THE
QUARTERLY JOURNAL
OF
THE GEOLOGICAL SOCIETY OF LONDON.
VOL. XXXIV.

1. *On our PRESENT KNOWLEDGE of the INVERTEBRATE FAUNA of the LOWER CARBONIFEROUS or CALCIFEROUS SANDSTONE SERIES of the EDINBURGH NEIGHBOURHOOD, especially of that Division known as the WARDIE SHALES; and on the FIRST APPEARANCE of certain SPECIES in these Beds.* By R. ETHERIDGE, Jun., Esq., F.G.S. (Read November 7, 1877.)

[PLATES I. & II.]

Introduction.—Little or no attention has been paid to the organic remains of the great series of strata below the Gilmerton or No. 1 Limestone of the Midlothian coal-field (adopted as the conventional base of the Carboniferous Limestone series by the Geological Survey), when compared with the numerous papers and other publications bearing on the fossils of the overlying strata or *Carboniferous Limestone Series*. It is true the fishes were examined by Agassiz*, and the plants to some extent by Lindley and Hutton, but in both cases only to a limited extent. Dr. Hibbert's celebrated paper on the Burdiehouse Limestone appears to have been the first memoir in which any systematic observations were recorded; and, with the exception of a few miscellaneous publications in the interim, it was not until the Geological Survey broke ground in the Edinburgh neighbourhood that any further detailed work of this nature was under-

* The study of the Fishes has been resumed by Dr. Traquair, F.G.S.
Q. J. G. S. No. 133.

2 R. ETHERIDGE, JUN., ON LOWER-CARBONIFEROUS INVERTEBRATA.

taken. We have the result of Mr. Salter's examination of a collection of fossils made by Messrs. R. Gibbs and W. Rhind during Prof. Geikie's survey of the district, in the Appendix to the 'Geology of the Neighbourhood of Edinburgh.' Notwithstanding that Mr. Salter's observations were confined to a mere list of the species obtained by the collectors, there can be no doubt that his were the first systematically carried out, and that they laid the foundation for future research.

In this communication I propose to give :—first, a summary of our present knowledge of the Invertebrate Fauna of the Calciferous Sandstone series as developed in the Edinburgh neighbourhood ; secondly, a description of the fossils from a particular horizon in the series, the Wardie Shales, contained in the cabinets of Mr. John Henderson and Mr. Gall ; and, thirdly, some general remarks on the first appearance of certain species in the Calciferous Sandstone series of this district. It will not be out of place, perhaps, for me to give a few particulars as to the extent and subdivisions of the Calciferous Sandstone Series before proceeding to the first of the foregoing subjects.

The strata comprised in the Calciferous Sandstone or Lower Carboniferous Series of Edinburghshire, as elsewhere in Scotland, speaking generally, are divisible into a superior or Cement-stone group and an inferior or Red Sandstone group. The former consists in this district of sandstone, shales, oil-shales, some thin corals, and a few limestones ; the latter of red and grey sandstones, conglomerates, marls, and cornstones *. Speaking of these divisions in the district in question, Prof. A. Geikie says the lower group " forms the ground on which the greater part of Edinburgh is built, whence it stretches southward by Craigmillar to Liberton, and south-westward along the western flank of the Pentland Hills. . . . The various strata [of the upper group] extend from the western and northern part of Edinburgh westward to Linlithgow, and south-westward by the Cobinshaw Reservoir into Lanarkshire " †.

The lower, or Red Sandstone group, has proved so unfossiliferous, hitherto, that it may be dismissed for the present. Passing to the Cement-stone group, the first well-marked horizon we meet with is formed by a " series of sandstones, shales, and thin limestones " in the streams flowing into the Clubbidean Reservoir from the northern flank of the Pentland Hills ‡. Above this there appear to be several well-marked horizons ; but as regards their order of superposition and relation to one another, there is some diversity of opinion. According to Prof. Geikie, the next most important group is that of the Wardie Shales exposed along the course of the Water of Leith, traceable for about six or seven miles southwards from their exposure on the shore of the Firth of Forth, at Newhaven or Wardie between Leith and Granton, and overlain by a vast series of

* J. Geikie, 'The Carboniferous Formation of Scotland,' p. 9.

† Descriptive Cat. Rock Specimens Geol. Survey Scotland, p. 18 ; see also Mem. Geol. Survey Scotland, 1861, No. 32, pp. 16-42.

‡ A. Geikie, Memoir 32, p. 18.

R. ETHERIDGE, JUN., ON LOWER-CARBONIFEROUS INVERTEBRATA. 3

yellow and white thick-bedded sandstones, the Granton and Craigleith Sandstones *. On the other hand, Mr. Henderson, in a recently published paper "On the Wardie and Granton Series of Sandstones and Shales" †, combats this view, and considers that the sandstones of Craigleith and Granton really underlie the Wardie Shales and form the base of the latter. In the course of his examination of the district, Mr. Henderson has observed at several localities well-marked bands of shale containing marine fossils, as at Woodhall, Dean Bridge, Drumsheugh, Craigleith, and Granton; and from the close identity of the species at these several localities he is led to consider the beds there exposed as occupying much the same position, near the base of the Wardie Shales and above the sandstones of Craigleith and Granton. Omitting all mention of contemporaneous igneous rocks, we come in ascending order to the horizon of the well-known and valuable Burdiehouse Limestone; but as this is without the scope of the present paper, it need not be further referred to here.

I. *On our present Knowledge of the Invertebrate Fauna of the Lower Carboniferous or Calceiferous Sandstone Series of the Edinburgh Neighbourhood.*

So far as I have been able to ascertain, representatives of the Foraminifera, Spongida, Coelenterata, and Echinodermata have not been recorded from the above rocks. The most likely locality to yield members of either of these divisions will be the bed of marine shale at Woodhall, in the water of Leith, afterwards to be more fully noticed.

Annelida.—In Dr. Hibbert's memoir "On the Freshwater Limestone of Burdiehouse, &c." ‡, published in 1836, the occurrence is mentioned, in the fourth section of the paper ("The Microscopic Animals contained in the Limestone of Burdiehouse"), of minute shells with "a sort of spiral organization, by no means unlike that of the *Planorbis* or *Spirorbis*." He here clearly refers to the little Annelid named about this time *Microconchus carbonarius* by Murchison. Hibbert also noticed and figured a little body which he compared to a *Nautilus*, but remarked its want of septa §. The figure

* Mem. Geol. Surv. Scotl. p. 31.

† Trans. Edinb. Geol. Soc. 1877, iii. pt. 1, p. 24.

‡ Trans. R. Soc. Edinburgh, xiii. p. 169.

§ *Loc. cit.* p. 181. I consider this little body to be a well-marked variety of *Spirorbis carbonarius*, Murchison, and offer the following description of it:—

SPIRORBIS CARBONARIUS, Murch., var. *Hibberti*, var. nov. Pl. I. fig. 2.

Nautilus, Hibbert, Trans. R. Soc. Edinb. 1836, xiii. p. 151; Rhind, Excursions around Edinb. 1836, p. 35, fig. 14 c.

Var. char. Size exceeding that of the species itself, the last turn of the tube increasing more rapidly; aperture with a sigmoidal or nautiliform margin reflected somewhat back over the umbilicus, which is deep. By following the direction of the surface-striae the sigmoidal margin can be traced.

Horizon. Beds in connexion with the Burdiehouse Limestone, in the neighbourhood of Edinburgh.

4 R. ETHERIDGE, JUN., ON LOWER-CARBONIFEROUS INVERTEBRATA.

of this variety of *Spirorbis carbonarius* was again reproduced by Dr. W. Rhind in a little work entitled 'Excursions illustrative of the Geology and Natural History of the Environs of Edinburgh'*. The first collective account of the Lower-Carboniferous fossils, as previously stated, was that given by Mr. Salter in the Appendix to the Memoir on the Geology of Edinburgh. The list of Invertebrata comprised exactly one dozen species, of which two were Annelids, viz. *Spirorbis carbonarius*, Murch., and *Sp. helicteres*, Salter, both obtained by Mr. R. Gibbs in the Clubbidean Limestone, at the extreme base, according to Prof. Geikie, of the Cement-stone group. *Sp. helicteres* was originally described by Mr. Salter from specimens obtained by the Rev. T. Brown, M.A., near Fifeness, and figured and described in the latter gentleman's paper "On the Mountain Limestone and Lower Carboniferous Rocks of the Fifeshire Coast"†.

Mr. Salter remarked on the unattached habit of this worm, and stated that it occurs in distinct beds, hundreds grouped together, yet without ostensible attachment to any other object than its own species. The same remark will apply to its condition at Clubbidean. In May 1870 Mr. C. W. Peach communicated a paper to the Edinburgh Geological Society "On the Discovery of *Spirorbis carbonarius* (Murchison) in the Limestone of Burdiehouse, &c."‡. The same species was again found by Mr. J. Henderson on striated stems, like Calamites, from a black shale in Forrest Road, Edinburgh §.

In a short article entitled "Palæontological Notes," contributed to the 'Geological Magazine' in July last (1877), I called attention to a *Spirorbis* occurring in a band of limestone at the Oakbank Oil Works, near Mid Calder, which appears to be closely allied to *S. siluricus*, Eichw.

Crustacea.—We are again indebted to Dr. Hibbert for the first notice of Ostracoda from this series of rocks. He named and figured *Cypris scoto-burdigalensis* and *Daphnoidea*, sp., from the Burdiehouse Limestone ||. The first of these has since been placed in the genus *Leperditia* by Prof. T. Rupert Jones, F.R.S.; and the second has been named by him *D. Hibberti*. Dr. William Rhind also reproduced the original figures of these species ¶; and Mr. Salter recorded further localities where they might be obtained **. A very interesting paper was published by Dr. R. Paterson in the year 1837, "On the Fossil Organic Remains found in the Coal Formation at Wardie, near Newhaven" ††. After describing the plants, Dr. Paterson mentions the Entomostraca, which, he says, are to be referred "to the genera *Cypris* and *Daphnoidea*." He adds, on another page, "These microscopic crustaceous remains are

* 12mo, 1836, p. 35.

† Trans. R. Soc. Edinb. xxii. p. 401.

‡ Trans. Geol. Soc. Edinb. 1871, ii. pt. 1, p. 82.

§ "On Fossils found in the Rocks underlying the South Side of Edinburgh," Trans. Geol. Soc. Edinb. 1871, ii. pt. 1, p. 138.

|| Hibbert, *loc. cit.* pp. 179, 180.

¶ Excursions, 1836, p. 35.

** Memoir 32, p. 145.

†† Edinb. New Phil. Journ. 1837, xxiii. pp. 146-155.

R. ETHERIDGE, JUN., ON LOWER-CARBONIFEROUS INVERTEBRATA. 5

to be seen in conjunction with a small shell of the genus *Ostrea*, with Corallines, with plants to be referred to the genus *Fucoides*, as well as with the multitude of terrestrial plants." William Hutton contributed an article, "Note upon the Burdiehouse Limestone," to the joint work by himself and Dr. Lindley *, in which he describes the great abundance of the *Cypris* in that particular bed; he says, "we find, in the utmost profusion, so as even in some parts to make the rock almost oolitic, the shells of *Cypris*, with other minute Entomostraca &c." Only two species of Ostracoda are mentioned by Prof. T. Rupert Jones and Mr. J. W. Kirkby in their paper "On the Entomostraca of the Carboniferous Rocks of Scotland" †, as occurring in the Burdiehouse Limestone, viz. *Beyrichia subarcuata*, Jones, and *Leperditia Okeni*, Münster, although Prof. Jones added to these in 1871, in two papers bearing the titles "On a new Locality for *Leaia*" ‡ and "On some Bivalved Entomostraca from the Coal-measures of S. Wales." *Leaia* was discovered by Mr. C. W. Peach in an ironstone nodule at Wardie, on the Firth of Forth, in the Wardie-shale section of the Cement-stone group. In an Appendix to the second of the foregoing papers a new *Estheria* (*E. Peachii*) was briefly described §. It was discovered by Mr. D. Grieve, F.G.S., at Camston Quarry, Arthur's Seat, in beds referable, according to Prof. Geikie, to the upper portion of the Red Sandstone group. The occurrence of both the *Leaia* and the *Estheria* were brought under the notice of the British Association in 1871, by Mr. C. W. Peach, in a paper "On additions to the List of Fossils and Localities of the Carboniferous Formations in and around Edinburgh" ||. At the same Meeting an interesting discovery of "Fossiliferous Strata at Lochend" near Edinburgh was announced by Mr. D. Grieve, who found, in an indurated shale, plants and "a crustacean, *Cypris scoto-burdigalensis*, or an allied species" ¶.

Polyzoa.—I am unacquainted with any published notice of the occurrence of Polyzoa in the Edinburgh Lower Carboniferous rocks.

Brachiopoda.—In Mr. T. Davidson's paper on "Scottish Carboniferous Brachiopoda," the only locality mentioned as yielding brachiopods which can with certainty be referred to a Lower Carboniferous horizon is the before-mentioned locality Wardie, where *Lingula squamiformis* is obtained **. Mr. Salter also quotes it from the same place ††.

Pelecypoda (Lamellibranchiata).—Dr. Hibbert discovered a bivalve in shale above the Burdiehouse Limestone, which he figured under the name of *Unio nuciformis* ‡‡; it, with other fossils, was reproduced by Dr. W. Rhind, and ultimately referred to the genus *Anthracostea* by Salter §§. In 1838, Dr. W. Rhind published another

* Fossil Flora of Gt. Brit. 1837, iii. pp. 22-35.

† Trans. Geol. Soc. Glasgow, ii. p. 213.

‡ Geol. Mag. vii. p. 96.

§ Brit. Assoc. Report, 1871, pt. 2, p. 109.

** Geologist, iii. p. 264.

†† Hibbert, *loc. cit.* p. 245.

§ *Ibid.* p. 214.

¶ *Ibid.* p. 98.

†† Memoir 32, p. 146.

§§ Salter, *loc. cit.* p. 146.

6 R. ETHERIDGE, JUN., ON LOWER-CARBONIFEROUS INVERTEBRATA.

little work, 'The Age of the Earth'*, in which he devoted a portion of plate ii. to the illustration of some Lower-Carboniferous fossils from the Water of Leith. The name *Axinus pentlandicus* was adopted by Dr. Rhind for what I take to be two specifically distinct shells: one of these, fig. *b*, was afterwards described and figured, without reference to Rhind's book, by Captain T. Brown, as *Pachyodon pyramidatus*, in a paper "On some new Species of the genus *Pachyodon*"†; the other, fig. *a*, is probably Brown's *Pachyodon nucleus* of the same paper. Brown's shells were found in "coal shale at Woodhall, on the north side of the Pentland Hills." It is almost unnecessary for me to observe that there is no coal shale at Woodhall. Fig. *g* of Dr. Rhind's plate is that of a *Modiola*, afterwards described by Capt. Brown as *Avicula modioliforme* in his 'Fossil Conchology,' where he also redescribed the two previous shells (*Pachyodon pyramidatus* and *P. nucleus*), but referred them to *Unio*‡. In the previously quoted paper by the Rev. T. Brown, on the Carboniferous rocks of the Fifeshire coast, Mr. Salter gave a figure of a new species of *Schizodus* found by Mr. Brown to be plentifully distributed throughout the Fifeshire lower series. The late Dr. Fleming obtained the same shell at Colinton, water of Leith, and would have referred it to *Anatina attenuata*, M'Coy; but Mr. Salter, on examining the hinge, pronounced it a *Schizodus*§. I have since described this shell as *S. Salteri*||, in memory of my late friend; and when so doing I pointed out that it was probably identical with *Pachyodon pyramidatus*, Brown, and *Axinus pentlandicus* (fig. *b*), Rhind; but as both these authors appear to have figured imperfect examples of these shells, the matter must remain in a state of uncertainty, until an appeal can be made to their original specimens. Four species of bivalves are recorded in the Survey Memoir by Mr. Salter—the *Avicula modioliforme*, Brown, a thin-shelled species of *Anthracomya*? from the Wardie Shales, the *Anthracosia*? (*Unio*) *nuciformis* from the Burdiehouse Limestone, and an oval species of *Myalina* from the Clubbidean basement-beds of the Cement-stone group¶. In a short paper of my own, published in 1875, I described the shell I have here mentioned under the name of *Schizodus Salteri*** . I was supplied by my friend Dr. Traquair with some good interiors; and by means of these, in conjunction with the original specimens kindly lent me by the Rev. Mr. Brown, the hinge-structure of the species was satisfactorily worked out. Dr. Traquair, at the same time, lent me specimens of the *Modiola* figured by Dr. Rhind, from which I was able to show its identity with *Myalina crassa*, Fleming. In a paper I communicated to the 'Annals and Magazine of Natural

* 12mo, 1838.

† Ann. & Mag. Nat. Hist. 1843, xii. p. 390, pl. 16*.

‡ Illustrations of the Foss. Conch. Gt. Brit. 1849, pp. 162, 178, 179, pls. 66* and 73.

§ Trans. R. Soc. Edinb. xxii. p. 392.

|| Ann. & Mag. Nat. Hist. 1875, xv. p. 431.

¶ Memoir 32, p. 146.

** Annals, loc. cit.

R. ETHERIDGE, JUN., ON LOWER-CARBONIFEROUS INVERTEBRATA. 7

History' in August last year* a shell was described as *Leptodomus clavatus*, which is common at four localities—Woodhall, Granton, Drumshough, and Craigleith. Some further remarks are made upon this species further on. The base of the Cement-stone group at the Clubbidean Reservoir in the Pentland Hills appears to be well marked by the presence of a limestone in which a bivalve occurs referred by Mr. Salter to the genus *Myalina*. I have never seen good specimens of this form. A thin papyraceous little shell is very characteristic of the Wardie Shales at Slateford, of which numerous specimens are in the Survey Collection. By Mr. Salter it was regarded as an *Anthracomya*†; I have labelled it *Anthracoptera papyracea*, R. Eth. (MS.). In the 'Geological Magazine' for June last (1877) I described another bivalve, equally characteristic of the beds in connexion with the Burdiehouse Limestone, as *Anthracomya scotica*‡.

Gasteropoda.—No members of this class had been described from our Lower Carboniferous rocks, so far as I am aware, until I noticed the occurrence of a variety of *Bellerophon decussatus*, Flem., at Woodhall, Water of Leith§.

Cephalopoda.—Mr. Salter recorded two species of *Orthoceras* from Livingston, near Mid Calder. I am not aware that any other specimens have been found in that immediate locality.

II. *Descriptions of the Species from the Wardie-Shale section of the Cement-stone group contained in the Cabinets of Mr. John Henderson and Mr. Gall, Edinburgh.*

With the exception of a few of the specimens, the species described in the following pages are in the cabinet of Mr. J. Henderson, who has collected extensively from the Wardie Shales, and has been kind enough to place his collections at my disposal for description. I am also indebted to Mr. Gall, through Mr. Henderson, for the loan of several additional specimens from the same beds. I must not omit to mention that Mr. James Bennie has made an extensive collection, not only from the Wardie-Shale division, but also from the other horizons of the Lower Carboniferous. In working out Mr. Henderson's fossils the examination of the Survey Collection has been of great assistance to me; and could I have combined the description of the latter with the present notes, the number of species from the Lower Carboniferous generally would be greatly increased, and the conclusions arrived at of a more extended and complete character.

I have experienced considerable difficulty in the discrimination of some of the species, not only from the usually bad state of preservation in which the specimens are found, but also from the want of works bearing on similar deposits and their contents elsewhere.

* "Notes on Carboniferous Lamellibranchiata," vol. xviii. 4th series, p. 101.

† Memoir 32, p. 146.

‡ Dec. 2, iv. p. 244, t. 12. fig. 8.

§ Geol. Mag. Dec. 2, iii. p. 244.

8 R. ETHERIDGE, JUN., ON LOWER-CARBONIFEROUS INVERTEBRATA.

This has rendered necessary the establishment of several new species, although I have endeavoured to avoid this as much as possible.

The occurrence of beds of shale, in the Calcareous Sandstone series of this neighbourhood, with fossils of a decidedly marine facies has, I think, been little noticed. That containing the greatest variety of species, the Woodhall Shale, was in all probability known to the earlier geological explorers of Edinburgh; but its very marked marine character was not so definitely ascertained until its exploration was undertaken by Messrs. Henderson and Bennie. Dr. Page read a paper at the British-Association Meeting in 1855 "On the Freshwater Limestone of Dr. Hibbert," in which he insisted that, although the Burdiehouse Limestone in its palæontological features was of undoubted freshwater origin, still in the series there are bands containing marine fossils*—a point which has been fully borne out by later researches. Mr. Henderson has obtained from the Woodhall shale at least 17 well-defined species, and Mr. Bennie about the same number. Of these, 10 are afterwards met with and become characteristic of the true marine Carboniferous Limestone, and 3 or 4 doubtfully so.

Description of the Species.

Class ACTINOZOA.

Order TABULATA.

Genus CHÆTETES, Fischer.

CHÆTETES, sp. ind. Pl. II. figs. 33 & 33 a.

Sp. char. Corallum forming an irregular, thin, incrusting expansion, composed of very short hexagonal or polygonal tubes; angles of the tubes, or calicles, bearing a small, rounded, and blunt mamelon or "monticule."

Obs. My friend Prof. H. A. Nicholson, who has devoted much time to the elucidation of the species of this genus, agrees with me in regarding this as probably a *Chætetes*, more especially as distinct "monticules" are visible. He thinks it (and I quite agree with him) an open question whether some of the incrusting species referred to this genus are not truly Polyzoa.

Loc. and Horizon. Shale with other marine fossils below the weir of Woodhall Barley-mill, Water of Leith, at Juniper Green, near Edinburgh, incrusting Orthoceratites. In the Wardie-Shale section of the Cement-stone group.

* Brit. Assoc. Report for 1855, pt. 2, p. 91.

Class ANNELIDA.

Order TUBICOLA.

Genus SPIRORBIS, Lamarck.

Spirorbis, Lamarck, 1818, Hist. Nat. Anim. sans Vertèbres, v. p. 358.

SPIRORBIS CARBONARIUS, Murchison. Pl. I. figs. 1 & 2.

Microconchus carbonarius, Murch. Sil. Syst. 1839, p. 84, f. D 1-10.

Spirorbis carbonarius, Murch. Siluria, 1867, 4th ed. p. 302, Foss. 83.

Sp. char. Tube attached by one side, forming a more or less closed helix of from $1\frac{1}{2}$ to 3 turns, not all in the same plane, increasing in size slowly towards the aperture, and dextral; umbilicus deep; aperture oval or circular, sometimes extended into a short free tube. Ornamentation consisting of unequal ridges of growth, with intervening microscopic spiral striæ.

Obs. This is so variable a species that I have been able to distinguish no less than four, or perhaps five, well-marked varieties in a large collection of specimens which has lately passed through my hands, besides Mr. Henderson's specimens. The above description applies only to the latter, and would require to be somewhat extended to include the varieties. Another point to be determined is the relation this species bears to *Spirogyphus marginatus*, M'Coy, as it frequently forms a distinct groove for itself on the organism to which it is attached.

Loc. and Horizon. In black bituminous shale at Katesmill, above Colinton, Water of Leith, associated with *Anthracozya scotica*, R. Eth., Jun. In entomostracan shale, adhering to indeterminate bivalve shells at Woodhall, Water of Leith. Both horizons in the Wardie-Shale division of the Cement-stone group.

Genus SERPULITES, Macleay.

Serpulites, Macleay, 1839, Murchison's Silurian System, p. 700.

SERPULITES CARBONARIUS, M'Coy. Pl. I. fig. 3.

Serpulites carbonarius, M'Coy, Synop. Carb. Foss. Ireland, 1844, p. 170, t. 23. f. 32.

Sp. char. Tube small, compressed, shelly, terminating posteriorly in two lengthened cylindrical tubes, the prolongation of the lateral thickened ridges (M'Coy).

Obs. The posterior cylindrical tubes are not preserved; but the lateral thickened ridges are quite clear. Prof. M'Coy describes the tube as shelly; but I am satisfied that a certain amount of horny matter also entered into its composition. The longitudinal wrinkles on the surface of the tube are sufficiently fine to pass for striæ.

Loc. and Horizon. In a bed of marine shale, below the ford at the

10 R. ETHERIDGE, JUN., ON LOWER-CARBONIFEROUS INVERTEBRATA.

weir of Woodhall Mill, Juniper Green, in the Wardie-Shale section of the Cement-stone group.

Class BRACHIOPODA.

Genus DISCINA, Lamarck.

DISCINA NITIDA, J. Phillips. Pl. I. figs. 4-6.

Orbicula nitida, J. Phill. Geol. Yorkshire, 1836, ii. p. 221, t. 9. f. 10-13.

Discina nitida, Davidson, Mon. Brit. Carb. Brachiopoda, Pal. Soc. p. 179, t. 48. f. 18-25.

Obs. A small depressed variety of this species has been found at two localities by Mr. Henderson. When the specimens are collected, the slightest touch usually destroys the whole of the shelly matter.

Loc. and Horizon. In a hardened shale, associated with Lamelli-branches, quarry on the north side of the Colinton road, under Craiglockhart Hill, near Edinburgh; in shale with other marine fossils at Woodhall, as before.

Genus LINGULA, Bruguière.

LINGULA SQUAMIFORMIS, J. Phillips. Pl. I. fig. 7 (and fig. 8?).

Lingula squamiformis, J. Phill. Geol. Yorkshire, 1836, ii. p. 221, t. 9. f. 14; Davidson, Mon. Brit. Carb. Brach., Pal. Soc. p. 205, t. 49. f. 1-10.

Obs. This species was first recorded from the Cement-stone group by Mr. T. Davidson *, and afterwards by the late Mr. Salter †. They give Wardie, on the shore of the Firth of Forth, between Leith and Granton, as the locality. In addition to one of the following localities, Mr. James Bennie has obtained *L. squamiformis* at two other localities in the neighbourhood of Mid Calder.

Loc. and Horizon. In hardened shale at quarry under Craiglockhart Hill (?), associated with *Lingula mytiloides*; in black shale in the Water of Leith at Dean Bridge, Edinburgh, Wardie-Shale division of the Cement-stone group.

LINGULA MYTILOIDES, J. Sowerby. Pl. I. figs. 9, 10.

Lingula mytiloides, J. Sow. Min. Con. 1813, i. p. 55, t. 19. f. 1, 2; Davidson, Mon. Brit. Carb. Brach. Pal. Soc. p. 207, t. 48. f. 29-36.

Obs. Previous to seeing the specimens in Mr. Henderson's Cabinet, I had examined a few obtained by Mr. Bennie, on behalf of the Geological Survey, at Craigeleith Quarry, and had submitted

* Geologist, 1860, iii. p. 264.

† Mem. Geol. Survey Scot. No. 32, 1861, p. 146.

R. ETHERIDGE, JUN., ON LOWER-CARBONIFEROUS INVERTEBRATA. 11

them to Mr. T. Davidson, F.R.S., who was kind enough to favour me with the following reply to my letter:—"As you say, one or two of them look like a small variety of *L. squamiformis*. This last is, however, a much larger shell; and I would almost feel inclined to refer them to *L. mytiloides*." The present individuals so closely resemble those, that, although they are in any thing but a good state of preservation, I do not hesitate to refer them to the same species.

Loc. and Horizon. In hardened shale, quarry under Craiglockhart Hill, as before; in shale with other marine fossils at Woodhall Mill, as before; in shale above the sandstone at Craighleith Quarry, near Edinburgh.

Class PELECYPODA (LAMELLIBRANCHIATA).

Genus AVICULA, Klein.

AVICULA HENDERSONI, sp. nov. Pl. I. fig. 11.

Sp. char. Obliquely transversely elongated, very inequilateral. Anterior end well marked, divided off by the byssal sinus; posterior end produced, obtusely rounded; posterior wing flattened, falciform; hinge-line straight, not so long as the shell; ventral margin sub-parallel with the hinge-line, indented by the byssal notch, otherwise convex. Posterior slope well marked, obtusely rounded; byssal sinus extending from the beak as a pronounced groove in each valve; widening towards the ventral margin. Umbones anterior, prominent. Surface of both the body of the shell and the posterior wing covered with very regular concentric imbricating striae.

Obs. *Avicula Hendersoni* is closely allied to several Irish species figured by Prof. M'Coy*, and seems to be nearest to his *A. angusta*, but with the dorsal and ventral margins much more nearly parallel than in the latter, in this respect corresponding more closely with *A. recta*, M'Coy, and *A. gibbosa*, M'Coy, from which, however, it otherwise differs considerably. I name the species after Mr. Henderson, to whom I am indebted for the loan of the majority of the specimens described in this communication.

Loc. and Horizon. In a hard Cyprid shale, quarry on the north side of the Colinton road, under Craiglockhart Hill, near Edinburgh, near the base of the Cement-stone group; in shale with marine fossils at Woodhall, as before.

Genus AVICULOPECTEN, M'Coy.

Aviculopecten, M'Coy, 1851, Ann. & Mag. Nat. Hist. vii. p. 171.

AVICULOPECTEN, sp.

Obs. A portion of one valve has been obtained from the Woodhall Shale. It is a radiately striated species, with the ribs crossed by

* Synop. Carb. Foss. Ireland, t. xiii. f. 20.

12 R. ETHERIDGE, JUN., ON LOWER-CARBONIFEROUS INVERTEBRATA.

fine close concentric striæ, or else toothed, especially on the only remaining ear.

Loc. and Horizon. In shale, with other marine fossils, at Woodhall Mill, as before.

Genus ANTHRACOPTERA, Salter.

Anthracoptera, Salter, 1862, Mem. Geol. Survey, Country around Wigan, p. 37.

Gen. char. Shell aviculiform, very slightly inequivalve, with a slight byssal notch in both valves; left valve the most convex. Hinge-line with a thickened margin, but no hinge-plate of any kind; there is an obscure tooth in the anterior part of the hinge, but no lateral teeth. Posterior adductor scar large and subcentral; anterior scar small, umbonal, with at least two supplementary scars; shell thin, with a puckered or plaited epidermis. (*Salter.*)

Obs. The genus *Anthracoptera* was proposed by the late Mr. Salter to include numerous Coal-measure shells "hitherto called *Myalina* or *Avicula* with doubt, but evidently distinct from one and the other of these genera. They have not the unequal valves of *Avicula* nor the striated hinge-plate of *Myalina*, nor indeed any hinge-plate at all." I now propose to place in this genus, in addition to the Coal-measure fossils for which it was established, some bivalves from the Lower Carboniferous rocks of this neighbourhood, of which the internal characters of the shell, so far as I have been able to make them out, appear to have more in common with this genus than with *Myalina*. About two or three years before Mr. Salter proposed his name, Dr. Dawson established his genus *Naiadites* for similar shells, characteristic of the South-Joggins Coal-measures, Nova Scotia. In a paper on "Fossil Shells from the Coal-measures of Nova Scotia"*, Mr. Salter pointed out the synonymy of the two names, and claimed for his own precedence over that of Dr. Dawson on the ground of more complete description. *Anthracoptera* appears to have been regarded by Salter as one of either the Aviculidæ or Mytilidæ, whilst by Dr. Geinitz the typical American species, *A. (Naiadites) carbonaria*, Dawson, is looked upon as a *Dreissena* †. The affinity of these shells has been discussed by Dr. Dawson at some length; he considers them to be brackish-water shells allied to the Mytilidæ, or embryonic forms of Unionidæ ‡, and states that the structure of the shell is similar to that of the latter family.

ANTHRACOPTERA ? OBESA, sp. nov. Pl. I. figs. 12, 13 (& 14?).

Sp. char. Trigonal, very gibbous, inequality of the valves distinctly marked; anterior side pointed, well marked, and defined by the byssal furrow in each valve; posterior side but little flattened, its

* Quart. Journ. Geol. Soc. xix. p. 80.

† N. Jahrbuch, 1864, p. 654; Geol. Mag. 1865, ii. p. 205.

‡ Acadian Geology, 1867, p. 203.

R. ETHERIDGE, JUN., ON LOWER-CARBONIFEROUS INVERTEBRATA. 13

margin slightly sigmoidal. Hinge-line straight, as long as the shell, its margin thickened on each valve, leaving in casts two long grooves. Umbones well developed, contiguous, but not touching, anterior, but not quite terminal, with a broad, very obtusely rounded diagonal ridge proceeding from each, to which the shell owes much of its exceedingly convex form. Byssal furrows shallow, most pronounced in the left valve; marginal notch not deeply excavated. Anterior muscular impressions quite anterior, infra-umbonal. Surface of the shell covered with concentric subimbricating lamellæ, crowded and striiform on the anterior end, but opening out and becoming lamellar on the diagonal ridge and posterior wing.

Obs. The shells comprised in this species very much resemble some *Myalina*; but I believe I am more justified in referring them to the present genus than to *Myalina*, of the striated hinge-plate of which I can find no trace; neither has any definite evidence presented itself which would warrant me in placing them in either *Avicula* or *Pterinea*. The much more central position of the diagonal ridge, greater convexity of the shell, and the sigmoidal margin of the posterior end at once distinguish *A. obesa* from either *Anthracoptera*? or *Myalina* (*Avicula*) *quadrata*, Sow., *A.*? or *M.* (*Avicula*) *modiolaris*, Sow., *A.*? or *M.* (*Modiola*) *carinata*, Sow. *, or *Anthracoptera*? *Browniana*, Salter (= *Avicula tenua*, Brown). I am not acquainted, and so cannot institute a comparison, with any of those Coal-measure fossils figured by Captain T. Brown in his 'Fossil Conchology' †, many of which will doubtless fall into the genus *Anthracoptera*; but *A. obesa* appears to be quite distinct.

Loc. and Horizon. In a bed of hard micaceous sandstone, Drumsheugh, Water of Leith, at Dean Bridge, Edinburgh, Wardie-Shale division of the Cement-stone group; in altered shale underlying trap, Corstorphine Hill, near Edinburgh; in a band of limestone above the sandstone at Craigleith Quarry, near Edinburgh?

Genus MYALINA, De Koninck.

Myalina, De Koninck, Anim. Foss. Terr. Carb. Belgique, p. 125.

MYALINA CRASSA, Fleming (non G. & F. Sandberger).

Var. *modioliformis*, Brown.

Obs. In the 'Annals and Magazine of Natural History' for June 1875 I described a series of specimens of *M. crassa*, Flem., from the Fife Carboniferous-Limestone series and the Lower Carboniferous of this neighbourhood, and gave the synonymy of the species as then known to me. I remarked on the slighter make of the latter as compared with the Fife examples. I find that the Water-of-Leith shells from the Lower Carboniferous rocks were described

* In one place Mr. Salter referred these species to *Myalina* (Iron Ores Gt. Britain, 1861, pt. 3, p. 228), in another with doubt to *Anthracomya* (*ibid.*, p. 230), and again in a third to *Anthracoptera* (Oldham Memoir, 1864, p. 64). He appears to have been in great doubt as to their true generic affinity.

† Plate 62.

14 R. ETHERIDGE, JUN., ON LOWER-CARBONIFEROUS INVERTEBRATA.

many years ago by Captain Thomas Brown as *Avicula modioliforme*; but as I cannot distinguish any characters, either external or internal, by which to specifically distinguish Captain Brown's shell from Dr. Fleming's, I propose to adopt the name given by the former as a varietal designation for the thinner and lighter form of *M. crassa*. To the synonymy already given must therefore be added:—

Avicula modioliforme, Brown, Foss. Conchology, 1849, p. 162,
pl. 66. fig. 19.
" " Morris, Cat. Brit. Foss. 1854, 2nd ed.,
p. 162.
" " Salter, Mem. Geol. Survey Scotl. No. 32,
1861, p. 146.

A specimen from Fifeshire obtained since my paper was written exhibits another character not hitherto figured, a series of minute pits (? muscular-fibre-pits) running from above the double umbonal anterior muscular scars along the edge of the thickened hinge-area backwards. This is also visible in a specimen from the Water of Leith which has lately come under my notice; but here the pits are shallower, wider, and further removed from the edge of the hinge-area.

Loc. and Horizon. Forming a bed of shale with *Schizodus Salteri*, above and below the shale with marine fossils, at Woodhall, as before.

MYALINA SUBLAMELLOSA, sp. nov. Pl. I. fig. 15, and Pl. II. figs. 16, 17.

Sp. char. Trigonal; anterior side small, truncated, with a slightly sigmoidal margin, descending from the beak at rather less than a right angle; posterior end expanded, flattened, with its margin slightly convex or subtruncate. Hinge-line somewhat depressed, a little less than the width of the shell, the angle formed by the union of the hinge-line and posterior margin an obtuse one. Beaks sharp, terminal, curved anteriorly, with a slightly prominent sigmoidal ridge extending from each down the anterior side and close to its margin; ventral margin convex. Shell ornamented with concentric lines of growth.

Obs. This species may be compared with *Mytilus Flemingii*, McCoy*, *Myalina lamellosa*, De Kon.†, *Myalina perattenuata*, Meek and Hayden‡, and *M. meliniformis*, Meek and Worthen§; but its greatest affinity is with the first two of these. From *Mytilus Flemingii* it may be distinguished by possessing a smaller and more truncated anterior end, the bounding ridge from the beaks being less posterior in position, a less-depressed and shorter hinge-line, and a more broadly rounded ventral margin. From *Myalina lamellosa*,

* Synop. Carb. Foss. Ireland, p. 76, pl. xi. fig. 29.

† Anim. Foss. Terr. Carb. Belgique, p. 126, t. 3. fig. 6.

‡ Geol. Rep. Illinois, v. p. 582, t. xxvi. fig. 11.

§ Ibid. ii. p. 343, t. xxvii. fig. 3.

R. ETHERIDGE, JUN., ON LOWER-CARBONIFEROUS INVERTEBRATA. 15

the shell under consideration may be known by the slightly sigmoidal outline of its anterior end, and its less-depressed hinge-line—characters which, when taken together, give a different appearance to *M. sublamellosa* from that possessed by *M. lamellosa*. It also bears a general resemblance to the *Myalinae* figured by Prof. W. King from the Permian rocks of England.

Loc. and Horizon. In hardened Cyprid shale, quarry under Craiglockhart Hill, on north side of the Colinton Road near Edinburgh; Cement-stone group.

Genus NUCULANA, Link, = LEDA, Schumacher.

NUCULANA SHARMANI, sp. nov. Pl. II. fig. 18.

Sp. char. Transversely elongated, slightly clavate, moderately convex. Anterior end rounded; posterior end produced, gradually compressed laterally to the bluntly rounded point. Ventral margin convex, sloping upwards posteriorly. Unibones nearly but not quite central, a little anterior; lunule probably small and ill-defined; escutcheon or posterior lunette narrow, and not deeply marked, or bounded by ridges from the beak. Surface of the valves ornamented with imbricating striæ; on the posterior end these striæ widen out, become coarser and broader, and assume the aspect of small waves or fluctuations.

Obs. From *Leda attenuata*, Fleming, the present species is distinguished by the more central position of the beaks, and much more equal-sided appearance of the shell, blunter termination of the posterior end, and smaller and narrower escutcheon. From *Nucula* (or *Leda*?) *birostrata*, M'Coy *, it is distinguished by its straighter posterior end and larger antero-ventral development; from *Nucula* (or *Leda*?) *clavata*, M'Coy †, by the more central position of the beaks, and longer anterior end. From *Nucula* (or *Leda*?) *leiorhynchus*, M'Coy ‡, the ornamentation of the posterior end will at once distinguish it. *Leda intermedia*, mihi, is a far more laterally compressed shell; and the posterior end is less attenuated than in *N. Sharmani*. The arched and very clavate form of *L. Traquairii*, mihi, may be taken as a distinctive character between it and the present species. I name the species with much pleasure after my friend Mr. G. Sharman, Assistant Palæontologist to the Geological Survey.

Loc. and Horizon. In shale with marine fossils, at Woodhall, as before.

Genus SCHIZODUS, King.

Schizodus, King, 1844, Ann. & Mag. Nat. Hist. xiv. p. 313; Permian Foss. England, 1850, p. 185.

* Synopsis Carb. Foss. Ireland, 1844, p. 68, pl. xi. fig. 23.

† *Ibid.* p. 69, pl. xi. fig. 25.

‡ *Ibid.* p. 69, pl. xi. fig. 27.

16 R. ETHERIDGE, JUN., ON LOWER-CARBONIFEROUS INVERTEBRATA.

SCHIZODUS SALTERI, R. Etheridge, Jun. Pl. II. fig. 19.

Schizodus Salteri, R. Eth., Jun., Ann. & Mag. Nat. Hist. 1875, xv. p. 431, pl. 20. figs. 6-9.

The examples from the Lower Carboniferous of this neighbourhood do not essentially differ from Fifeshire specimens, except perhaps that the concentric striæ are a little less marked.

Loc. and Horizon. In shale with marine fossils at Woodhall, as before. In a shelly ironstone at Drumsheugh, Water of Leith, at Dean Bridge, near Edinburgh; in shale, with other marine fossils, behind West Breakwater, Granton; in ditto at Craigleith Quarry, above the sandstone.

Genus ANTHRACOSIA, King.

Anthracosia, King, 1844, Ann. & Mag. Nat. Hist. xiv. p. 313.

ANTHRACOSIA? (UNIO) NUCLEUS, Brown? Pl. II. fig. 20.

Axinus pentlandicus (pars), Rhind, Age of the Earth, 1836, pl. 2. fig. a.

Pachyodon nucleus, Brown, Ann. & Mag. Nat. Hist. 1843, xii. p. 394, pl. 16*. fig. 1.

Unio nucleus, Brown, Fossil Conchology, 1849, p. 178, t. 73. fig. 8.

Obs. I have already pointed out* that I believe Dr. Rhind figured two separate species under the name of *Axinus pentlandicus*. One of these figures (fig. b) is, I think, the shell now known as *Schizodus Salteri*, mihi. The other (fig. a) was that to which Captain T. Brown gave the name of *Pachyodon* (or *Unio*) *nucleus*. The original locality was Woodhall, Water of Leith. A very ill-preserved shell in Mr. Henderson's collection has, so far as can be ascertained, the general outline of *Unio nucleus*; but it is impossible, on the characters afforded by it, to give a description of the species.

Loc. and Horizon. In hardened shale, lowest part of the Cement-stone group, quarry on the north side of the Colinton Road, under Craiglockhart Hill, near Edinburgh.

Genus ANTHRACOMYA, Salter.

Anthracomya, Salter, 1861, Iron Ores Gt. Britain, pt. iii. p. 229.

ANTHRACOMYA SCOTICA, R. Eth., Jun.

Anthracomya scotica, R. Eth., Jun., Geol. Mag. 1877, dec. 2. iv. p. 244, t. 12. fig. 8.

Obs. A few fragments which appear referable to this characteristic fossil are in Mr. Henderson's collection. They are much too fragmentary for description or figuring.

Loc. and Horizon. In black shale of the Wardie series, Water of Leith, at Katesmill, near Slateford, Edinburgh.

* Ann. & Mag. Nat. Hist. 1875, xv. p. 432.

Genus PANDORA, Bruguière.

PANDORA? *TYPICA*, R. Eth., Jun. Pl. II. figs. 22, 23 (and 21?).

Leptodomus? clavatus, R. Eth., Jun., Ann. & Mag. Nat. Hist. 1876, xviii. p. 102, pl. 4. figs. 9, 10.

Sp. char. Somewhat clavate, a little arcuated, very inequilateral, gibbous in the umbonal region; length much exceeding the height. Anterior side short, convex, its margin rounded; posterior side much more compressed, transversely elongated, its margin sharply truncated; umbones prominent, quite anterior, but the beaks not terminal. A blunt diagonal ridge traverses each valve from the umbo to the posterior ventral angle; posterior slope a little concave. Dorsal margin long, slightly arcuated; dorsal and ventral posterior angles sharp and well defined. Ornamentation consisting of concentric striæ, which are suddenly deflected on reaching the diagonal ridge, and traverse the posterior slope parallel to the posterior margin in a very regular manner.

Obs. My former description of this species was drawn up from crushed specimens; but the acquisition of nearly perfect examples enables me to give a more definite diagnosis. For individuals in the crushed state the characters given in the 'Annals' are quite appropriate; for it is a fact worthy of note that, when crushed, all specimens of this species which have come under my notice appear to be compressed into a similar form and to a like degree the outline becomes more clavate and arcuated, the posterior end recurved and truncated obliquely, the posterior slope still more concave, and divided down its centre by a groove from the beak backwards, and the surface a good deal wrinkled.

The reference to *Pandora* is made exclusively on the close external resemblance this species bears to that genus. I have not seen any of the internal characters; neither can I say whether the shell was inequivalve or not, as it should be if a true *Pandora*. *P.? typica* resembles in many respects *Lutraria elongata*, McCoy*, and to some extent *Pandora clavata*, McCoy†, and will, perhaps, occupy an intermediate position between the two. I have assigned to the species the name *typica*, from its great prevalency in certain beds of shale in the Cement-stone group around Edinburgh. Mr. Henderson notices its occurrence, under the name of *Pandora* sp., in his paper on the Wardie Shales, previously referred to.

Loc. and Horizon. In the bed of shale at Woodhall, as before; Drumsheugh, near Dean Bridge, in a similar bed; in ditto behind the western breakwater at Granton Harbour; in ditto above the sandstone at Craighleith Quarry. Cabinets of Messrs. Henderson and Gall; and collection Geol. Survey Scotland, collected by Mr. James Bennie.

I also give figures of two undetermined bivalves (figs. 24 & 25) in the collection of Mr. Gall and Mr. Henderson, from Drumsheugh and Water of Leith respectively.

* Synopsis Carb. Foss. Ireland, 1844, p. 52, t. viii. fig. 3.

† *Ibid.* p. 51, t. xi. fig. 1.

18 R. ETHERIDGE, JUN., ON LOWER-CARBONIFEROUS INVERTEBRATA.

Class GASTEROPODA.

Genus LITTORINA, Férussac.

LITTORINA SCOTO-BURDIGALENSIS, sp. nov. Pl. II. figs. 26, 27.

Sp. char. Shell conic-oval, imperforate; spire obtusely pointed; whorls four, flattened or shoulder-like immediately below the suture in each whorl, especially the last one; suture distinctly marked, the last whorl twice as large as the other three. Peristome entire; aperture oval, rounded below. Outer lip . . . ?; inner lip reflected over the spire. Surface of the shell without ornamentation.

Obs. The above description is drawn up from specimens kindly lent by Mr. Gall, through Mr. Henderson. After much consideration, both on my own part and that of my friend Dr. J. C. Purvis, I have provisionally placed this troublesome little shell in the genus *Littorina*. All the specimens I have seen separated from the matrix are, at the best, but imperfectly preserved; but, so far as can be made out, it appears to be a member of the Littorinidæ, and has also perhaps some characters in common with the Paludinidæ. Previous to seeing Mr. Gall's specimens, I had named those in the Survey Collection, in MS., as above, from the fact that the species is the chief component of a thin shelly band at the base of the Burdiehouse Limestone at the Raw Camps Quarries, near Mid Calder. The band in question is locally called "Buckie-fake," and appears to contain little else than this small Gasteropod. The Burdiehouse Limestone is usually considered to be of freshwater, or at the least estuarine origin. Should this species be proved to have more affinity with *Paludina* than with *Littorina*, it will tend to support this hypothesis; still, even if referred to *Littorina*, it will not detract much from the fresh- or brackish-water origin of the Burdiehouse Limestone.

Loc. and Horizon. Drumsheugh, near Dean Bridge, Edinburgh.

Genus PLEUROTOMARIA, DeFrance, 1824.

PLEUROTOMARIA MONILIFERA, Phillips?. Pl. II. fig. 28.

Pleurotomaria monilifera, Phill. (1836), Geol. Yorksh. ii. p. 227, t. 15. fig. 10 a; De Koninck (1842-45), Anim. Foss. Terr. Carb. Belg. p. 387, t. 34. fig. 2; Brown (1849), Foss. Conch. p. 87, t. 40. figs. 30, 34.

Obs. All the specimens are crushed; but there appear to be traces of the shallow groove of the body-whorl, with its tuberculated bordering keels, characteristic of the species, as described by Prof. De Koninck. There are also indications of spiral and transverse ridges.

Loc. and Horizon. Water of Leith, at Woodhall, in the bed of shale with marine fossils.

R. ETHERIDGE, JUN., ON LOWER-CARBONIFEROUS INVERTEBRATA. 19

Genus MURCHISONIA, D'Archiac & De Verneuil.

Murchisonia, D'Archiac & De Verneuil, 1841, Bull. Soc. Géol. de France, xii. p. 159.

MURCHISONIA STRIATULA, De Koninck ?. Pl. II. fig. 29.

Murchisonia striatula, De Kon. Descr. Anim. Foss. Terr. Carb. Belgique, 1844, p. 415, t. 40. fig. 7.

Obs. Our little shell approaches nearer to Prof. De Koninck's description than to any other I can find. Unless the Woodhall shells are young examples of *M. striatula*, the difference in size is very marked; and, further, the ornamentation does not quite coincide with that of Prof. De Koninck's species. So far as I have been able to discriminate them, the ridges and grooves are less than twelve in number; and the former are separated by more equal spaces than the grooves of *M. striatula* appear to be. The whorls vary in number; Mr. Henderson's specimens possess eight, whilst in the Survey Collection there is one from the same locality, collected by Mr. Bennie, with eleven whorls. *Loxonema polygyra*, M'Coy*, is nearer to the present shells in point of size, but is marked with much too few concentric ridges.

Loc. and Horizon. In the shale with marine fossils at Woodhall, as before.

Genus BELLEROPHON, De Montfort.

BELLEROPHON DECUSSATUS, Fleming, var. *undatus*, R. Eth., Jun. Pl. II. fig. 30.

I described this variety in the 'Geological Magazine' for April (1876)†. It differs from the typical form in having a series of broad obtuse fluctuations or waves in the direction of the transverse striae. The latter are clearly visible in young specimens; but in older and larger individuals they become obscured or obsolete, or nearly so.

Loc. and Horizon. Woodhall, as before.

Class PTEROPODA.

Genus CONULARIA, Miller.

Conularia (Miller), Sowerby, Mineral Conchology, iii. p. 107.

CONULARIA sp. ind.

Obs. One fragment only has come under my observation in Mr. Henderson's collection; but in the Geological Survey Cabinet there are two others which, although only portions also, afford more information than the other. The specimens represent a part of one of the faces of the pyramid with its median ridge. The transverse

* Synop. Carb. Foss. Ireland, 1844, p. 30, t. iii. fig. 1.

† Decade 2, vol. iii. p. 155, t. vi. figs. 9, 10.

20 R. ETHERIDGE, JUN., ON LOWER-CARBONIFEROUS INVERTEBRATA.

ridges are plain and unornamented, and not in any way denticulated or notched. They unite subalternately with the median ridge, the point of junction being marked by a slight enlargement or button. The flattened interspaces between the transverse ridges are minutely wrinkled vertically. The explanation of this is probably that given by Mr. J. de C. Sowerby, who, in describing *C. quadrisulcata* says:—"Many of the specimens in ironstone have smooth furrows between the crenated ridges; in others the furrows are crossed by striæ; and both these forms may sometimes be found in one specimen, and arise from the presence or absence of a thin dark brown skin or covering, the interior of which is smooth and the exterior wrinkled"*.
Loc. and Horizon. Woodhall, as before.

Class CEPHALOPODA.

Genus NAUTILUS, Breynius.

NAUTILUS CARINIFERUS, J. de C. Sowerby?. Pl. II. figs. 31, 32.

Nautilus cariniferus, J. de C. Sow. (1824), Min. Con. v. p. 130, t. 482. figs. 3, 4; Phillips (1836), Geol. Yorksh. ii. p. 232, t. 17. fig. 19; De Koninck, Anim. Foss. Terr. Carb. Belg. p. 549, t. 48. figs. 11, 12; Brown (1849), Foss. Conch. p. 32, t. 22.

Obs. In the impression of the specimen represented by fig. 31, there are distinct traces of the denticulated keels of the above species, still more distinctly seen in the fragment, fig. 32. Were it not for the crenulated ridges or keels, marking a distinctive character, these fragments would scarcely be worth notice; but the paucity of marine life, speaking generally, in the Lower Carboniferous rocks around Edinburgh, renders it necessary to catalogue every fragment exhibiting the slightest trace of definite characters. If the reference to *N. cariniferus* is correct, then Prof. De Koninck's suggestion that the shell was covered with fine transverse striæ is confirmed. These may be seen on a part of the flattened impression, as well as similar longitudinal lines.

Loc. and Horizon. Woodhall, in the shale with other marine fossils, as before.

NAUTILUS, sp. ind.

Obs. A crushed and compressed example obtained by Mr. Gall at Craighleith, somewhat resembling in general appearance *N. cyclostomus*, Phill.; but, except for the fact that it proves the presence of a *Nautilus* in the band of shale at Craighleith, the specimen is quite useless for specific identification.

Loc. and Horizon. Craighleith Quarry, in shale above the sandstone, Cement-stone group. Cabinet of Mr. Gall.

* Trans. Geol. Soc. 2nd ser. v. (expl. of pl. xl.).

Genus ORTHOCERAS, Breynius.

ORTHOCERAS, sp. ind. Pl. II. figs. 33, 34.

Obs. Mr. Henderson possesses several fragments of this genus, from the Woodhall and Granton shale, which I think may all be referred to one species. The shell tapers gradually, the section is circular, and the siphon small and central. There is a very finely striated epidermal covering, the striæ being very fine, close, and slightly waved; but they must not be confounded with the sharp annular striæ of *O. cinctum*, Sow. These characters correspond tolerably well with the description of *Orthocera cylindracea*, Flem.*; but really so little has been done towards the determination of this and other equally ill-defined Carboniferous Orthoceratites that the reference of mere fragments to any of them is, to say the least of it, unsatisfactory. A revision of the Carboniferous Orthoceratites will, whilst bringing to light some undoubtedly new forms, no doubt tend to abolish quite half the so-called species which have been made, in favour of a few and broad but thoroughly recognizable types.

Loc. and Horizon. Woodhall, as before; Granton, in bed of shale behind western breakwater.

A description of the Invertebrates of the Cement-stone group generally, as developed in the Edinburgh district, and contained in the Collection of the Geological Survey of Scotland, would considerably add to the number of the species described in the foregoing sketch. Unfortunately circumstances over which I have no control prevent me from offering a description of these; and in this instance it is owing to the kindness of Messrs. Henderson and Gall that I am able to so far advance the subject.

The following Table (p.22) has been constructed to show the relative occurrence of the species at the localities cited. It will be observed that no less than 18 species occur in the Woodhall shale, whilst at the Craiglockhart Quarry there are six, two of which have not been observed at Woodhall. At Drumsheugh two of the most characteristic shells of the Woodhall shale occur, viz. *Schizodus Salteri*, mihi, and *Pandora typica*, mihi, accompanied by *Anthracoptera? obesa*, mihi. The latter is very characteristic of certain beds at Craigleith Quarry and Corstorphine Hill, and at the former locality is associated with *P. typica*, in a similar way as at Drumsheugh.

III. *Remarks on the First Appearance of certain Species in the Calcareous Sandstone Series of the Edinburgh district.*

We are in possession of little or no published information concerning the Invertebrate life of the lower division of the Calcareous Sandstone Series, the Red Sandstone group. Entomostraca are found at one or two localities (such as *Estheria Peachii*, Jones, in

* Thomson's *Annals of Philosophy*, 1875, v. p. 202.

Table showing the Occurrence of the Species hitherto noticed or described from the Lower Carboniferous or Calcareous Sandstone series of the Edinburgh district.

Genus and Species.	Synonyms.
<i>Spirorbis carbonarius</i> , <i>Murchison</i>	<i>Microconchus</i> (<i>Murch.</i>)
—, var. <i>a</i> , <i>Hibberti</i> , <i>R. Eth.</i>	<i>Nautilus</i> (<i>Hibbert</i>)
—, var. <i>b</i> (<i>R. Eth.</i>)	
— <i>helictetes</i> , <i>Salter</i>	
<i>Serpulites carbonarius</i> , <i>M' Coy</i>	
<i>Chaetetes</i> , sp. ind. (<i>R. Eth.</i>)	
<i>Beyrichia subarcuata</i> , <i>Jones</i>	
<i>Daphnoides Hibberti</i> , <i>Jones</i>	
<i>Esteria Peachii</i> , <i>Jones</i>	<i>Cypris</i> (<i>Hibbert</i>)
<i>Leperditia Okeni</i> , <i>Munster</i> , var. <i>scoto-burdigalensis</i> , <i>Hibbert</i> .	

24 R. ETHERIDGE, JUN., ON LOWER-CARBONIFEROUS INVERTEBRATA.

the Arthur's-Seat beds); but at present these appear to be all we know of. Proceeding upwards, however, we meet with some debatable beds of sandstone and shale resting on the felstones of Warklaw Hill along the north flank of the Pentland Hills*, which Prof. Geikie informs me he is inclined to place at the base of the Cement-stone group. These beds, where cut by the Clubbidean Burn, contain *Sphenopteris affinis*, L. & H., *Leperditia scoto-burdigalensis*, Hibbert, and a crushed bivalve which Mr. Salter considered an oval species of *Myalina*†. In the south bank of the Clubbidean Reservoir a limestone of the same set of beds is seen to be almost entirely made up of *Spirorbis helicteres*, Salter, with *Sp. carbonarius*, Murchison. This appears to be the first appearance of which we have any record of Pelecypoda and Annelida in the Lower Carboniferous of this district, and was regarded by Mr. Salter as indicative of marine conditions‡. In some shales overlying the Greenstone of Craiglockhart Hill, seen in an old quarry on the north side of the Colinton road, near Edinburgh, a more copious fauna has been found by Mr. Henderson. We there meet with *Discina nitida*, Phill., *Lingula squamiformis*, Phill.?, *L. mytiloides*, Sow., *Avicula Hendersoni*, mihi, *Myalina sublamellosa*, mihi, and *Anthracosia? nucleus*, Brown.

On passing to the strata more properly known as the Wardie Shales, we meet with a still further increase in the life of the Lower Carboniferous. The Annelida are augmented by the appearance of *Serpulites carbonarius*, M'Coy, at Woodhall. The Actinozoa also first put in an appearance in this horizon; for, we find many of the Orthoceratites occurring in the Woodhall shale covered with a parasitic *Chaetetes*. Brachiopoda had previously been recorded from the Wardie Shales, as before stated, by Mr. Davidson and Mr. Salter, in the form of *Lingula squamiformis* at Wardie. A well-marked example of this species has been obtained by Mr. Henderson in the Water of Leith at the Dean Bridge, Edinburgh; whilst *Lingula mytiloides* has passed from the Craiglockhart Shale to the Woodhall horizon, accompanied by *Avicula Hendersoni*. The occurrence at Juniper Green of the frequently-mentioned bed of shale below the ford at Woodhall Mill brings us, perhaps, to one of the most important points in connexion with the Carboniferous geology of the south-east of Scotland; for we here meet with the first appearance of several species of marine shells which pass upwards from these beds and ultimately become some of the most characteristic fossils of the Carboniferous Limestone. The species contained in this bed which have previously made their appearance are *Spirorbis carbonarius*, *Discina nitida*, *Lingula mytiloides*, and *Avicula Hendersoni*. Those which first make their appearance here are *Chaetetes*, sp. ind., *Serpulites carbonarius*, *Aviculopecten*, sp. ind., *Myalina crassa*, Flem., var., *Schizodus Salteri*, *Pandora typica*, *Pleurotomaria monilifera*?, *Murchisonia striatula*?, *Bellerophon decussatus*, Flem., var., *Conularia*, sp. ind., *Nautilus cariniferus*?, and *Orthoceras*. One species, *Nuculana Sharmani*, is peculiar to this bed.

* Memoir 32, p. 18.

† *Ibid.*

‡ *Ibid.* p. 144.

R. ETHERIDGE, JUN., ON LOWER-CARBONIFEROUS INVERTEBRATA. 25

At Drumsheugh, Dean Bridge, certain beds of sandstone and shale have been investigated by Mr. Henderson and Mr. Gall; and the fossil contents go far, I think, to prove Mr. Henderson's view of the identity of this bed with the Woodhall Shale, as amongst them are two of the most characteristic shells of the latter bed, *Schizodus Salteri* and *Pandora? typica*. Another species accompanying them, but not found at Woodhall, is *Anthracopectera? obesa*, mihi, which also occurs at Craigleith Quarry, and has been obtained by Mr. Henderson, and also by Mr. Bennie, in an altered shale underlying trap at the north end of Corstorphine Hill, near Edinburgh. A shell which afterwards becomes exceedingly characteristic of the Burdiehouse beds makes its first appearance in black shale in the Water of Leith at Kate's Mill near Slateford. I have elsewhere described this species as *Anthracomya scotica*, and shown that it may be identical with *Unio nuciformis*, Hibbert; but as I cannot trace the type of the latter, it is a question which will, I am afraid, remain unsettled. Mr. Henderson has only obtained fragments from Kate's Mill; but even these are infested with the little *Spirorbis carbonarius*, as are nearly all the individuals from the horizon of the Burdiehouse Limestone. The most interesting point in connexion with the Entomostraca of the Wardie Shales is the first appearance of the Coal-measure genus *Leaia*, for the discovery of which we are indebted to Mr. C. W. Peach, in an ironstone nodule at Wardie. Little has been written on the Invertebrates of the Burdiehouse Limestone and associated beds. They appear to be chiefly remarkable for the abundance of *Spirorbis carbonarius* and its varieties, the *Anthracomya* previously indicated, and the great quantity of Ostracoda forming what is usually termed "Cyprid Shale." The more important forms are *Leperditia scoto-burdigalensis*, Hibbert, *L. Okeni*, Münster, and *Daphnoidea* (or *Cypridina*) *Hibberti*, Jones. It is hardly necessary to point out, as the previous Table sufficiently indicates it, the close correspondence which exists between the organic remains from the bands of marine shale found at Woodhall, Drumsheugh, Craigleith, Craiglockhart, and Granton.

CONCLUSION.

In the foregoing pages I have endeavoured to give, first, an outline of our knowledge of the Invertebrate fauna of the Calciferous Sandstone Series up to the present time; secondly, I have given descriptions and figures of numerous species from Mr. Henderson's collection, thereby increasing the fauna largely; thirdly, I have appended some remarks on the first appearance of many of these fossils, and indicated the occurrence of, at least, three or four marine beds in the Calciferous Sandstone Series, in addition to that mentioned by Mr. Salter at Clubbidean. They are:—Craiglockhart Quarry with *Discina nitida*, *Lingula squamiformis?*, *L. mytiloides*, &c.; Woodhall, Water of Leith, with a copious fauna (see Table); and (if not identical with the latter) Drumsheugh; whilst the fourth may perhaps be indicated by the occurrence of *Lingula squamiformis* at Dean Bridge, Water of Leith.

26 R. ETHERIDGE, JUN., ON LOWER-CARBONIFEROUS INVERTEBRATA.

In relation to the first appearance of species, I have shown the occurrence, low down in the Calciferous Sandstone Series, of fossils which afterwards attain their greatest development in, and become characteristic of, the Carboniferous Limestone Series.

EXPLANATION OF PLATES I. & II.

- Fig. 1. *Spirorbis carbonarius*, Murchison, highly magnified. Coll. Geol. Survey Scotland.
- Fig. 2. *Sp. carbonarius*, var. *Hibberti*, R. Eth., highly magnified. Coll. Geol. Survey Scotland.
- Fig. 3. *Serpulites carbonarius*, M'Coy, nat. size. Coll. Mr. John Henderson, Woodhall, Water of Leith.
- Figs. 4-6. *Discina nitida*, Phillips, nat. size. Two dorsal and one ventral valve. Woodhall, Water of Leith, near Edinburgh.
- Fig. 7. *Lingula squamiformis*, Phillips, nat. size. Coll. Mr. John Henderson, Dean Bridge, Water of Leith, near Edinburgh.
- Fig. 8. *L. squamiformis*, Phill.?, natural size. Coll. Mr. John Henderson, Craiglockhart Quarry, near Edinburgh.
- Figs. 9, 10. *L. mytiloides*, Sowerby, near the nat. size. Coll. Mr. J. Henderson, Craiglockhart and Woodhall.
- Fig. 11. *Avicula Hendersoni*, R. Eth., Jun., twice the nat. size. Coll. Mr. J. Henderson, Craiglockhart-Hill Quarry.
- Figs. 12, 13 (and 14?). *Anthracopectera? obesa*, R. Eth., Jun., nat. size.
Figs. 12, 13. Casts in micaceous sandstone, Drumsheugh.
Fig. 14. Compressed and flattened individual in altered shale, Corstorphine Hill. Coll. Mr. J. Henderson.
- Figs. 15-17. *Myalina sublamellosa*, R. Eth., Jun., nat. size. Coll. Mr. John Henderson, Craiglockhart Hill Quarry, near Edinburgh.
- Fig. 18. *Nuculana Sharnani*, R. Eth., twice Jun., nat. size. Woodhall, Water of Leith, near Edinburgh.
- Fig. 19. *Schizodus Salteri*, R. Eth., Jun., nat. size. Coll. Mr. J. Henderson; Drumsheugh, near Dean Bridge, Edinburgh.
- Fig. 20. *Anthracoidea? nucleus*, Brown?, nat. size; a poor and bad specimen. Coll. Mr. J. Henderson, Craiglockhart-Hill Quarry, near Edinburgh.
- Figs. 22, 23 (and 21?). *Pandora? typica*, R. Eth., Jun., natural size.
Fig. 21. Drumsheugh. Coll. Mr. Gall. Shell crushed anteriorly.
Fig. 22. Drumsheugh. Coll. Mr. J. Henderson.
Fig. 23. Young form, Woodhall, water of Leith. Coll. Mr. J. Henderson.
- Figs. 24, 25. Two small bivalves, undetermined casts.
Fig. 24. Twice nat. size. Drumsheugh. Coll. Mr. Gall.
Fig. 25. About twice the nat. size. Water of Leith. Coll. Mr. J. Henderson.
- Fig. 26. *Littorina? scoto-burdigalensis*, R. Eth., Jun., much enlarged. Drumsheugh, near Dean Bridge, Edinburgh. Coll. Mr. Gall.
- Fig. 27. The same, enlarged. Water of Leith. Coll. Mr. J. Henderson.
- Fig. 28. *Pleurotomaria monilifera*, Phillips?, nat. size. Woodhall, Water of Leith. Coll. Mr. J. Henderson.
- Fig. 29. *Murchisonia striatula*, De Koninck?, enlarged. Woodhall. Coll. Mr. J. Henderson.
- Fig. 30. *Bellerophon decussatus*, Flem., var. *undatus*, R. Eth., Jun., nat. size. Woodhall. Coll. Mr. J. Henderson.
- Figs. 31, 32. *Nautilus cariniferus*, J. De C. Sowerby?, nat. size. Woodhall. Coll. Mr. J. Henderson.
- Fig. 33. *Orthoceras*, sp. ind., nat. size, with incrusting coral. Woodhall. Coll. Mr. J. Henderson.
- Fig. 33 a. *Chaetetes*, sp. ind., fragment enlarged from fig. 33.
- Fig. 34. *Orthoceras*, sp. ind., nat. size. Woodhall. Coll. Mr. J. Henderson.

G. Shannondel, C.L. Griesbach lib.

Mintern Bro^s imp.

LOWER CARBONIFEROUS INVERTEBRATA.