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IV.—*Descriptions of certain peculiar Bodies which may be the Opercula of small Gasteropoda, discovered by Mr. James Bennie in the Carboniferous Limestone of Law Quarry, near Dalry, Ayrshire, with notes on some Silurian Opercula. By R. ETHERIDGE, Jun.*

[Plate II.]

INTRODUCTION.—The object of the present communication is to briefly describe several small bodies which Mr. Bennie and myself are mutually agreed in regarding as the opercula of minute Gasteropoda, and which were discovered by the former some time ago in a bed of highly fossiliferous and siliceous limestone near Dalry. The interest attached to these remains lies in the fact that occasionally small entire shells are found in the same stratum with one form of the opercula about to be described *in situ*, thus affording a very good demonstration of their true affinity. The description of a large *Naticopsis* with the operculum *in situ* and several examples of *Euomphalus sculptus* from the Wenlock Limestone, all contained in the British-Museum collection, will complete the account. Mr. Bennie has kindly furnished me with the following notes on the bed of limestone from which the fossils were obtained.

Law Quarry is situated on the Cubeside farm, about two miles north-west of Dalry, and only a few hundred feet from the edge of the great mass of bedded traps which stretch from Dalry to Largs. The band of limestone forms a subsidiary bed (probably the lowest) in the Howrat Limestone (=the Hurlet or Main Limestone), the lowest bed of the Lower Carboniferous Limestone group of Scotland. It may be 12 feet or so in thickness, and is very hard and compact where solid and unweathered. The bed is highly charged with siliceous matter, as a large percentage of the contained fossils have been changed into some form of silica. A bed of *Lithostrotion* is present, every polypite of which is completely silicified. The percentage of silica is so high that the limestone is only wrought for manure by the neighbouring agriculturists.

The fossils are obtained by washing the disintegrated material found on ledges of the quarry-face and in fissures and pockets made by the natural jointing of the rock.

Interest will be added to the matter if the descriptions are prefaced by a brief epitome of the structure of the Gasteropod operculum, and a similar account of the number of genera in which this organ has been found in position in Palæozoic shells, a by no means frequent occurrence.

The operculum of the Gasteropoda consists of a layer more or

less composed of horny material, strengthened by the addition of calcareous matter. The inner surface carries a muscular scar; and the point from which the operculum commences is termed the nucleus. It may fit the mouth of the shell with accuracy; or the entrance may be only partially closed by it; and, again, in some genera it is quite wanting. The operculum may be said to be concentric when it increases equally all round and the nucleus is central or subcentral—imbricated or lamellar when growing on one side only and with a marginal nucleus—unguiculate or claw-shaped, with the nucleus apical or in front. The operculum is said to be spiral when it grows only on one edge, revolving as it grows, and is always sinistral in dextral shells; when few-whirled the operculum is said to be paucispiral, or subs spiral when the turns are little marked; on the contrary, when the whirls are very numerous it is said to be multispiral. One side has sometimes a projection, in which condition the word “articulated” is used to express the form. The operculum is present in some species of a genus, absent in others; and it is also indifferently horny or shelly (*Woodward*)*.

The description of opercula in the Gasteropoda of the older rocks has not been of frequent occurrence, although a few instances have been observed both amongst Silurian and Carboniferous representatives of the class.

Amongst Silurian univalves we meet with the peculiar genus *Maclurea*, in which the operculum is thick, solid, and sinistrally subs spiral, with two internal projections, one of them beneath the nucleus, very thick and rugose†. Mr. Salter has given excellent figures of the operculum of both *M. Logani*, Salter‡, and *M. Peachii*, Salter§, from the Durness Limestone of the northern Highlands.

In addition to those of *Maclurea*, the operculum of *Euomphalus* has been noticed by the late Dr. S. P. Woodward||, who describes it as shelly, round, and multispiral.

Mr. F. Smithe, LL.D.¶, has described and figured the operculum of *Euomphalus sculptus*; Sow. He states that it is shelly, ovate, concave within, plane without, thin, and with a bevelled edge. The spiral consists of twelve whirls.

Passing to rocks of the Carboniferous period, we find that the operculum has been observed chiefly in the genus *Nati-*

* *Man. Mollusca*, pp. 101, 102.

† *Ibid.* p. 202.

‡ Murchison's 'Siluria,' 4th ed. p. 197, foss. 40. fig. 1 a; and dec. i. Geol. Survey Canada, t. i.

§ *Quart. Journ. Geol. Soc.* xv. p. 378, t. 13. figs. 1 b, 3-5.

¶ *Man. Moll.* p. 145.

|| *Proc. Cotteswold Nat. Field-Club.*

copsis. In 1844 Prof. M'Coy noticed that of *N. Phillipsii* (M'Coy)*, and figured this structure entirely filling-in the mouth of the shell†. Later on the same author stated that the operculum of *Naticopsis* differed from that of any of the Naticidae in being concentric and not spiral‡. The most complete description of the operculum of *Naticopsis* yet given is that by Messrs. Meek and Worthen. These authors describe it as thick and shelly, oval or subcircular in form, with a lateral or submarginal nucleus, with an entire absence of a spiral or subspiral structure, and no articulating projection. The inner side presents a distinct reniform scar of attachment, whilst the fine and concentric lines of growth are visible on the outside§.

Finally, in the British Museum is a fine example of *Naticopsis Phillipsii*, M'Coy (?=*N. elliptica*, Phill.), with the operculum *in situ*, which will be described hereafter; it is the shell referred to by Prof. M'Coy||.

1. CARBONIFEROUS FORMS.

It is quite open to argument whether some of these bodies may not be the otoliths of fishes. Bearing this in mind, I consulted my colleague, Mr. W. Davies, F.G.S., who was kind enough to examine the specimens with me. The result of the inquiry was that, although some bore a striking resemblance to otoliths, others, on the contrary, appeared to afford evidence of the operculum view. The question even presented itself as to how large a proportion of the bodies found in rocks of a younger age than the Carboniferous, and usually regarded as otoliths, may be the opercula of Gasteropoda of those beds.

The first form is more or less circular in outline, rounded and thin-edged on one margin, thickened on the other, and produced into a blunted denticulation or two. The centre of one side is somewhat raised above the sharp margin, leaving a flattened zone, and sometimes traversed by a groove or two. This is a common type, and is frequently much worn, when the characters become obliterated. The opposite side is smooth and convex. Lower Carboniferous Limestone group, Law Quarry, near Dalry (Pl. II. fig. 1).

The second variety is small and oval, with a central rounded nucleus, and a notch in the margin opposite, to which the

* Synop. Carb. Limest. Foss. Ireland, 1844, p. 33.

† *Ibid.* t. 3, fig. 9.

‡ Brit. Pal. Foss. 1853, fasc. iii. p. 543.

§ Illinois Geol. Survey Report, iii. p. 365.

|| Brit. Pal. Foss. p. 543.

nucleus is nearest. The reverse side of the operculum is plain except for a slight convexity in the centre. As before, Law Quarry (Pl. II. fig. 2).

Another condition consists of elongated pinna-shaped bodies, flat or very slightly concave on one surface, and without visible marks or ornament. The other aspect is convex, particularly on one side, where it is thickened and gradually thins away to the edge. One end is rounded, the other bluntly pointed. As before, Law Quarry (Pl. II. fig. 3).

The fourth type consists of thin auriform bodies, a little thicker on one of the longer margins than on the other, concave on one side, more or less flattened on the opposite. The latter carries a minute central depression or umbilical spot, round which the surface is concentrically striated, and a direct groove passing to the acuminate end. On the concave side of these opercula there is a scar which may be generally described as horsehoof-shaped, and a groove bounding the raised portion. As before, Law Quarry, and on a similar horizon at Inverteil Quarry near Kirkcaldy. (Pl. II. fig. 4).

The fifth and last form is that of a small, thin, round operculum, concave on one side, more or less convex on the other. The concave side shows a doubly impressed scar, having the appearance of a dumb-bell. As before, Law Quarry (Pl. II. fig. 5).

The deposit yielding the opercula occasionally furnishes examples of *Gasteropoda* with them *in situ*. I give two illustrations of this, one with the operculum entire, the other with it only partially preserved. In both cases the opercula fit the mouths of the shells completely. In the former of these there is a central depression, and the thickened side of the operculum is placed against the pillar-lip of the shell, the sharp edge being outward, resting against the outer lip. There are faint signs of concentric striæ; and the centre is depressed. In all probability these are minute species of *Naticopsis* (Pl. II. figs. 6 & 7).

The sum of the information deducible from the study of these little objects appears to be, that, in the first place, certain Carboniferous *Gasteropods* possessed thick bony opercula, of a more or less oval form, speaking generally, and of variable size.

In the second place, on the contrary, others were provided with thin, round, or irregularly oval doors to their apertures, and when any structure is visible it appears to be concentric.

Again, a form of an entirely different shape is foreshadowed by the elongated variety described as the preceding third type.

We do not possess as yet any evidence to show the presence in our Carboniferous rocks of the *imbricated*, *unguiculate*, *paucispiral*, *multispiral*, and other forms into which the opercula of Gasteropoda have been grouped.

In our Silurian rocks, on the other hand, we have the spiral operculum in *Euomphalus*.

The *Naticopsis* in the British-Museum collection is unfortunately, except in the region of the mouth, imperfect. In all probability it is *N. Phillipsii*, M'Coy. The operculum is oval, somewhat pointed in its upper part, and concave externally, the most depressed point answering to the internal muscular scar. It bears the closest resemblance to those opercula *in situ* from Law Quarry described in a preceding paragraph. The concentric striae are very close and regular. It fits the aperture of the shell exactly, and is more or less thickened where it abuts against the pillar-lip (Pl. II. fig. 8).

2. SILURIAN FORMS.

The British-Museum collection contains two peculiar bodies from the Upper Silurian beds of the island of Gothland, stated on the labels forwarded with the specimens to be the opercula of *Euomphalus* (Pl. II. fig. 9). They are bluntly conical in form, rising from a flattened or somewhat concave base. The smaller is $3\frac{1}{2}$ lines high, by nearly 6 wide; the larger one is 7 lines in height, by a little more than 6 lines in diameter. Both are marked by close-set concentric raised lines of laminae, subimbricating upwards. About half the distance from the base to the blunt apex the sides are somewhat constricted, and the upper part is thus partially separated from the lower. The flatly concave base is bounded by a marginal rim, and the centre is occupied by a somewhat sunken coiled nucleus. These bodies have a very peculiar appearance, and, if really opercula, must have belonged to a strong massive shell. The upper third or apical portion appears to be devoid of concentric lines or ridges.

The collection is also enriched by several specimens of a *Euomphalus* with the operculum in place, from the Wenlock Limestone, and by an operculum lying on the weathered surface of the limestone, separated from the shell. The opercula of these shells correspond generally with the description given by Mr. Smithe, but differ in one or two minor particulars.

The marginal outline is quite circular or round; but as the centre is approached the spiral rings become decidedly oval (Pl. II. fig. 13). The number of these rings in the best-preserved of our specimens is seventeen, and there were evidently a few more. There is, however, no trace of a nodose or bead-

like character, so far as my examination of these specimens has gone. The rings are concentric and ridge-like, each separate from the other, with well-marked interspaces between them, the interspaces being quite double the width of the ridges, if not a little more (Pl. II. fig. 13).

Three of the British-Museum specimens with the operculum in place have the latter presented with the spiral whirls outwards; and this surface is decidedly (although not very) concave (Pl. II. figs. 10 & 11).

This is shown in a somewhat exaggerated form in the free example, but heightened by fracture and compression from above. On the other hand, in a fourth example, also with the spiral side of the operculum exposed in place, the latter is quite depressed conical (Pl. II. fig. 12).

Lastly, in a fifth specimen the circular form of the operculum is well exhibited, and a somewhat different appearance visible (Pl. II. fig. 14). The operculum is depressed a little immediately within the margin, and then rises at the centre into a low spiral prominence. The surface is shining and smooth, except near the margin, where there are a few very fine spiral thread-like lines. This aspect is rather difficult of explanation; but I believe it to represent either the interior of the plate or a cast of the interior, and to be reversed in position.

The five specimens here noticed are what is usually called *Euomphalus sculptus*, J. de C. Sow.*, which was briefly described as having the "surface ornamented with concentric furrows and elevated lines." This description must have been taken from a very much worn example; for even in indifferent specimens the close, transverse, undulating frills of growth which cross these "elevated lines" are quite visible.

The characters of a well-preserved example of *E. sculptus* are quite those assigned to another species, *E. funatus*, J. de C. Sow.†, viz., "Conical, very short; ornamented with many spiral threads, united by more numerous transverse lines; umbilicus rather small."

It will be noticed that no mention is made of the number of concentric ridges, or any approach thereto, in the respective species. On comparing the figures, however, it will be seen that those on the body-whorl of *E. funatus* are much wider apart and less numerous than those on a corresponding portion of the shell of *E. sculptus*.

* Murchison's 'Silurian System,' p. 626, t. 12. f. 17.

† Min. Conch. 1824, v. p. 71, t. 450. f. 1 & 2; 'Silurian System,' p. 626, t. 12. f. 20.

Without asserting the identity of these two forms, it becomes necessary to point out the very close relation existing between them; and it may be that they are only the old and young conditions of one species. The concentric ridges on the body-whorl of *E. sculptus* become wider apart as the suture is approached, when they often assume very much the appearance given in the figures of *E. funatus* referred to. The apparent similarity between these shells should be indicated, in case any difference may be detected in their opercula. That of *E. funatus* has not been described, so far as I know.

EXPLANATION OF PLATE II.

- Fig. 1.* A small circular operculum (?) produced into a blunted denticulation. Law Quarry.
Fig. 2. A small oval operculum, with a central globular nucleus. Law Quarry.
Fig. 3. An elongated pinna-shaped body, probably an operculum. Law Quarry.
Fig. 4. A thin, somewhat auriform body of the same nature. Inverteil Quarry, near Kirkcaldy, Fife.
Fig. 5. A small, thin, round operculum. Law Quarry.
Figs. 6 & 7. Two small shells, probably species of *Naticopsis*, with the opercula *in situ*. Law Quarry.
Fig. 8. *Naticopsis Phillipsii*, McCoy, with the operculum in place, but partially abraded on one side. Collection, British Museum.
Fig. 9. A supposed operculum, conical and with imbricating ridges. Upper Silurian, island of Gothland. Collection, British Museum. $\times 2$.
Figs. 10 & 11. *Euomphalus sculptus*, Sow., with the operculum in place. Wenlock Limestone. Collection, British Museum.
Fig. 12. Another specimen, but with the outer side of the operculum somewhat conical. Collection, British Museum.
Fig. 13. The operculum of *E. sculptus* free. Collection, British Museum.
Fig. 14. *Euomphalus sculptus*? with a shining scarcely spiral operculum. Collection, British Museum.

(N.B. The originals of figs. 1-7 are in the cabinet of Mr. James Bennie.)

V.—*Descriptions of new Species of Lepidoptera in the Collection of the British Museum.* By ARTHUR G. BUTLER, F.L.S., F.Z.S., &c.

[Plate IV.]

THE species described in the present paper are chiefly from India and China, all, with one exception, being Asiatic, and the latter being the first African species in a hitherto purely Asiatic genus.