syst. Sil. Bohême, i., Atlas, pl. 42, f. 24. [2] *Loc. cit.*, f. 15.

larging towards the front. Glabella a little less than half the length of the entire head, and about one-third of its breadth. The axal grooves are plain and well defined, subparallel, or inclined to be slightly concave about the middle of the glabella, but at the base curving outwards, and, with the assistance of two additional grooves curving inwards, cutting off two small basal, triangular glabella-lobes. The fore part of the glabella is subdivided by two transverse, somewhat arched grooves into three unequal lobes. The frontal, or most anterior of the lobes, is rounded towards its fore part, and is the second in point of size; the median and smallest lobe corresponds in form to the bounding grooves; whilst the third and largest lobe is gradually attenuated towards the posterior margin of the glabella, by the cutting off of the small lateral triangular lobes. The cheek-margin gradually widens towards the front of the head, and is bounded by the limb; it is ornamented, both in front and on the sides, by subregular, strong, radiating, and bifurcating ridges.

Thoracic rings not preserved.

The pygidium generally resembles the head-shield in form. It is, however, a little longer, and may be said to be generally rectangular, enlarging towards the posterior margin. The axis consists of three principal lobes, defined by two transverse grooves, in conjunction with the axal furrows, which are well marked; the two anterior lobes are of about the same size, and less than the last lobe, which is rounded on its posterior margin; (the two anterior lobes are subdivided by a vertical or longitudinal prominent tubercle, approximating to the anterior margin of the tail.) Tail-margin enlarging towards the rear, and ornamented in a similar manner to the cheek-margin of the head-shield; (limb smooth, enlarging posteriorly, and terminating at the angles in short spines).

Obs.—A lengthened search through the literature of the genus *Agnostus* has not brought under our notice a more fitting resting-place for the present remains than Barrande's *A. perrugatus*. At any rate, our form is so close to this, that

we should not be warranted in establishing for it a new name, with the limited material now before us. The characters in our description which are inserted in brackets, show those points not observed with certainty in the Girvan specimens, but which are given by M. Barrande as distinctive of his species. As regards the limb surrounding the cheek- and tail-margins, we believe this to be simply hid by irremovable matrix in our specimens; and as to the tubercle on the axis of the pygidium, it is a question if the remains of this are not actually present. On the whole, therefore, we regard our determination as open to little doubt, the only valid departure we can point out between the Bohemian and Scotch examples being the somewhat coarser radiating ridges of the cheek- and tail- margins in the latter. M. Barrande has already shown the relation of *A. perrugatus* to *A. exsculptus*, Angelin,[1] and *A. Moorei*, Salter.[2]

Agnostus princeps, Salter,[3] has light radiations on the margin, but nothing to be compared with the present species; and in addition, the divisions of the glabella and tail are different from those of the latter. *A. Americanus*, Billings,[4] possesses irregular, radiating, rugose striæ on its fringes; but here, again, the subdivisions of the glabella and tail-axis are dissimilar to those of our species. In the following Trilobites the fringes are highly reticulate or punctate, but not in the least marked with radiating ridges—viz., *Agnostus aculeatus*, Angelin;[5] *A. punctuosus*, Angelin;[6] and *A. nodosus*, Belt.[7]

In the absence of the limb-spines, and the doubtful presence of the axis-tubercle, we regard fig. 7, Pl. XX., as the pygidium, rather than glabella, similar to fig. 6, on account of its greater relative length, and absence of any basal lobes like those of the latter illustration.

[1] Pal. Suecica, 1854, p. 7, t. 6, f. 8.
[2] Quart. Jour. Geol. Soc., xxii. p. 486, figs. *a* and *b*.
[3] M. G. S. Dec., xi. t. 1, f. 1-5.
[4] Pal. Foss. Canada, p. 396, f. 372, *a* and *b*.
[5] *Loc. cit.*, p. 8, t. 6, f. 12.
[6] Ibid., p. 8, t. 6, f. 11.
[7] Geol. Mag., iv. p. 295, t. 12, f. 3, *a* and *b*.

Loc. and Horizon.—Shore at Whitehouse, near Girvan, in a dark-grey to blue, hard, hackly-fractured, calcareous shale, of Lower Silurian age. (Gray Collection.)

In Bohemia *A. perrugatus* is found in the schists of Band D 1, the equivalent of our Lower Llandeilo, or Arenig rocks.

Sub-class CIRRIPEDIA.

Order THORACICA (*Continued*).

(See *Fasciculus II.* p. 213.)

Genus TURRILEPAS, H. Woodward.

(See *Fasciculus II.* p. 213.)

Obs.—Additional evidence of the occurrence of this genus in the Girvan rocks has been obtained since the publication of our last Fasciculus, which renders it necessary that we should return to the study of it.

The arrangement of the plates in *Turrilepas* has been studied and explained by M. Barrande and Dr H. Woodward. Through their researches we learn that the plates are disposed in numerous regular and parallel vertical series round an imaginary axis, with the acute or pointed end of the various plates directed to a greater or less degree towards the summit or aperture of the organism, in such a manner that their longer axes are, to all intents and purposes, parallel with the longer axis of the body. The number of these rows is variable, but they are so disposed that in contiguous series the plates are alternate in position, and partially cover one another laterally. In addition to this, the plates of each series are strongly imbricate from below upwards, and resemble one another in form.

Each series appears to be composed of plates differing in outline from those bordering it; at any rate this holds good so far as the structure of *Turrilepas* is at present known. Dr Woodward has shown that in *T. Wrightii* there are certainly four series, of different forms to one another—an elongated,

kite-shaped series on each side of the organism, with two central rows of more expanded, inequilateral, and dissimilar plates.[1] Similarly, M. Barrande remarks that the longer (or more kite-shaped plates) form the series near the borders of the organism, whilst the shorter (or broader) plates are arranged near the middle of the test.

Opinions appear to differ somewhat as to the analogy of the parts in *Turrilepas*, although both Woodward and Barrande agree in considering the whole organism as allied to *Loricula*. The former[2] clearly believes the at present known remains of *Turrilepas* to represent the peduncle of *Loricula*, as defined and understood by Dr Darwin; on the other hand, M. Barrande considers it to follow from this, if we adopt Dr Woodward's views, that we are not yet acquainted with the opercular valves forming the capitulum of *Turrilepas*, but that the plates at present known to form the body of *T. Wrightii* represent simply the peduncle. It must, however, be borne in mind that M. Barrande has pointed out the existence of another form of valve, termed by him the "cancellated plate" (*valve fénestrée*), and of which the precise position and use in the economy of *Turrilepas* are not at present understood. It will be in the remembrance of our readers that we have shown the existence of a similar plate both in the Silurian rocks of Girvan and the Pentland Hills, associated with the other remains of this genus.

Speaking broadly, there is a rough kind of bilateral symmetry in the manner in which the pointed, or "kite-shaped," plates are arranged on the opposite sides of *Turrilepas*. This is seen in the largest and best preserved of Barrande's specimens,[3] as well as in Woodward's figure;[4] and both agree, also, in the position of these plates, with their longer axes almost parallel with that of the body. A better illustration of this bilateral symmetry, if it may be so called, is seen in one of Mrs Gray's examples from Girvan. Unfortunately, as in the case of many other specimens exhibiting important details, the one now in question

[1] Quart. Jour. Geol. Soc., xxi. p. 488, t. 14, f. 1 *h*, 1 *l*.
[2] Ibid., 488.
[3] *Loc. cit.*, t. 20, f. 1.
[4] *Op. cit.*, t. 14, f.

is only a fragment. Still there are visible two rows, or series, of broadly V-shaped scales in the central line, having on each side a series of the elongated, or kite-shaped plates, but with this difference, that the latter instead of being parallel with the longer axis of the specimen, are placed more or less at right angles to it, with a slight curve upwards. Three other specimens, a good deal compressed, but all more or less entire, show this in a less marked degree, but still sufficiently to attract attention when compared with *T. Wrightii.*

Again, the more perfect specimens figured by M. Barrande exhibit a strange angularity, or crestiform appearance along the middle line of the individual, which, though now partially crushed, must have had some relation to the original form of the animal. Curiously enough, there is in one of the most perfect specimens from Girvan a similar well-marked ridge.

Although the remains collected by Mrs Gray differ a little in the size of the plates amongst themselves, we are unable to look upon them as other than those of a single species, most undoubtedly distinct from *T. Wrightii*, de Kon., sp., and equally so from our *T. Scotica*, but allied to one of Barrande's forms, although, so far as we can make out, dissimilar to this last in many points. We propose to describe this under the name of *T. Peachii.*

Turrilepas Peachii, Eth. and Nich. (*sp. nov.*)

(Pl. XX., figs. 8-10.)

Spec. char.—Body elongated, of the usual form met with in the genus, having on one side at least a central longitudinal keel or carinal ridge, on each side of which the larger kite-shaped plates are bilaterally arranged, more or less at right angles to it in the lower part of the organism, but becoming, *apparently*, more and more parallel with it towards the apex of the body. Component plates or scales of two orders (so far as preserved), the large, elongated, curved, kite-shaped plates, and

the broad, short, more or less arched plates, with a senicated lower margin. The former occupy the sides of the body, and are at right angles to the longer axis as before described, with a strong narrow median keel, and ornamented with broad, flat, and somewhat distant, imbricating lamellæ, which pass over the keel, and become crowded together, and deflected rapidly towards the apex of the plates on the most convex margins of the latter; the apex of these plates is simply bluntly-pointed. The arched plates are not distinctly visible, but their ornamentation is similar to the kite-shaped ones.

Obs.—We much regret that the fragmentary state of our specimens does not permit us to give more particulars of this interesting form. No comparison with the Dudley species is required, as they are at once seen to be distinct. The kite-shaped plates of *T. Peachii* appear to be less curved than those of *T. Scotica*, nobis, and we have not been able to detect any trace of the finely-drawn-out needle-shaped superior extremity of the plates of that species. Again, the ornamentation is quite different in both forms. In *T. Scotica* the concentric ridges are exceedingly fine, numerous, and close set; on the other hand, those of the present species, as above described, are coarse and strong, wide apart, and with the imbricating character well displayed.

From *T.* (*Plumulites*) *Bohemicus*, Barr.,[1] which our species resembles in size, the latter may be distinguished by the much stronger and narrower longitudinal ridge of the larger plates, and the nature of the imbricating laminæ. It approaches nearest, apparently, to *T. regius*, Barr.,[2] but the form and ornamentation will again act as distinguishing marks.

We have much pleasure in naming this in honour of our friend Mr B. N. Peach, of the Geological Survey of Scotland.

Loc. and Horizon.—Whitehouse Bay, in a similar bed to the species above described. (Gray Collection.)

[1] Syst. Sil. Boh., i., Suppl. Atlas, t. 20, f. 1 *a* and *b*. [2] Ibid., t. 20, f. 6 and 7.

Class ANNELIDA.

The class Annelida appears to be represented in the Girvan area to a very limited extent. Only one genus of Tubicola has hitherto been recognised, and we are not in a position to increase the number. Tracks of Worms or Annelid markings —so called—have been found in one or two localities, and will be treated of in succeeding pages.

Genus SERPULITES, Macleay, 1839.

Serpulites, Macleay, Murchison's Sil. Syst., 1839, p. 700.
„ „ Annals Nat. Hist., 1840, iv. p. 387.
„ M'Coy, Brit. Pal. Foss., Fasc. I. 1851, p. 132.
„ Etheridge, jun., Geol. Mag., 1880, dec. 2, vol. vii. p. 304.

Obs.—The structure of this genus has been amply treated of by its author, Professor M'Coy, Mr Salter, and others, and recently more fully by one of the present writers, to whose remarks we would beg to refer those interested.

Serpulites longissimus, Murchison?
(Pl. XX., fig. 12, 13.)

S. longissimus, Murchison, Sil. Syst., 1839, p. 608, t. 5, f. 1.
„ „ M'Coy, Brit. Pal. Foss., Fasc. I. 1851, p. 132.
„ „ Salter, in Murchison's Siluria, 1867, 4th ed., t. 16, f. 1.

Spec. char.—Tube subcompressed, tapering, thin, glossy; thickened margins rod-like, narrow, but well marked; surface here and there wrinkled longitudinally, and crossed by obtuse undulations, somewhat more than their own distance apart, now and then losing their obtuse character, and becoming fine and sharp.

Obs.—We are by no means satisfied that the three specimens before us belong to Murchison's species. Professor M'Coy remarks of the latter, "tapering at the rate of only two lines in five inches." Now, our first specimen, measuring three inches in length, has a continuous breadth of five lines, almost that of the

figured example of *S. longissimus*, and may perhaps be fairly assumed to be that species. Both the other examples taper rapidly, one especially so. The latter, slightly curved, is four inches one line long, with a breadth of four lines at the wider end, and one line at the pointed extremity. The other specimen is three inches in length, likewise curved to some extent, and tapering in nearly the same ratio to that just described, the measurements in this case being five lines at the broadest end, and two at the smallest. Whether *S. longissimus*, Murchison, tapers to so fine an extremity, we are unable to say; certainly we have not met with an example of it, and so far as we are aware, no description yet published appears to comprehend the whole organism. The regular and rapid attenuation of the tube in the second instance above described, very closely resembles that of *Serpulites dispar*, Salter,[1] but this is described as possessing only a width of two lines in its widest part. For the proper determination of these worm-tubes, two things are necessary—a knowledge of the entire organism, and the requisite allowance in giving measurements to be made for compression.

Loc. and Horizon.—Drummuck Burn, in a fine-grained dark mudstone; Penwhapple Glen, in a similar matrix. (Gray Collection.)

THE SO-CALLED WORM-TRACKS OF THE GIRVAN DISTRICT.

We have now to consider a most problematical series of so-called organic remains, by some writers supposed to be the trails of Errant Annelides, or castings of their burrows; by others the tracks of Mollusca; and by some the markings made by Crustacea; while there are not wanting those who have advanced the view that they represent the actual bodies of the worms, now replaced by mud. Lastly, the vegetable origin of some of these enigmatical markings has been advocated from time to time.

[1] M'Coy's Brit. Pal. Foss., p. 132.

Those which will be specially referred to in this portion of our Monograph are known under the names of *Nereites*, *Myrianites*, *Nemertites*, and *Crossopodia;* and in referring to them, we shall freely avail ourselves of some remarks on the subject made by one of us in a recent publication,[1] in addition to other observations mutually made since the former was written.

1. NEREITES (*Macleay*, 1839).—The markings or impressions known under this name are described as of considerable length, consisting of a central axis of nearly equal width throughout, with, on each side, a series of thick, short, lobe-like projections, called feet, and each surmounted by a small marking compared to the segmental foot-tubercles of the Annelida.[2] Two conditions of this form have been described from British Silurian Rocks—*Nereites Cambrensis*, Murchison, and *N. Sedgwickii*, Murchison. The red micaceous flagstones of Penwhapple Glen have yielded a specimen (Pl. XXIII., fig. 1), faintly preserved, which may perhaps be referable to the former. It is, at the best, very indistinct, but appears to be composed of a median linear axis, with lateral protuberances, separated by interspaces, both the former and latter being rather irregular in their outline, although the protuberances show a tendency to the rounded form. In addition to *Nereites Sedgwickii*, this faint impression equally resembles a supposed plant, the *Phyllocorda sinuosa*, Ludwig,[3] and another problematical fossil, *Nereograpsus Jacksoni*, Emmons,[4] which will be referred to hereafter

Loc. and Horizon.—Penwhapple Glen, in red micaceous flagstone. (Gray Collection.)

2. MYRIANITES (*Macleay*, 1839).—The usual definition applied to the markings known under this name is, that the body is curved in long transverse folds or irregular undulations, longer and more slender than in *Nereites*, with indistinct

[1] Manual of Palæontology, 2d edit., 1879, pp. 320-326.
[2] Sil. System, 1839, p. 700; M'Coy, Brit. Pal. Foss., p. 128.
[3] *See* Schimper, Handb. der Pal., 1879, ii. Bd. 1 lief., p. 50.
[4] American Geol., 1855, i. pt. 2, t. 2, f. 2.

"feet," furnished with short "cirri,"[1] or, more properly, "foot-tubercles." In ordinary specimens, all that is seen is the surface of the matrix, marked by winding and tortuous linear impressions or markings, of extremely small comparative width, and easily recognisable from it by their darker colour and slightly different texture. These meandering markings wind over the surface of the stone in indefinite undulations; in one so-called species, *M. tenuis*, M'Coy, often appearing to cross one another—although, in the typical "species," their arrangement is a much more regular one. Prof. M'Coy, in his description of the former, says, "I have only in one part seen traces of the cirri;" but so far as our own observation has gone, we have not observed a trace of any such structure, although a large number of examples have been examined. We have from the Girvan area three kinds of markings or impressions which may perhaps be referred to *Myrianites*. The first of these (Pl. XXIV., fig. 1) consists of a thin raised ridge, or depressed line forming narrow, more or less parallel, concentric loops, spreading over a considerable surface, each loop expanding somewhat towards its lateral extremities. These markings differ from the typical *M. Macleayi*, Murchison, in the expansion of the termination of the loops, the absence of a truly coiled or concentric condition of their arrangement, and the occasional intersection of the markings by one another in their course. The second form resembles the first, in so far that the terminations of the loops (Pl. XXIII., fig. 2) are enlarged; but they differ in their greater regularity, there being a tendency to a much more complete concentric arrangement; while the tracks do not cross one another so far as observed. The third description of marking which would fall under the name *Myrianites* consists of meandering, convoluted, or interlacing little raised runs of great length, at times tremulous in their course, at others firm, enclosing either elongated, but irregular or rounded and oval spaces (Pl. XXIV., fig. 2). This last condition appears to be, without doubt, the *M. tenuis*, M'Coy.

[1] Sil. System, p. 700; M'Coy, Brit. Pal. Foss., p. 129.

Myrianites Macleayi, Murchison,[1] is composed of a series of elongated narrow subparallel coils graduating towards a central point; and according to the figure in the "Silurian System," the body gives off a number of close, short, straight processes, the so-called "cirri." Such a form, with the latter in position, we have not seen from Girvan; but eliminating these cirri from consideration for the moment, tracks in the form of long curved transverse loops, as in our second case, just cited, are common enough, assuming to some extent the more or less circular form seen in Murchison's figure. These may be a condition of *M. Macleayi*, or they may be only referable to the next form about to be noticed.

The persistence of these markings referred to *Myrianites* is remarkable, Dr E. Emmons having described similar ones under the name of *M. Murchisoni* and *M. Sillimani*,[2] from his Taconic System of the United States of North America, and in this respect we see a repetition of the facts pointed out by us previously in the case of *Nereites*. *M. Sillimani* and *M. Murchisoni* are composed of a series of regular, narrow, graduating, concentric loops, exactly as in the typical British species.

3. CROSSOPODIA (*M'Coy*, 1851 = *Crossochorda* (pars), Schimper, 1879).—Another of these so-called genera, *Crossopodia*, M'Coy, was established[3] to include supposed worms with a long slender body, composed of short, numerous, wide segments, and clothed with "very long, delicate, crowded cirri, forming a broad dense fringe on each side."

The presence of this form at Girvan depends, so far as we have seen, upon a single doubtful specimen (Pl. XXIV., fig. 3), which has the arrangement of the loops as in *Crossopodia*, but with the intimate structure somewhat different. The surface of the track is a little raised above that of the slab, and flattened, but without any appearance of the arched form of *Crossopodia*, the central ridge, or the transverse markings. Where the sur-

[1] Sil. System, t. 27, f. 3.
[2] Agric. of New York, 1846, i. p. 69, t. 16, f. 1 and 5.
[3] Annal. Nat. Hist., 1851, vii. p. 395; Brit. Pal. Foss., p. 130.

face has been accidentally removed, the particles in the interior of these loops appear to have undergone rearrangement, and instead of either coinciding with the matrix, or having merely a confused appearance, are seen to be in curved lines across the abraded tracks, resembling, as it were, a series of small cups or shallow cones. In other portions of the track, however, where the surface has been likewise removed, this rearrangement of particles is wanting; and from the confused state of the latter, the track has every appearance of having been hollow. Now this track is to a certain extent identical with the second form described under *Myrianites*, but in the present case the loops are continuously drawn out, and lack the concentric condition of the latter. It is to all intents and purposes a *Crossopodia*, with the body preserved, and the lateral striated portions removed. Both these conditions are particularly well shown in the figure of *C. Scotica*[1] given by Professor M'Coy, which will serve to illustrate our meaning. It is possible that another fragment with lateral striations, and of which we give a figure, (Pl. XXIII., fig. 3), may also be a *Crossopodia*. The geological range, like the geographical distribution of *Crossopodia*, is extensive. It is met with in the Silurian rocks of the United States, and has been described under the name of *C. Loomisii*, Emmons, sp.,[2] whilst two conditions have been noticed from the Carboniferous beds of Northumberland—*C. Embletoni*, G. Tate,[3] and *C. media*, G. Tate.[4] Another slightly different form has been found in the coal-measures of Queen's County by the Rev. Professor Haughton, and figured by him.[5]

4. Eione (*G. Tate*, 1859).—In this "genus" the body is composed of a series of bead-shaped rings, separated from one another by deep sulcations, resembling in many respects a deeply-cleft *Orthoceratite*, or like the separated siphuncle of the genus *Actinoceras*.

[1] Brit. Pal. Foss., t. 1, D. f. 15. [2] Agric. of New York, 1846, i. p. 69, t. 15, f. 3.
[3] Trans. Berwickshire Nat. Field Club, 1863, iv.
[4] Ibid. (See also Trans. Tyneside Nat. Field Club, iv. p. 22 *et seq.*, Pls. 5-8, in a paper by the late Mr Albany Hancock.)
[5] Jour. Geol. Soc. Dublin, 1858, viii. pt. 1, p. 87, Pls. 8-11.

The same beds at Penwhapple Glen yielding the markings previously noticed have furnished several runs composed of a series of rounded depressions following one another in close order, and so forming a continuous, more or less moniliform chain (Pl. XXIV., fig. 4). It is possible that the more perfect state of these would resemble Mr Tate's *Eione moniliforme*[1] of the Carboniferous series.

5. Two other kinds of tracks remain to be briefly noticed. The first of these (Pl. XXIII., fig. 4) is formed by a series of small but broad, rather flattened, closely bent convolutions, following rapidly on one another. They are margined on one side by a depression following the convolutions, and corresponding in width to that of the latter. The second to be referred to (Pl. XXIII., fig. 5) is a simple meandering trail, crossing and recrossing itself at intervals, at times represented by a ridge, at others by a groove. The ridge appears to be bordered on one side or the other, and at times on both, by a groove. Similar tracks to this have been referred, both in Silurian and Carboniferous rocks, to *Nemertites*, Macleay. From the former they have been described by Professor Hall,[2] and from the Carboniferous by Mr G. Tate, as *N. undulata*.[3]

Considerations as to the Identity and Character of these Trails and Markings.—It may not be out of place to recapitulate the fact that the tracks known under the names of *Myrianites*, Macleay, *Nereites*, Macleay, *Nemertites*, Macleay (= *Nereograpsus*, Geinitz), *Crossopodia*, M'Coy, and *Eione*, G. Tate, have, one or all, been considered to be—

a. The trails of soft-bodied Annelids (Emmons, Hall, and others).
b. Structures representing the actual body of the worm itself (Murchison, M'Coy, &c.)
c. The tracks of Gasteropoda (Hall, &c.)
d. The tracks of Crustacea (Albany Hancock, Hall, and others).
e. Structures representing the remains of marine plants (Professor Schimper and others).

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[1] Geologist, 1859, ii. p. 68, t. 2, f. 6; Trans. Berwickshire Nat. Field Club, 1863, iv.
[2] Pal. New York, ii. p. 32. [3] *Loc. cit.*

It is of course almost superfluous to observe that in these tracks and trails we have no trace of the remains of organic matter, in the true sense of the word. They are supposed to have been formed by the animal, if a worm, or mollusc, dragging its body over the surface of wet sand or mud, between tide-marks, or in shallow water; and from such a point of view the presence of actual organic matter cannot be expected. As regards any which may be of vegetable origin, the organic matter has been entirely removed,—a phenomenon by no means confined to the Silurian rocks, as the same is frequently found to be the case with those remains in strata of the Carboniferous period, about the vegetable origin of which there is no doubt.

Now, looking at the markings known as *Nereites*, *Myrianites*, and *Crossopodia*, in the first place, it is difficult to conceive, as suggested by Professor Schimper, how a soft-bodied animal like an Annelide could, in passing over mud, or any other more or less yielding deposit, avoid defacing, to a great extent at least, by the hinder part of its body, the first-formed portion of its track. It would hardly be possible for the resultant impression to have that clear, sharp, and well-defined appearance so frequently exhibited by these tracks. As another argument against an Annelidous affinity, Schimper points out the extreme length to which these markings sometimes extend: the longest known living member of the class he states to be the *Lumbriconereis gigantea*, Quatref., which does not exceed a length of sixty centimetres. Another point which appears to be equally against the usually accepted affinity is the fact that these tracks or trails frequently take a sudden bend in a contrary direction to their former course, without disturbing in the least the regularity and bilateral symmetry of the so-called "feet" and other parts.

Schimper, in abandoning the Annelidan affinities of *Nereites* and other similar forms, has placed them amongst the Algæ, proposing for their reception the group *Chordophyceæ* (lace- or ribbon-algæ).[1] Two of the chief reasons for this change are

[1] Handb. der Pal., ii. Bd. 1 lief., p. 48.

the dichotomisation, which he says is sometimes visible, and the occasional presence of a broad thallus-like root of attachment. The latter is seen in the figure of *Phyllochorda sinuosa*, Ludwig, sp., from the Devonian rocks of Thuringia, and in a great measure induces us to believe that the typical *Nereites*, at least, are in all probability the remains of a plant with the whole of the organic matter removed.

Another point in favour of Schimper's reference of these remains to the Plantæ lies in the fact that the lower end frequently presents the central axis devoid of the lateral prolongations, resembling as it were the basal bare portion of the midrib in a *Laminaria*. This is exhibited in a form described by Emmons, *N. Jacksoni*,[1] which, if congeneric with Murchison's typical species, seems to us to be simply an impossibility as the work of an Annelide, to say the least of it.

With regard to *Myrianites*, we may first consider the smaller form of markings to which the name of *M. tenuis*, M'Coy, has been given; and we cannot do better than quote here some remarks recently made on this subject by one of us,[2] which to a very great extent have tended to settle the nature of the markings.

In ordinary markings of *M. tenuis* "all that is seen is that the surfaces of the strata are marked by winding and tortuous linear impressions, of extremely small comparative width, and easily recognisable from the matrix by their darker colour and slightly different texture. These meandering markings wind over the surface of the stone in indefinite undulations, often appearing to cross one another; and no one, looking at such a specimen, would be inclined to doubt that he had to deal with the trails left upon the mud of the sea-shore by some soft-bodied marine animals, though he might question if these could be Annelides. Other specimens, however, of the same fossil, which have been carefully examined by the author, prove conclusively that, in spite of appearances, *Myrianites* is

[1] Agric. New York, i. p. 69, t. 15, f. 1.
[2] Man. of Pal., 2d ed., pp. 321-323.

not only not Annelidan in its nature, but that it cannot possibly be the *track* of any animal whatever. It can be shown, in fact, that the narrow serpentine markings upon the surface of the stone, which are universally understood under the name Myrianites, are really *the cut edges of thin vertical laminar expansions, sinuously folded, and seen in horizontal section.* In fig. 10, a portion of one of the specimens referred to is figured, from which it will be seen that the fossil *cuts directly across the laminæ of deposition*, its actual surface (where exposed by ex-

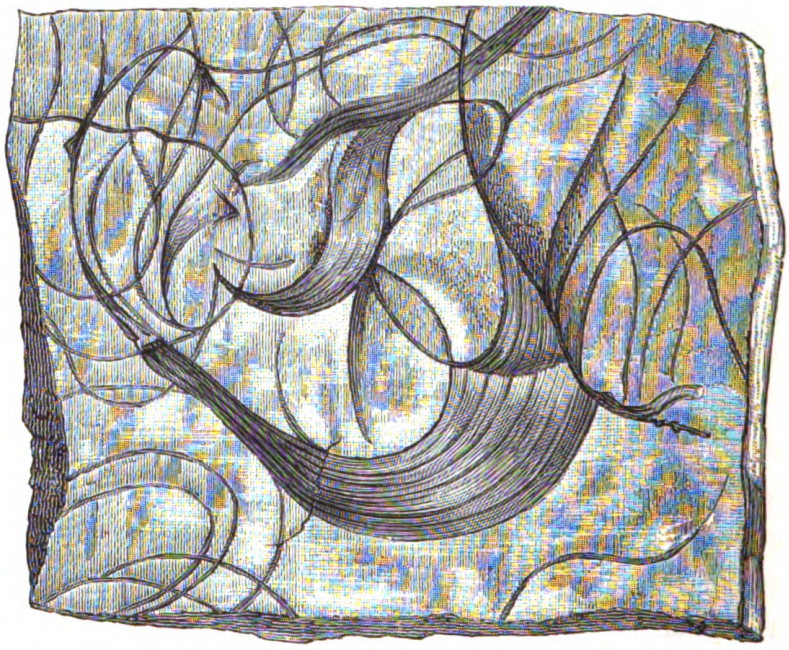


Fig. 10.—Fragment of a slab, showing *Myrianites tenuis*, from the Silurian slates of Thornilee, Peeblesshire, of the natural size. The slab has split at different levels in different parts, and the fossil is seen to cut vertically across the laminæ of deposition, the surfaces thus formed being concentrically striated.

foliation of a part of the slab) being marked with concentric striæ. It is therefore quite clear that Myrianites was really a thin, erect, folded, leaf-like expansion, of some kind or another, and that what palæontologists have described under this name is only the horizontally cut edge of this expansion as seen on the surface of the stratum. What *Myrianites* really is, is quite an open question. It is, perhaps, a peculiar form of Fucoid. That it is not Annelidan seems perfectly certain." On further

and careful consideration, we do not see how, if *M. tenuis* is to be regarded in the light of the remains of an organism, it can be looked upon as other than those of an erect sea-weed of large proportions; but we think it doubtful if it can lay claim to be considered as of organic origin at all.

It will be more convenient to consider next, in conjunction with the preceding, the subparallel transverse loops we have provisionally referred to *Myrianites*, and those meandering or tortuous windings noticed in our fifth paragraph. That these are the trails of some Invertebrate animals, we have not the slightest reason to doubt. One of the chief points of interest in connection with them is their very wide distribution, occurring as they do in the Silurian rocks of both the Old and the New World, and extending as high as the Carboniferous series.

Professor James Hall remarks[1] of them, "Tracks of various animals, some of which, as they passed over or just beneath the surface of the sand, have left a certain furrow or trail. . . . From the character of the surface of the arenaceous beds in which they occur, I am inclined to the belief that many of them were made while the bed was exposed above the water, and most of the others in very shallow water."

Hall states that the general character of these trails is "that of a meandering furrow, more deeply depressed at the two sides, elevated at the centre, and margined by a slightly elevated ridge of sand, which appears to have been pushed outward in the progress of the animal. Others of them are a simple furrow, with the deepest depression in the centre. . . . In their general character some of them are not unlike the trails made by *Natica* or *Littorina*, and others are more like the meandering trails of *Idotea*. In many the great length of the meandering line, which crosses and recrosses itself many times, seems to indicate that the animal moved rapidly over the surface. In others the trails are larger, and

[1] Pal. New York, ii. p. 26.

the animal probably moved much more slowly, the length being often limited to a few inches.'[1]

As the recrossed tracks are supposed to indicate rapidity of movement, Hall considers that they can hardly be those of Gasteropoda, for the members of this class as a rule move slowly, but *Idotea* moves with considerable rapidity. In illustration of these views he further adds,—"The trails of *Melania*, made on sandy and muddy bottoms beneath shallow water, are more similar in their meandering direction and recrossings" (*i.e.*, to the markings in question) "than the trails of *Natica*, which are usually of no great extent. The *Melania*, on the contrary, often leaves a trail of several feet long, winding about in this manner; but the trail in this case is a simple depression, margined by a slight ridge, produced by the animal pushing away the material from before it, and piling it up on each side. The tracks of *Littorina* on a sandy beach resemble these in some degree; but they are usually more direct, and show fewer recrossings in the same space."[2]

Similar wandering tracks which occur in the Carboniferous rocks of the north of England have been referred to the Mollusca by Mr E. W. Binney. He has compared them to those of *Littorina littoralis* and a bivalve.[3]

The remarks of Professor Hall, and of other observers who have made both these tracks and trails, and those of living Mollusca, their study to a very great extent, appear to be so conclusive, that we feel ourselves obliged to accept them as an explanation of those markings represented by our figures (Pl. XXIII., figs. 4 and 5; Pl. XXIV., figs. 1 and 4). It has been objected by one of us,[4] in reviewing this subject, that it is almost inconceivable that traces of the animals should not have been found in company with the tracks and trails originated by them. It is a curious fact, that in the finely levigated

[1] Proc. American Assoc. Adv. of Science, Cambridge, 1849, p. 256; Pal. N. York, ii. p. 26.

[2] Pal. N. York, ii. p. 28.

[3] Trans. Lit. Phil. Soc. Manchester, x. p. 189, t. 1, f. 1, t. 2, f. 1.

[4] Nicholson, Palæontology, 2d ed., p. 325.

deposits in which they are found there should be, as a rule, such an entire absence of the remains of veritable organisms which might have given rise to them. The objection, however, is only one of secondary importance when compared with the undoubtedly important facts which have been adduced by various writers to account for the origin of such phenomena.

We have to deal, finally, with the tracks known as *Crossopodia*, M'Coy, which were regarded by the author of the "genus" as the remains of veritable bodies of marine worms. Similar trails have on several occasions been noticed from the Carboniferous rocks [1] of this country, and described as *Crossopodia Embletoni* by Mr G. Tate.[2] It is also probable that the genus *Cymaderma*, of Professor J. Duns, D.D.,[3] is here referable.

By far the most important contribution which has hitherto appeared attempting to explain the nature of trails similar to *Crossopodia*, is that by the late Mr Albany Hancock.[4] He showed in the most successful manner that similar trails were produced now on the sandy beaches of our own coasts by small Amphipod Crustaceans—*Sulcator arenarius*, Spence Bate, and *Kröyera arenaria*, S. B. Both these animals burrow a little below the surface of the sand, and produce slightly different runs. That of the first species, with which we are mostly concerned, is a slightly raised track, to a certain extent ribbon-like in shape, with a median groove, transversely ridged or striated, of considerable length, and often intricate and convoluted. The sand is pushed upwards by the Crustacean, and the trail thus formed partially subsides as the creature passes on, whilst by its breaking along the centre, the median groove is formed. At intervals, the Amphipod, by thrusting itself through the sand, leaves an oval swelling; and so, by repetition, a series of roughly formed nodules is produced.

[1] "An Account of a large Fossil Marine Worm," &c., &c., by E. Wood—The Naturalist, 1851, No. 1, p. 14; No. 2, p. 41.

[2] Geologist, 1859, ii. p. 66, t. 2, f. 1 and 2; Trans. Berwickshire Nat. Field Club, 1863, iv.

[3] Proc. R. Soc. Edin., ix. p. 352.

[4] Trans. Tyneside Nat. Field Club, iv. p. 17.

In further illustration of the subject, Mr Hancock figured [1] a large *Crossopodia* from the Carboniferous rocks of Northumberland, as much as six feet in length, and in all probability identical with *C. Embletoni*, Tate. Now, in addition to the very close resemblance borne by the exterior of the underground passages of *Sulcator arenarius* to *Crossopodia*, the resemblance is made still stronger by certain appearances presented by some American Silurian *Crossopodiæ*, as described by Professor Hall. He says that at intervals along the trail of the form in question the stone is elevated into vesicular knobs, with a small opening in the centre: [2] this appears to have a strong analogy with the apertures made in its tunnel by *Sulcator arenarius!*

Although it is not by any means our intention to infer from this resemblance the existence, during Carboniferous and Silurian times, of an animal identical with the *Sulcator*, we certainly do think that, presuming no other and better explanation to be forthcoming, it must be at least admitted that such markings as *Crossopodia* may be caused by Crustaceans of some form or other. Mr Hancock suggested they might be, so far as the Carboniferous trails are concerned, the work of Trilobites,[3] and showed that the genera existing at that period might have excavated them. This explanation will hardly hold for the similar tracks of the Girvan area; because, with one or two exceptions, all the Trilobites previously described are far too large to have excavated the runs found there. The habits of Trilobites also, it is needless to observe, have been considered by many of the best authorities to be of a different nature.

As a counterpoise to Mr Hancock's valuable suggestion, we have another to offer which may perhaps take its place in this subject. Fig. 11 is a much reduced drawing by Mr C. Berjeau, from the original sketch made by Mr Robert Gray, F.R.S.E., of the trail of our common Mollusc, *Purpura lapillus*, taken from nature, as the *Purpura* made the track on firm

[1] *Loc. cit.*, pls. 7 and 8. [2] Pal. N. York, ii. p. 31. [3] *Loc. cit.* p. 32.

sand at Ardrossan Sands, Ayrshire, April 16, 1864. This trail is to all intents and purposes one form of the Carboniferous and Silurian *Crossopodia.* In the first place, it may be taken

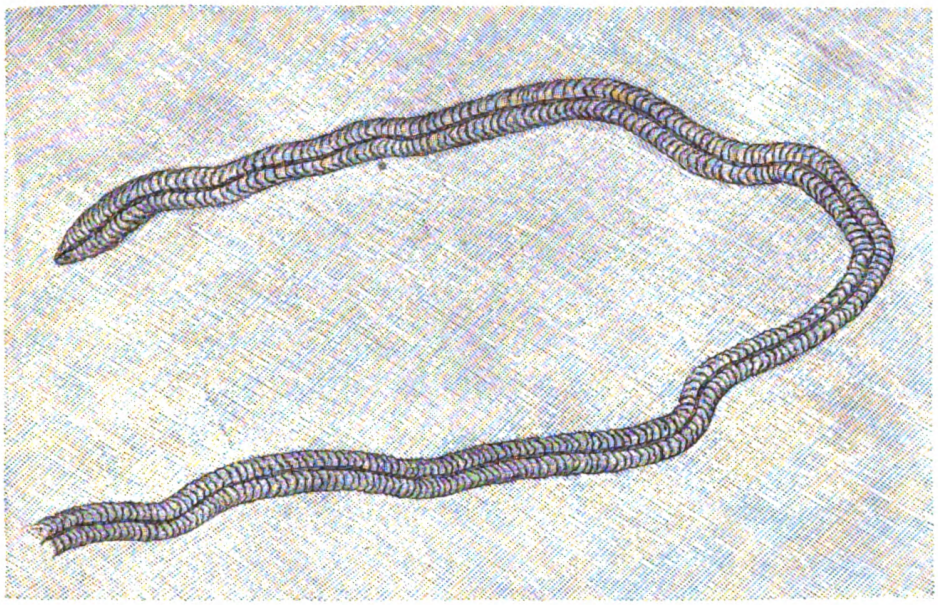


Fig. 11.—Track of *Purpura lapillus* on firm sand, Ardrossan Sands, April 16, 1864. Reduced three diameters.

to represent one of the transverse loops of that body; in the second, there is the same ribbon-like form, only a little arched, the central groove or depression representing the body of *Crossopodia*, and the transverse ridges representing the striæ.

Taking into consideration, therefore, the foregoing demonstration, coupled with the remarks by Professor James Hall, previously quoted, we think it highly probable that such tracks as *Crossopodia* are as likely to have been made by Gasteropoda as by Crustacea. Professor Schimper goes further than this, and treats *Crossopodia* from the same point of view as *Nereites;* but although inclined to support him in referring the latter to the vegetable kingdom, we cannot, at present at least, accept this resting-place for the tracks or markings now under consideration. For this form Schimper has established the sec-

tion *Diplochorda*, or doubly-ribbed Algæ, and the genus *Crossochorda* for those resembling M'Coy's *Crossopodia*.

We feel we cannot do better than conclude this interesting but difficult branch of our subject by quoting the words of our friend Professor T. Rupert Jones, F.R.S.,[1] from his interesting paper, "On Tracks, Trails, and Surface-markings," &c., as follows: "Trilobital, Bellinural, Amphipodal, and other Crustaceans, with sea-worms and Molluscs, may have made most of the trails, runs, or tracks that we have to do with in the Palæozoic rocks; and even insects may have aided in some instances, as intimated by Mr Emmons."

CLASS ECHINODERMATA.

Order ASTEROIDEA.

We possess no published information of the occurrence of this group in the Silurian rocks of Girvan. During 1879, Mrs Gray's researches have brought to light two forms of Star-fish, in the highly fossiliferous rocks of Thraive Glen, appertaining to what has usually been considered the genus *Palæaster*, Hall; but a series of observations lately made by us has convinced us that the Star-fishes usually referred to that genus in this country do not belong to it. That is to say, *Palæaster*, Salter, 1856, is not the equivalent of *Palæaster*, Hall, 1852, as now understood. To demonstrate this, and to show the affinity of the two forms from Girvan, we shall have to investigate the subject somewhat fully.

ON THE BRITISH SILURIAN STAR-FISHES REFERRED TO *PALÆASTER*, HALL.

The genus *Palæaster* was originally proposed by Prof. James Hall in 1852[2] for an American Silurian Star-fish with five rays, these latter being composed of five or more series of plates.

[1] Geologist, 1862, v. p. 139.

[2] Pal. N. York, ii. p. 247.

Hall, in his specific description of *P. Niagarensis*, says the lower sides of the arms have "two ranges of plates on each side of the avenue, the outer range composed of strong hexagonal plates, with an inner range of smaller ones alternating," &c. There is also a large pentagonal plate inserted in each of the five angles, at the base of the arms. In 1867, Prof. Hall redescribed [1] *Palæaster*, consequent on the original specimens not showing the whole structure of these interesting fossils. *Palæaster*, according to the later definition, has two ranges of plates on each side of the ambulacral groove, in addition to the ambulacral plates, which occupy the groove itself. In other words, the under surface of each arm, as now understood, consists of six rows of plates—thus: The two alternating series of ambulacral ossicles abutting against one another in the centre, and placed in the ambulacral groove; a row on each side of these, the adambulacral, which are rather square in form; and, outside these, a row of large marginal plates on each side, or six series in all, three on each side.

This structure is plainly visible in the figures of two of Hall's species, *P. matutina* and *P. Shæfferi*, and is described in others. If confirmation of the accuracy of Hall's later descriptions be required, it may be found in those of other species by the late Mr F. B. Meek, who has invariably described [2] the ambulacral surfaces of the *Palæasters* of the Cincinnati group of Ohio as consisting of six series of plates.

Between the dates of the two descriptions of *Palæaster* by Prof. Hall, the late Mr J. W. Salter adopted [3] the name for certain British Silurian Star-fishes without a disc, and having deep avenues bordered by very large plates, his conception of the genus being based on Hall's first definition. Mr Salter's later descriptions are based upon the same supposition; and in this he has been followed by most British and a large number of European palæontologists.

[1] Twentieth Annual Report N. York State Cabinet, p. 282.

[2] Ohio Geol. Report, 1873, i. pt. 2, pp. 58-66.

[3] Brit. Assoc. Report for 1856, pt. 2, p. 76; Annals, Nat. Hist., 1857, xx. p. 324; Mem. Geol. Survey, 1866, iii. p. 289.

It follows, therefore, that *Palæaster*, Salter, is not *Palæaster*, Hall, as now understood by American authors; and it is by their view we must be guided in this matter, otherwise endless confusion would arise in the nomenclature of these Silurian Star-fishes. The whole matter resolves itself into one question—Have, or have not, the British species six rows of plates on the ambulacral surface of the arms, or only four? If the former, they will fall within the genus *Palæaster*, Hall. On the other hand, if only four plates are there to be found, they cannot be so placed, and *Palæaster*, Salter, becomes a term of no meaning,—and the species so termed must be referred to one or other of the many genera of Palæozoic Star-fishes already proposed; or failing this, a new genus must be created for them.

The two species of Star-fish discovered by Mrs Gray at Girvan have the ambulacral surface composed of four rows of plates, without the slightest doubt, and are therefore members of the group *Palæaster*, Salter.

We have carefully examined all the British species of so-called *Palæaster* to which we could obtain access, including some forms named in MS. by the late Mr Salter, with the following result. The described species are—

Palæaster asperrimus, Salter.
„ *coronella*, „
„ *imbricatus*, „
„ *obtusus*, Forbes—

two other forms—*P. hirudo*, Forbes, and *P. Ruthveni*, Forbes—being now referred to the genus *Urasterella*, M'Coy.

(*a*) *Palæaster asperrimus*, Salter, is an unsatisfactory species. The specimens in the Museum of Practical Geology have the large transverse ossicles very apparent; but as to whether there is a row inside or outside these, or both, we are by no means certain. It appears, however, to have possessed only four rows.

(*b*) *P. coronella*, Salter. According to its description, the upper surface only of this species is known. We have not seen the ambulacral surface.

(*c*) *P. imbricatus*, Salter. The lower surface of this is likewise unknown. The specimen which serves as the type may be almost looked upon as worthless from a specific point of view.

(*d*) *P. obtusus*, Forbes, has decidedly only four rows of plates on the ambulacral surface of the arms, and is in consequence not a *Palæaster*, as defined by Hall. The large arm-plates are strongly punctate, and the small ambulacral plates contracted in the middle and expanded at the sides.

To sum up: we have one species not referable to *Palæaster;* one of which the structure is rather doubtful, but which is probably congeneric with the first; and two of which the ambulacral structure is unknown.

For those forms possessing only four rows of plates on the ambulacral surface of the arms, including the two species discovered by Mrs Gray at Girvan, with *P. obtusus*, Forbes, and probably *P. asperrimus*, Salter, we are in want of a generic name,—provided none of the hitherto described genera will admit them.

Before entering on this subject, however, it will be well to point out that we do possess, in our Silurian rocks, at least one species of true *Palæaster*—viz., *P. Caractaci*, named, but not described, by Salter.[1] We have examined admirable specimens of this species in the Museum of Practical Geology and the British Museum; and there are, without doubt, six rows of plates on the ambulacral surface of the arms.

In examining the characters of the numerous genera which have from time to time been proposed for Palæozoic Star-fishes, whether of the Asteroid or Ophiuroid type, we may at once dismiss the multiradiate genera, such as—

Lepidaster, Forbes, 1850.
Helianthaster, F. Roemer, 1864.
Eucladia, H. Woodward, 1867.
Trichotaster, Wright, 1873.

Neither in the Girvan forms about to be described, nor in the

[1] Cat. Foss. Mus. Pract. Geol., 1865, p. 30.

British forms referred to *Palæaster*, is there the slightest sign of a disc connecting the arms; we may therefore dismiss at once all those genera so provided—viz.:

Protaster, Forbes, 1849.
Aspidosoma, Goldfuss, 1848.
Palasterina, M'Coy, 1851.
Palæocoma, Salter, 1857 (*non* D'Orb.)
Rhopalocoma, „ „
Palæodiscus, „ „
Schænaster, Meek and Worthen, 1860.
Eugaster, Hall, 1867.
Ptilonaster, „ „
Alepidaster, Meek, 1872.

We may next dismiss those genera in the organisation of which there are special characters entirely separating them from the forms now under discussion, viz.:—

Glyptaster, Hall, 1852.[1]
Edrioaster, Billings, 1858.
Onychaster, Meek and Worthen, 1860.

Three other genera may be eliminated, either from their ventral surface being totally unknown, or from their general structure so little ascertained that a comparison is unnecessary.

Cribellites, G. Tate.
Cœlaster, G. and F. Sandberger (*non* Agassiz, *nec* D'Orb.)
Calliaster, Trautschold, 1879.

Finally, we come to those genera after the type of *Palæaster*, Hall, in which the arms are five in number, no disc uniting these arms, and the ambulacral surface being composed of a variable number of rows of plates, from two to six, irrespective of scattered disc-plates. *Palæaster* we have already considered. Like it, the genus *Petraster*, Billings,[2] possesses six rows of plates on the lower surface of the arms, these being similarly arranged: according to Hall, it is only an abnormal *Palæaster*. The genus *Argaster* generally resembles the former, but has five instead of six rows of plates—viz., two rows of

[1] May be the remains of a Crinoid.
[2] Geol. Survey Canada, Dec. 3, 1858, p. 79.

very large marginal pieces, the usual adambulacral plates, and a single row of ambulacral ossicles.

In the genus *Urasterella*, M'Coy, the skeleton on the ventral side of the arms appears to be of a very simple description—merely two rows of ossicles bordering the ambulacral grooves. *Stenaster*, Billings, is also described[1] as possessing only two rows of large plates bordering the avenues, one on each side. It has been regarded by Hall and Meek as identical with *Urasterella*, M'Coy. Another genus, *Tæniaster*, Billings, has four rows of plates on the ventral surface of each arm, and so far corresponds to our Silurian species; but the ambulacral plates are of a peculiar form, being constricted in the middle. Hall states that a disc exists in *Tæniaster*, and that it is probably identical with *Protaster*, Forbes.

One of the peculiar forms described by Salter, *Bdellocoma*, is said to have six rows of plates like *Palæaster*, but arranged as in *Palæocoma*, Salter, and without any trace of the disc of the latter. The ambulacral ossicles are much contracted.

The Devonian *Archasterias*, J. Müller, is a particularly interesting genus from its close approximation to *Palæaster*, Hall. The ambulacral surface of the arms, as in the latter, appears to be composed of six rows of plates, the ambulacral plates themselves being the smallest, and set alternately in two rows. According to Zittel, the two genera are probably identical. Lastly, in *Xenaster*, Simonowitch, six rows of plates form again the order of arrangement, accompanied by numerous intercalated disc-plates between, and about the bases of the arms. Now, the complexity of the arm-plates in *Palæaster*, *Petraster*, *Argaster*, *Bdellocoma*, *Archasterias*, and *Xenaster*, and the equal simplicity of them in *Urasterella* (=*Stenaster*, Billings), quite forbids the reference to either of them of the four-rowed Girvan and other similar British forms. We still have Billings's *Tæniaster*, which has four rows of plates as in our specimens; but, unfortunately, Hall has thrown doubt over the nature of this Star-fish by asserting that in Billings's very

[1] Ibid., p. 97.

type-specimens a disc occurs, which would give to the genus a totally different appearance to that presented by the British examples under discussion, otherwise we should have been glad to have adopted Mr Billings's genus for the latter.

We are unable to place the Star-fishes from Girvan in any of the genera just mentioned, and are therefore constrained to propose for them, with *Palæaster obtusus*, Forbes, and probably *P. asperrimus*, Salter, the generic name of *Tetraster*.

Genus TETRASTER, Etheridge jun., and Nicholson (*gen. nov.*)

Palæaster, Salter, *et auct.* (*non* J. Hall).

Gen. char.—Body convex to depressed-convex, five-rayed; upper surface of the arms composed of three or more rows of plates, bearing tubercles or spines, close set or scattered; ventral or ambulacral surface composed of four rows of plates, two on each side. Avenues deep, occupied by the two series of ambulacral ossicles, bordered by the two rows of marginal pieces, one row on each side. Arms themselves long or short, becoming broad or somewhat petaloid in the latter form.

Obs.—This genus is closely allied to *Palæaster*, Hall, and has the general appearance of the latter, but differs from it in the structure of the ventral portion of the arms, as previously stated. *Tæniaster* would perhaps have sufficed had not Hall stated that it possessed a disc, which would at once throw it out of our category. The points of difference between it and the foregoing genera will be obvious when the structure of the following species is compared with the remarks on the former given a few pages back.

Tetraster Wyville-Thomsoni, Eth. jun., and Nich. (*sp. nov.*)

(Pl. XXI., figs. 1-8.)

Spec. char.—Body stellate, convex when perfect; arms short, broad, wedge-shaped, non-petaloid, and tapering to an obtusely rounded point, with straight sides. Avenues deep and wide,

continuous to the mouth, not arched over with plates at their upper ends. The bordering rows of plates, eight to nine in number, on the ventral surface of the arms, are large, transverse, and elongated, becoming smaller towards the apex, and with a punctate structure; the ambulacral plates are small, narrow, and pointed at their outer extremities. Apertures between the ambulacral plates large and circular.

Obs.—The affinities of the species are clearly with *T. obtusus*, Forbes, *sp.*, from which it differs in two essential points. In the first place, the arms are obtusely wedge-shaped, instead of lanceolate or petal-shaped, as in Forbes's species, so altering the general appearance in a very marked manner. Secondly, in the specimens examined by us the avenues are open and continuous to the central depression of the mouth, and are not in any way bridged over by any of the plates, so far as we have been able to ascertain, as is the case in *T. obtusus;* and furthermore, the avenues are moderately broad, instead of being narrow.

The specimens are all preserved as casts, from which we have been able to take excellent wax reliefs, showing all the characters in detail: most of the examples are fragmentary, but one or two are entire. It affords us much pleasure to name this after Sir Wyville Thomson, F.R.S., who, with the late Mr J. W. Salter, was one of the earliest investigators of the Girvan Silurian Fauna.

Loc. and Horizon.—Thraive Glen, in a highly fossiliferous rock. (Gray Collection.)

Tetraster, *sp. ind.*

(Pl. XXI., figs. 9 and 10.)

Spec. char.—Body stellate, with slowly tapering arms, which increase little in width throughout their whole length; upper surface unknown, but the body was convex and probably granular. Avenues of the arms broad, and not bridged over by any of the plates; marginal ambulacral plates moderately

convex, transversely elongated, or oblong in form, and less in width than the ambulacral plates; those in the angles of the rays are the largest, and somewhat more elongated than the others; oral plates not visible. The ambulacral plates are also oblong in form, and of regular shape, from sixteen to eighteen in each series; pores of medium size, set laterally at the sides of the ambulacra. Total length of arms, 16 mm.

Obs.—We are, unfortunately, only in possession of a single example of the form; but the much larger size and different proportions at once separate it from the preceding species. The arms are much longer and straighter, and the plates of the ambulacra more nearly equal.

In some of its characters it approaches very closely to *T.* (*?*) *asperrimus*, Salter, *sp.;* but as we have no definite proof of the existence of the remarkable asperities of the upper surface visible in the latter, we prefer to retain the two forms separate —the more so as we have not seen any trace of the prominent spines attached to the marginal plates of the ambulacra of *T.* (*?*) *asperrimus.*

Loc. and Horizon.—Thraive Glen, as before.

Order CRINOIDEA.

The encrinital remains of the Girvan Silurian area are of a very fragmentary and unsatisfactory nature, and consist principally of portions of the column of attachment. Entire calices have been met with at two localities only, Craighead and Penkill, and a few scattered, although well-marked plates, in the conglomerate at Balcletchie. The only species hitherto recognised with any degree of certainty is the *Glyptocrinus basalis*, M'Coy;[1] but as this identification has hitherto depended upon the determination of stems only, it may be looked upon as open to doubt. The localities which have yielded the remains of Crinoidea are :—

[1] Cat. W. Scot. Foss. 1876, p. 15.

1. *Craighead.*—In the limestone and shale; calices and portions of stems.
2. *Penkill.*—In the bluish-grey fossiliferous rock of that locality; calices and portions of stems.
3. *Balcletchie.*—In the dark fossiliferous mudstone; portions of stems. In the conglomerate; separate plates of the calyx.
4. *Shalloch Mill.*—In the fossiliferous shale; portions of stems.
5. *Woodland Point.* — In shale with *Encrinurus punctatus;* fragments of stems.
6. *Bargany Pond burn.*—In shale; fragments of stems.

A few of the stem-fragments are of a sufficiently marked character to be worthy of separate notice, their ultimate identification being probable.

The first of these is a pentagonal stem (Pl. XXII., fig. 1), with flat and straight sides. The component ossicles are thin, equal, or subequal and regular, and, when viewed horizontally, with an inner marked pentagonal zone. Canal circular. Craighead limestone.

The second stem is quadrangular (Pl. XXII., fig. 2), small, with the opposite sides equal, two and two, but very unequal to one another. The sides are a little concave, with an indistinct ridge running down the centre, which arises from a projection of the lateral centre of each ossicle. Ossicles alternately larger and smaller, the larger ones with a single indistinct tubercle at the four angles. Canal small; the transverse section of the ossicles exhibits on the surface of each, four ridges proceeding from the edge of the canal to the sides of the column, one to each of the four projections at the side of each ossicle previously mentioned. Craighead limestone.

A third stem is composed of thick, bony, outwardly rounded, circular ossicles, each one tapering above and below, so that the articular surface is of much less diameter than the general periphery, the union of every two ossicles giving rise to an interposed plain space (Pl. XXII., figs. 3 and 4). Canal pen-

tagonal; articular surface striated. There appears to be a certain variation in this description of stem—in the form and succession of the ossicles: all, however, will probably be included under the one form. The interspaces of less diameter are broad or narrow, plain or finely striated. Craighead and Penkill.

A fourth, and by far the most common Crinoid stem, in the Girvan district, is large, plain, and circular, composed of equal, regular, close-fitting, unornamented ossicles, with the articular surfaces a little biconcave and finely striated radiately. Craighead, Balcletchie, Penkill, &c. (Pl. XXII., fig. 5).

Another form of stem is composed of ossicles larger and smaller alternately, either quite plain, or the larger ones ornamented with a circlet of tubercles. Section oval, canal large, its margins with articular striæ. Penkill, Balcletchie (Pl. XXII., figs. 6, 7, and 8).

Another form of the stem occurs at Balcletchie, in which the ornamenting tubercles are replaced partially by side arms.

Numerous other varieties of stem might be quoted from the Girvan district; but as they are by themselves, generally speaking, undeterminable, they need not be noticed, with one exception—described hereafter.

We may now pass to a description of the entire or partially entire calices which have been obtained by Mrs Gray.

Genus Glyptocrinus, Hall, 1847.

Glyptocrinus, Hall, Pal. N. York, 1847, i. p. 281.
„ Billings, Fig. and Descrip. Canadian Org. Remains, Dec. 4, 1859, p. 55.

Obs.—The calyx in this genus is either pyriform, oval, or globular, and in some of its species very large. The column is also large, usually round, and strongly annulated or moniliform. The plates composing the calyx are flat, thin, and smooth, or ornamented with radiating ridges, striæ, or raised margins. The basal plates are five, and either pentagonal or hexagonal. The primary radials are large pentag-

onal plates, the secondary hexagonal in form, and the tertiary heptagonal. The regular inter-radials are usually six in number, but those of the azygous inter-radius, or anal side, are seven or more. In addition to the striæ or ridges ornamenting the individual plates, the surface of the calyx is traversed by five prominent ridges, which, taking their origin from the primary radial plates, cross the secondary plates of the same name, and bifurcate on the tertiary, the divisions extending to the base of each pair of arms. (Hall and Billings.)

Throughout the whole Silurian area of the southern uplands of Scotland, at certain horizons the casts of scattered and strongly annulated stem-rings are common, which in all probability are those of this genus.

Glyptocrinus (?) *sp. ind.*

(Pl. XXII., figs. 9-11.)

Obs.—In no case have we more than about half of the calyx or cup of this Crinoid preserved; and what there is presented to us, is in that indistinct state which renders determination doubly difficult.

The arrangement of the plates appears to be that of *Glyptocrinus*, in so far as the basal plates, first, second, and third radials, and certain of the inter-radials are concerned. Here, however, in every case, the calices are broken off, and the further superposition of the plates is unknown. The individual pieces composing the calices are thicker and much more convex than is usually found to be the case in *Glyptocrinus*, and their conversion into that peculiar form of calcite so frequently met with in the remains of the Palæozoic Echinodermata has quite obliterated the surface ornamentation which usually is present in the species of this genus. Notwithstanding this, however, the five great radial ridges, which take their rise at the primary radials, extend to the tertiary radials, and there bifurcate, are still perceptible. The late Mr J. W. Salter proposed the separation of *G. basalis*, M'Coy, one of our British

species, from the genus as defined by Prof. Hall, on account of the presence of parabasal plates.[1] This, if a sound generic character, and not one of an advanced specific nature, will doubtless recommend itself; but so far as our observation has gone, the Girvan forms do not possess these parabasals, and will fall directly into the genus *Glyptocrinus* itself.

We believe, provided our reference to *Glyptocrinus* be correct, that the Girvan forms are specifically distinct from any hitherto described, both in the form and size of the calyx, and in that of the constituent plates. We would, in this case, propose for it the name of *G. globularis*, in allusion to the globular form of the cup or calyx.

Loc. and Horizon.—Craighead, in the shale of the Craighead limestone; common. (Gray Collection.)

The only other remain of *Glyptocrinus* we have to refer to is a specimen from Thraive Glen (Pl. XXII., fig. 12),—an example of the upper part of the cup, with portions of the arms, from which the integument has been removed, leaving an internal cast of the parts. The markings representing the divisions of the plates are but indistinctly seen. The segmentation of the arms, however, is very well shown, as are also the ridges proceeding from the base of the latter over the calyx.

Loc. and Horizon.—Thraive Glen, in a highly fossiliferous liver-coloured sandstone. (Gray Collection.)

Genus Myelodactylus, Hall, 1852.

Myelodactylus, Hall, Pal. N. York, 1852, ii. p. 191.
Ophiocrinus, Charlesworth (MS.), Coll. Brit. Mus. (*non* Angelin, *nec* Semper).
Herpetocrinus, Salter, Cat. Camb. Sil. Foss., Woodw. Mus. Cambridge, 1873, p. 118.

Obs.—This name was proposed to include what Prof. Hall took to be the arms and fingers of a Crinoid, "the remarkable feature of which is the foramen or medullary canal penetrating the column of joints,—a character not existing in the species

[1] Mem. Geol. Survey, iii. p. 283.

where the fingers are composed of a double series of joints, and which is not conspicuous in the simple jointed fingers without tentacula."

The remains of this organism consist of thin, wide, flat joints, always curved in the same direction, and sometimes tightly wound in successive coils. The united joints are curved convexly on the outer side or back of each coil, where they are sometimes slightly tubercular and occasionally ridged, whilst on the inside the coils are concave. Each plate or ossicle is, in fact, semicircular, or, more properly speaking, crescentiform, and "penetrated vertically by an oblong quadrangular canal:" the two extremities of each crescent are truncated. The articulating surface is of a complex structure. (Hall.)

Myelodactylus convolutus, Hall, consists of a series of these joints united together, and tightly wound into successive close-fitting coils, the convex back of one coil adjusting itself to the concave inner surface of that preceding it. The so-called "tentacula" are attached only to the edges of the inner side. As before stated, these were believed by Prof. Hall to be the arms and fingers of a Crinoid.

In 1873, the late Mr J. W. Salter's posthumous genus *Herpetocrinus* was published,[1] which is stated to be identical with *Myelodactylus*, Hall, and was proposed for it, as "the name based on false ideas cannot be kept." All Mr Salter says of his genus is as follows: "A minute cup, all but obsolete, and with dichotomous narrow arms, branched like those of *Homocrinus*, Hall. This is set on a narrow cylindrical sub-erect stem, which soon, however, becomes compressed, then hollowed on one side, and bears close-set axillary arms to the lowest part, so far as observed. The stems, coiled up like an adder, resemble arms of Crinoids rather than stems." This description, coupled with the figure given by Mr Salter, renders it quite evident that *Myelodactylus*, Hall, and *Herpetocrinus*, Salter, are identical.

We possess, from Girvan (Pl. XXI., figs. 11 and 12), certain

[1] Cat. Camb. Sil. Foss., Woodw. Mus. Cambridge, p. 118.

fragments, which, although in no way presenting a complete coil, as in *M. convolutus*, or a perfect example, as in the figure[1] of *H. Fletcheri*, still possess all the characters assigned to the former by Hall, when examined in fragments. In the first place, there occur at two localities portions, and almost complete circles or coils, of ossicles, forming crinoid stems, sometimes bearing small axillary stems attached to the inner edge of the coil (Pl. XXI., fig. 12), exactly as in Hall's *Myelodactylus*. These imperfect specimens are composed of a large number of thin semicircular ossicles, so shaped as to form, when united together, a strong ridge or keel on the outer side, and on which the sutures between the respective ossicles are more strongly marked than on the sides. The largest and best preserved of our specimens clearly shows traces of the concave inner side. Our specimens appear to represent two species, the axillary arms previously mentioned being visible in one of them only. We do not consider Hall's having mistaken stems for arms as a sufficient reason for the rejection of his name, and therefore adopt it in preference to Mr Salter's. If every name in palæontology based on a false idea is to be abandoned in place of a subsequently proposed one when properly and correctly defined, confusion will be endless. Numbers of cases could be cited in which names given on an erroneous interpretation of structure are retained by our best authorities.

The British Museum collection contains several instances of these coiled-up stems from Dudley, to which the MS. name *Ophiocrinus*, Charlesworth, is attached. Mr Edward Charlesworth, F.G.S., has kindly informed us that this name was proposed by him for these strange Crinoids about fourteen years ago, at one of the meetings of the Birmingham Natural History Society; but so far as he is aware, his description has never been published. Be that as it may, we suspect it is identical with the much earlier proposed *Myelodactylus*, Hall. The name *Ophiocrinus* has also been made use of by both Angelin and Semper.

[1] Is not this a restoration?

Myelodactylus, *sp.* (or *sps.?*) *ind.*

(Pl. xxi., figs. 11 and 12.)

Loc. and Horizon.—In the grey fossiliferous mudstone of Penkill; in the dark greenish-blue fossiliferous mudstone of Balcletchie (?). (Gray Collection.)

In addition to the fragmentary remains of Crinoidea just described, the Balcletchie conglomerate has yielded a few small perisomatic plates, in regard to the affinities of which we are somewhat doubtful. They may only be those of a Crinoid with highly ornate plates, or, on the other hand, those of a Cystidean. The plates in question (Pl. xxii., figs. 13-19), are small pentagonal or hexagonal flattened bodies, having on their exterior surfaces ridges radiating from the centre of the plates, and arranged in zones or groups, as so frequently seen on the surface of those of the Cystoidea.

In one plate these ridges are coarse and few in number; in another, much finer, and in better defined groups, with a plain central space, somewhat elevated above the general surface, and giving off flexuous branches which separate the groups of striæ (Pl. xxii., fig. 13). Other forms are present, but in too indistinct a state of preservation for description. One or two specimens show what appear to be the interior of these plates; but of which kind, it is impossible to say. Here the surface is smooth and plain, a little concave, and with five double rows of minute pits or punctæ (Pl. xxii., fig. 18), each double row radiating from the centre to one of the angles of the pentagon. In a single instance there are only four of these double rows of pits (Pl. xxii., fig. 19).

We have not observed any trace of plates bearing the characteristic pectinated rhombs, or hydrospires, of the Cystoidea; and it is within the bounds of possibility that, supposing these to be the plates of Echinoderms of this order, the latter may have belonged to that section in which the pectinated rhombs are represented by pores or fissures scattered without definite

order over the plates of the body or calyx; and further, that the pores just described may bear some relation to the hydrospires. This is borne out by the appearance of another plate, not previously referred to, in which some of the coarse ridges have become abraded, and are now visible as elongated fissures.

In fact, that this is the case is, we think, tolerably clear from the structure of a fourth specimen, in which the pores are visible penetrating through to the exterior, as a circlet round the central smooth portion of the plate, and then, as in the former case, when viewed from the interior, forming five or six double radii.

Lastly, another form of ornamented plate in the Balcletchie conglomerate consists of one having a central point, from which four radii proceed. These radii, or ridges, are joined one to another by straight ornamenting lines parallel to the margins of the plate, producing a square figure.

In taking into consideration the affinity of these plates, it must not be forgotten that the late Mr J. W. Salter described minute sharp tubercles on the interior of the plates of *Glyptocrinus*, but which in no way gave rise to perforations. They are placed "along the edges, or at the angles of the plates, or more commonly still on either side of the faint radiating ridges."[1] As seen in the casts, he compares them to the surface pores of the *Sphæronites*.

So far as we can see, these little plates from Girvan appear to have more in common with the Cystoidea than the Crinoidea.

[1] Mem. Geol. Survey, iii. p. 283.

INDEX.

The names in ordinary type are those described in the present work.
Those in *italics* are synonyms.
Those with an asterisk (*) prefixed are merely referred to in illustration of remarks.

* Acestra, Roemer, 240.
Acidaspis, Murch., 121.
* Acidaspis Barrandei, Fletcher, 128.
* Acidaspis bispinosa, M'Coy, 128.
* Acidaspis Brightii, Murch., 128.
Acidaspis callipareos, Wyv. Thomson, 125.
* Acidaspis Caractaci, Salter, 128.
* Acidaspis coronatus, Salter, 128.
* Acidaspis crenatus, Emmrich, 129.
* Acidaspis Dufrenoyi, Barr., 125.
Acidaspis Grayæ, R. Eth., 126.
Acidaspis hystrix, Wyv. Thom., 123.
* Acidaspis Hughesii, Salter, 128.
* Acidaspis Jamesii, Salter, 128.
* Acidaspis Keyserlingi, Barr., 128.
Acidaspis Lalage, Wyv. Thom., 121.
* Acidaspis mira, Barr., 128.
* Acidaspis ovatus, Emmrich, 125.
* Acidaspis Prevosti, Barr., 125.
* Acidaspis rara, Barr., 128.
* Acidaspis tricornis, Barr., 128.
Acidaspis unicus, Wyv. Thom., 118.
Acidaspis, sp., 206.
Æglina, Barr., 283.
Æglina armata, Barr., 286.
Æglina rediviva, Barr., 284.
* Agnostus, Brongn., 200, 296.
* Agnostus aculeatus, Angelin, 298.
Agnostus agnostiformis, M'Coy, 200.
* Agnostus Americanus, Billings, 298.
Agnostus convexus, Salter, 200.
* Agnostus exsculptus, Angelin, 298.
* Agnostus Moorei, Salter, 298.
* Agnostus nodosus, Belt., 298.
Agnostus perrugatus, Barr., 296.
* Agnostus punctuosus, Angelin, 298.
Agnostus trinodus, Salter, 200.
Aldens beds, 232.
* Alepidaster, Meek, 322.
* Alveolites, Lamk., 38.
Alveolites Labechei, Edw. and H., 38.
Alveolites (?) Peachii, Eth., 31.
Amphitryon, Corda, 145.
Ampyx, Dalman, 176, 177.
Ampyx Austinii, Portlock, 188.
* Ampyx Brückneri, Boll., 182.
* Ampyx costatus, Boeck, 185.
Ampyx Hornei, E. and N., 184.
Ampyx (?) Macconochiei, E. and N., 183.
* Ampyx mammillatus, Sars, 185.
Ampyx Macallumi, Salter, 180.
* Ampyx nasutus, Dalm., 182.
* Ampyx parvulus, Forbes, 182.
* Ampyx prænuntius, Salter, 182.
Ampyx rostratus, Sars, 178.
Ampyx Sarsii, Portlock, 178.
* Ampyx tumidus, Forbes, 182.
Ampyx (?) sp., 206.
Aptychoides (auct), 211.
Aptychopsis, Barr., 210, 211.
* Aptychopsis glabra, Woodw., 211.
* Aptychopsis Lapworthi, Woodw., 211
* Aptychopsis Wilsoni, Woodw., 211.
Archasterias, Müller, 323.
Ardmillan Brae beds, 229.
* Asaphus, Brongniart, 153.
Asaphus cyllarus, His., 190.
Asaphus gigas, De Kay, 153.

Asaphus radiatus, Salter, 153.
* Asaphus rectifrons, 153.
Asaphus seticornis, His., 190.
Asaphus tuberculatus, Buck., 108, 109.
* Asaphus tyrranus, Salter, 154.
Atractopyge verrucosa, Corda, 111.
* Aulacophyllum mitratum, His., 80.

Balcletchie Beds, 227.
* Basilicus, Salter, 153.
Bdellocoma, Salter, 323.
* Beyrichia, M'Coy, 218.
Beyrichia comma, Jones, 219.
Beyrichia impendens, Jones, 219.
Beyrichia Klœdeni, M'Coy, 218.
* Beyrichia Salteriana, 219.
Beyrichia tuberculata, Salter, 218.
* Beyrichia venusta, Billings, 220.
Blair Farm beds, 233.
Brachampyx, Forbes, 176, 177.
Bronteopsis, Thomson, 166.
Bronteopsis Scotica, Salter, 167.
* Bronteus, Goldfuss, 162.
Bronteus Andersoni, E. and N., 162.
* Bronteus Barrandii, Hall, 165.
* Bronteus flabellifer, Goldf., 164.
* Bronteus Hibernicus, Portl., 164.
* Bronteus laticauda, Wahl., 164.
* Bronteus occasus, W. and M. 165.
* Bronteus signatus, Phill., 164.
Bronteus, sps., 165, 166.

Calamopora Gothlandica, Goldf., 37.
Calamopora spongites, Eichw., 38.
* Calliaster, Trautschold, 322.
* Callopora, Hall, 39.
Calostylis, Lindström, 63.
* Calostylis denticulata, Lindström, 64.
Calostylis Lindströmi, N. and E., 65.
* Calymene, Brong., 140.
* Calymene Alportiana, Salter, 142.
Calymene Blumenbachii, Brong., 140.
* Calymene Caractaci, Salter, 143.
Calymene (?) clavifrons, Dal., 101.
Calymene Niagarensis, Hall, 142.
Calymene punctatus, Dalm., 109.
Calymene senaria, Conrad, 141.
Calymene spectabilis, Ang., 141.
* Calymene tuberculosa, Salter, 142.
Calymene variolaris, Brong., 109.
Calymene verrucosa, Dalm., 111.
Caphyra, Barrande, 145.
Catenipora, Lamk., 274.
Catenipora approximata, Eichw., 49.
Catenipora escharoides, Lamk., 49.
Catenipora labyrinthica, Goldf., 49.
Catenipora tubulosa, Lamx., 49.
Centrotus, Lindström, 81.
* Chætetes, Fischer, 43.
* Chætetes, Fletcheri, Edw. and H., 43.
* Chætetes petropolitanus, Pand., 35, 53.
* Chætetes pulchellus, Edw. and H., 43.
Chætetes, sp. ind., 43.
* Cheirurus, Beyrich, 100.
Cheirurus bimucronatus, Murch., 100, 202.
Cheirurus clavifrons, Dalm.? 101, 202.
Cheirurus gelasinosus, Portl., 100.
* Cheirurus gibbus, Beyrich, 106.
* Cheirurus glaucus, Bill., 106.
* Cheirurus Hawlei, Barr., 204.
* Cheirurus insignis, Beyrich, 106.
* Cheirurus juvenis, Salter, 103.
* Cheirurus octolobatus, Salter, 101, 103.
* Cheirurus ornatus, Dalm., 106.
* Cheirurus satyrus, Bill., 106.
Cheirurus trispinosus, Young, 105.
* Cheirurus vinculum, Barr., 204.
Cheirurus, sp. ind., 107, 203, 204.
* *Chiton Wrightianus*, de Kon., 213.
* Chondrites, Sternb., 9.
* Chondrites verisimilis, Salter, 9.
Clathrodictyon, N. and M., 237.
* Clathrodictyon cellulosum, N. and M., 239.
Clathrodictyon vesiculosum, N. and M., 238.
* *Clisiophyllum denticulatum*, Kjerulf, 64.
* Coccoseris, Eichw., 61.
* Cœlaster, G. and F. Sandb., 322.
* Conocephalites striatus, 189.
* Conocephalites Sulzeri, 189.
Corals, general remarks on, 92.
Craighead limestone, 93.
* Cribellites, G. Tate, 322.
Crossochorda, Schimper, 307.
Crossopodia, M'Coy, 307.
* Crossopodia Embletoni, Tate, 308.
* Crossopodia Loomisii, Emmons, 308.
* Crossopodia media, Tate, 308.
Crossopodia Scotica, M'Coy, 308.
Crustacea, general remarks on, 223.
Cryptonemus punctatus, Angelin, 109.
* Cyathaxonia, Mich., 81.
* Cyathaxonia cornu, Mich., 81.
* Cyathaxonia Dalmani, Edw. and H., 81, 84.

* Cyathaxonia Siluriensis, M'Coy, 81.
Cyathophyllum articulatum, Edw. and H., 74.
Cybele, Lovén, 110.
Cybele bellatula, Dalm., 113.
* Cybele brevicaudata, Angelin, 114.
* Cybele dentata, Esmark, 114.
* Cybele Lovéni, Linnarsson, 205.
Cybele punctata, Fletcher, 108.
Cybele rugosa, Portlock, 112, 205.
Cybele sexcostata, Salter, 111.
Cybele verrucosa, Dalm., 111, 114.
Cyclocrinus Spaskii, Eichw., 14.
* Cyclocrinus, Eichw., 10.
Cyclopyge, H. and C., 283.
Cyclopyge armata, Barr., 286.
Cyclopyge megacephala, Corda, 284.
* Cyclopyge mirabilis, Forbes, 287.
Cyclopyge rediviva, Barr., 284.
* Cymaderma, Duns, 315.
* Cyphaspis, Burmeister, 140.
Cyphaspis megalops, M'Coy, 140.
Cyrtometopus affinis, Angelin, 101.
* Cythere, O. F. Müller, 216.
Cythere aldensis, M'Coy, 216.
Cythere aldensis, var. major, Jones, 216.
Cythere Grayana, Jones, 217.
Cythere Wrightiana, J. and H., 217.
Cytheropsis aldensis, M'Coy, 216.

* Deiphon Forbesii, Barr., 121.
* Dictyocaris, Salter, 212.
Dictyocaris, sp., 212.
Dindymene, Corda, 114.
Dindymene Cordai, E. and N., 115.
* Dindymene Friderici-Augusti, Corda, 116.
* Dindymene Haidingeri, Barr., 116.
Dione, Barr., 289.
Dionide, Barr., 289.
* Dionide atra, Salter, 291.
* Dionide euglypta, Angelin, 292.
* Dionide formosa, Barr., 292.
Dionide Lapworthi, E. and N., 290.
* Dionide (?) perplexa, Billings, 292.
Dionide, sp., 293-295.
* Diplochorda, Schimper, 318.
Discinocaris, Woodward, 210, 211.
Drummuck beds, 231.
* Dysplanus, Burm., 155.

* Eccoptochile, 119.
* Edrioaster, Billings, 322.
Egle, Barr., 283.
Egle rediviva, Barr., 284.
Eione, Tate, 308.
* Eione moniliforme, Tate, 309.
* Encrinurus, Emmrich, 108.
Encrinurus punctatus, Brün., 108, 110.
Encrinurus punctatus, var. arenaceus, Salter, 109.
Encrinurus punctatus, var. calcareus, Salter, 108, 205.
Encrinurus sexcostatus, 110.
Encrinurus Stokesii, M'Coy, 109.
Encrinurus variolaris, Brong., 110.
* Entomis, Jones, 223.
Entomis globulosa, Jones, 223.
Entomolithus paradoxus, Linn., 141.
* Eucladia, H. Woodw., 321.
* Eugaster, Hall, 322.

* Favosites, Lamk., 34, 281.
* Favosites aspera, D'Orb., 34, 282.
Favosites Girvanensis, N. and E., 34.
Favosites Goldfussi, D'Orb., 37.
Favosites Gothlandica, Lamk., 37.
* Favosites Hisingeri, Edw. and H., 33.
Favosites Mullochensis, N. and E., 36, 281.
Favosites Niagarensis, Hall, 37.
Favosites spongites, Lons., 38.
Favosites sub-basaltica, D'Orb., 37.
Fistulipora, M'Coy, 38.
Fistulipora favosa, N. and E., 40.
Fistulipora (?) pilula, N. and E., 41.

Girvanella, N. and E., 23.
Girvanella problematica, N. and E., 23.
* Glyptaster, Hall, 322.
Glyptocrinus, Hall, 328.
Glyptocrinus, sp., 329.
* Grantia, 20.

Halysites, Fischer, 49, 274.
Halysites attenuata, Fischer, 49.
Halysites catenularia, Linn., 33.
Halysites catenulata, Linn., 49, 275.
Halysites catenularia, M.-Edw., 49.
Halysites escharoides, De Blainv., 49, 275.
Halysites labyrinthica, M.-Edw., 49.
Halysites, sp., 278, 279, 280.
Harpes megalops, M'Coy, 140.
Harpidella megalops, M'Coy, 140.
* Helianthaster, Roemer, 321.

Heliolites, Dana, 57, 241.
Heliolites affinis, Billings, 251.
Heliolites Daintreei, E. and N., 250.
Heliolites dubia, F. Schmidt, 250.
Heliolites exiguus, Billings, 250.
Heliolites favosus, Salter, 26.
Heliolites foliacea, N. and E., 259.
Heliolites Grayi, Edw. and H., 58, 252.
Heliolites inordinata, Lonsd., 253.
Heliolites interstincta, Wahl., 27, 57, 241, 243, 254.
Heliolites macrostylus, Hall, 252.
Heliolites megastoma, M'Coy, 241, 247.
Heliolites micropora, Eichwald, 244, 245.
Heliolites Murchisoni, Ed. and H., 243, 244.
Heliolites (?) parasitica, N. and E., 259.
Heliolites parvistella, Roemer, 247.
Heliolites placenta, Goldf., 248.
Heliolites plasmoporoides, E. and N., 249.
Heliolites porosa, Goldf., 244.
Heliolites pyriformis, Hall, 246.
Heliolites sparsus, Billings, 249.
Heliolites speciosus, Billings, 251.
Heliolites subtilis, M'Coy, 253.
Heliolites subtubulata, M'Coy, 243.
Heliolites tenuis, Billings, 247.
Herpetocrinus, Salter, 331.
* Hyalonema, Gray, 239.
Hyalonema (?) Girvanense, N. and E., 239.
* Hyalonema parallelum, M'Coy, 240.
* Hyperammina, 21.
* Hyperammina vagans, Brady, 23.

Illænopsis Thomsoni, Salter, 156.
Illænus æmulus, Salter (?) 157.
* Illænus, Dalm., 155.
Illænus Bowmani, Salter, 155.
Illænus crassicauda, Wahl. (?), 160.
Illænus Davisii, Salter, 159.
Illænus latus, M'Coy, 156.
Illænus Macallumi, Salter, 162.
Illænus Murchisoni, Salter (?), 161.
Illænus nexilis, Salter, 158.
Illænus Rosenbergii, Eichw. (?), 159.
Illænus Thomsoni, Salter, 156.
Ischadites, Murch., 19.
* Ischadites antiquus, Salter, 20.
Ischadites Kœnigii, Murch., 20.
* Isotelus, De Kay, 153.
Isotelus gigas, De Kay, 153.
Kirkhill beds, 233.
* Kröyera arenaria, S. Bate, 315.

* Lepidaster, Forbes, 321.
* Leucophthalmus, Kœnig, 19.
* Lichas, Dalm., 131.
* Lichas anglicus, Beyrich, 139.
Lichas Barrandei, Fletcher (?), 132, 139.
Lichas Geikiei, E. and N., 137.
Lichas Grayii, Fletcher, 134, 139.
* Lichas heteroclyta, Barr., 139.
Lichas Hibernicus, Portl., 133.
* Lichas hirsutus, Fletcher, 139.
* Lichas laciniatus, Dalm., 132.
Lichas laxatus, M'Coy, 131, 139.
* Lichas macrocephalus, Eichw., 134.
* Lichas verrucosus, Eichw., 139.
Lichas, sp. ind., 135.
* Lichenalia, Hall, 54.
Lindströmia, N. and T., 80.
* Lindströmia columnaris, Nich., 84.
Lindströmia Dalmani, Edw. and H., 84.
Lindströmia lævis, N. and E., 90.
Lindströmia subduplicata, M'Coy, 84, 86.
Lonchodomus, Angelin, 177.
Lonchodomus rostratus, Angelin, 178.
* Loricula, 213.
* Lumbriconereis gigantea, Quatref., 310.
* Lyellia, 252.
* Lyellia Americana, Edw. and H., 252.
Lyopora, N. and E., 25.
Lyopora favosa, M'Coy, sp., 26.

Madrepora interstincta, Linn., 57.
Madreporites interstinctus, Wahl., 57.
* Monticulipora, D'Orb., 47.
* Monticulipora petropolitana, Pander, 250.
Mulloch Hill beds, 95, 225.
Myelodactylus, Hall, 330.
* Myelodactylus convolutus, Hall, 331.
Myelodactylus, sp., 333.
Myrianites, Macleay, 305, 311.
* Myrianites Macleayi, Murch., 307.
* Myrianites Murchisoni, Emmons, 307.
Myrianites tenuis, M'Coy, 306, 312.
* Myrianites Sillimani, Emmons, 307.

* Nemertites undulata, Tate, 309.
* Neograpsus Jacksoni, Emmons, 311.
Nereites, Macleay, 305, 310.

Nereites Cambrensis, Murch., 305.
Nereites Sedgwickii, Murch., 305.
Nidulites, Salter, 10.
Nidulites favus, Salter, 11, 18.
Nidulites parvus, E. and N., 18.
Nuttania Hibernica, Portl., 133.

Odontopleura, Emmrich, 121.
Ogygia (?) rugosa, Portl., 112.
* Onychaster, M. and W., 322.
Ophiocrinus, Charlesworth, 330.
Oploscolex, Salter, 213.

Palæaster, Hall, 318.
Palæaster, Salter, 318, 324.
Palæaster asperrimus, Salter, 320.
Palæaster Caractaci, Salter, 321.
Palæaster coronella, Salter, 320.
* *Palæaster hirudo*, Forbes, 320.
Palæaster imbricatus, Salter, 321.
* Palæaster matutina, Hall, 319.
* Palæaster Niagarensis, Hall, 319.
Palæaster obtusus, Forbes, 321.
Palæaster Ruthveni, Forbes, 320.
* Palæaster Shæfferi, Hall, 319.
* Palæocoma, Salter, 322.
* Palæodiscus, Salter, 322.
Palæophyllum, Billings, 67.
* Palæophyllum divaricans, Nich., 73.
* Palæophyllum rugosum, Billings, 73.
Palæopora interstincta, M'Coy, 57.
Palæopora favosa, M'Coy, 18, 25, 26.
Palæopora subtubulata, M'Coy, 243.
* Palasterina, M'Coy, 322.
* Pasceolus, Billings, 10.
* Pasceolus Halli, Billings, 14.
* Pasceolus globosus, Billings, 14.
Peltocaris, Salter, 210.
Peltocaris (?), sp., 212.
Penkill beds, 96, 227.
Penwhapple beds, 230.
Petraia, M'Coy, 67, 85.
Petraia æquisulcata, M'Coy, 79.
* Petraia Benediana, De Kon., 86.
Petraia subduplicata, M'Coy, 86.
* Petraia uniserialis, M'Coy, 91.
Petraster, Billings, 322.
* Phacops, Emmrich, 98.
Phacops Brongniarti, Portl., 99, 201.
* Phacops Downingiæ, 98.
* Phacops longicaudatus, 204.
Phacops Stokesii, M.-Edw., 98.
Phacops truncato-caudatus, E. and N., 99.
* Phyllocorda sinuosa, Ludwig, 305.
Pinacopora, N. and E., 52, 264, 272.
Pinacopora Andersoni, N. and E., 272.
Pinacopora Grayi, N. and E., 54.
Pinnocaris, Eth., jun., 207.
Pinnocaris Lapworthi, Eth., jun., 210.
Plasmopora, Edw. and H., 263, 264.
Plasmopora exserta, N. and E., 269.
* Plasmopora follis, Edw. and H., 268.
Plasmopora Girvanensis, N. and E., 266.
* Plasmopora micropora, Goldf., 268.
* Plasmopora petaliformis, Lonsd., 33, 267.
* Plasmopora scita, Edw. and H., 267.
Plumulites, Barr., 213.
Polytomurus, H. and C., 289.
Porites pyriformis, Lonsd., 57.
Prasopora, N. and E., 44.
Prasopora Grayæ, N. and E., 35, 46, 48.
* Primitia, Jones and Holl, 220.
Primitia Barrandiana, Jones, 220.
* Primitia Beyrichiana, J. and H., 222.
* Primitia Logani, Jones, 221.
* Primitia mundula, Jones, 221.
* Primitia prunella, Barr., 221.
* Primitia simplex, Jones, 221.
Proetus, Steininger, 169.
* Proetus Archiaci, Barr., 172.
* Proetus ascanius, Barr., 172.
* Proetus Bohemicus, Barr., 172.
* Proetus concinnus, Dalm., 173.
* Proetus corycœus, Hall, 173.
* Proetus decorus, Barr., 172.
Proetus Girvanensis, E. and N., 169.
* Proetus latifrons, M'Coy, 171.
* Proetus Lovéni, Barr., 172.
* Proetus micropygus, Barr., 172.
* Proetus Missouriensis, Shum., 173.
* Proetus myops, Barr., 172.
* Proetus natator, Barr., 172.
Proetus procerus, E. and N., 174.
* Proetus protuberans, Hall, 173.
* Proetus Ryckholtii, Barr., 172.
* Proetus Spurlockii, Meek, 173.
* Proetus Stokesii, Murch., 171.
* Proetus striatus, Barr., 172.
* Proetus superstes, Barr., 172.
* Proetus Swallovii, Shum., 173.
* Proetus unguloides, Barr., 172.
* Proetus venustus, Barr., 172.
Propora, Edw. and H., 264, 270.
Propora conferta, Edw. and H., 268.
Propora Edwardsii, N. and E., 270.

* Propora tubulata, Lonsd., 271.
* Protaræa, 59.
* Protaræa vetusta, Hall, 63.
* Protaster, Forbes, 322.
* Ptilonaster, Hall, 322.
Ptychophyllum Craigense, Linds., 74.
* Pyritonema, M'Coy, 240.

Raphiophorus, Angelin, 177.
* Receptaculites Canadensis, Bill., 20.
Receptaculites Neptuni, 20.
Remopleurides, Portl., 145.
* Remopleurides affinis, Bill., 145, 148.
Remopleurides Barrandii, E. and N., 151.
* Remopleurides Canadensis, Billings, 145, 148, 152.
Remopleurides Colbii, Portl., 146, 150.
Remopleurides dorsospinifer, Portl., 148, 150.
Remopleurides Kolbii, Emmrich, 146.
Remopleurides laterispina, Corda, 149.
Remopleurides laterispinifer, Portl., 145, 149, 150.
Remopleurides longicostatus, Portl., 150.
* Remopleurides Panderi, Billings, 145, 148, 152.
* Remopleurides platyceps, M'Coy, 145, 148.
* Remopleurides quatuorlineatus, Ang., 145, 152.
* Remopleurides radians, Barr., 145.
* Remopleurides Schlotheimi, Billings, 145, 152.
* Remopleurides sexlineatus, Angelin, 145, 152.
Remopleurides, sps., 149, 150.
* Rhopalocoma, Salter, 322.

* Saccammina, Sars., 21.
Saccammina Carteri, Brady, 21.
* Salteria, Wyv. Thomson, 199.
Salteria primæva, Wyv. Thomson, 199.
* Schænaster, M. and W., 322.
Serpulites, Macleay, 303.
* Serpulites dispar, Salter, 304.
Serpulites longissimus, Murch., 303.
Shalloch Mill beds, 97.
Solenocaris, Meek, 207.
* Solenocaris, Young, 207.
Solenocaris solenoides, Young, 207.
* Sphærexochus, Beyrich, 107.
Sphærexochus mirus, Beyrich, 107.
* Sphærocoryphe, Angelin, 119.
* Sphæronites, 334.
* Sphæronites tesselatus, Phill., 16.
* Sphærospongia, Salter, 10.
* Sphærospongia hospitalis, Salter, 17.
* Sphærospongia melliflua, Salter, 14.
* Staurocephalus, Barrande, 117, 283.
Staurocephalus globiceps, Portl., 117.
Staurocephalus Maclareni, Wyville Thomson, 118.
Staurocephalus nodulosus, Salter, 121.
Staurocephalus (?) unicus, Wyv. Thomson, 118.
Staurocephalus (?), sp. 283.
* Stenaster, Billings, 323.
* Strephodes, M'Coy, 68.
Strephodes Craigensis, M'Coy, 74.
Streptelasma, Hall, 67.
Streptelasma (?) æquisulcatum, M'Coy, 79.
Streptelasma aggregatum, N. and E., 71.
* Streptelasma corniculum, Hall, 70, 75.
Streptelasma corniculum, Schmidt, 76.
Streptelasma Craigense, M'Coy, 74.
* Streptelasma expansa, Hall, 68.
Streptelasma Europæum, Rom., 71, 76.
* Stygina latifrons, Salter, 169.
Stylaræa, Von Seebach, 60.
Stylaræa occidentalis, N. and E., 62.
* Stylaræa Römeri, Von Seebach, 63.
* Sulcator arenarius, S. Bate, 315.

Tæniaster, Billings, 323.
Tetradium, Dana, 29.
Tetradium Peachii, N. and E., 30, 31.
Tetraster, E. and N., 324.
Tetraster (?) asperrimus, Salter, 324.
Tetraster obtusus, Forbes, 324.
Tetraster Wyville-Thomsoni, E. and N., 324.
Tetraster, sp., 325.
* Thecostegites auloporoides, Edw. and H., 51.
* Thecostegites Bouchardi, Edw. and H., 51.
Thecostegites (?) Scoticus, N. and E., 50.
Thraive Glen beds, 232.
Tretaspis, M'Coy, 188.
Tretaspis secticornis, M'Coy, 190.
* Trichotaster, Wright, 321.

Trilobites Blumenbachii, Schl., 141.
Trinodus agnostiformis, M'Coy, 200.
Trinodus tardus, M'Coy, 200.
Trinucleus, Lhwyd, 188, 288.
Trinucleus Bucklandi, Barr., 190.
Trinucleus concentricus, Eaton, 198.
Trinucleus Macconochiei, E. and N., 288.
Trinucleus seticornis, His., 189, 190.
Trinucleus, sp., 198, 288.
Tubipora catenularia, Linn., 49.
Tubipora catenulata, Gmelin, 49.
Turbinolopsis, Phill., 85.
Turrilepas, Woodw., 213, 299.
* Turrilepas Bohemicus, Barr., 302.
* Turrilepas Haswelli, Salter (MS.), 215.
Turrilepas Peachii, E. and N., 301.
* Turrilepas regius, Barr., 302.
Turrilepas Scotica, Eth. jun., 214.
* Turrilepas Wrightii, Woodw., 215, 299.

Urasterella, M'Coy, 320, 323.

Xenaster, Simonow., 323.

* Zaphrentis, 70.
* Zaphrentis cylindrica, Edw. and H 70.
Zaphrentis Guerangeri, Edw. and H., 70.
Zethus, Pander, 110.
Zethus atractopyge, M'Coy, 111.

END OF THE FIRST VOLUME.

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PLATE I.

Fig. 1. Small specimen of *Lyopora favosa*, M'Coy, sp., of the natural size. *Coll.* H. A. Nicholson.

Fig. 1 *a*. A few calices of the same, enlarged.

Fig. 1 *b*. Thin transverse section of the same, viewed on a dark background, of the natural size. *Coll.* H. A. Nicholson.

Fig. 1 *c*. Another transverse section, also viewed on a dark background, of the natural size. *Coll.* H. A. Nicholson.

Fig. 1 *d*. Vertical section of same, similarly viewed, of the natural size. *Coll.* H. A. Nicholson.

Fig. 1 *e*. A few calices of 1 *c*, enlarged about ten times.

Fig. 2. Side view of a large specimen of *Favosites Girvanensis*, Nich., and Eth. jun., of the natural size.

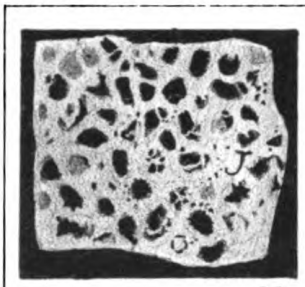
Fig. 2 *a*. Under surface of an average example of the same, of the natural size.

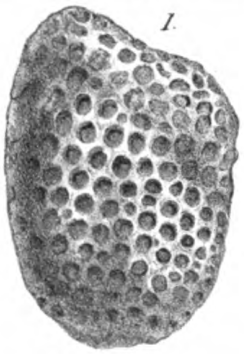
Fig. 2 *b*. Vertical section of the same, showing tabulæ,.enlarged about twenty-five times.

Fig. 2 *c*. Vertical section of another example, without tabulæ, similarly enlarged.

Fig. 2 *d*. Transverse section of the same, similarly enlarged.

Fig. 3. Transverse section of *Tetradium Peachii*, magnified about one hundred times. *Coll.* H. A. Nicholson.

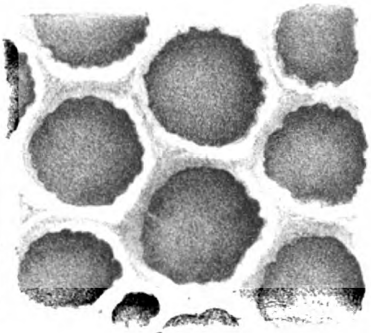

1.b


1.

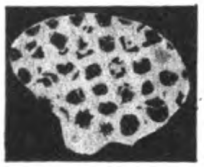

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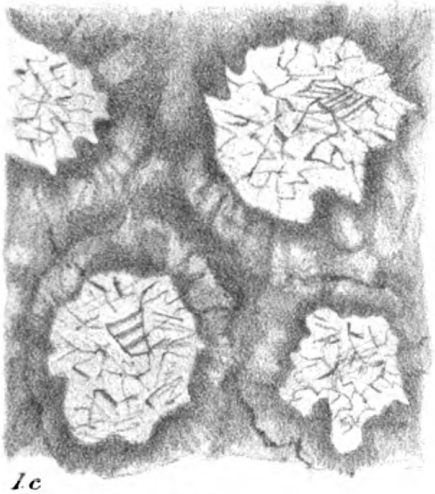

2.a

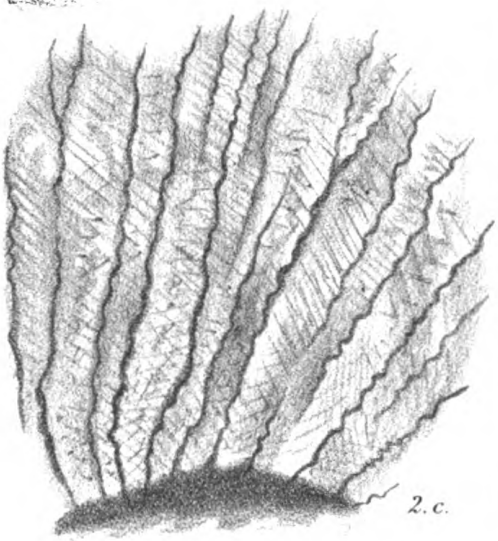

1.d

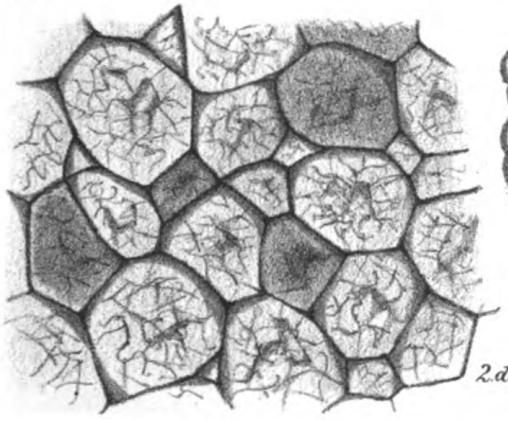

1.a


2.b


1.c


1.c


2.c.


2.d

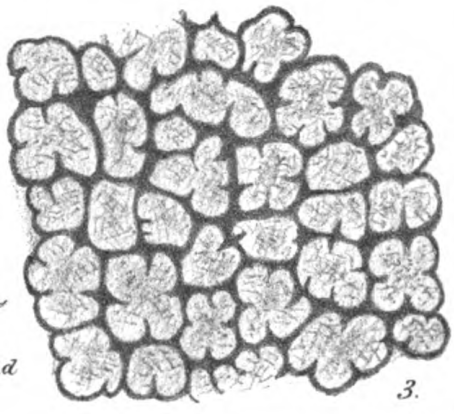

3.

PLATE II.

Fig. 1. Vertical section of *Tetradium Peachii*, in which tabulæ are abundantly developed, enlarged about fifty times. *Coll.* H. A. Nicholson.

Fig. 1 *a*. Another vertical section of the same, similarly enlarged, in which tabulæ are absent.

Fig. 1 *b*. Mass of *Tetradium Peachii*, showing the form of the surface, of the natural size.

Fig. 2. A small example of *Favosites Mullochensis*, the base of which has been cut away, of the natural size. No surface-characters are shown.

Fig. 2 *a*. Transverse section of the same, enlarged ten times.

Fig. 2 *b*. Vertical section of part of the same, similarly enlarged.

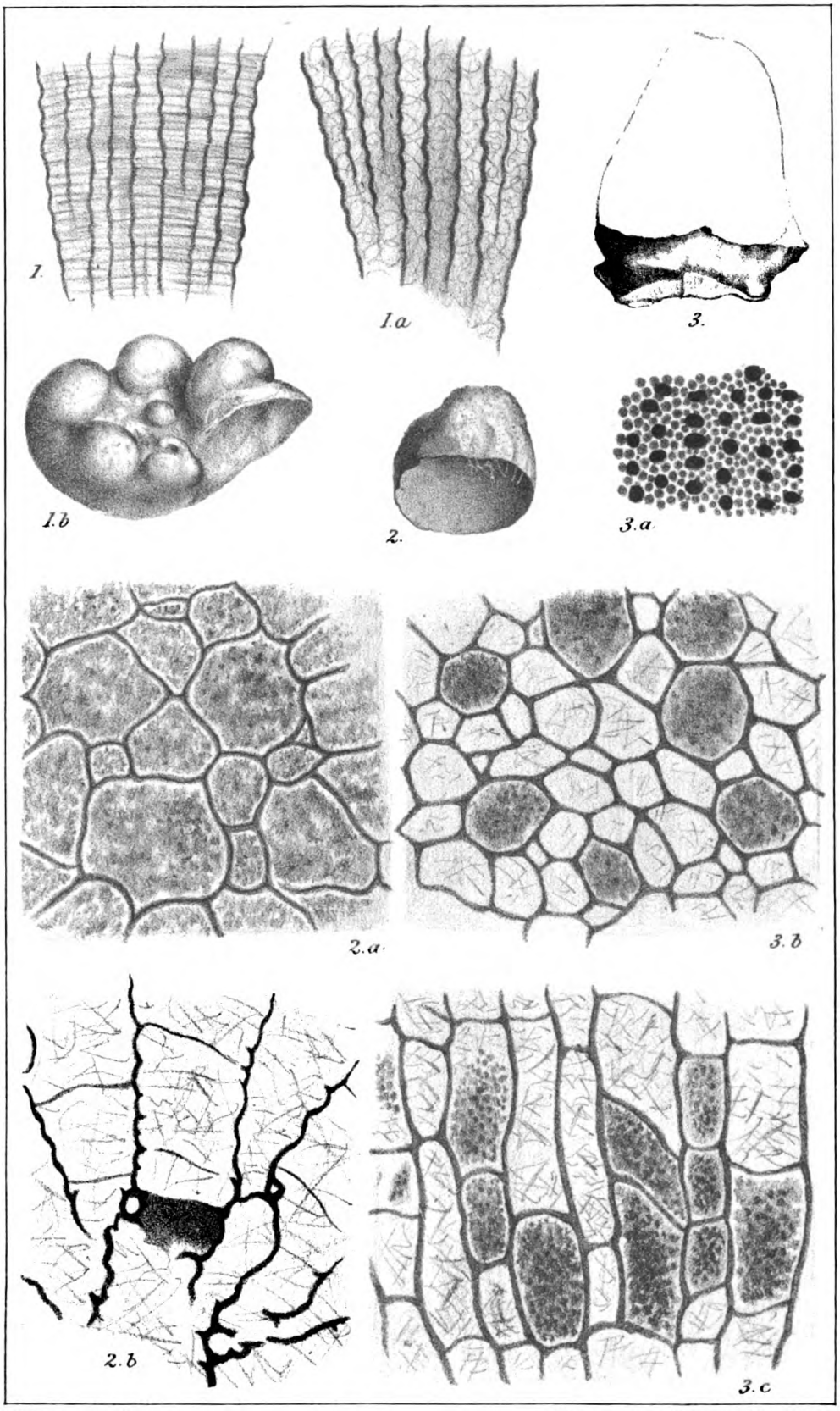
Fig. 3. Fragment of the base of a mass of *Fistulipora favosa*, of the natural size. The outline shows the original size of the mass prior to sectioning.

Fig. 3 *a*. Portion of the weathered surface of the same, enlarged about six times. The larger tubes appear black, not from shadow, but from being filled with the dark matrix, while the intervening tubuli are filled with calcite.

Fig. 3 *b*. Portion of a transverse section of the same, enlarged twenty-five times.

Fig. 3 *c*. Longitudinal section of the same, similarly enlarged.

H Alleyne Nicholson, del. Plate II.



C Bergeau, lith. G. Waterston, Sons & Stewart, Lith^rs Edin^r

PLATE III.

Fig. 1. A specimen of *Fistulipora* (?) *pilula*, of the natural size, viewed from one side.

Fig. 1 *a*. Small portion of the transverse section of the same, enlarged about twenty-five times.

Fig. 1. *b*. Portion of the vertical section of the same, enlarged about twelve times.

Fig. 2. Fragment of *Chætetes*, sp., of the natural size.

Fig. 2 *a*. Part of the transverse section of the same, enlarged ten times.

Fig. 2 *b*. Part of the vertical section of the same, similarly enlarged.

Fig. 3. *Under* surface of the epithecal plate of a small example of *Pinacopora Gray*, of the natural size.

Fig. 3 *a*. *Upper* surface of the epithecal plate of another specimen of the same, from which all the corallites have been denuded, except a few casts on the extreme margin,—of the natural size.

Fig. 3 *b*. *Upper* surface of another specimen of the same, in which the bases of a number of the corallites are still left adherent to the epithecal plate,—of the natural size.

Fig. 3 *c*. Vertical section across the corallum of another specimen of the same, imperfect at the sides,—of the natural size.

Fig. 3 *d*. Horizontal section across the corallites of another specimen of the same, enlarged about twenty times.

Fig. 3 *e*. Vertical section through part of the corallum of another specimen of the same, enlarged about ten times. In this and the preceding figure the large-sized corallites are lettered *p*, while the intervening tabulate tubes are lettered *t*.

Fig. 3 *f*. Cast of the upper surface of a large specimen of *Pinacopora Grayensis*.

Fig. 3 *g*. Portion of the cast, enlarged five times. The short fluted columns in this are casts of the larger corallites, while the intervening spaces were originally occupied by the smaller tubes.

Fig. 3 *h*. Portion of a corallum which has naturally split in two along a horizontal plane, showing the corallites embedded in the dark matrix, —enlarged five times.

Fig. 3 *i*. Portion of a vertical section of corallum, similarly embedded in matrix, and similarly enlarged.

Fig. 3 *j*. Portion of the surface of a gutta-percha mould of the natural cast of *Pinacopora Grayensis*, showing the calices,—enlarged five times.

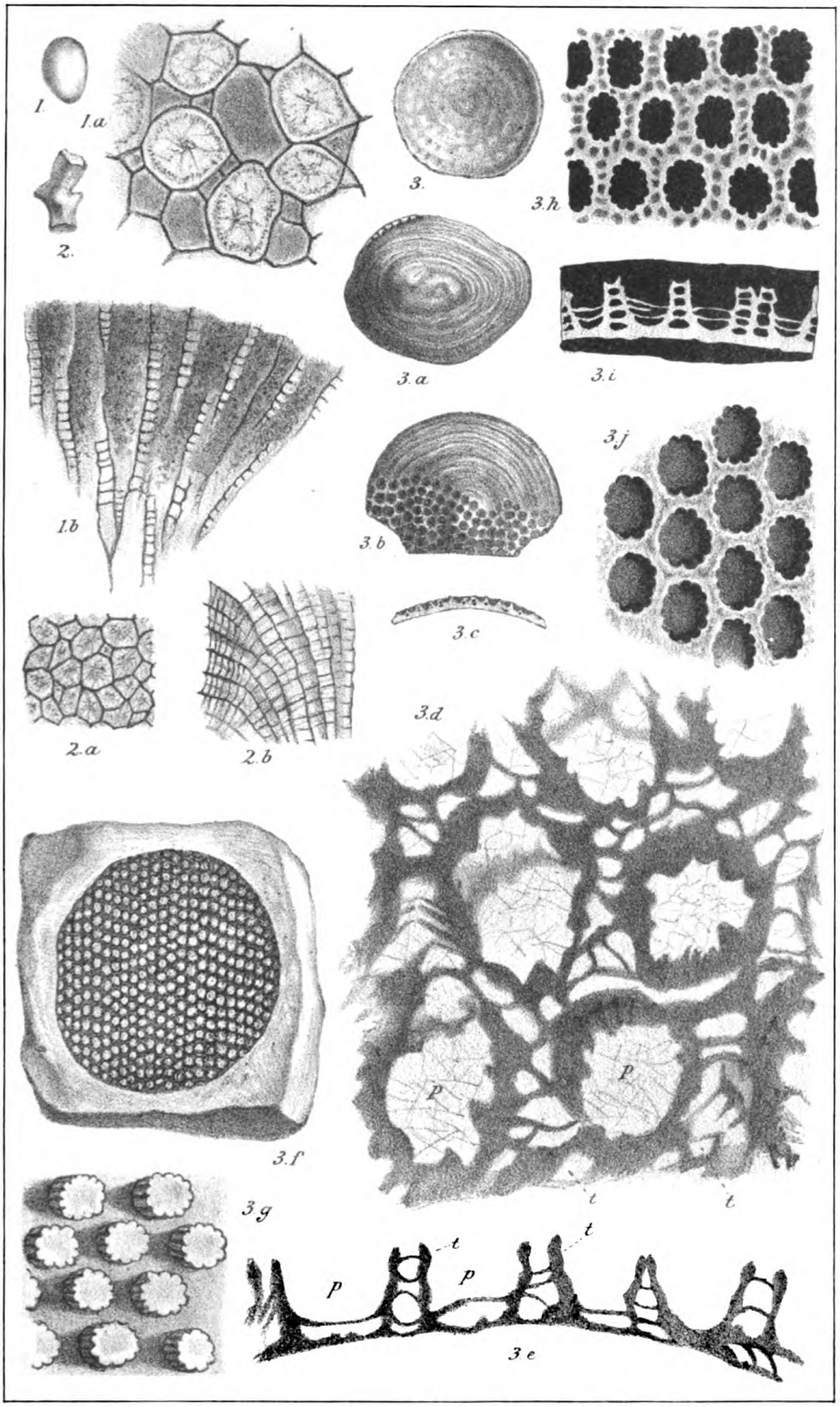

1.
1.a
2.
3.
3.h
3.a
3.i
1.b
3.b
3.j
3.c
2.a
2.b
3.d
p
p
t
t
3.f
3.g
t
t
p
p
3.e

PLATE IV.

Fig. 1. Portion of the surface of *Thecostegites* (?) *Scoticus*, enlarged five times.

Fig. 1 *a*. Portion of a slice of the same, taken parallel with the surface, enlarged ten times, showing the calices, with their rudimentary septa. The calices are filled with the dark-coloured matrix, and as the section intersects the corallites obliquely, the walls of the tubes are brought into view.

Fig. 1 *b*. Portion of a vertical section of the same, enlarged ten times. The section traverses on one side the exterior of the corallum, and the surrounding matrix is seen to have penetrated to some extent into some of the tubes.

Fig. 2. Portion of the transverse section of *Stylaræa occidentalis*, enlarged twenty times, showing two calices, and part of a third, with their columellæ, and the reticulate structure of the cœnenchyma. Viewed by transmitted light. *Coll.* H. A. Nicholson.

Fig. 2 *a*. Portion of the same section as the preceding, enlarged ten times, and viewed on a dark background.

Fig. 2 *b*. Part of a vertical section of *Stylaræa occidentalis*, enlarged ten times, showing tabulæ. The columella is shown in parts of the tubes.

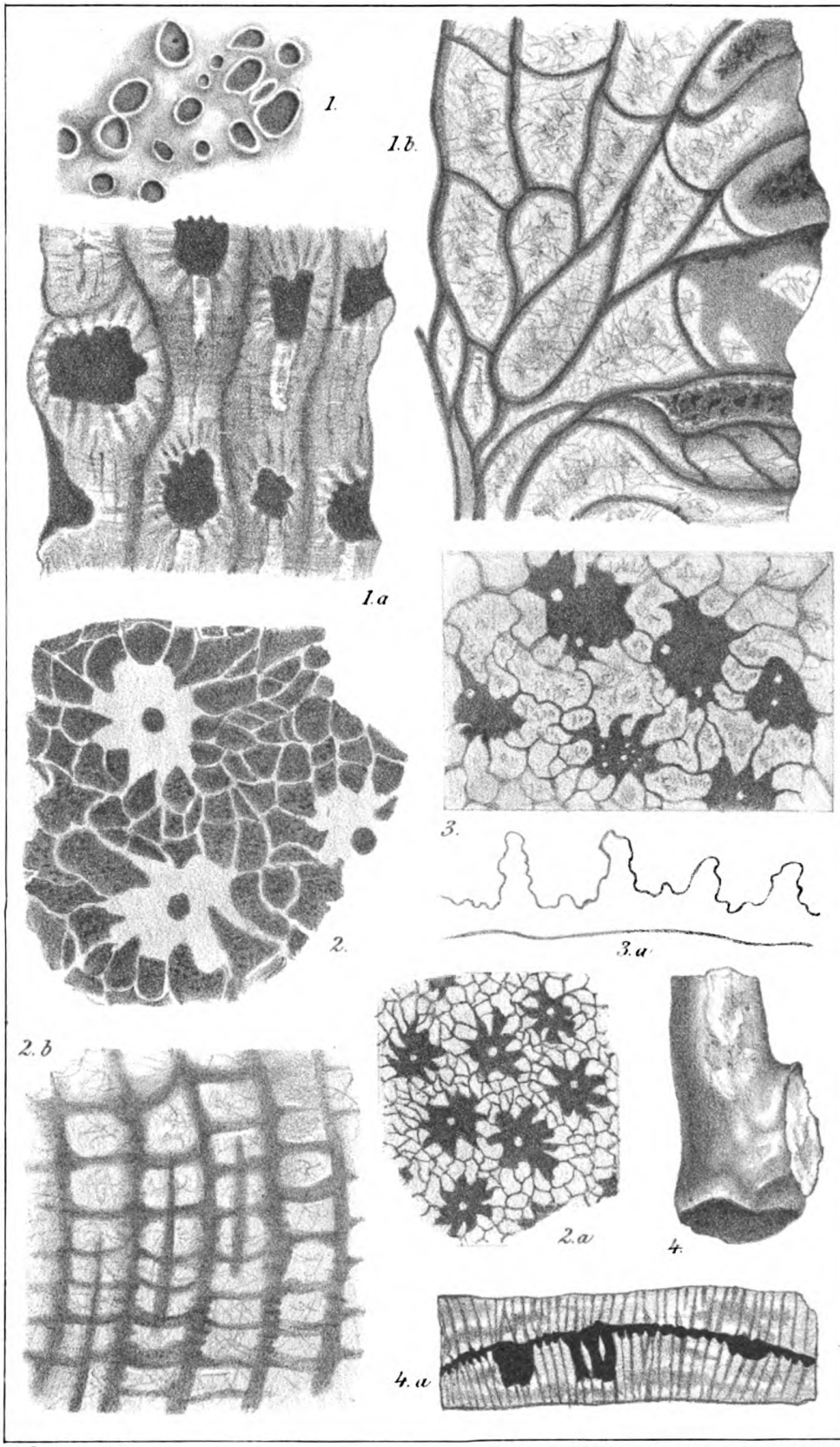
Fig. 3. Portion of a transverse section of *Protaræa vetusta*, from the Cincinnati group of Ohio, viewed on a dark background, and enlarged ten times. The circular light-spaces in the floors of the calices are sections of tubercles which rise from the bottom of the cup, and project into the visceral chamber. *Coll.* H. A. Nicholson.

Fig. 3 *a*. Vertical section of *Protaræa vetusta*, enlarged, and shown in outline. In the floor of two of the calices is seen a predominant tubercle, which may represent a rudimentary columella. *Coll.* H. A. Nicholson.

Fig. 4. Fragment of a branched specimen of *Heliolites Grayi*, Edw. and H., of the nat. size.

Fig. 4 *a*. Portion of the transverse section of the branch of another specimen of the same, enlarged about five times, showing parts of two successive layers of growth—the lower layer exhibiting sections of the calices and smaller tubes. Between the two layers there exists an in-filling of the dark matrix of the surrounding rock.

H. Alleyne Nicholson, del. Plate IV.



C. Berjeau, lith. C. Waterston, Sons & Stewart, Lith^rs Edin^r

PLATE V.

Fig. 1. Part of a thin transverse section (the best of many made) of *Helioütes Grayi*, Edw. & H. (?), enlarged nearly twenty times.

Fig. 2. An average example of *Calostylis Lindströmi*, Nich. and Eth., of the natural size.

Fig. 2 *a*. Another example of the same, showing the base of a lateral bud, enlarged two diameters.

Fig. 2 *b*. Transverse section of the same, enlarged six times.

Fig. 2 *c*. Portion of a longitudinal section of the same, enlarged six times, showing the trabecular sclerenchyma, the central spongy columellar mass, with imperfect tabulæ crossing the lateral spaces.

Fig. 3. Thin section across part of a colony of *Streptelasma aggregatum*, Nich. and Eth., of the natural size. Several of the corallites are seen in process of division.

Fig. 3 *a*. A single corallite of the same, giving off young corallites from its oral extremity, of the natural size.

Fig. 3 *b*. Transverse section of a corallite of the same, enlarged about eight times, showing the thick false wall, the two orders of septa, and the union of some of the primary septa with a central trabecular columella. In this particular corallite no dissepiments can be detected.

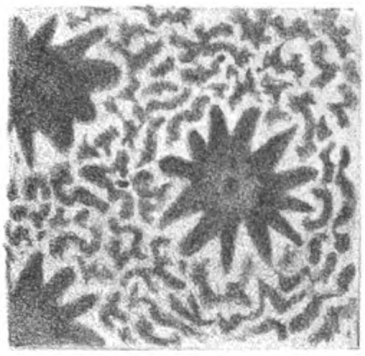
Fig. 3 *c*. Longitudinal section of a corallite of the same, enlarged eight times, showing the thick wall, the well-developed tabulæ, and the columella.

Fig. 4. Fragment of a full-grown specimen of *Streptelasma Craigensis*, M'Coy, sp., viewed sideways, of the natural size. The specimen shows, more markedly than many, the close-set and conspicuous annulations of growth of this species.

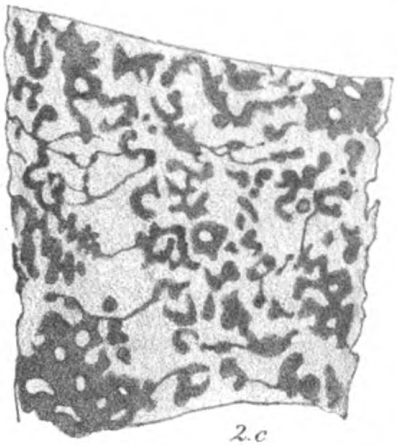
Fig. 4 *a*. Transverse section of a small example of the same, enlarged four times, showing the characters of the pseudo-columella, septa, and dissepiments. The sides of the section are broken away, so that the false wall is imperfect.

Fig. 4 *b*. Long section of a small example of the same, enlarged four times, showing the false wall, the tabulæ, and the pseudo-columella.

Fig. 4 *c*. A small specimen, supposed to belong to *S. Craigensis*, M'Coy, sp., with which it agrees in internal structure, but consisting of three corallites, apparently produced by fission.



1.



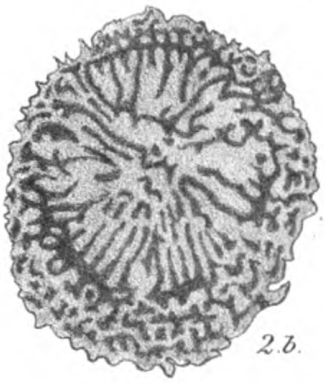
2.c



2.



3.a



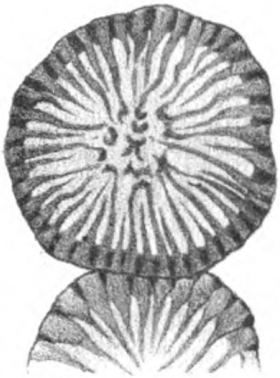
2.b.



2.a



3.



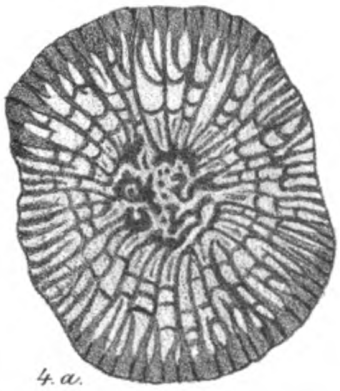
3.b.



3.c



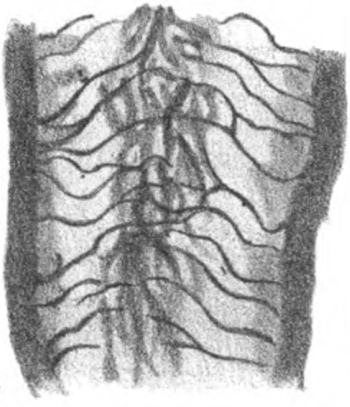
4.



4.a.



4.c



4.b

PLATE VI.

Fig. 1. Side view of one of the larger specimens of *Streptelasma Europæum*, Roemer, the upper part of which is crushed in,—of the natural size.

Fig. 1 *a*. A smaller example of the same, of the natural size.

Fig. 1 *b*. Cross-section of another specimen of the same, enlarged rather more than three times, showing the central reticulate pseudo-columella.

Fig. 2. An average specimen of *Lindströmia subduplicata*, M'Coy, sp., viewed from the front, of the natural size. The upper part of the specimen being crushed in, its apparent width is unnatural, and it looks more widely turbinate than it really is.

Fig. 2 *a*. A smaller specimen of the same, viewed sideways, of the natural size.

Fig. 2 *b*. Vertical section of the same, enlarged about four times, showing the deep calice, the fasciculate structure of the pseudo-columella, and two or three imperfect tabulæ.

Fig. 2 *c*. Vertical section of another specimen of the same, enlarged four times, showing a great upward prolongation of the columella into the bottom of the calice, and the nearly solid filling of the bottom of the visceral chamber.

Fig. 2 *d*. Transverse section of another example of the same, enlarged five times, showing the union of the larger septa with the great central mass of the columella.

Fig. 2 *e*. A small portion of the outer surface of the cast of the same species, showing the slight crenulation of the laminæ representing the interseptal loculi, which is present in ordinary examples. Enlarged.

Fig. 2 *f*. Small portion of the cast of the supposed variety of the same (var. *crenulata*, M'Coy) showing the deep crenulation of the laminæ representing the filled-up interseptal loculi. Enlarged.

Fig. 3. Cross-section of *Streptelasma* (?) *æquisulcatum*, M'Coy, sp., enlarged four times, showing the twisted and inosculating septa, the presence of secondary septa, and the few dissepiments. The centre of the visceral chamber is filled up in reality with the matrix, but there are indications of a reticulated pseudo-columella. The light spaces represent the original cavities of the corallum.

Fig. 4. A medium-sized example of *Lindströmia lævis*, Nich. and Eth., viewed dorsally and in profile, of the natural size.

Fig. 4 *a*. Side view of a very large specimen of the same, of the natural size.

Fig. 4 *b*. Vertical section of the same, enlarged five times, showing the central columellar mass, the deep calice, and the arched ascending tabulæ.

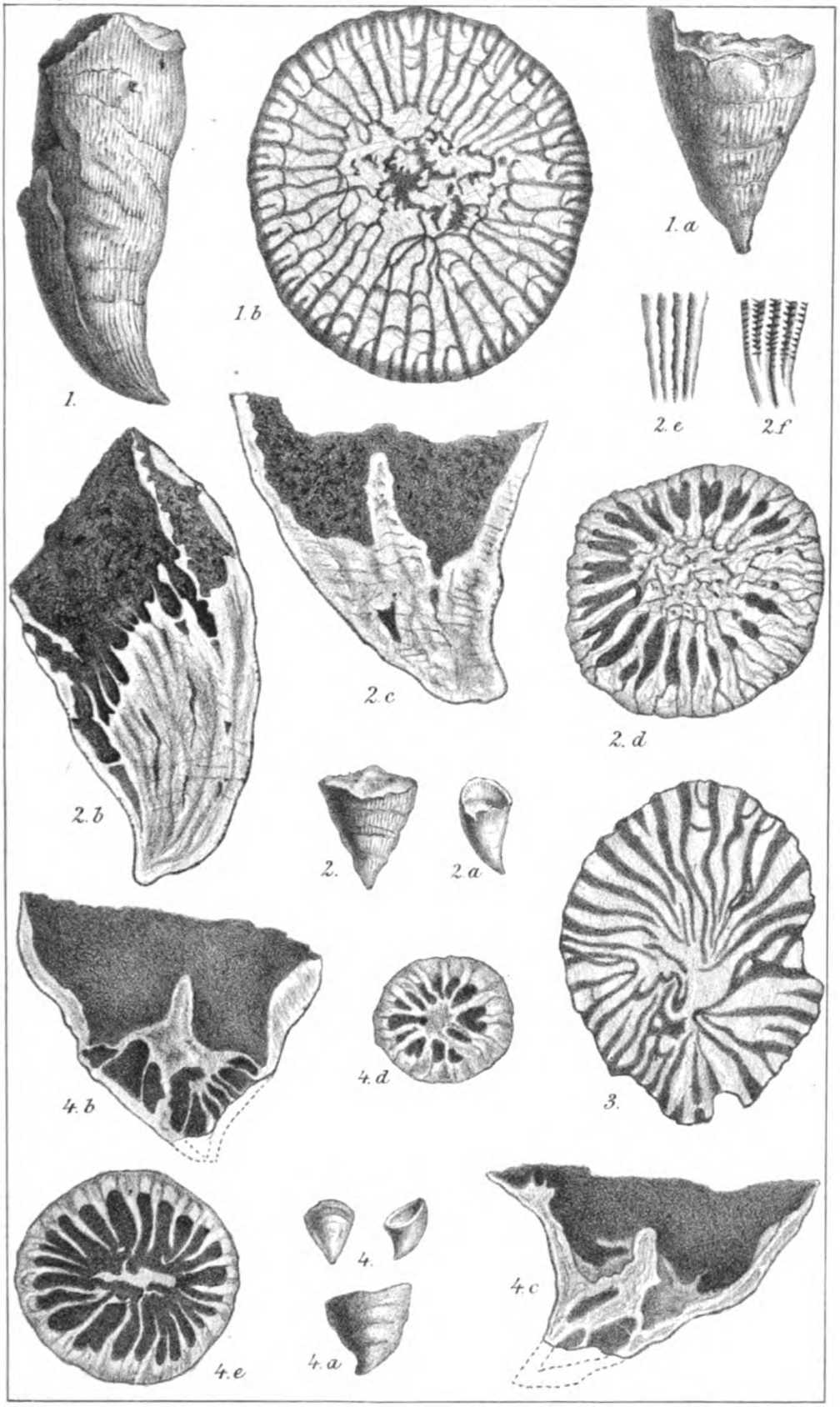
Fig. 4 *c*. Vertical section of another example of the same, enlarged similarly.

Fig. 4 *d*. Transverse section of the same, close above the base, enlarged five times, showing the union of the larger septa with the central columellar mass.

Fig. 4 *e*. Transverse section of another specimen of the same, taken just below the floor of the calice, enlarged five times, showing the decrease in proceeding upwards of the size of the columella.

H. Alleyne Nicholson, del.

Plate VI



C. Berjeau lith.

Waterston, Sons & Stewart, Lith^rs Edin^r

PLATE VII.

PHACOPS BRONGNIARTI, *Portlock*, p. 99.

Fig. 1. Exceedingly fine cast of a specimen from Ardmillan Brae (*Coll. Mus. Pract. Geology*); x 2.

Fig. 2. Decorticated example from Mulloch Hill quarry, with half the head only preserved; x 2.

PHACOPS TRUNCATO-CAUDATUS, *Portlock*, p. 99.

Fig. 3. Decorticated specimen of the pygidium and a portion of the thorax; small transverse striæ are well shown. Drummuck Quarry; x 5.

Fig. 4. Similar example from same locality; x 2.

CHEIRURUS GELASINOSUS, *Portlock* (?), p. 100.

Fig. 5. An example showing the glabella and its furrows, a portion of the cheek and neck-segment. Balcletchie; x 2.

Fig. 6. Another example from the same locality, showing a larger portion of the cheek and neck-segment; x 2.

CHEIRURUS CLAVIFRONS, *Dalman* (?), p. 101.

Fig. 7. A fine glabella, placed somewhat on one side, showing the three furrows, the posterior quite circumscribing the posterior lobe; the scrobiculæ of the cheeks are also visible. Drummuck quarry—nat. size.

Fig. 8. The same specimen, front view—nat. size. Fig. 8 *a*, a portion of the roughened surface highly magnified.

CHEIRURUS, *sp. ind.*, p. 104.

Fig. 9. A portion of a glabella, allied to, but slightly different from, *C. clavifrons* (?). The glabella is broken-off across the posterior furrows. Drummuck—nat. size. Fig. 9 *a*, ornamentation magnified.

PLATE VII.—*continued.*

CHEIRURUS TRISPINOSUS, *Young*, p. 105.

Fig. 10. A glabella, with the ornamentation preserved, the three spines in place, the middle one being broken off, and the position of the posterior lobe and furrow shown. Penkill—nat. size.

Fig. 11. A crushed head, showing the three spines projecting from the matrix. Penkill; x 2.

Fig. 12. A part of a free-cheek, showing the ornamentation and the thickened anterior margin. Penkill—nat. size.

Fig. 13. A somewhat crushed head from the same locality, exhibiting the genal spines in a fine state of preservation, and the broken base of the cervical spine—nat. size. Fig. 13 *a*, the right spine enlarged three times.

Fig. 14. A glabella, with some of the original integument remaining, the basal and ocular furrows visible and basal lobes. The bases of the genal spines are preserved, but not the cervical. Penkill—nat. size.

Fig. 15. Another glabella seen from behind, in which the neck-segment and base of its spine are exceedingly well shown, as also are the circumscribed basal lobes and the ornamentation. Penkill—nat. size.

Fig. 16. The same seen from the front, showing the blunt anterior of the glabella—nat. size.

Fig. 17. A restoration of the head, copied from Dr J. Young's figure (*Proc. Nat. Hist. Soc. Glasgow*, I., pt. 1, t. 1, f. 6 *a*).

CHEIRURUS, *sp. ind.*, p. 107.

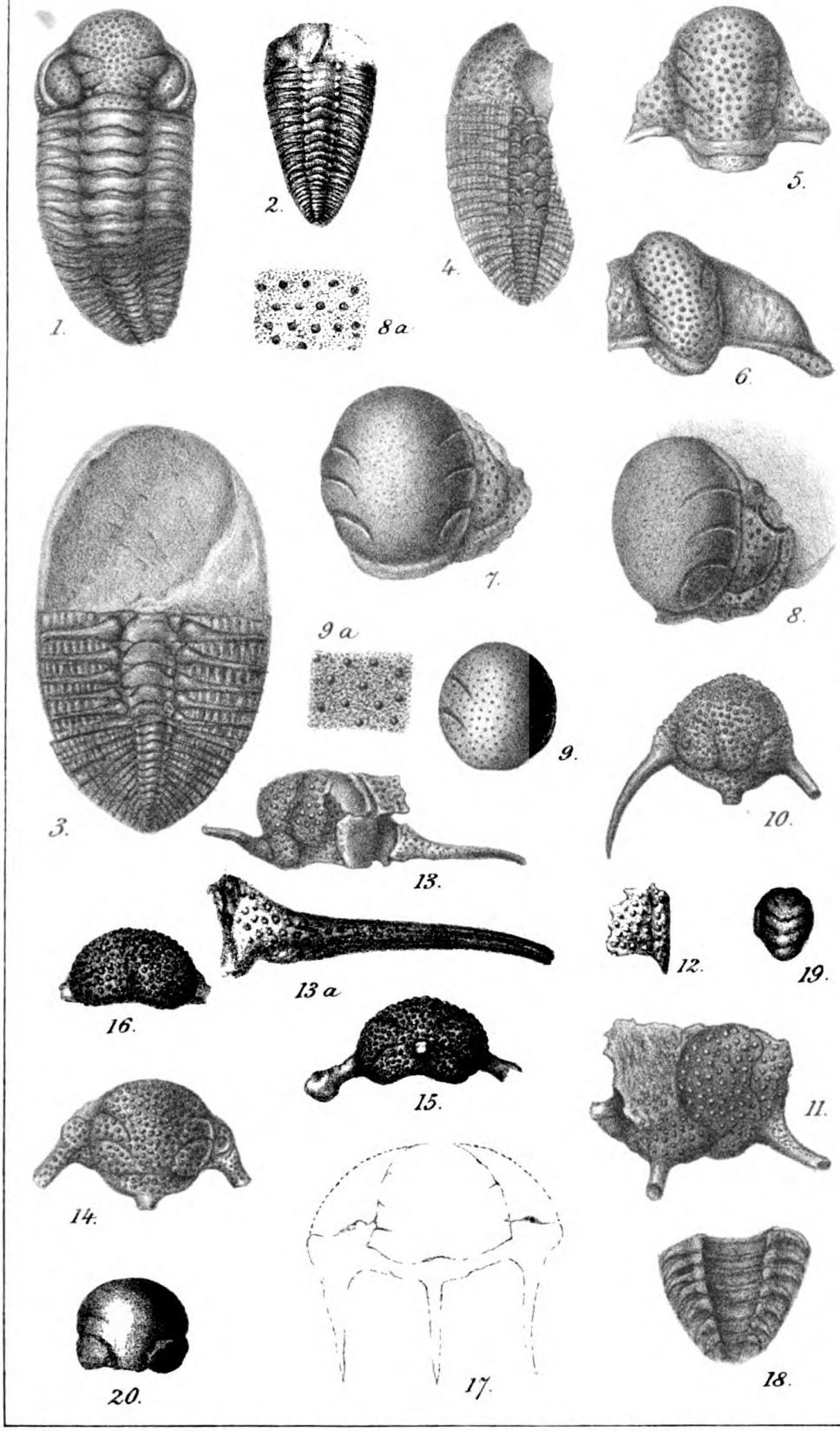
Fig. 18. Portion of thorax and pygidium of an undetermined species from Drummuck; x 3.

CHEIRURUS (?), *sp. ind.*, p. 107.

Fig. 19. A minute form from Balcletchie, showing only two glabella furrows; x 4.

SPHÆREXOCHUS MIRUS, *Beyrich*, p. 107.

Fig. 20. Glabella, exhibiting the characteristic form and lobes of this species, from the coarse-grained ash, or fine conglomerate, of Balcletchie—nat. size.



C Berjeau. lith.

Waterston, Sons & Stewart, Lith^rs Edin^r

PLATE VIII.

ENCRINURUS PUNCTATUS, *Brünnich*, var. ARENACEUS, *Salter*, p. 109.

Fig. 1. A nearly complete specimen from Penkill; the tubercules on the head and tail are well preserved, and also the eyes; x 3.
Fig. 2. A well-preserved decorticated specimen from Mulloch; x 3.
Fig. 3. A pygidium from Penkill; x 2.
Fig. 4. A pygidium from the Craighead limestone; x. 3.

CYBELE RUGOSA, *Portlock*, p. 112.

Fig. 5. An almost perfect example from Drummuck, showing the chief characters of the species; it is a little imperfect about the tail, but on comparison with fig. 6, the features will be found to be identical—nat. size.
Fig. 6. A well-preserved cast of a typical pygidium from Drummuck—*a*, nat. size; *b*, x 2.
Fig. 7. A coiled and decorticated specimen split in half longitudinally; the course of the facial suture and the peculiar glabella lobes are well shown. Drummuck; x 2.

DINDYMENE CORDAI, *Eth.* and *Nich.*, p. 115.

Fig. 8. A well-preserved example, minus the head, from Drummuck. The characteristic tail is plainly exhibited; x 2.

STAUROCEPHALUS (?) UNICUS, *Wyv. Thomson*, p. 118.

Fig. 9. The cephalic shield with the glabella removed—a cast from Balcletchie; x 2.
Fig. 10. An impression of an almost perfect specimen from the same locality; the glabella has been accidentally pressed down upon the other portions; x 2.
Fig. 11. The type of *St. Maclareni* (Wyv. Thomson); cast of the tail from Penwhapple Glen (*Coll. Mus. Pract. Geology*)—nat. size.
Fig. 12. A portion of the cephalic shield, with the integument remaining; the relative positions of the genal and anterior spines are exhibited. Balcletchie; x 2.

PLATE VIII.—*continued.*

Fig. 13. Two heads in contact, in both of which the frontal lobe, eyes, and cephalic spines are well exhibited. Penkill; x 2. Fig. 13 *a*, a portion of the ornamentation of the frontal lobe highly magnified.

Fig. 14. A cephalic shield partly protruding from the matrix, in which the frontal lobe is visible, with a portion of its ornamentation; the eye *in situ*, and the broken bases of the three spines on the left side. Balcletchie; x 2. Fig. 14 *a*, the eye enlarged.

Figs. 15 and 16. Two isolated frontal lobes of the glabella from Balcletchie—nat. size.

ACIDASPIS LALAGE, *Wyv. Thomson*, p. 121.

Fig. 17. An example, with the portions of the head and thorax preserved, including the thoracic spines. Balcletchie; x 3.

Figs. 18-22. The head or cephalic shield in various states of preservation, with and without the spines preserved. Balcletchie. Figs. 18, 21, 22; x 3. Fig. 19; x 5.

ACIDASPIS HYSTRIX, *Wyv. Thomson*, p. 123.

Fig. 23. A cast of the thorax and pygidium from Balcletchie, showing the granulated surface and spines; x 3.

Fig. 24. An isolated pygidium from Balcletchie; x 5.

Fig. 25. Another example, showing the pygidium, and a part of the thorax, spines, granular ornamentation, &c. Balcletchie; x 5.

ACIDASPIS GRAYÆ, *R. Etheridge, jun.*, p. 126.

Fig. 26. A decorticated and somewhat crushed specimen, showing the general characters of the species. Balcletchie; x 2.

PLATE IX.

ACIDASPIS GRAYÆ, *R. Etheridge, jun.*, p. 126.

Figs. 1 and 3. Casts of the pygidium and portion of the thorax, with the denticulated spines in place, and also the reticulate surface of the former. Balcletchie. Figs. 1 x, 2 ; fig. 3 ; x 1½ times.

Figs. 2, 4, and 6. Various specimens of the pygidium; in figs. 2 and 4 the spines are fifteen in number, but in fig. 6 there are sixteen. Fig. 4 *a*, one of the spines magnified, showing the denticles. Balcletchie. Figs, 2, 4, and 6 ; x 2. Fig. 4 *a ;* x 5.

Fig. 5. A cast of a few thoracic segments, with spines attached ; the positions of the denticles are shown as small holes in the casts of the spines. Balcletchie. Fig. 5 *a ;* x 2. Fig. 5 *b ;* x 10 times.

Fig. 7. A portion of a cephalic shield, with the genal spine, probably of this species. Balcletchie ; x 3.

LICHAS BARRANDEI, *Fletcher* (?), p. 132.

Fig. 8. An impression in yellow schist of a well-preserved pygidium, showing the extended axis, lateral flaps, and ornamentation. Mulloch Hill (*Coll. Mus. Pract. Geology*)—nat. size.

LICHAS HIBERNICUS, *Portlock*, p. 133.

Fig. 9. Forehead and side lobes of a large glabella, highly ornamented, and with a portion of the neck-segment preserved. Craighead—nat size. Fig. 9 *a*, ornamentation highly magnified.

Fig. 10. A somewhat crushed cast, showing similar features to the last, and also a portion of one of the accessory lobes. Balcletchie—nat. size.

LICHAS GRAYII, *Fletcher* (?), p. 134.

Fig. 11. A decorticated example of the forehead-lobe, two side-lobes, one of the accessory lobes, and the neck-lobe. Mulloch Hill ; x 2.

Fig. 12. The same specimen seen from the front, showing the anterior portion of the front lobe, and the two side-lobes ; x 2.

PLATE IX.—*continued.*

LICHAS, *sp. ind.*, p. 135.

Fig. 13. Part of the forehead-lobe, one of the lateral lobes, the eye-lobe, and eye of a large species of *Lichas*. Drummuck—nat. size.

Fig. 14. Opposite side of the same specimen, showing a part of the hypostome and one of its wings—nat. size.

NIDULITES FAVUS, *Salter*, p. 18.

Fig. 15. Portion of a cavity left by a specimen resembling fig. 16, showing the convex casts of the cups, with here and there the papillæ formed by the casts of the styliform processes—nat. size. Mulloch Hill.

Fig. 16. Half of a globose or pyriform (?) specimen, being the internal mould of an individual from which the true integument has disappeared, leaving the characteristic hexagonal or pentagonal cups, with the styliform pits or depressions in the centre—nat. size. Mulloch Hill.

Fig. 17. Portion of another globose example, showing the cup-casts and styliform pits; x 4. Mulloch Hill.

Fig. 18. Portion of a specimen similar to fig. 15, showing the irregular form of the cups, the central papillæ, and the surface peeling-off concentrically; x 4. Mulloch Hill.

Fig. 19. Showing the cups of the globose body of *Nidulites* similar to fig. 16, in apposition with their convex casts, such as fig. 15, leaving between them a narrow space from which has been removed the true integument or shell of the organism; x 2. Mulloch Hill.

Fig. 20. A transparent microscopic section obtained from a slice taken from fig. 19, where preserved in the matrix as a series of small, hollow calcareous cups, the general convexity of the body being clearly discernible; x 2. Mulloch Hill.

Fig. 21. Portion of a specimen similar to fig. 15, exhibiting a depression (? central), with the remains of a small plug or peduncle, and spreading from it fibres resembling an investing membrane; x 4. Upper Llandovery, Haverford West (*Coll. Mus. Pract. Geology*, London).

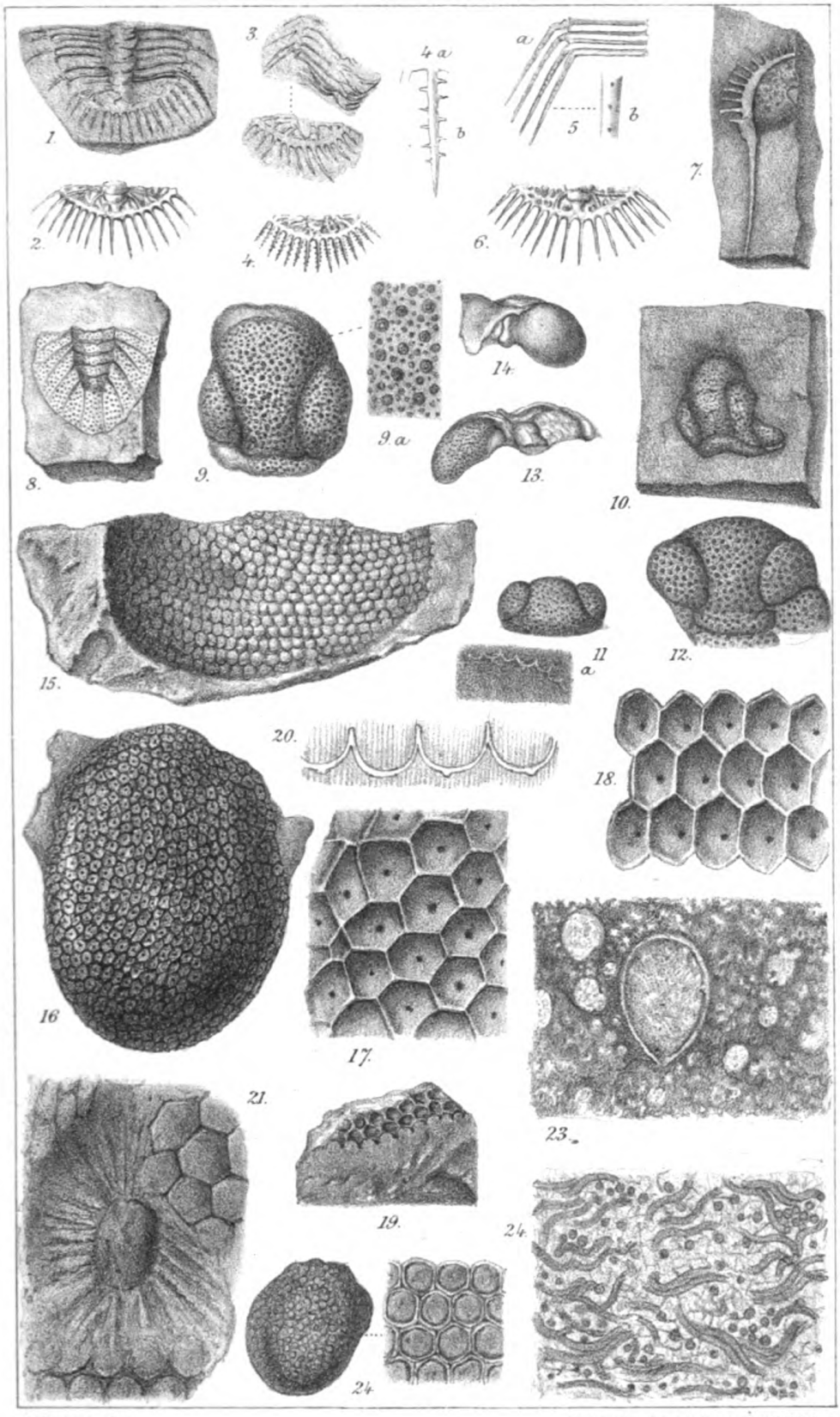
Fig. 22. An almost perfect globose specimen similar to fig. 15, but in which the cup-casts have been worn down, leaving spaces unoccupied representing the true walls. Mulloch Hill—nat. size. A few of the plates are enlarged 4 diameters.

SACCAMMINA CARTERI, *Brady*, p. 21.

Fig. 23. Portion of a slice of limestone showing sections of *S. Carteri*. Tramitchell; x 5 (*Coll.* H. A. Nicholson).

GIRVANELLA PROBLEMATICA, *N.* and *E.*, p. 23.

Fig. 24. Portion of a slice of limestone showing the tubes of *G. problematica*. Tramitchell; x 50 (*Coll.* H. A. Nicholson).



C. Berjeau, lith

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PLATE X.

LICHAS GEIKIEI, *Eth. jun.*, and *Nich.*, p. 137.

Fig. 1. A decorticated example, exhibiting the cephalic shield, portion of the thorax and the tail. Drummuck Quarry (*Coll. Geol. Survey Scot.*); x 2.

CALYMENE BLUMENBACHII, *Brong.*, p. 140.

Fig. 2. An almost perfect but decorticated specimen from Drummuck—nat. size.

Fig. 3. Another specimen, somewhat deficient about the head, but with the labrum in position, from the same locality—nat. size.

Fig. 4. Cephalic shield without the free cheeks, but with portions of the integument remaining. Drummuck Quarry—nat. size. Fig. 4 *a*, ornamentation of integument enlarged.

Fig. 5. Pygidium, approaching the true form of *Calymene Blumenbachii*. Drummuck—nat. size.

Fig. 6. Two-thirds of a small individual, probably referable to this species, decorticated. Mulloch Hill—nat. size.

ENCRINURUS PUNCTATUS, var. CALCAREUS, *Salter*, pp. 108 and 205.

Fig. 7. A decorticated pygidium, with the base of the mucronate extension preserved. Penkill—nat. size.

REMOPLEURIDES COLBII, *Portlock*, p. 146.

Fig. 8. A decorticated example of the glabella and a portion of the body; the elongated eyes are visible at the side of the former. Fig. 8 *a*, the glabella seen from the front, exhibiting the tongue-like forward projection. Drummuck—nat. size.

REMOPLEURIDES, *sp. ind.*, p. 149.

Fig. 9. A decorticated fragment, perhaps referable to the last, but probably different. Fig. 9 *a*, ornamentation of glabella enlarged. Drummuck—nat. size.

REMOPLEURIDES LATERISPINIFER, *Portlock*, p. 149.

Fig. 10. A portion of the body, with one of the elongated lateral spines in position. Ardmillan; x 2.

PLATE X.—*continued.*

Fig. 11. Another specimen, showing in addition the granular ornamentation, of the surface. Ardwell; x 2.

REMOPLEURIDES, *sp. ind.*, p. 150.

Fig. 12. Portion of an individual, with the glabella, eyes, and a few segments preserved. Balcletchie; x 2.

REMOPLEURIDES BARRANDII, *Eth. jun.*, and *Nich.*, p. 151.

Fig. 13 A glabella, with the eyes and furrows. Balcletchie; x 2.
Fig. 14. Another, but similar, example, from the same locality; x 2.
Fig. 15. A glabella, with the furrows faintly marked. Balcletchie; x 2.
Fig. 16. The only specimen with the free-cheeks, and one of the genal spines in position. Balcletchie; x 3.

ASAPHUS RADIATUS, *Salter*, p. 153.

Fig. 17. Cast of a pygidium, named by the late Mr. J. W. Salter (*Coll. Mus. Pract. Geol.*)—nat. size.

ASAPHUS GIGAS, *De Kay* (?), p. 153.

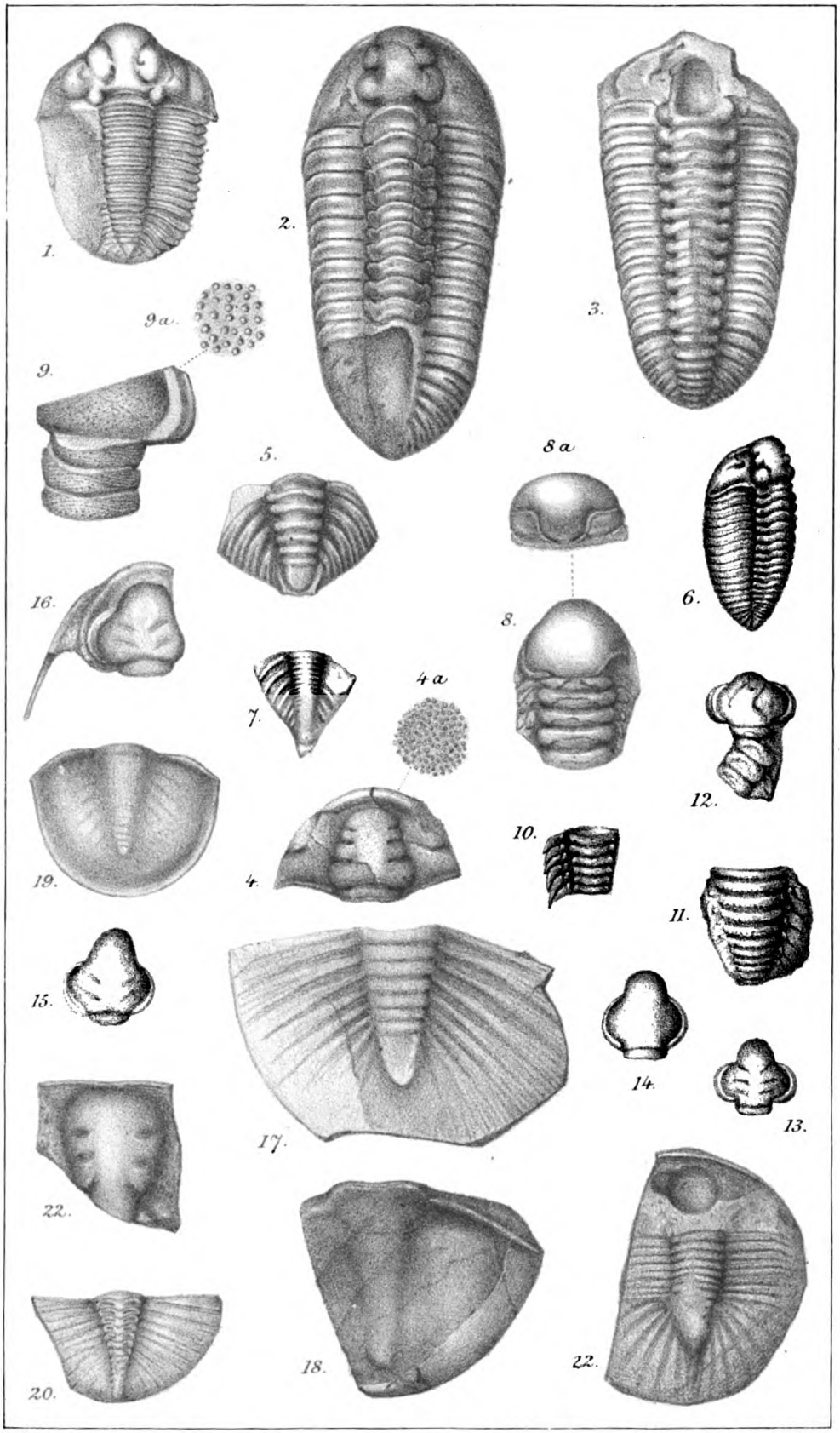
Fig. 18. Cast of a pygidium, probably referable to this species. Balcletchie—nat. size.
Fig. 19. Another specimen, from Ardmillan Brae (*Coll. Mus. Pract. Geol.*)—nat. size.

ASAPHUS, *sp. ind.*, p. 154.

Fig. 20. A pygidium, showing traces of the peculiar glands described by the late Mr Salter. Balcletchie—nat. size.

BRONTEOPSIS SCOTICA, *Salter*, p. 167.

Fig. 21. The most complete specimen known—two-thirds of the entire body; the hypostome is seen *in situ*. Balcletchie—nat. size.
Fig. 22. A portion of the glabella, with the peculiar pit-like furrows; one of the original specimens upon which Mr Salter founded the name. Penwhapple Glen (*Coll. Mus. Pract. Geology*)—nat. size.



C. Berjeau, lith ad nat

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PLATE XI.

BRONTEOPSIS SCOTICA, *Salter* (cont.), p. 167.

Fig. 1. Portion of the glabella, with the furrow-depressions. Balcletchie—nat. size.

Fig. 2. A pygidium, from the same locality—nat. size.

Fig. 3. Another specimen, same locality, with the terminal appendage of the axis well displayed—nat. size.

Fig. 4. One of the original specimens, so named by the late Mr Salter. Penwhapple Glen (*Coll. Mus. Pract. Geology*)—nat. size.

Fig. 5. A tail of a young individual. Balcletchie—nat. size.

ILLÆNUS BOWMANI, *Salter*, p. 155.

Fig. 6. An almost complete specimen. Balcletchie—nat. size.

Fig. 7. Side-view of the head of a small fragmentary individual, distorted, with one of the eyes seen *in situ*. Balcletchie; x 2.

Fig. 8. A large head, which from the characteristic groove, &c., appears to be perhaps referable to this species. (*Hunterian Museum*)—nat. size.

ILLÆNUS THOMSONI, *Salter*, p. 156.

Fig. 9. A large but badly preserved pygidium. Mulloch Hill—nat. size.

ILLÆNUS ÆMULUS, *Salter* (?), p. 157.

Fig. 10. A pygidium, with portions of the integument preserved, showing the broadly inverted and V-shaped sculpture. Penkill—nat. size.

ILLÆNUS NEXILIS, *Salter* (?), p. 158.

Fig. 11. An almost complete example—nat. size.

Fig. 12. A large epistome resembling those referred by Mr Salter to this species. Penkill—nat. size.

Fig. 13. A smaller example from the same locality—nat. size.

ILLÆNUS ROSENBERGII, *Eichwald* (?), p. 159.

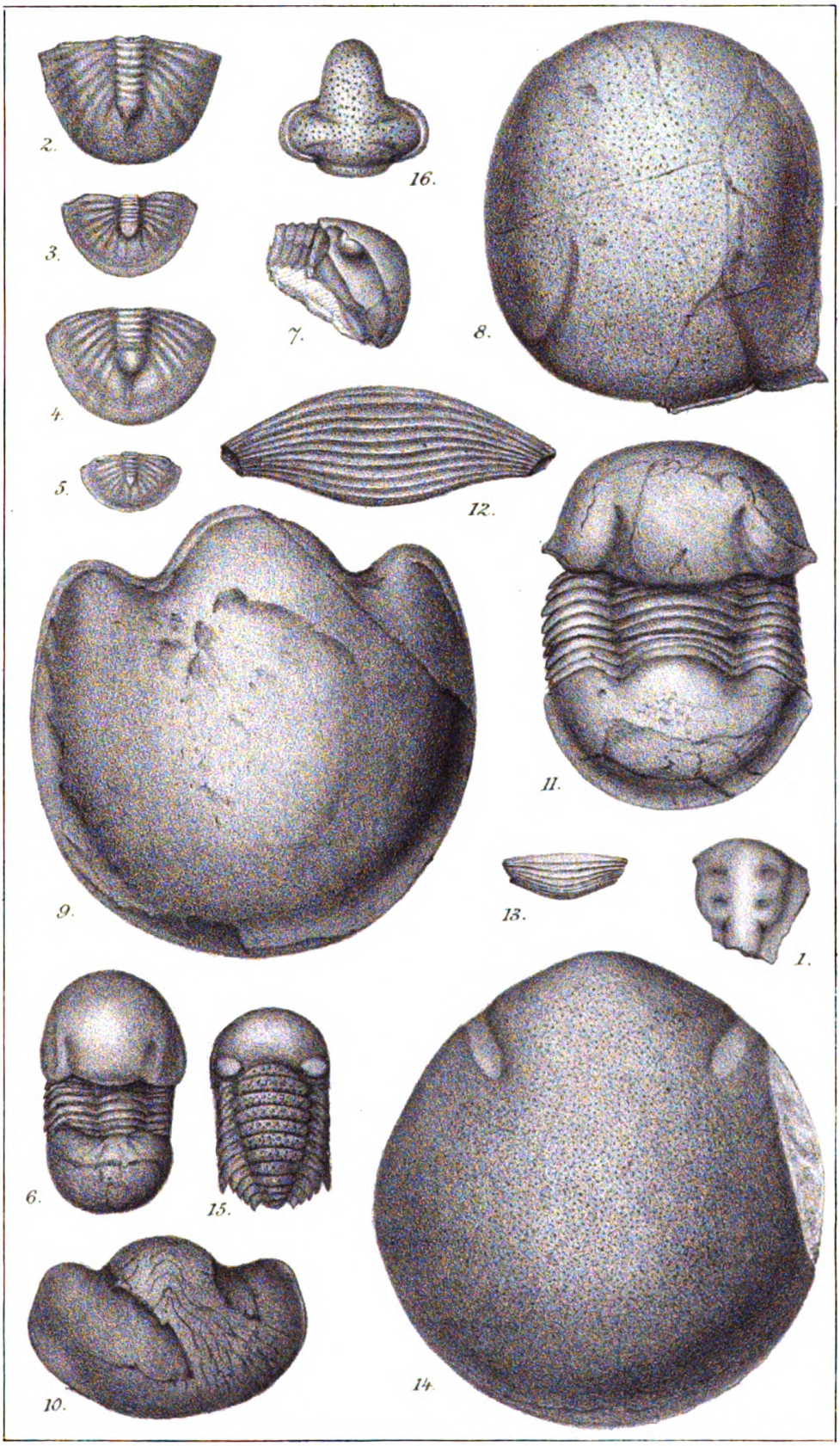
Fig. 14. A large pygidium, presumed to be that of this species.—nat. size.

REMOPLEURIDES LATERISPINIFER, *Portlock*, p. 149.

Fig. 15. An almost entire specimen, with the integument removed. Ardmillan; x 3.

REMOPLEURIDES BARRANDII, *Eth. jun.*, and *Nich.*, p. 151.

Fig. 16. A glabella, with the eyes and surface-ornamentation preserved. Ardmillan; x 4.



C Berjeau, lith ad nat.

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PLATE XII.

ILLÆNUS MURCHISONI, *Salter* (?), p. 161.

Fig. 1. A portion of a large specimen, probably referable to this species. It is placed upside-down to show the marginal striations. Penkill—nat. size.

ILLÆNUS MACALLUMI, *Salter*, p. 162.

Fig. 2. Cast of a rather small pygidium. Mulloch Hill—nat. size.

BRONTEUS ANDERSONI, *Eth. jun.*, and *Nich.*, p. 162.

Fig. 3. A pygidium, drawn from two specimens, showing the trilobation of the axis, with its segments, and the characteristic concentric laminæ. Penkill —nat. size.

Fig. 4. A similar specimen, showing traces of trilobation, &c. Penkill—nat. size.

Fig. 5. The most complete specimen known, showing a portion of the glabella and thorax. Penkill (*Hunterian Mus. Coll.*)—nat. size.

BRONTEUS, *sp. ind.*, p. 165.

Fig. 6. Remains of a large pygidium, showing numerous strong, radiating ridges from the edge of the axis, which is not preserved. Craighead Limestone—nat. size.

PROETUS GIRVANENSIS, *Eth. jun.*, and *Nich.*, p. 169.

Fig. 7. The most perfect specimen known, quite free of the matrix. Fig. 7 *a*, thorax and pygidium. Fig. 7 *b*, side-views of head, thorax, and pygidium. Fig. 7 *c*, cephalic shield, showing the small eyes and broad cheeks. Fig. 7 *d*, the same, from before, exhibiting the space between the anterior margin of the glabella and the front margin of the shield. Drummuck (*Coll. Mus. Pract. Geol.*)—nat. size.

Fig. 8. A very rotund and short variety, showing the quadrate glabella, broad cheeks, and eyes in position. Drummuck (*Coll. Geol. Survey Scotland*); x 1½.

Fig. 9. Another very perfect specimen from the same locality; full view of the body. Fig. 9 *a*, side-view; x 2.

PLATE XII.—*continued.*

Fig. 10. A specimen, with the glabella-furrows preserved, and in an equally good state of preservation with the foregoing. Drummuck; x 2.

PROETUS PROCERUS, *Eth. jun.*, and *Nich.*, p. 174.

Fig. 11. General view, showing the longer and more slender form, and the more elongated glabella than in the last species. Fig. 11 *a*, side-view. Drummuck; x 3.

ILLÆNUS ÆMULUS, *Salter* (?), p. 157.

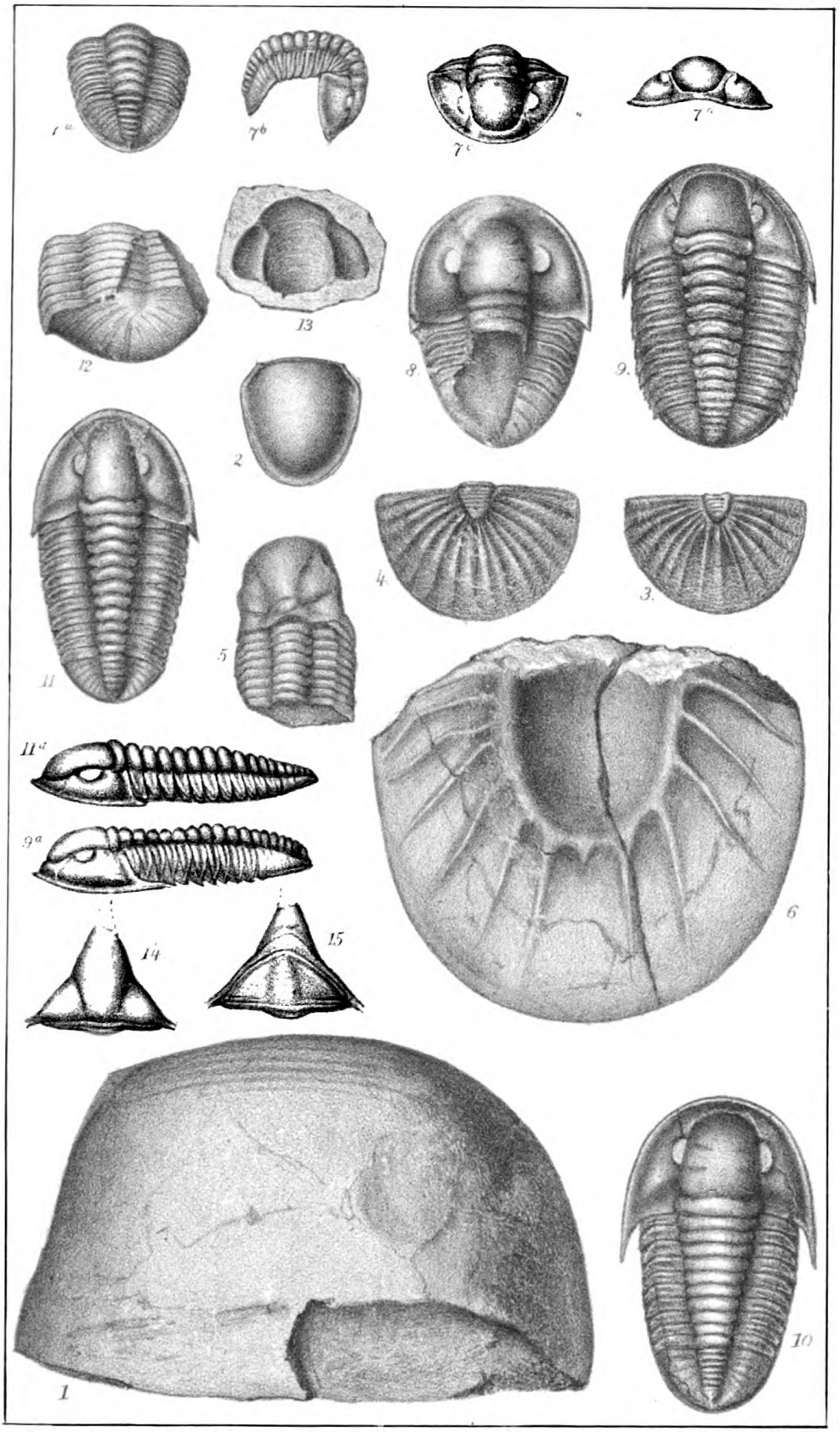
Fig. 12. A tail and eight thoracic segments, believed, from the ornamentation of the former, to belong to this species. Penkill—nat. size.

Fig. 13. A glabella, bearing the same kind of sculpture, and from the same locality—nat. size.

AMPYX ROSTRATUS, *Sars.*, p. 178.

Fig. 14. The upper side of a specimen, clear of the matrix, showing the glabella and some of the thoracic somites. Drummuck (*Coll. Mus. Pract. Geol.*) —nat. size.

Fig. 15. The under surface of the same specimen, with the pygidium pressed up against the under portion of the head—nat. size.



C. Berjeau lith. ad nat

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PLATE XIII.

AMPYX ROSTRATUS, *Sars.*, p. 178.

Fig. 1. The glabella, with portions of the frontal and genal spines preserved. Drummuck—nat. size.

Fig. 2. Another glabella, in which the depressions along the axal furrows are visible. Fig. 2 *a*, side-view of the same. Drummuck—nat. size.

Fig. 3. Pygidium, with the segmented and tuberculated axis preserved. Drummuck; x 1½.

AMPYX HORNEI, *Eth. jun.*, and *Nich.*, p. 184.

Fig. 4. A large cephalic shield, without the free-cheeks. The pyriform and mammillary glabella, with its apical tubercle, is well preserved. The radiatory ridges of the fixed cheeks are also visible. Balcletchie—nat. size.

Fig. 5. Another shield, drawn from two specimens. The anterior truncated margin is well shown, and also the radiating ridges previously mentioned. Balcletchie (*Mus. Pract. Geol. Coll.*, and *Gray Coll.*)—nat. size.

Fig. 6. A shield in which there are traces of genal spines remaining, from Balcletchie—nat. size.

Fig. 7. A thorax and pygidium of this species. Balcletchie—nat. size.

Fig. 8. Another pygdium, isolated. Balcletchie; x 2.

AMPYX MACALLUMI, *Salter*, p. 180.

Fig. 9. A cephalic shield, without the free-cheeks, drawn from two specimens. The form of the glabella, the course of the axal furrows, and traces of the genal spines, are shown. Balcletchie; x 2.

Fig. 10. Another shield, without the free-cheeks, but having the base of the frontal spine preserved. Balcletchie—nat. size.

Fig. 11. View of the under surface of head (rostral shield) with the genal spines in position. Fig. 11 *a*, portion enlarged to show striation. Balcletchie—nat. size.

Fig. 12. A pygidium, in which the half-segmentation of the lateral lobes is well seen. Balcletchie; x 2.

PLATE XIII.—*continued.*

TRINUCLEUS SETICORNIS, *His.*, var. BUCKLANDI, *Barr.*, p. 190.

Fig. 13. General view of an almost perfect specimen. Drummuck—nat. size.

Fig. 14. The cephalic shield of a young form, showing the ocular tubercles, but no eye-line. Pomeroy, Ireland (*Coll. Mus. Pract. Geol.*); x 2.

Fig. 15. A young form, in which the cephalic fringe is particularly well preserved. Fig. 15 *a*, side-view. Fig. 15 *b*, the depressions or funnels of the fringe enlarged. Drummuck.

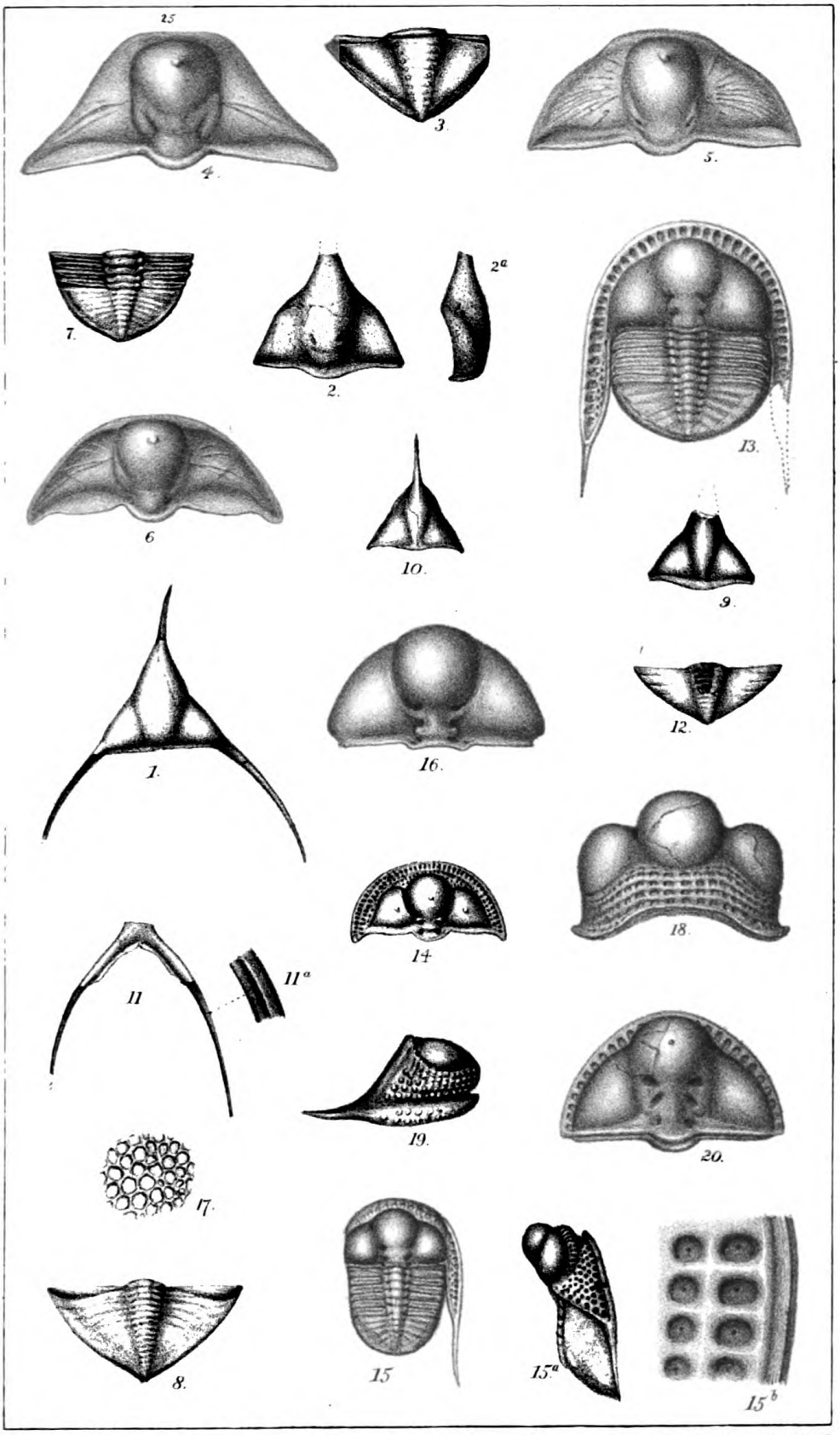
Fig. 16. Another cephalic shield, in which the glabella-furrows are well shown. Drummuck—nat. size.

Fig. 17. A portion of the reticulation ornamenting the glabella, enlarged.

Fig. 18. Front view of a shield, in which the ridges separating the parallel lines of fringe-depressions are well preserved. Drummuck; x 2.

Fig. 19. Side-view of a cast of a remarkably well developed fringe, in which the non-punctate striated space is visible. Drummuck (*Coll. Mus. Pract. Geol.*); x 2.

Fig. 20. Cephalic shield of a young individual in which the ocular tubercles and "eye-lines" are preserved. Drummuck; x 2.



C. Berjeau, lith. ad. nat.

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PLATE XIV.

AMPYX (?) MACCONOCHIEI, *Eth. jun.*, and *Nich.*, p. 183.

Fig. 1. A small individual, probably referable to this genus, from which the integument has been removed. Balcletchie; x 4.

TRINUCLEUS, *sp. ind.* (*sp. a*), p. 198.

Fig. 2. A portion of the fringe and one of the genal spines of a species of *Trinucleus*. Shalloch Mill; x 1½.

TRINUCLEUS, *sp. ind.* (*sp. b*), p. 198.

Fig. 3. One of the cheeks and a narrow fringe, from the same locality as the last; x 1½.

TRINUCLEUS, *sp. ind.* (*sp. c*), p. 198.

Fig. 4. A very triangular pygidium, probably referable to this genius. Shalloch Mill—nat. size.

SALTERIA PRIMÆVA, *Wyv. Thomson*, p. 199.

Fig. 5. An almost complete specimen, in the collection of the Hunterian Museum. Balcletchie; x 2.

AGNOSTUS AGNOSTIFORMIS, *M'Coy*, p. 200.

Fig. 6. A figure drawn from a series of specimens, in which the cephalic and pygidium spines are more or less visible. Balcletchie; x 4.

PHACOPS BRONGNIARTI, *Portlock*, pp. 99 and 201.

Fig. 7. A very large and almost complete specimen, but a little crushed here and there. Drummuck (*Coll. Geol. Survey, Scot.*)—nat. size.

Fig. 8. A well-preserved glabella, eyes, and fixed cheeks. Ardmillan; x 2.

CHEIRURUS BIMUCRONATUS, *Murch.*, pp. 100 and 202.

Fig. 9. A portion of the thorax of a very large decorticated example (*Coll. Geol. Survey, Scot.*) Drummuck—nat. size.

CHEIRURUS CLAVIFRONS, *Dalman* (?), pp. 101 and 202.

Fig. 10. A glabella, in which the two kinds of ornamentation are visible, with portions of the fixed cheeks. Drummuck—nat. size; 10 *a*, and 10 *b*, the ornamentation much enlarged.

PLATE XIV.—*continued.*

CHEIRURUS? *sp. ind.* (*sp. a*), p. 203.

Fig. 11. A small pygidium, perhaps referable to a species of this genus. Balcletchie; x 4.

CHEIRURUS? *sp. ind.* (*sp. b*), p. 203.

Fig. 12. Portion of a peculiar cephalic shield, consisting of the glabella and fixed cheeks, with an anterior prolongation of the former, and the glabella and neck furrows. Balcletchie; x 2.

CYBELE RUGOSA, *Portlock*, pp. 112 and 205.

Fig. 13. This figure is represented in Pl. VIII., fig. 5, but as that illustration does not give a satisfactory and fair representation of the specimen, it is here redrawn. It will be noticed that in the former the genal and thoracic pleural spines were left out—nat. size.

ACIDASPIS? *sp. ind.*, p. 206.

Fig. 14. A specimen, generally supposed from the general appearance of the thorax and tail to be of this genus. It is a mere mould in a shaley matrix, but has the position of the labrum defined (*Coll. Geol. Survey, Scot.*) Near Bargany Pond; x 2.

PROETUS? or ACIDASPIS? *sp. ind.*, p. 206.

Fig. 15. A mould, in a similar rock to the last (*Coll. Geol. Survey, Scot.*) Near Bargany Pond; x 4.

AMPYX? *sp. ind.*, p. 206.

Fig. 16. Portion of the cephalic shield of a Trilobite of doubtful determination. The surface is in places tubercular. Balcletchie; x 4.

PINNOCARIS LAPWORTHI, *Eth. jun.*, p. 210.

Figs. 17-20. Various specimens of the half-carapace, with the delicate concentric ornament. Fig. 17 has a small object near it which may be one of the tail-spines. Balcletchie—nat. size.

PELTOCARIS? *sp. ind.*, p. 212.

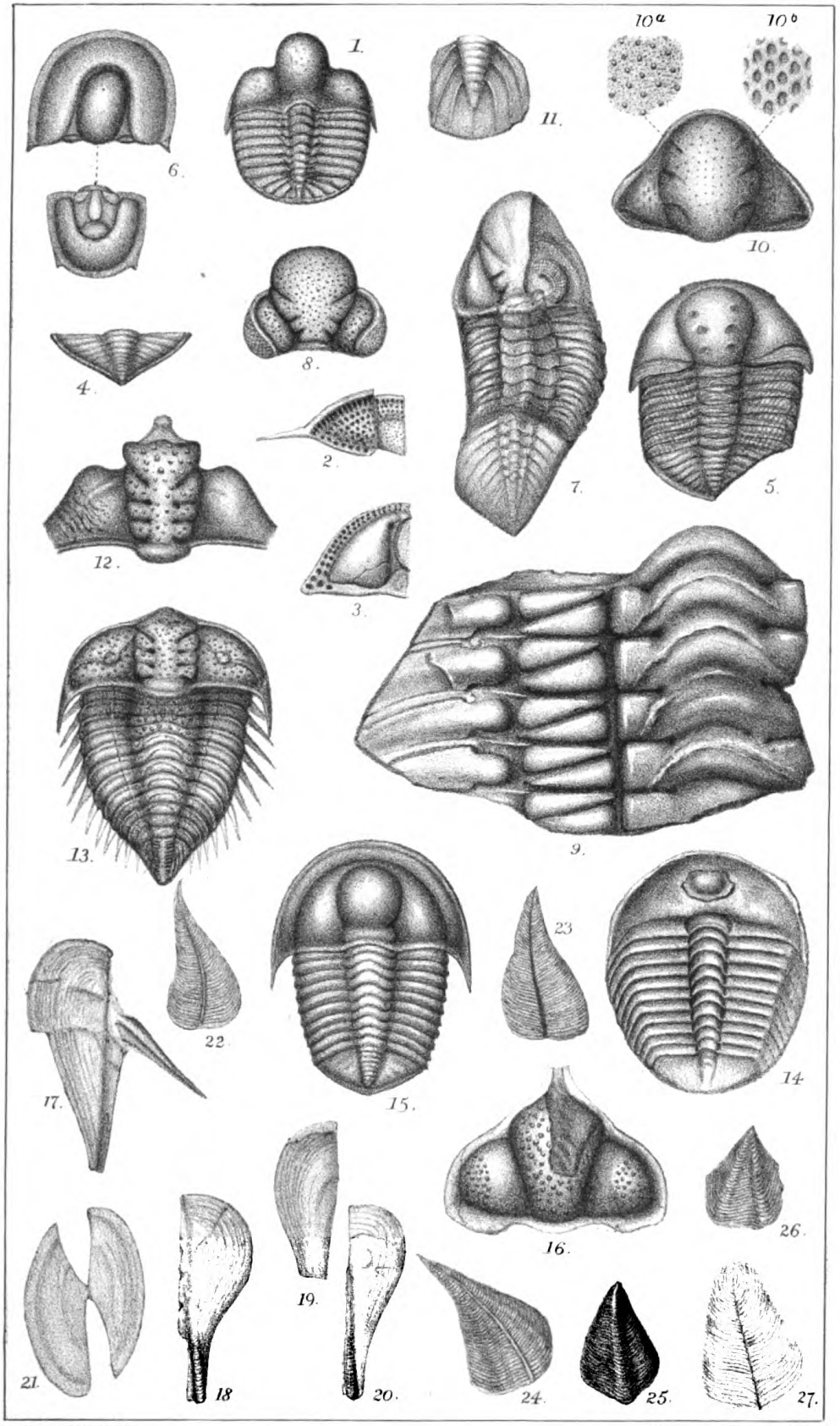
Fig. 21. A carapace, of which the two halves are somewhat displaced, probably referable to this genus (*Coll. Geol. Survey, Scot.*) Penwhapple Burn; x 2.

TURRILEPAS SCOTICA, *Eth. jun.*, p. 214.

Figs. 22-25. Three forms of plates of this species; three of them exhibit the fine needle-like extremity. Balcletchie; x 3.

Fig. 26. Another form of plate from the same locality; x 4.

Fig. 27. The "reticulate plate," same locality; x 4.



C. Burgeau, lith ad nat

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PLATE XV.

CYTHERE ALDENSIS, *M'Coy*, p. 216.

Fig. 1. A bivalved carapace, somewhat broken. Fig. 1 *a*, side-view. Fig. 1 *b*, dorsal view. Fig. 1 *c*, end-view of one valve. Aldens.

Fig. 2. Another example. Fig. 2 *a*, side-view of a right valve. Fig. 2 *b*, end-view of same. Aldens.

Fig. 3. Side-view of a left valve showing some trace of the muscle-spot.

C. ALDENSIS, *M'Coy*, var. major, *Jones*, p. 216.

Fig. 4. Three views of an example from Aldens. Fig. 4 *a*, side-view of the left valve, somewhat crushed. Fig. 4 *b*, edge-view of the same. Fig. 4 *c*, end-view of the same.

CYTHERE GRAYANA, *Jones*, p. 217.

Fig. 5. Two views of an example from Aldens. Fig. 5 *a*, side-view of the left valve. Fig. 5 *b*, end-view of the same.

Fig. 6. Two views of another specimen from the same locality. Fig. 6 *a*, side-view of a left valve, with a muscle-mark. Fig. 6 *b*, end-view of the same.

CYTHERE WRIGHTIANA, *Jones* and *Holl.*, p. 217.

Fig. 7. Two views of a specimen from the greenish-black limestone of Aldens. Fig. 7 *a*, right valve, side-view. Fig. 7 *b*, end-view of the same.

BEYRICHIA KLŒDENI, *M'Coy*, p. 218.

Fig. 8. Two views taken from different examples. Fig. 8 *a*, hollow cast of the exterior of the left valve. Fig. 8 *b*, side-view of a right valve. Thrave Glen.

BEYRICHIA COMMA, *Jones*, p. 219.

Fig. 9. A bivalved carapace, imperfect at the edges. Fig. 9 *a*, side-view of a left valve. Fig. 9 *b*, end-view of the carapace. Fig. 9 *c*, edge-view of the same, from the greenish fine-grained sandstone of Thrave Glen.

PLATE XV.—*continued.*

BEYRICHIA IMPENDENS, *Jones*, p. 219.

Fig. 10. External casts, under various conditions of pressure, from Girvan and the Pentland Hills. Fig. 10 *a*, normal form of casts. Figs. 10 *b* and *c*, casts of specimens differently squeezed (*Coll. Geol. Survey, Scot.*)

PRIMITIA BARRANDIANA, *Jones*, p. 220.

Fig. 11. Various views of valves and casts, showing different development of the sulcus on the shell, and impressions on the casts.

Fig. 11 *a*, Side-view of a valve with faint sulcus.

Fig. 11 *b*, Side-view of a cast, showing one large and two slight furrows.

Fig. 11 *c*, Side-view of a valve with three slight furrows, the middle one strongest and marked with a pimple.

Fig. 11 *d*, Side-view of a valve, somewhat irregular in form, with traces of two furrows.

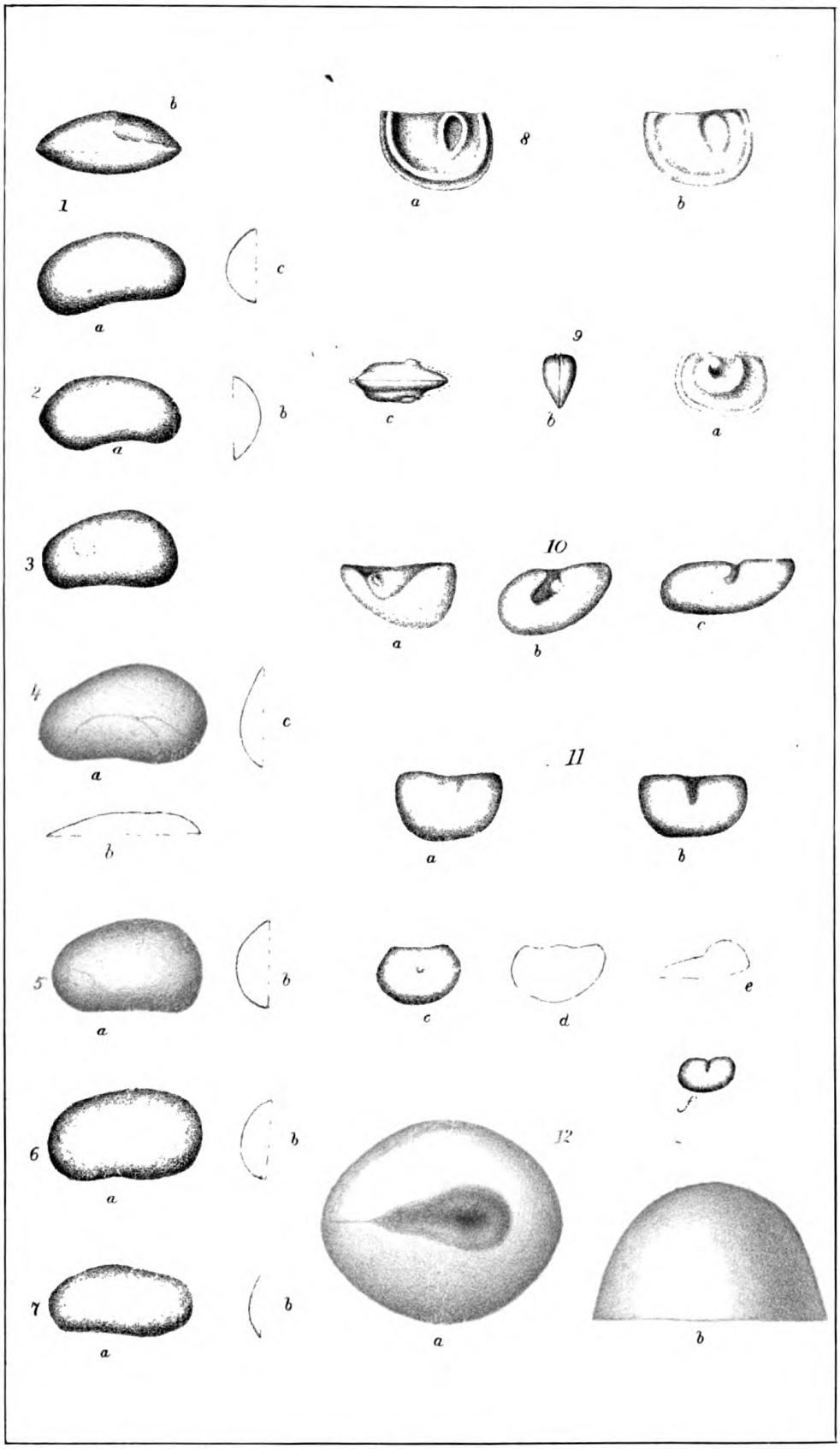
Fig. 11 *e*, Edge-view of the same.

Fig. 11 *f*, Side-view of a valve retaining a small portion of the shell, and showing a deep median sulcus, also a faint anterior (?) sulcus with a small pimple.

ENTOMIS GLOBULOSA, *Jones*, p. 223.

Fig. 12. Internal cast of a sub-conical valve, modified by pressure. Fig. 12 *a*, surface-view of a tent-shaped cast, with a pit at apex, and a short furrow on the longest axis of the body. Fig. 12 *b*, side-view of the same.

(*All the figures on Plate XV. are magnified twelve diameters.*)



C. Berjeau, lith. ad nat

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PLATE XVI.

PLATE XVI.

Fig. 1. Small specimen of *Heliolites interstincta*, Linn., from Woodland Point, Girvan, of the natural size.

Fig. 1 *a*. Tangential section of the same, enlarged five times, showing well-developed septa in the large corallites.

Fig. 1 *b*. Vertical section of the same, enlarged five times, showing the deeply concave tabulæ of the large tubes.

Fig. 2. Tangential section of an example of *Heliolites interstincta*, Linn., from the Wenlock Limestone of Stoke-Edith, enlarged five times, showing the well-developed and irregularly anastomosing septa of the large corallites. *Coll.* H. A. Nicholson.

Fig. 2 *a*. Vertical section of the same specimen, enlarged five times, showing the horizontal and comparatively remote tabulæ. Traces of the septa are also seen in the interior of the large corallites.

Fig. 2 *b*. Transverse section of a single large corallite of the same specimen, with a single encircling zone of small corallites, enlarged twenty times, showing the reticulated septa.

Fig. 3. Tangential section of an example of *Heliolites interstincta*, Linn., from the Wenlock Limestone of Gotland, enlarged five times, showing the comparatively large size of the larger corallites, and their quite rudimentary septa. *Coll.* H. A. Nicholson.

Fig. 3 *a*. Vertical section of the same specimen, enlarged five times, showing the crowded and anastomosing tabulæ of the large corallites.

Fig. 4. Tangential section of a specimen of *Heliolites interstincta*, Linn., from the Wenlock Limestone of Stoke-Edith, enlarged five times, showing the rudimentary condition of the septa. The large corallites are somewhat smaller than in fig. 3. *Coll.* H. A. Nicholson.

Fig. 4 *a*. Vertical section of the same specimen, enlarged five times. The tabulæ of the large tubes differ from those of fig. 3 *a* in being comparatively remote.

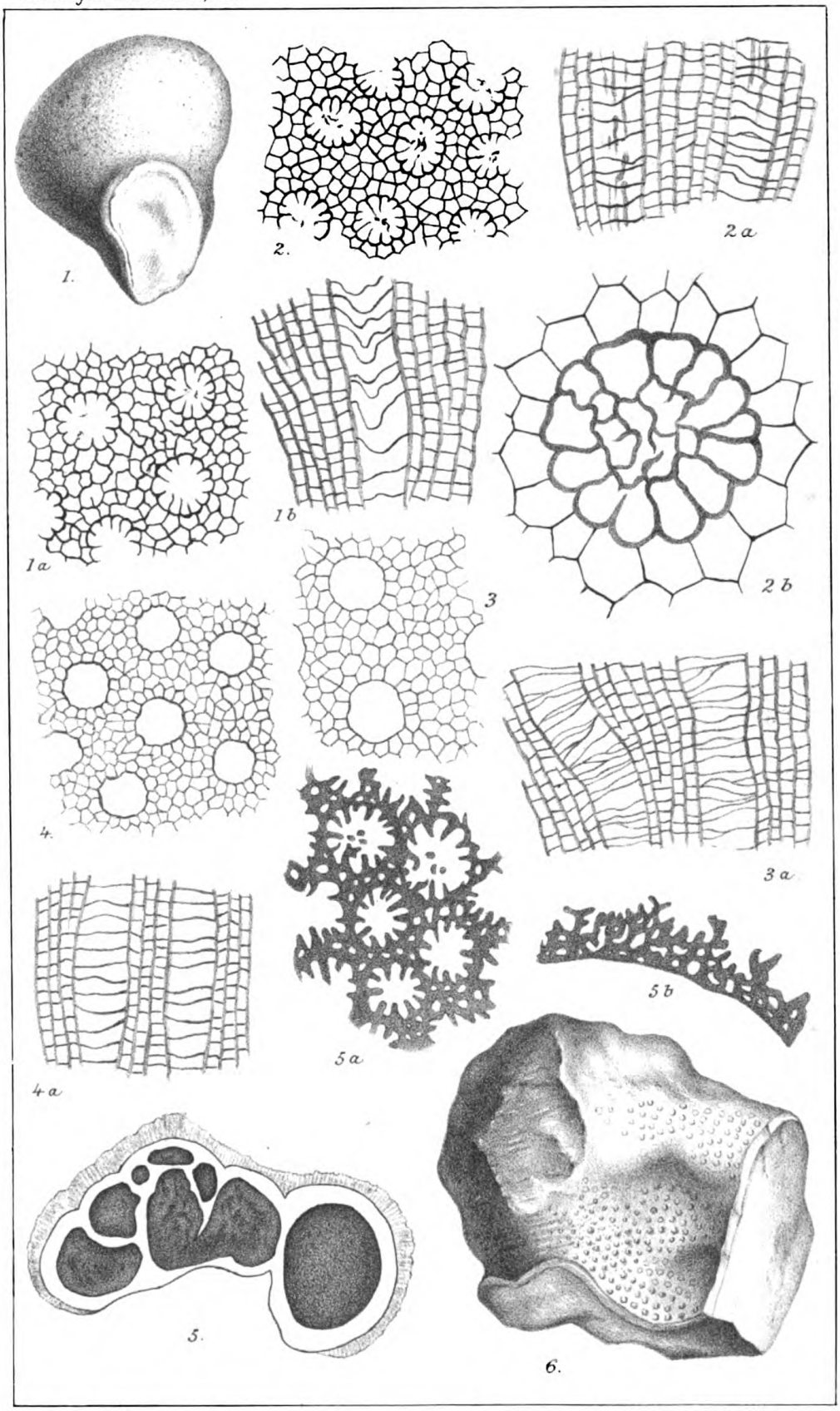
Fig. 5. Vertical section of the shell of a Gasteropod covered with a colony of *Heliolites* (?) *parasitica*, Nich. and Eth. jun., enlarged twice. Mulloch Hill, Girvan.

Fig. 5 *a*. Tangential section of the corallum of *H.* (?) *parasitica*, enlarged five times. Mulloch Hill, Girvan.

Fig. 5 *b*. Vertical section of the same corallum, similarly enlarged.

Fig. 6. An imperfect specimen of *Heliolites foliacea*, Nich. and Eth. jun., from Woodland Point, Girvan, of the natural size. The under surface of the corallum is adherent to the matrix.

H. Alleyne Nicholson, del. Plate XVI.



C. Berjeau, lith. Waterston & Sons, Lith^rs Edin^r

PLATE XVII.

Fig. 1. Portion of the surface of *Heliolites foliacea*, Nich. and Eth. jun., enlarged five times, showing the calices of the large and small corallites. Woodland Point, Girvan.

Fig. 1 *a*. Part of a tangential section of the same, enlarged ten times, showing the great thickness of the walls of the small corallites.

Fig. 1 *b*. Part of a vertical section of the same, embracing the entire thickness of the corallum, enlarged ten times, showing the thick-walled corallites and the occasional tabulæ.

Fig. 2. A specimen of *Plasmopora Girvanensis*, Nich. and Eth. jun., of the natural size. Woodland Point, Girvan.

Fig. 2 *a*. Part of a tangential section of the same, enlarged about five times.

Fig. 2 *b*. Part of a vertical section of the same, enlarged about five times, showing the vesicular tabulæ of the small corallites.

Fig. 3. A specimen, imperfect below, of *Propora Edwardsii*, Nich. and Eth. jun., of the natural size, from Woodland Point, Girvan.

Fig. 3 *a*. Part of a tangential section of the same, enlarged five times.

Fig. 3 *b*. Part of a vertical section of the same, enlarged five times.

Fig. 4. Part of a tangential section of *Plasmopora exserta*, Nich. and Eth. jun., enlarged five times, from the Wenlock Limestone of Dudley. *Coll.* H. A. Nicholson.

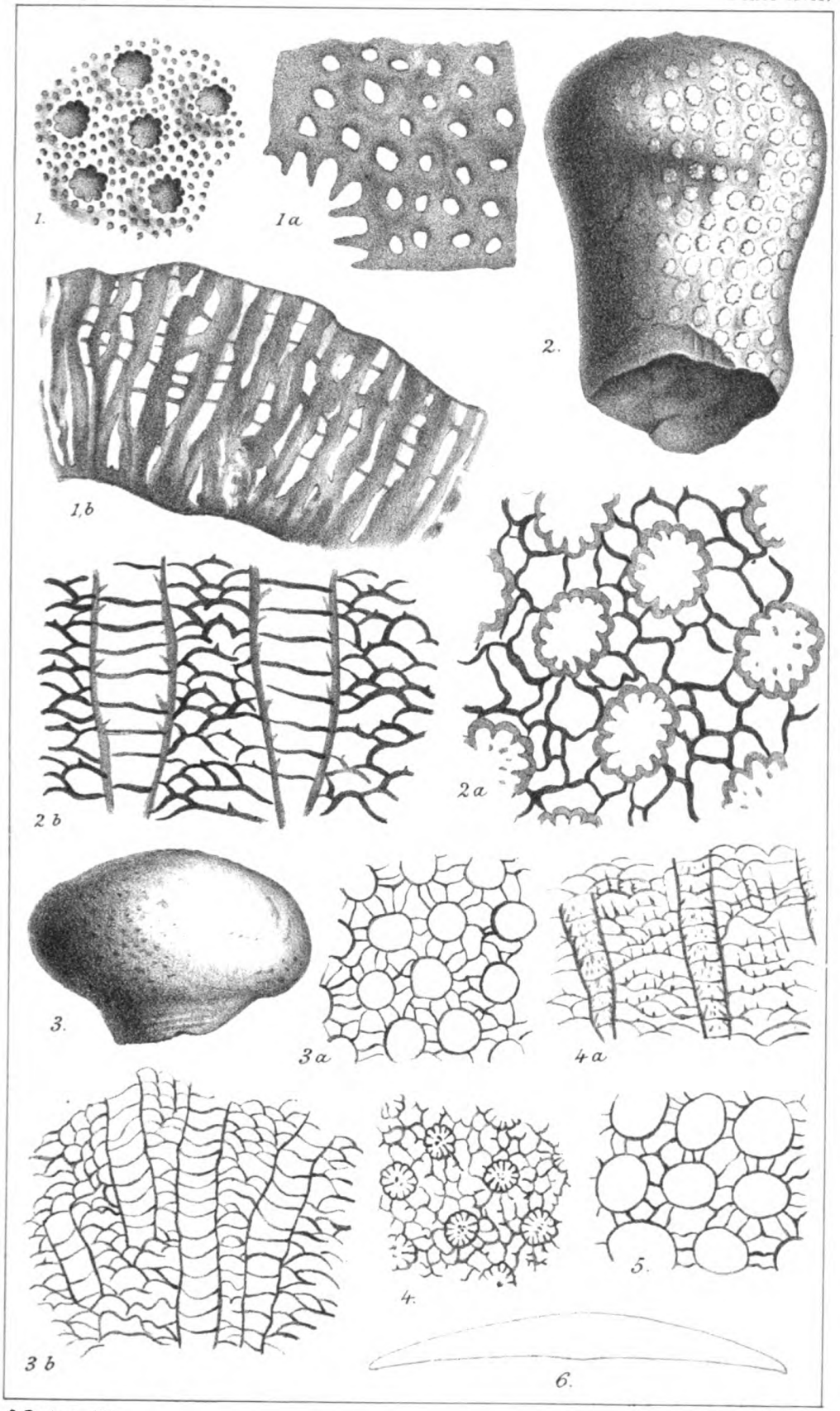
Fig. 4 *a*. Vertical section of the same, enlarged five times, showing the spiniform septa of the large corallites, and the imperfect walls of the small corallites.

Fig. 5. Part of a tangential section of *Propora tubulata*, Lonsd., from the Wenlock Limestone of Longhope, enlarged five times, for comparison with fig. 3 *a*. *Coll.* H. A. Nicholson.

Fig. 6. Outline of the corallum of a very large specimen of *Pinacopora Andersoni*, Nich. and Eth. jun., from Woodland Point, Girvan, divided across its centre and viewed in profile, of the natural size.

H. Alleyne Nicholson, del.

Plate XVII.



C. Berjeau, lith.

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PLATE XVIII.

Fig. 1. Under surface of a very large specimen of *Pinacopora Andersoni*, Nich. and Eth. jun., from Woodland Point, Girvan, of the natural size, showing the concentrically striated basal epitheca. The specimen is the same as that shown in elevation in fig. 6, Plate XVII.

Fig. 1 *a*. A small portion of the upper surface of the same, enlarged about five times, showing the large calices, with their rudimentary septa.

Fig. 1 *b*. Under surface of a very small specimen of the same, of the natural size.

Fig. 1 *c*. Vertical section of the same specimen as the last, of the natural size, showing the form of the corallum.

Fig. 1 *d*. Part of a vertical section of the same species, embracing the entire thickness of the corallum, enlarged about five times, showing the vesicular tabulæ of the small corallites.

Fig. 1 *e*. Part of another vertical section of the same, showing that the tabulæ of the small corallites are in places horizontal and in places vesicular, and that they are continued to a point much nearer the surface than is the case with the horizontal tabulæ of the large corallites.

Fig. 2. Transverse section of part of the corallum of *Halysites*, sp., allied to *H. catenularia*, but wanting small tubes intercalated between the larger corallites, enlarged five times. Woodland Point, Girvan.

Fig. 3. Transverse section of *Halysites*, sp., allied to *H. escharoides*, Lam., enlarged five times.

Fig. 3 *a*. Vertical section of a few tubes of the same, showing the cut ends of the spinulose septa. Woodland Point, Girvan.

Fig. 4. Transverse section of *Halysites*, sp., enlarged five times. Cement-stones, Shalloch Mill, Girvan. *Coll.* Charles Lapworth.

Fig. 5. Transverse section of a small specimen of *Favosites Mullochensis*, Nich. and Eth. jun., from Woodland Point, Girvan, enlarged five times.

Fig. 5 *a*. Part of a single corallite of the same, slightly generalised; enlarged to show the arrangement of the mural pores and the undulated walls.

Fig. 5 *b*. Vertical section of the same, enlarged five times, showing the sharply undulated walls and the remote tabulæ. Woodland Point, Girvan.

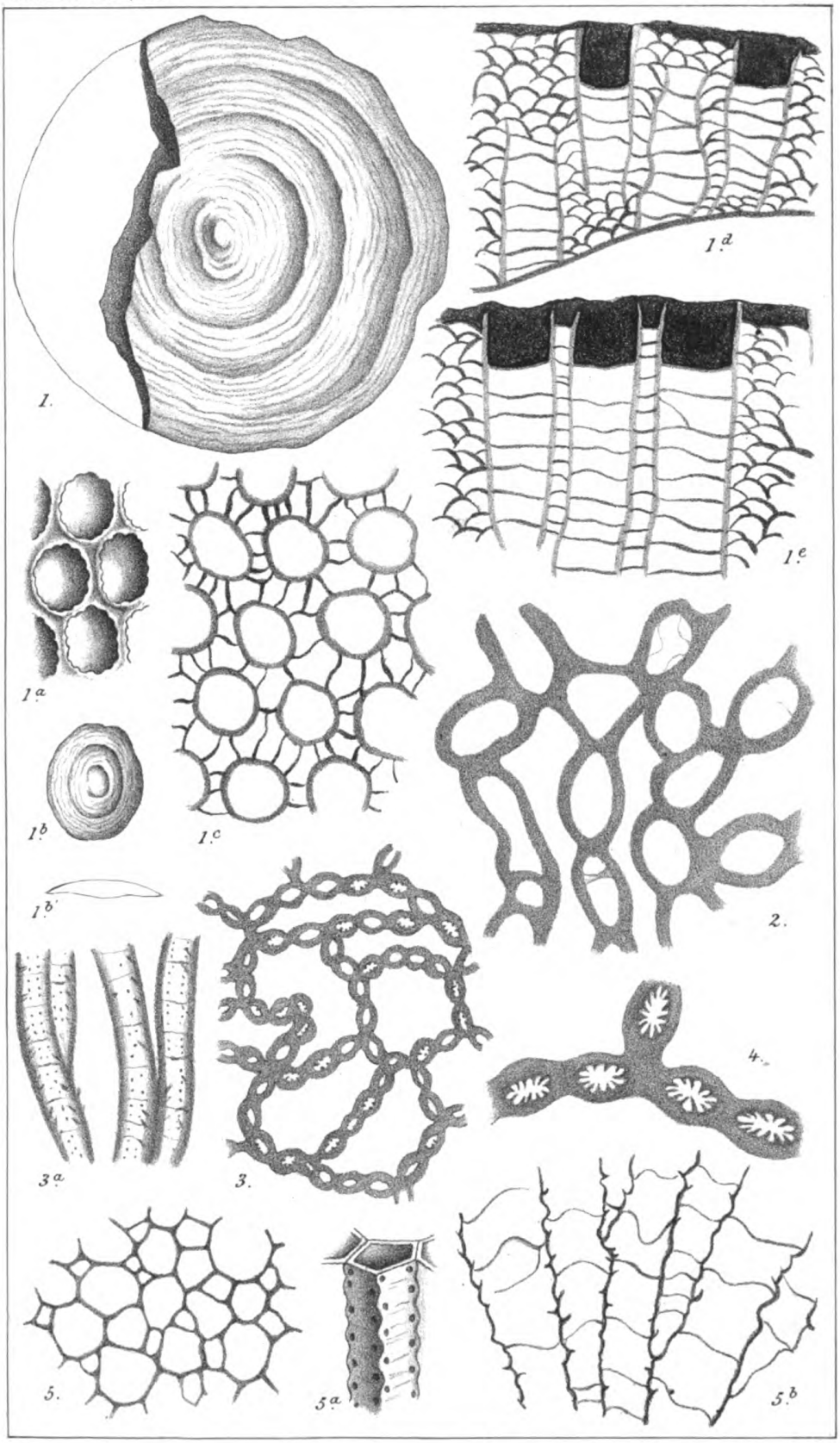

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1d.
1e.
1a.
1c.
1b.
1b'
2.
3a.
3.
4.
5.
5a.
5b.

PLATE XIX.

Fig. 1. Fragment of a mass of limestone traversed by the root-fibres of *Hyalonema Girvanense*, Nich. and Eth. jun., of the natural size. Knockgeerin, near Girvan. *Coll.* C. Lapworth.

Fig. 1 *a*. Transverse section of a portion of the same, enlarged five times. Some of the fibres show the axial canals.

Fig. 1 *b*. Longitudinal section of part of the same, enlarged five times, and cut slightly obliquely as regards the long axes of the fibres. The fibres show, as in the preceding, a great difference in size, while some exhibit the axial canals, and most are traversed by transverse partitions.

Fig. 2. Vertical section of a fragment of *Clathrodictyon vesiculosum*, Nich. and Murie, enlarged twenty-five times, from the Upper Silurian Mudstones of Woodland Point, Girvan.

STAUROCEPHALUS? *sp. ind.*, p. 283.

Fig. 3. The remains of a badly preserved specimen, showing portions of the head, thorax, and pygidium ; × 3.

CYCLOPYGE REDIVIVA, *Barr. sp.*, p. 284.

Fig. 4. An entire example, with the divisions of the body well preserved, from Whitehouse ; × 6.

CYCLOPYGE ARMATA, *Barr. sp.*, p. 286.

Fig. 5. A glabella, retaining a portion of the frontal spine, and with grooves faintly marked. Whitehouse ; × 2.

Fig. 6. Another example from the same locality ; × 2.

Fig. 7. The epistoma and portions of the large confluent eyes. Whitehouse ; × 3.

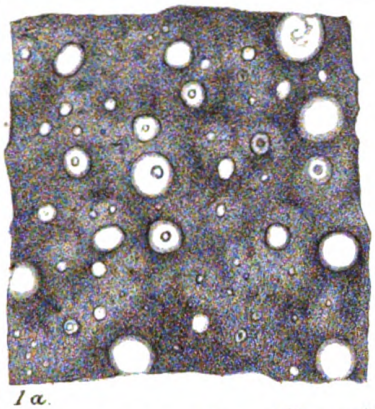
Fig. 8. A series of the facets of the eyes, highly magnified ; same locality.

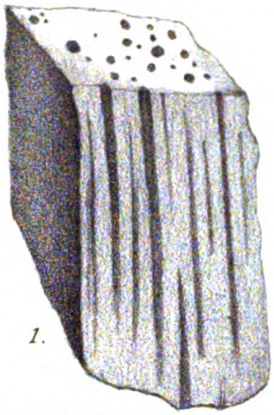
TRINUCLEUS MACCONOCHIEI, *Eth. jun.*, and *Nich* , p. 288.

Fig. 9. A cast in wax, taken from the original specimens (see Fasciculus II., t. xiv. f. 1), and showing the constriction at the base of the glabella ; × 4.

TRINUCLEUS, *sp. ind.*, p. 288.

Fig. 10. The glabella, one cheek, and a portion of the punctate fringe of a large *Trinucleus*. Whitehouse—nat. size.

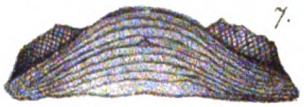

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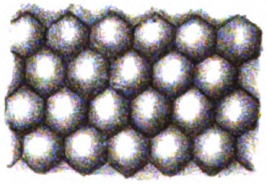

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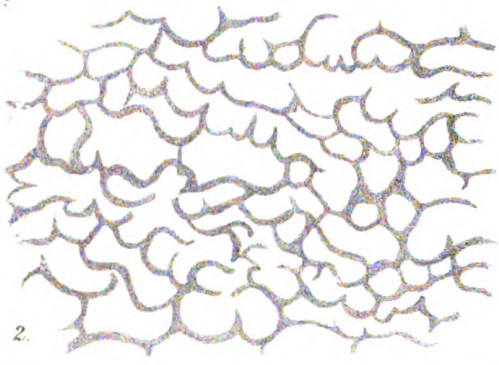

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PLATE XX.

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(See page 20, p. 226.

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PLATE XX.

DIONIDE LAPWORTHI, *Eth. jun.*, and *Nich.*, p. 290.

Fig. 1. An almost entire individual, showing the semicircular head-shield, long genal spines, small glabella, narrow thorax, and generally attenuated body. Whitehouse—nat. size.

DIONIDE, *sp. ind.*, p. 293.

Fig. 2. A pygidium (or portion of one only?). Whitehouse; × 3.

DIONIDE, *sp. ind.*, p. 294.

Fig. 3. A much elongated pygidium? Whitehouse; × 3.

DIONIDE (?), *sp. ind.*, p. 294.

Fig. 4. A small pygidium with six segments and a terminal appendage reaching to the posterior margin; referred with doubt to *Dionide*. Whitehouse; × 8.

DIONIDE (*immature form*), p. 295.

Fig. 5. A small entire example, probably representing an immature form. There are four thoracic somites developed, and a large pygidium. Whitehouse; × 6.

AGNOSTUS PERRUGATUS, *Barr* (?), p. 296.

Fig. 6. A glabella, which appears to possess all the essential characters of this species. The divisions of the glabella, including the two basal lobes, are quite apparent, and the radiated cheek-margin is well shown. Whitehouse; × 6.

Fig. 7. A minute specimen, which we believe to represent the pygidium of this species. Whitehouse; × 4.

TURRILEPAS PEACHII, *Eth. jun.*, and *Nich.*, p. 301.

Fig. 8. The largest specimen we possess, although fragmentary. The large kite-shaped plates are arranged at right angles to the longer axis. Whitehouse; × 2.

Fig. 9. A much more entire specimen, but smaller than Fig. 8. The gradation of the kite-shaped plates from right angles to nearly parallel in position with the longer axis is well shown. Whitehouse; × 2.

Fig. 10. Another example, somewhat more elongated in form, but possessing the same general characters. Whitehouse; × 2.

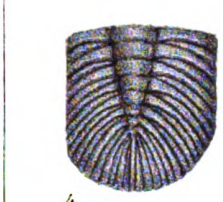
SERPULITES LONGISSIMUS, *Murchison*, p. 303.

Fig. 12. A compressed tapering tube of this species from Drummuck—nat. size.

Fig. 13. Another example from the same locality—nat. size.

TRINUCLEUS SETICORNIS, *var.* BUCKLANDI, *Barr*.

Fig. 11. The specimen represented in Fasciculus II. (t. xiii. f. 20), refigured to show the small "eye-lines" passing through the ocular tubercles; × 2.



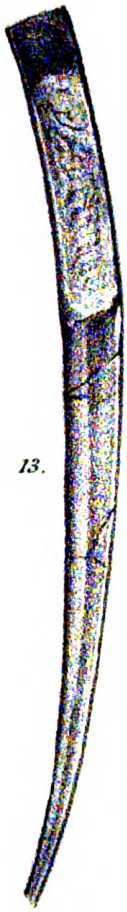
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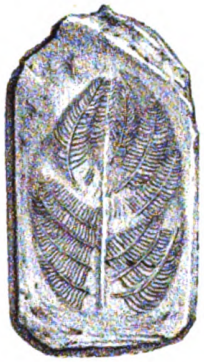
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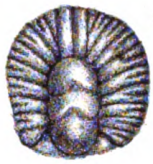
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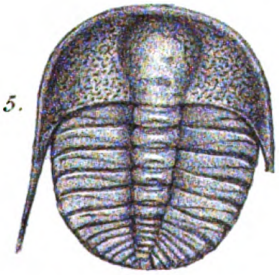
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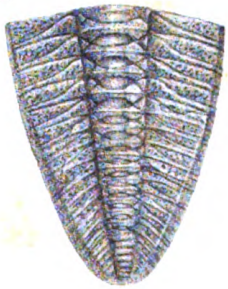
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PLATE XXI.

TETRASTER WYVILLE-THOMSONI, *Eth. jun.*, and *Nich.*, p. 324.

Figs. 1 - 8. Various specimens preserved as casts in the highly fossiliferous deposit of Thraive Glen, showing the general arrangement of the plates.

Figs. 2, 3, 6, and 7 are impressions in wax from the foregoing figures which represent the actual specimens. Figs. 1 and 2, × 3 times; figs. 4-8, × 4 times.

TETRASTER, *sp. ind.*, p. 325.

Fig. 9. A specimen preserved as a cast in the fossiliferous rock of Thraive Glen, with one arm almost entire, and portions of the other four; × 2.

Fig. 10. Wax cast of the same; × 2.

MYELODACTYLUS (?), *sp. ind.*, p. 333.

Fig. 11. Portion of a coiled stem, probably referable to this genus. It is rounded on the convex, and hollowed out on the concave side. Fossiliferous mudstone of Penkill—nat. size.

Fig. 12. Portion of another stem, with the remains of the auxiliary side arms on the concave side. Balcletchie—nat. size.

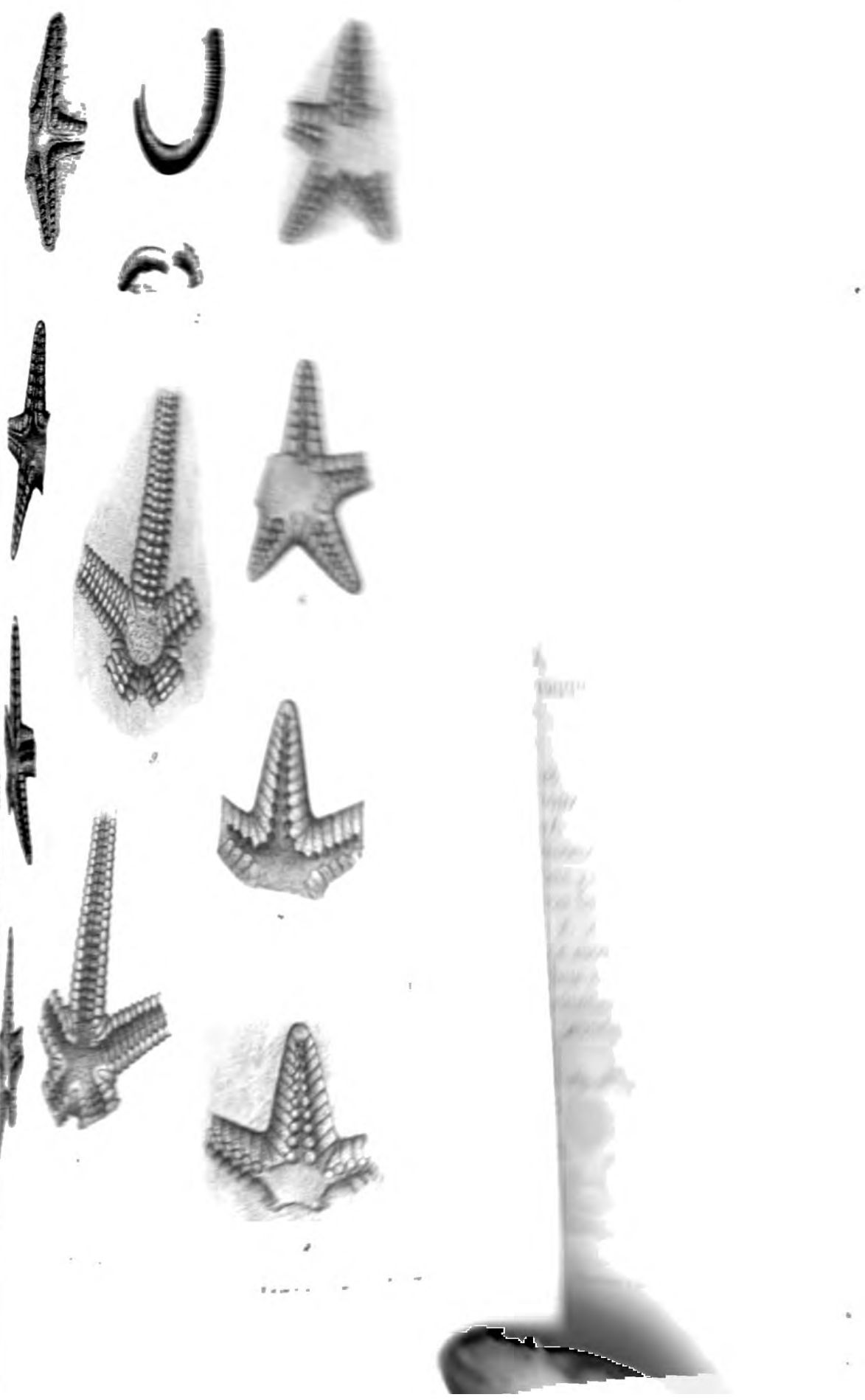


PLATE XXII.

CRINOID STEMS, pp. 327, 328.

Fig. 1. Small pentagonal stem from the Craighead Limestone—nat. size.

Fig. 2. Small quadrangular stem, with the opposite sides equal, two and two. Craighead Limestone—enlarged.

Figs. 3 and 4. Stem composed of thick, bony, circular ossicles, larger and smaller, from the Craighead Limestone—somewhat enlarged.

Fig. 5. A stem, common in the Girvan district, composed of large, plain, equal, circular, and regular joints—nat. size.

Figs. 6, 7, and 8. Varieties of another stem, in which the joints are usually larger and smaller alternately, and sometimes ornamented with tubercles. Balcletchie—nat. size.

GLYPTOCRINUS, *sp. ind.*, p. 329.

Fig. 9. Side view of the lower portion of the calyx, showing the arrangement of the plates and the characteristic ribs passing upwards. Craighead Limestone; × 2.

Figs. 10 and 11. Basal views of other specimens from the same horizon; × 2.

GLYPTOCRINUS, *sp. ind.*, p. 330.

Fig. 12. An internal cast, from the fossiliferous rock of Thraive Glen, of the upper part of the calyx and bases of the arms; × 1½.

Plates of CRINOIDEA or CYSTOIDEA, p. 333, 334.

Fig. 13. Small plate with a central plain space, from which radiate seven flexuose ridges: the interspaces are striated outwards.

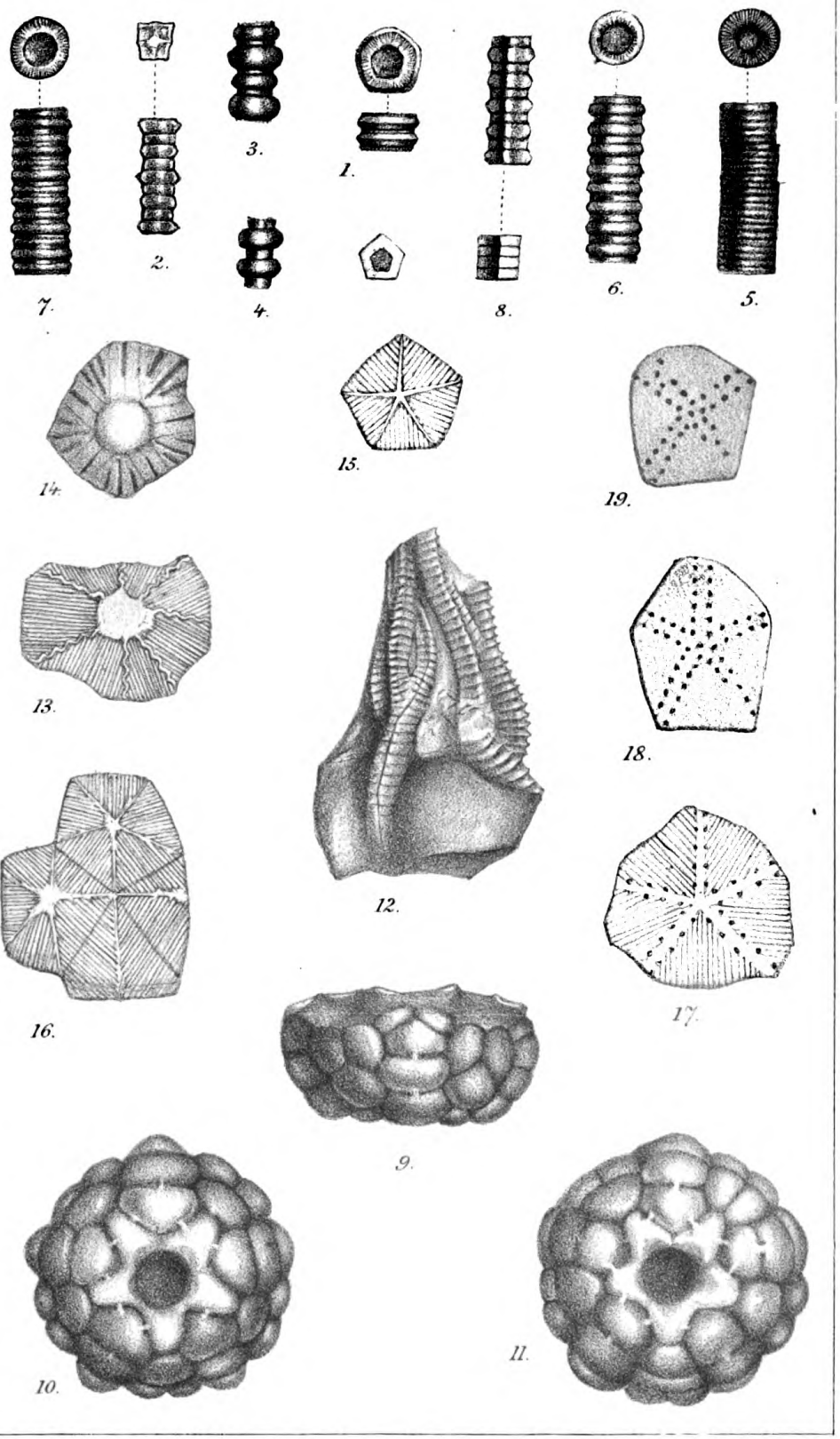
Fig. 14. Another plate, in which the ridges have become broader, at the expense of the intervening portions of the plate.

Figs. 15 and 17. Small plates, in which the separating ridges are five in number and non-flexuous.

Fig. 16. A peculiar plate, in which the radii are four in number, proceeding from a central point.

Figs. 18 and 19. The interiors of two small plates, bearing five and four double radiating rows of puncta respectively, proceeding to the angles of the plates.

(*The specimens represented by Figs.* 13-19 *are all from the Balcletchie Conglomerate, and the figures are each enlarged four times.*)



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PLATE XXIII.

NEREITES, *sp. ind.*, p. 305.

Fig. 1. A form near the so-called *Nereites Cambrensis*, Murchison—nat. size. Penwhapple Glen.

MYRIANITES, *sp. ind.*, p. 306.

Fig. 2. Portion of a specimen showing the concentric loops—nat. size. Penwhapple Glen.

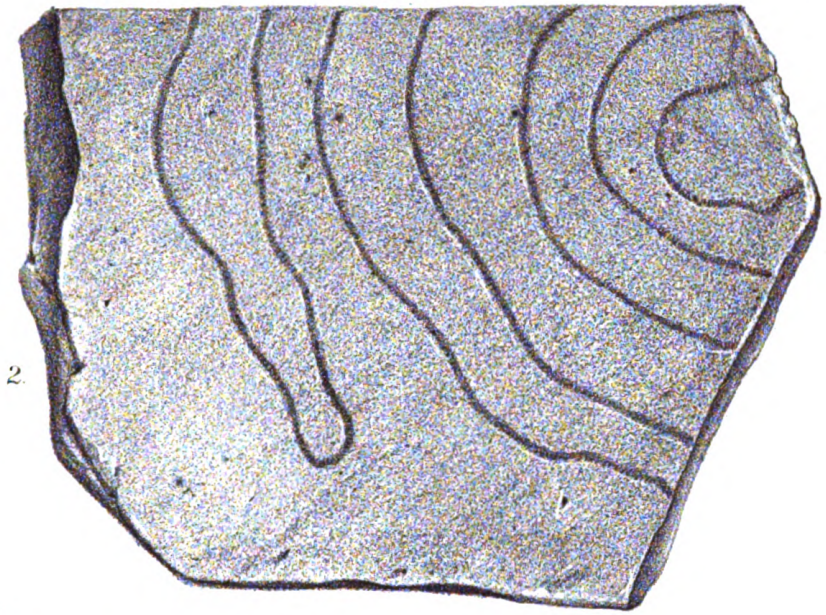
CROSSOPODIA (?), *sp. ind.*, p. 308.

Fig. 3. A small fragment, which may perhaps belong to this so-called genus, with delicate lateral striæ—nat. size. Penwhapple Glen.

NEMERTITES (?), *sp. ind.*, p. 309.

Fig. 4. A much convoluted, somewhat elevated track, which may perhaps be included under this name—nat. size. Penwhapple Glen.

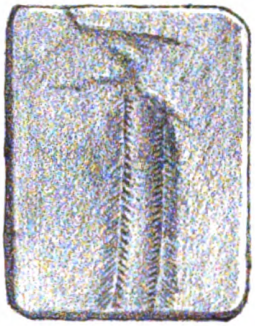
Fig. 5. A different track referred to the same name, but of a more meandering nature—nat. size. Penwhapple Glen.



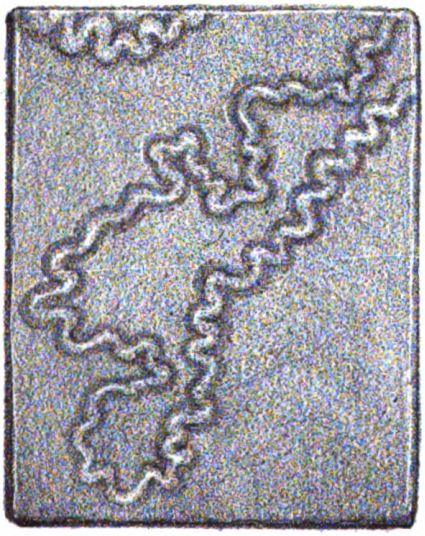
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PLATE XXIV.

MYRIANITES, *sp. ind.*, p. 306.

Fig. 1. Portion of a specimen exhibiting the concentric loops enlarging at the ends—nat. size. Penwhapple Glen.

MYRIANITES TENUIS, *M'Coy* (?), p. 306.

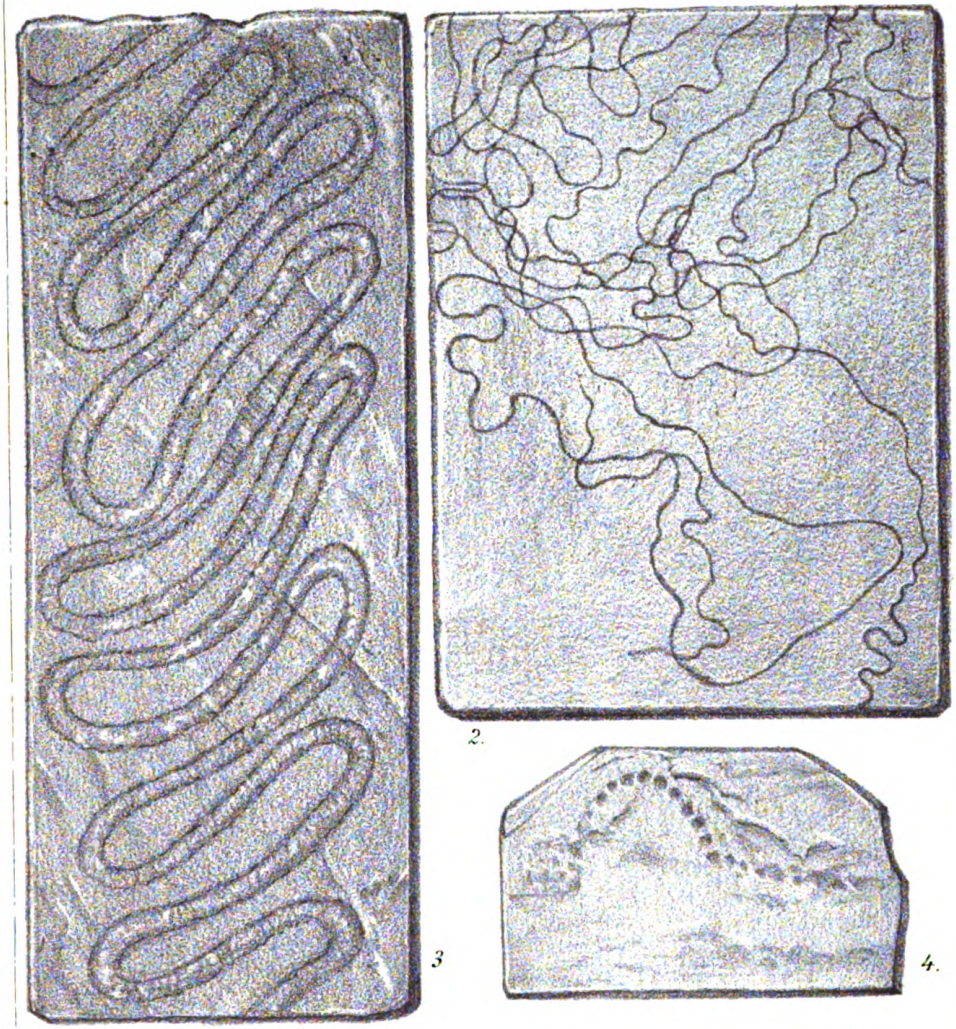
Fig. 2. Portion of an example presumed to belong to this so-called species—nat. size. Penwhapple Glen.

CROSSOPODIA SCOTICA, *M'Coy* (?), p. 307.

Fig. 3. An example which appears to correspond in its chief characters with this form—nat. size. Penwhapple Glen.

EIONE (?), *sp. ind.*, p. 309.

Fig. 4. A small fragment of shell exhibiting a series of consecutive depressions, which correspond with those described under the above name—nat. size. Penwhapple Glen.



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