

UPPER LLANDEILO BRACHIOPODS FROM THE BERWYN HILLS, NORTH WALES

by A. R. MACGREGOR

ABSTRACT. Twenty-one species are described and figured, including the following new species, *Corineorthis biconvexa*, *McEwanella berwynensis*, *Glyptorthis minor*, *Atelelasma anatolica*, *Holderleyella subcarinata*, *Oxoplecia nantensis*, *Parastrophinella parva*, *Parastrophinella costata*, and *Rafinesquina simplex*. *Macrocoelia llandeiloensis* (Davidson) is redescribed from topotype material as Davidson's original material appears to be lost.

The fauna described was collected from three small inliers of Llandeilo rocks in the Berwyn Dome, North Wales. The fauna is composed of two elements, an indigenous element whose ancestors are to be seen in older rocks in the Anglo-Welsh Province and an exotic element. Within the exotic element various species appear to be migrants from the Scotto-Appalachian Province, the Baltic Province, and the Bohemian Province. One species must at present be regarded as cryptogenetic.

THIS paper is a systematic description of the brachiopod fauna found in the three inliers of Llandeilo rocks in the Berwyn Hills, together with a discussion of that fauna. The Llandeilo rocks, in which the fossils occur, are divided into three units on the basis of their lithology. At the base, resting on rocks of unknown age beneath, is a Calcareous Ash 200 feet thick, followed by sandy and muddy Limestones 150 to 350 feet thick and then Shales 400 to 1,000 feet thick and calcareous in all but the topmost 100 feet. Only the zone of *Marrolithus favus* of the Upper Llandeilo has certainly been identified, but the lowest beds may extend down into the Middle Llandeilo.

The placing of this fauna in the Upper Llandeilo is based, not so much on the brachiopods themselves, as on the accompanying trilobite fauna and the stratigraphical relationships of the rocks in which the fossils were found. Both the trilobites and the rocks of the area will be described shortly in forthcoming papers.

The material was collected by the writer during the course of a study of the Lower Palaeozoic rocks of the area and of the Llandeilo rocks in particular. The writer wishes to thank Professor Bulman and Professor W. B. R. King for their guidance throughout the work, and Dr. Stubblefield and Professor Williams for helpful discussions. The work was carried out during the tenure of a Carnegie Research Scholarship and the field expenses were met by grants from the Cross Trust, and for these the writer extends his grateful thanks. The writer is also grateful for permission to examine specimens in the Geological Survey Museum, the Sedgwick Museum, and the British Museum (Natural History). All the figured material has been presented to the Sedgwick Museum, Cambridge, except the specimens of *Macrocoelia llandeiloensis* from the Geological Survey Museum, London. The writer is also indebted to the Carnegie Trust for the Scottish Universities for a grant towards the cost of the plates.

The brachiopod fauna. This consists of *Corineorthis biconvexa* sp. nov., *McEwanella berwynensis* sp. nov., *Platystrophia* cf. *precedens major* Whittington and Williams 1955, *?Skenidioides* sp., *?Cyrtototella* sp., *Glyptorthis minor* sp. nov., *Atelelasma anatolica* sp. nov., *?Atelelasma* sp., *Dalmanella parva* Williams 1949, *D.* cf. *lepta* (Bancroft) 1945, *Paucicrura immatura* (Williams) 1949, *Holderleyella subcarinata* sp. nov., *Salopia* cf. *salteri* (Davidson) 1871, *Oxoplecia nantensis* sp. nov., *Parastrophinella parva* sp. nov., *P. costata* sp. nov., *Rostricellula triangularis* Williams 1949, *Sowerbyella antiqua* Jones 1928, *?Dactylogonia* sp., *Rafinesquina simplex* sp. nov., *Macrocoelia llandeiloensis* (Davidson) 1871.

Much of it is indigenous in the sense that the genera were already present in the Anglo-Welsh Province; the rest of it is exotic and various genera make their first appearance in the province at this time. Various species occurring in the Lower Llandeilo of Llandeilo reappear in the Upper Llandeilo of the Berwyns. Much of this can be explained on the basis of facies control, since the sediments of the Upper Llandeilo of the Berwyns resemble the sediments of the Lower Llandeilo of Llandeilo and not the sediments of the Upper Llandeilo of Llandeilo. This facies control has led, up till now, to a false impression of the range of many of the Lower Llandeilo species of the type area, since many of these reappear in the Upper Llandeilo of the Berwyn Hills.

The following can all be regarded as indigenous to the Anglo-Welsh Province:

Corineorthis biconvexa, ?*Skenidioides* sp., *Glyptorthis minor*, *Dalmanella parva*, *D.* cf. *lepta*, *Paucicrura immatura*, *Horderleyella subcarinata*, *Oxoplecia nantensis*, *Rostricellula triangularis*, *Sowerbyella antiqua*, *Macrocoelia llandeiloensis*.

Corineorthis is not at present known in rocks of other than Llandeilo age or outside England and Wales, with one possible exception in Brittany and there it may be regarded as an immigrant from the north.

Skenidioides is known in a lower part of the Llandeilo of Llandeilo. Schuchert and Cooper (1932) were of the opinion that the Skenidiidae were descended from the Finkelnburgiidae, which is an essentially North American family apart from the occurrence of *Orusia* in the Baltic Province. These early representatives of *Skenidioides* may be looked upon as immigrants from North America or, just possibly, from the Baltic. They are contemporary with the first appearance of the genus in North America (Kay 1958).

In the Anglo-Welsh Province the earliest specimens of *Glyptorthis* previously recorded have been from the Caradocian and have usually been attributed to *G. crista* (M'Coy) on the basis of the ornament which, however, is characteristic of the whole family. The Glyptorthidae first appear in the Marmor stage in North America, where they are very abundant; they range on into the Silurian. The range is similar in Britain, an as yet undescribed species having recently been obtained from the base of the Llandeilo in Pembroke. *G. minor* from the Upper Llandeilo of the Berwyns may therefore be regarded as indigenous.

Dalmanella parva and *Paucicrura immatura* persist from the Lower Llandeilo Dalmanellidae, although in the latter species some minor changes are noticeable. The *Dalmanella* cf. *lepta* is rare, but may be regarded as anticipatory of the great increase in genera and species within the Dalmanellidae in the succeeding Caradocian.

Horderleyella appears in the Llanvirn at Llandeilo (Williams 1949) and *H. subcarinata* is a species intermediate in its features between the Llanvirn-Lower Llandeilo species of Llandeilo and the Caradocian species of the Welsh Borders.

Oxoplecia nantensis may be a reappearance of the genus already seen in the Lower Llandeilo of Llandeilo where *Cliftonia* is recorded by Williams (1953).

Rostricellula triangularis after being common in the Lower Llandeilo at Llandeilo is rare in the Upper Llandeilo of the Berwyns. The genus is known from contemporary and even earlier rocks in North America.

Sowerbyella makes its appearance in the Upper Llanvirn of Llandeilo, appearing also in the contemporary Pogonip Limestone of Nevada and Mystic Conglomerate of Quebec (Whittington and Williams 1955). Recent work by Spjeldnaes (1957) shows that

the closely allied genus *Alwynella* appears in the Llanvirn of the Oslo district and *Lepteloidea* and *Chonetoidea* in the Llandeilo rocks there. *Chonetoidea* also appears in the Middle Llandeilo of Bohemia (Havliček 1950). The Sowerbyellidae must have spread with great rapidity into many provinces upon their appearance. At present they appear to be cryptogenetic, though Cooper (1956) thought that *Pelonomia* might be ancestral to the sowerbyellids.

Macrocoelia llandeiloensis occurs as early as the Upper Llanvirn at Llandeilo (Williams 1953) and can be looked upon as indigenous therefore. This Llanvirn occurrence is contemporary with the first North American appearance of the genus.

The remainder of the fauna is exotic in origin, but with two exceptions can be attributed to two sources—the Baltic Province and the Scotto-Appalachian Province of Whittington and Williams (1955). In the absence in Scotland of fossiliferous shelly strata of this period and of the immediately preceding Lower Llandeilo, the latter is in effect the Appalachian Province. *?Dactylogonia* sp., *Parastrophinella parva*, and *P. costata* are from the Appalachian Province.

?Dactylogonia is the first appearance of the Leptaenidae in the Anglo-Welsh Province, although it is followed by the much commoner *Leptaena* in the Caradocian. Previously *Dactylogonia* was unknown outside eastern North America and Oklahoma.

The Parastrophinidae seem to take their origin, according to St. Joseph (1941), in the Camerellidae, which Cooper (1956) says reach their zenith between the Whiterock and Wilderness stages. In the Camerellidae the cruralium duplex is normally seen, and only the rare Brevicamerellidae attain the sessile cruralium of the Parastrophinidae. Previously the Parastrophinidae were unknown before the Caradocian of Britain and North America, and they remain uncommon until the Ashgillian and Llandovery. The occurrence of two species of *Parastrophinella*, one of them in abundance, in the Anglo-Welsh Province in the Upper Llandeilo is all the more remarkable.

The occurrence of these two genera in the Llandeilo and *Macrocoelia* in the Llanvirn, brings forward the first appearance of members of the Scotto-Appalachian fauna in the Anglo-Welsh Province. Whittington and Williams (1955) have pointed out that the Derfel Limestone contains little or nothing of the Scotto-Appalachian fauna; it seems that the early immigrants of the Llandeilo did not persist for long.

The remainder of the brachiopod fauna is, with the exception of *Salopia* and *Rafinesquina*, probably of Baltic origin: *McEwanella berwynensis*, *Platystrophia* cf. *precedens* major, *?Cyrtonotella* sp., *Atelelasma anatica*, and *?Atelelasma* sp.

The Platystrophiinae consist of only two genera within the Plectorthidae, regarded by Schuchert and Cooper (1932) as derived from the Finkelnburgiidae. The genus *Platystrophia* first appears in the Baltic Province, where it is recorded in the Uhaku Shales by Öpik (1930). From there it spread westwards, reaching Britain in the Upper Llandeilo and North America by Porterfield times. *P. precedens* is an American species erected by McEwan (1919), but this material like that of Whittington and Williams is very much earlier. Only *P. dentata* (Pander) seems a possible ancestor to the Welsh variety, the other species from the Uhaku Shales *P. biforata* having too advanced ribbing.

The allied genus *McEwanella* is problematic on account of its very patchy distribution and rarity. Only three species are known, *M. berwynensis* and two North American species from the Upper Ordovician. It is only on the Baltic origin of the Platystrophiinae that it is possible to suggest a Baltic origin for *McEwanella*.

Atelelasma anatolica is the first clitambonitid in the Anglo-Welsh Province, and in this respect it precedes, by a short time, the arrival of *Kullervo*, with the *Kullervo-Palaeostrophomena-Nicolella* association of Whittington and Williams, in the Derfel Limestone. This too appears to represent a stock migrating westwards from the Baltic to America. Although *Atelelasma* first appears in America, it is believed to be related to the older Baltic genus *Apomatella*.

Little comment can be offered on the ?*Cyrtonotella* since only a single specimen was collected. Although a Baltic stock, a species of *Cyrtonotella* was also collected from the contemporaneous rocks of Brittany.

Only two genera remain, *Salopia* and *Rafinesquina*. *Salopia* was discussed by Whittington and Williams (1955), who placed it in the Linoporellidae, although they had some doubts as to its affinities with the Draboviinae, a Bohemian subfamily within the Schizophoriidae. A comparison of *Salopia* with various genera within the Draboviinae shows considerable resemblances and the Bohemian Skiddavian genus *Nocturnellia* Havlíček 1950 seems a possible ancestor. If this ancestry is accepted then this is the only genus in the fauna that has immediate Bohemian ancestry.

The origin of the *Rafinesquina* is uncertain. The genus is unknown in North America before Wilderness times and this seems to be the first certain record in Britain. It is unknown before the Caradoc in either the Oslo district or in the Baltic. Salmon (1942) expressed the view that *Kirkina* from the Llanvirn equivalent Pogonip Limestone of Utah might be ancestral to both *Rafinesquina* and *Oepikina*. *Macrocoelia*, occurring in the Llanvirn, must also be one of the earliest genera of the Strophomenidae and may be another possible ancestor to *Rafinesquina*.

SYSTEMATIC DESCRIPTIONS

Superfamily ORTHACEA Walcott and Schuchert 1908

Family PLECTORTHIDAE Schuchert and Cooper 1930

Genus CORINEORTHIS Stubblefield 1939 sens nov.

Remarks. When the genus was erected by Stubblefield, *C. decipiens* Stubblefield 1939 was the only known species. It has a concave ventral valve. *C. pustula* Williams 1949 has a ventral valve that is convex in its earlier part before taking on a concave form. *C. biconvexa* sp. nov., otherwise answering closely to the genus, has a ventral valve that is gently convex throughout its length. It is proposed therefore to revise the generic diagnosis slightly to include forms with plane or gently convex ventral valves.

Revised diagnosis. Orthoid with convexo-concave, convexo-plane, or dorsiconvex valves, dental plates divergent, cardinal process with elongated shaft, brachiophore supporting plates convergent to form a cruralium, ornament multicostellate-fasciocostellate, ? coarsely exopunctate.

Corineorthis biconvexa sp. nov.

Plate 19, figs. 1-6

1929 *Orthis* (*Dalmanella*) *rankini*, Davidson, Wedd *et alia*, p. 32.

Derivation of name. Biconvex, having both valves convex.

	<i>Length</i> (mm.)	<i>Breadth</i> (mm.)	<i>Depth</i> (mm.)
<i>Holotype.</i> A 46841, Pl. 19, figs. 1-3. Internal mould of dorsal valve	13+	17	5
<i>Paratypes.</i> 1. A 46842, Pl. 19, fig. 6. External mould of ventral valve	16	24	3.5
2. A 46843, Pl. 19, figs. 4, 5. Internal mould of ventral valve	15	16	4

Material. Internal and external moulds of dorsal and ventral valves, 150 specimens.

Type locality. SJ 11602860, 60 yards south of Carnedd-y-forwyn, 2 miles north of Llanrhaiadr-ym-Mochnant, Montgomeryshire.

Horizon. Upper Llandeilo, Calcareous Ash.

Diagnosis. Both valves convex, the brachiophores long and slender rising sharply above the notothyrial platform.

Description. Exterior: typically orthid outline, wider than long with maximum width anterior to the hinge-line. Dorsal valve strongly convex with well marked median sulcus widening to the anterior; interarea anacline near orthocline. Ventral valve convex, less so than the dorsal valve, umbo slightly incurved, interarea apsacline. Multicostellate with very fine concentric ridges between the ribs. Seventy to ninety ribs round the circumference at half an inch from the umbo.

Dorsal interior: notothyrial platform small with simple cardinal process running forward on to the median septum as a fine ridge. Bounded laterally by moderately long brachiophores rising steeply above the dental sockets and the notothyrial platform; they are divergent but not strongly so. In larger specimens the brachiophores are more massive as is the cardinal process at its posterior end. Sockets deep and bounded by fulcral plates. Supporting plates converge on to the median septum which is quite strong and runs forward for one-third to half the length of the valve. Muscle scars sometimes well developed, when they are seen to be subtriangular in outline, running almost exactly half-way to the anterior margin in the holotype. The large posterior adductors are separated from the quadrangular anterior adductors by a transverse ridge. Ribbing is impressed over the interior of both valves.

Ventral interior: delthyrium open, deep, teeth rising slightly above the straight hinge-line, and with well developed dental sockets. Dental plates bounding the posterior part of the ventral muscle scars. These consist of narrow adductor scars bounded laterally by diductors with muscle tracks and weak longitudinal ridges. In the postero-lateral corners of the valve are the pustules of the genital markings, and these extend over a small area only.

Remarks. This material resembles *C. pustula* Williams 1949, but before considering this it is necessary to mention some discrepancies in Williams's description. His text-figure of the interior of the dorsal valve is misleading since the brachiophores are much larger than he shows (see Pl. 19, figs. 7, 8); further, the notothyrial platform is not recessed, as would appear in his text-figure 3, where it contains the cardinal process, and in fact it continues without a break on to the median septum. In the interior of the ventral valve he only figures the internal mould. By doing this he failed to show the crural fossettes

that are present on the teeth. These additional features became apparent when poly-vinyl-chloride moulds of the type material in the Sedgwick Museum were taken from specimens A 16680, A 25321, and A 25323.

The Berwyn material differs from *C. pustula* in the following respects: the ventral valve is moderately convex throughout its length while in *C. pustula* it is flat to concave anteriorly. The brachiophores are not as massive as they are in *C. pustula* but they are longer, standing considerably higher above the floor of the notothyrial platform (Pl. 19, figs. 2, 3). There is some variation in the brachiophores, but in none of the material are they so massive as in *C. pustula*.

Williams's species was restricted to one horizon in the Lower Llandeilo, but this material was obtained abundantly in the Llandeilo of the Berwyn Hills, although restricted to the Calcareous Ash division there. There is little resemblance to *C. decipiens* Stubblefield, which has a concave ventral valve, or to *C. globosa* Williams. In the discussion of this last species Williams (1949) pointed out that there was a considerable resemblance to *Orthis salteri* Davidson and that that species might have to be put into a new genus. Since then Whittington and Williams (1955) have set up the genus *Salopia* with *O. salteri* as the type species. A comparison of '*C. globosa*' with that genus shows many similarities, indeed more than there are between that genus and other species of *Corineorthis*. It is therefore considered that *Corineorthis globosa* is probably *Salopia globosa* as suggested by Williams, but the determining factor is the presence or absence of punctae which have never been demonstrated in '*Salopia globosa*'.

Since this is the third species of *Corineorthis* to be described from the Llandeilo it seems possible that the genus may be limited to strata of Llandeilo age. It has not been recorded from any other formation.

EXPLANATION OF PLATE 19

The photographs are of natural external and internal moulds and of plastic moulds made from these. They are unretouched, but the specimens were lightly coated with ammonium chloride before being photographed.

Figs. 1-6. *Corineorthis biconvexa* sp. nov. 60 yards south of Carnedd-y-forwyn, 2 miles north of Llanrhaiadr-ym-Mochnant. 1, A 46841, holotype, internal mould of dorsal valve, $\times 2$. 2, 3, Normal and posterior views of plastic mould of holotype, $\times 2$, posterior view to show form of brachiophores. 4, A 46843, paratype 2, internal mould of ventral valve, $\times 2$. 5, Plastic mould of paratype 2, $\times 2$. 6, Plastic mould of A 46842, paratype 1, external mould of ventral valve, $\times 2$.

Figs. 7-8. *Corineorthis pustula* Williams. Craig-y-beri, Llanarmon, Carmarthenshire. 8, 7, Normal and posterior views of plastic mould of A 16680, syntype 2, internal mould of dorsal valve, $\times 1.5$, posterior view to show form of brachiophores. (For comparison with figures of *Corineorthis biconvexa*.)

Figs. 9-15. *McEwanella berwynensis* sp. nov. 9-12 from 35 yards north of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant. 9, A 46844 *b*, holotype, external mould of dorsal valve, $\times 2$. 10, Plastic mould of holotype, $\times 2$. 11, 12, Normal and posterior views of A 46844 *a*, paratype 1, internal mould of dorsal valve, $\times 2$. 13, 14, 15, From 80 yards north-north-east of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant. 13, A 46920 *b*, paratype 3, internal mould of ventral valve, $\times 3$. 15, A 46920 *a*, paratype 2, external mould of ventral valve, $\times 3$. 14, Plastic mould of paratype 2, $\times 2$.

Figs. 16-20. *Glyptorthis minor* sp. nov. 16-18 from 35 yards north of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant. 16, A 46848, paratype 1, external mould of dorsal valve, $\times 3$. 17, A 46921, holotype, internal mould of dorsal valve, $\times 3$. 18, Plastic mould of holotype, $\times 3$. 19, 20, From 200 yards north-north-west of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant. 19, A 46849 *b*, paratype 3, external mould of ventral valve, $\times 3$. 20, A 46849 *a*, paratype 2, internal mould of ventral valve.

Subfamily PLATYSTROPHIINAE Schuchert 1929
Genus MCEWANELLA Foerste 1920

Diagnosis. Platystrophiinae with the whole surface multicostellate, the costellae covering the coarse costae. Internally like *Platystrophia* with very little adventitious shell deposition.

McEwanella berwynensis sp. nov.

Plate 19, figs. 9-15

Derivation of name. Latin, *berwynensis*, belonging to the Berwyns or Berwyn Hills.

	Length (mm.)	Breadth (mm.)	Depth (mm.)
<i>Holotype.</i> A 46844b, Pl. 19, figs. 9, 10. External mould of the dorsal valve	18	19	5
<i>Paratypes.</i> 1. A 46844a, Pl. 19, figs. 11, 12. Internal mould of the dorsal valve	14	18	6
2. A 46920a, Pl. 19, figs. 14, 15. External mould of the ventral valve	9	8	4
3. A 46920b, Pl. 19, fig. 13. Internal mould of the ventral valve	9	7	4

} Laterally compressed

Material. One dorsal valve external and internal mould and one fragment, one ventral valve external and internal mould.

Type localities. Holotype and paratype 1 from SJ 12262802, 35 yards north of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant, Montgomeryshire. Paratypes 2 and 3 from SJ 12272807, 80 yards north-north-east of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant, Montgomeryshire.

Horizon. Upper Llandeilo, Calcareous Shale.

Diagnosis. Only some ten plications, and with a fold in the ventral valve.

Description. Exterior: strongly biconvex, a weak fold in the ventral valve and a weak sulcus in the dorsal valve, ten strong plications in the dorsal valve and nine in the ventral, the two central ones in the dorsal valve being stronger than the others. The plications do not extend as far round the edge of the shell as the hinge-line. Greatest breadth at the hinge-line which is straight. External surface covered by costellae both on the costae and in the grooves between. There are approximately four costellae in 2 mm. Concentric growth-lines are present at irregular intervals. Dorsal interarea anacline near orthocline, curved over the hinge-line; ventral interarea apsacline also curved over the hinge-line.

Dorsal interior: this is of the normal platystrophid type; there is a simple linear cardinal process, strongly divergent brachiophores with the supporting plates converging to unite with the floor of the valve beneath the cardinal process. Sockets small with fulcral plates. Narrow deep crural pits beneath the brachiophores. Cardinal process continued forward for a short distance on the crest of the median plication, seen on the interior of the valve as a fold. Muscle scars rather obscure, small, triangular, and lying anterior to the crural pits, each having its base parallel to the midline and its apex pointing laterally, about 1.5 mm. long and 1.0 mm. wide.

Ventral interior: delthyrium open, deep; teeth with divergent supporting plates which pass forward into ridges on the floor of the valve bounding the muscle scar which is quarter the length of the valve, the ridges become parallel and then converge, decreasing in height so that they are almost imperceptible where they join anteriorly. It is not possible to differentiate the different parts of the muscle. In paratype 3 it is partly obscured by a shell fragment lying in the posterior part of the scar. Scar is crossed by the five median costae, and is approximately diamond shaped with the anterior acute angle truncated a short distance from its apex. Marginally the costellae can be seen on the interior surface and posterolaterally concentric corrugations occur.

Remarks. *M. raymondi* Foerste, the genotype, has a prominent median fold in the dorsal valve, the two median plications being only 3 mm. apart in a valve 25 mm. wide, a condition quite different from this species. In *M. lineolata* Savage there are thirty costae and these often die out before reaching the anterior margin of the shell. The Welsh material is quite distinct from either and is therefore placed in a new species. It is also the earliest occurrence of the genus anywhere, the other two species being North American from the Caradocian and Ashgillian respectively. The distribution of the genus is sporadic in time and space, and is at present problematical.

Genus PLATYSTROPHIA King 1850

Platystrophia cf. *precedens major* Whittington and Williams

Plate 20, figs. 1-4

1955 *Platystrophia precedens major*, Whittington and Williams, p. 402, pl. 38, figs. 24-29.

Material. Dorsal internal and external moulds and ventral internal mould, total nine specimens.

EXPLANATION OF PLATE 20

The photographs are of natural external and internal moulds and of plastic moulds made from these. They are unretouched, but the specimens were lightly coated with ammonium chloride before being photographed.

Figs. 1-4. *Platystrophia* cf. *precedens major* Whittington and Williams. 100 yards north-north-east of Llyn-Onn, 3 miles west of Llanrhaiadr-ym-Mochnant. 1, A 46845 *a*, internal mould of dorsal valve, $\times 3$. 2, Plastic mould of dorsal interior, $\times 3$. 3, Plastic mould of A 46845 *b*, external mould of dorsal valve, $\times 3$. 4, A 46846, internal mould of ventral valve, $\times 3$.

Figs. 5-7. ?*Atelelasma* sp. 35 yards north of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant. 5, A 46851 *b*, external mould of dorsal valve, $\times 1.5$. 6, A 46851 *a*, internal mould of dorsal valve, $\times 1.5$. 7, Plastic mould of A 46851 *a*, $\times 1.5$.

Figs. 8-14. *Atelelasma anatolica* sp. nov. 35 yards north of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant. 8-10, A 35413, paratype 1, side, anterior, and posterior views of internal mould of ventral valve. $\times 3$. 11, A 35414, paratype 2, external mould of ventral valve, $\times 4$. 12, 13, Normal and posterior views of plastic mould of paratype 2, $\times 4$. 14, A 35412, holotype, internal mould of dorsal valve, $\times 2$.

Figs. 15-19. *Oxoplecia nantensis* sp. nov. 15-17, From 930 yards north-west of Plas-yn-glyn, 1 mile north-north-east of Llanrhaiadr-ym-Mochnant. 15, A 46867, paratype 1, internal mould of ventral valve, $\times 2.5$. 16, Plastic mould of paratype 1, $\times 2.5$. 17, A 46869, paratype 3, posterior view of internal mould of dorsal valve, $\times 3$. 18, From 200 yards north-north-west of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant, A 46922, holotype, internal mould of dorsal valve, $\times 3$. 19, From 80 yards north of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant, plastic mould of A 46868, paratype 2, external mould of ventral valve, $\times 2.5$.

Locality. SJ 07292634, 100 yards north-north-east of Llwyn-Onn, 3 miles west of Llanrhaidr-ym-Mochnant, Montgomeryshire.

Horizon. Upper Llandeilo, Limestone.

Description. Exterior: semicircular, strongly biconvex, with deep sulcus in the ventral valve of about 25 per cent. of the breadth of the valve and a high fold in the dorsal valve of about 30 per cent. of the breadth of the valve. Cardinal angles rectangular to slightly obtuse. Ventral interarea orthocline to slightly apsacline, dorsal interarea anacline. Notothyrium and delthyrium open. Ornament of strong costae, three on the dorsal fold with five on either side, ventral valve with two in the sulcus and five on either side.

Dorsal interior: cardinal process consists of a simple plate running the whole length of the notothyrial platform, brachiophores straight and divergent at 90° to each other, with fulcral and supporting plates, the latter converging rapidly to meet at the anterior end of the cardinal process. Sockets small. Posterior pair of adductor scars oval on either side of the median ridge; anterior pair quadrate to triangular narrowing anteriorly, separated by the median ridge, and from the posterior pair by a pair of transverse ridges set at about 70° to the median ridge.

Ventral interior: teeth simple, small, supported by short parallel dental plates which are continuous with the ridge round the muscle scars, these being approximately U-shaped but pointed towards the anterior. Muscle scar about one-fifth of the length of the valve, poorly differentiated, but with two longitudinal ridges (?) containing the median adductor scars. The diductor scars (?) pass on to the dental plates posterolaterally.

Remarks. This material is externally like *P. precedens* McEwan, but on account of its size it is more like its variety *P. precedens major* Whittington and Williams. From that variety it differs in the following respects: externally the fold and sulcus are much narrower, 25–30 per cent. of the breadth compared with an average of 48 per cent. None of the tubercular ornament of Whittington and Williams material has been seen in this material. Internally in the ventral valve the supporting plates are parallel and not just sub-parallel; the muscle scar is smaller being only one-fifth of the length of the valve compared with two-fifths in *P. precedens major*, the shape of the anterior end of the scar is also more pointed instead of rounded. In the dorsal valve only the shape and size of the muscle scars differ.

Õpik (1930) recorded *P. biforata* and *P. dentata* from the Uhaku Shales of Estonia; of these the former is too advanced in ribbing to be related to this species. The latter has eight or nine ribs lateral to the fold and sulcus compared to the five or six in this material but is otherwise similar. The species is a member of the bicostate group and sub-group A of McEwan (1919), i.e. with two plications in the sulcus and three on the fold. Neither the bifurcation nor the intercalation can be seen in this material.

Family SKENIDIIDAE Kozłowski 1929

Genus SKENIDIOIDES Schuchert and Cooper 1931

? *Skenidioides* sp.

Plate 22, fig. 17

Material. One dorsal valve internal mould.

Locality. SJ 12272807, 80 yards north of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant, Montgomeryshire.

Horizon. Upper Llandeilo, Calcareous Shale.

Description. Exterior: dorsal valve only; small semi-elliptical to sub-triangular, hinge-line straight, cardinal extremities rounded, obtuse, near 90°. Convex, anterior commissure sulcate, sulcus fairly broad and rounded. Interarea anacline, notothyrium open. Surface multicostellate.

Dorsal interior: notothyrial cavity moderately shallow, brachiophores with fulcral and supporting plates, former partly cutting off the sockets; latter quite strongly convergent to join the median ridge and forming a low, almost sessile cruralium. Cardinal process runs the length of the cruralium-notothyrium and passes anteriorly on to the median ridge which runs about three-quarters of the length of the valve.

Remarks. This valve can only be placed in *Skenidioides* with some hesitation on account of the following points: it is unlike contemporary species in being multicostellate instead of costate; the median septum is weakly developed anterior to the cruralium; the cardinalia are smaller than usual.

Family ORTHIDAE Woodward 1852, emended Schuchert and Cooper 1932

Subfamily ORTHINAE Schuchert and Cooper 1931

Genus CYRTONOTELLA Schuchert and Cooper 1931

? *Cyrtonotella* sp.

Plate 23, fig. 18

Material. One external mould of the ventral valve.

Locality. SJ 12262802, 35 yards north of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant, Montgomeryshire.

Horizon. Upper Llandeilo, Calcareous Shale.

Description. Exterior: ventral valve only; strongly convex, anterior margin rounded, lateral margins slightly convex almost straight. Cardinal angles approximately 90°. Interarea anacline and curved. Anterior commissure weakly uniplicate. Delthyrium unknown. Ornament multicostellate.

Remarks. There is some resemblance to the genus in the strongly convex ventral valve and the multicostellate ornament.

Subfamily GLYPTORTHINAE Schuchert and Cooper 1931

Genus GLYPTORTHIS Foerste 1914

Diagnosis. With typical glyptorthid lamellose exterior, sulcus in the dorsal valve and internally typical orthid cardinalia.

Glyptorthis minor sp. nov.

Plate 19, figs. 16-20

Derivation of name. Latin, *minor*, small or inferior, on account of the small size of this species.

	Length (mm.)	Breadth (mm.)	Depth (mm.)
<i>Holotype.</i> A 46921, Pl. 19, figs. 17, 18. Internal mould of the dorsal valve	4	5	1
<i>Paratypes.</i> 1. A 46848, Pl. 19, fig. 16. External mould of the dorsal valve	3.5	5	1 app.
2. A 46849 <i>a</i> , Pl. 19, fig. 20. Internal mould of the ventral valve	5	6	2.5
3. A 46849 <i>b</i> , Pl. 19, fig. 19. External mould of the ventral valve	5	6	2.5

Material. External and internal moulds of both valves, thirteen specimens in all.

Type localities. Holotype and paratype 1 from SJ 12262802, 35 yards north of Nant; paratypes 2 and 3 from SJ 12172815, 200 yards north-north-west of Nant, 1 mile north of Llanrhaidr-ym-Mochnant, Montgomeryshire.

Horizon. Upper Llandeilo, Calcareous Shale.

Diagnosis. Strongly convex ventral valve with almost orthocone interarea, gently convex dorsal valve with long, strong, median ridge internally.

Description. Exterior: lateral profile biconvex with strongly convex ventral valve and weakly convex dorsal valve. Outline subquadrate to subcircular, hinge-line less than greatest breadth which is half to two-thirds the way forward. Cardinal extremities rounded to obtuse, about 110°, anterior margin rounded, anterior commissure weakly uniplicate. Ventral fold broad and gentle, dorsal sulcus narrow and sharp posteriorly, becoming broader and shallower anteriorly. Ventral interarea slightly apsacline, almost orthocone, dorsal interarea smaller than ventral, anacline. Ornament of bifurcating costae crossed by strong concentric lamellae.

Dorsal interior: notothyrial cavity moderately shallow, cardinal process stout and raised anteriorly before flattening out near the front of the notothyrial platform, tapers sharply posteriorly. Brachiophores large and blunt, bounding the notothyrial cavity, supported by considerable adventitious shell which joins the strong median ridge in front of the notothyrial platform. The median ridge runs forward for three-quarters of the length of the valve. On either side of the median ridge and beneath the brachiophores are well developed adductor pits. Adductor impressions ill defined—? semicircular on either side of median ridge in front of the brachiophores. Sockets fairly small with well defined fulcral plates. Ribbing prominent over the whole of the inside of the valve. Slight concentric ridge on the floor of the valve about three-quarters of the way to the periphery.

Ventral interior: deep delthyrial cavity, teeth with gently convergent dental plates which join the large muscle platform. Muscle platform about half the length of the valve, tapering posteriorly, with the edge raised laterally and anteriorly; a short median ridge runs forward from the front of the muscle platform. Muscle scar with two longitudinal ridges at the anterior and a slight median ridge in line with the median anterior prolongation. At the posterior end of the muscle scar there is a small raised area with prominent lateral ridges making up a pedicle callyst. In front of and lateral to the muscle scar is a gentle rounded concentric hollow.

Remarks. Three species of *Glyptorthis* are known in North America from rocks of

Llandeilo equivalent age. They differ from this material in the following respects: *G. sulcata* Cooper has both valves strongly convex; *G. transversa* Cooper though similar in size has a much less convex ventral valve; *G. sp. 4* Cooper has a weakly convex ventral valve. In Britain *G. balclatchiensis* (Davidson) has a less convex ventral valve and a different ventral muscle scar. *G. crispa* (M'Coy) has a strongly convex dorsal valve without sulcus.

Superfamily CLITAMBONACEA Schuchert 1929, emended Schuchert and Cooper 1932

Family CLITAMBONITIDAE Winchell and Schuchert 1893

Subfamily ATELELASMATINAE Cooper 1956

Genus ATELELASMA Cooper 1956

Atelelasma anatolica sp. nov.

Plate 20, figs. 8-14

Derivation of name. Greek, *anatolē*, of the east, or eastern, this being the most easterly species described so far.

	Length (mm.)	Breadth (mm.)	Depth (mm.)
<i>Holotype.</i> A 35412, Pl. 20, fig. 14. Internal mould of dorsal valve	9	13.5	1 app.
<i>Paratypes.</i> 1. A 35413, Pl. 20, figs. 8-10. Internal mould of ventral valve	5	13	5
2. A 35414, Pl. 20, figs. 11-13. External mould of ventral valve	3.5	7.5	2.5

Material. External and internal moulds of dorsal and ventral valves, total 5 specimens.

Type locality. SJ 12262802, 35 yards north of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant, Montgomeryshire.

Horizon. Upper Llandeilo, Calcareous Ash.

Diagnosis. Plano-convex, wide, slightly auriculate, costellate, short median septum in deep ventral valve.

Description. Exterior: plano-convex to slightly concavo-convex with straight hinge-line equal to greatest width, semicircular, slightly auriculate, cardinal extremities just acute, near 90°. Anterior commissure rectimarginate. Ventral interarea long, strongly apsacline to catacline, curving gently over the hinge-line. Dorsal interarea anacline. Delthyrium open, but with lateral plates characteristic of the genus on either side slightly modifying the shape. Notothyrium filled by well developed chilidium with growth-lines. Surface costellate. Shallow fold in dorsal valve broadening anteriorly until it has virtually disappeared at the anterior margin. Weak sulcus in ventral valve with gentle fold on either side. Ventral valve strongly convex from side to side, only moderately so from front to back.

Dorsal interior: cardinal process a simple, short plate abutting against the chilidium. Notothyrial platform well developed, passing forward into a wide median ridge which fades out anteriorly. Brachiophores diverge at 30° from the hinge-line rising quite sharply and with a short groove on their lateral faces near their ends. Sockets well defined and slightly indenting the hinge-line. Adductor scars forming pits in front of the

notothyrial platform and on either side of the median ridge; the limit of the scars not seen either laterally or anteriorly. Broad shallow concentric ridges are developed on the interior of the valve and the ribbing is also seen over the inner surface, although most strongly marked peripherally. There is a slight, low, subperipheral ridge.

Ventral interior: teeth simple so far as can be seen. Spondylium about one-third of the length of the valve with transverse ridging posteriorly and longitudinal ridging further forward; situated above the floor of the valve, about half the length of the delthyrium and supported for half its length on a short median septum before being free from the floor of the valve and some distance above it. Internal surface shows ribbing and concentric corrugations, the ribs being most strongly marked peripherally.

Remarks. This species of a genus not hitherto recorded in Europe resembles its contemporaries in North America, though differing in detail from all of them. *A. decortica-tum* has the ventral valve markedly curved over the hinge-line; *A. obscurum* has larger lateral plates in the delthyrium and coarser ribbing; *A. platys* is half the size, has coarser ribbing and has a convex dorsal valve; *A. sulcatum* has a sulcate and moderately convex dorsal valve; *A. variabile* is much smaller, has too convex a dorsal valve while having an almost square outline.

Atelelasma makes its first known appearance in the Lenoir of Tennessee, equivalent to the Llanvirn of Britain, before becoming widespread in the Llandeilo equivalent Chazy rocks of North America, contemporary with this species.

The allied genus *Apomatella* lacks the well developed lateral plates of *Atelelasma* and the only species known, *A. ingrlica*, is markedly procline. Cooper (1956) remarks on the close relationship of these two genera, *Apomatella* appearing to be more primitive and known only from the Walchow, Arenig equivalent, of the Leningrad district. As a simpler but similar form it may be ancestral to *Atelelasma*.

?Atelelasma sp.

Plate 20, figs. 5-7

Remarks. A single clitambonitid dorsal valve from the same locality as *A. anatolica* was also collected. It differs from that species in a number of respects and may possibly belong to a different genus.

The differences are listed below. Externally the ribbing is multicostellate and the concentric ridges on the shell are much sharper and more pronounced. Internally the cardinalia are smaller; the notothyrial platform is smaller, while the cardinal process and the median ridge are shorter, the latter ending abruptly anteriorly at about one-sixth of the length of the valve. The brachiophores are inclined at about 45° to the hinge-line.

Without ventral valves to examine it is not possible to give a more precise identification.

Superfamily DALMANELLACEA Schuchert and Cooper 1931

Family DALMANELLIDAE Schuchert and Le Vene 1929 = WATSELLIDAE Schuchert and Cooper 1931

Genus DALMANELLA Hall and Clarke 1892

Dalmanella parva Williams

Plate 21, figs. 18-21

1949 *Dalmanella parva*, Williams, p. 169, pl. 8, figs. 11-14.

Lectotype (here selected). Geological Survey Museum, London, GSM 75251, internal mould of a dorsal valve, Williams 1949, pl. 8, fig. 11.

Material. Dorsal and ventral external and internal moulds, some 350 in all.

Localities. Almost all exposures of the Upper Llandeilo in the Iwrch Valley, Rhaiadr Valley, and Llangynog Inliers, lying north, north-west, and west of Llanrhaiadr-ym-Mochnant, Montgomeryshire.

Horizon. Upper Llandeilo, Calcareous Ash, Limestone, and especially Calcareous Shales.

Description. Exterior: subcircular, typically orthoid, with maximum width anterior to a straight hinge-line. Dorsal valve gently convex, especially posteriorly where the shell is raised with two shoulders, one on either side of a distinct median sulcus. Ventral valve sharply convex medianly, umbonal region moderately pronounced, ornamentation of concentric growth-lines and multicostellate primitive ribbing.

Dorsal interior: notothyrial platform with subparallel sides, extending anteriorly to form a median ridge and supporting a styliform cardinal process and a pair of brachio-phores. The latter consist of very abbreviated widely divergent fulcral plates and a pair of larger subparallel supporting plates. Dental sockets strongly divergent anteriorly,

EXPLANATION OF PLATE 21

The photographs are of natural external and internal moulds and of plastic moulds made from these. They are unretouched, but the specimens were lightly coated with ammonium chloride before being photographed.

- Figs. 1–5. *Paucicera immatura* (Williams). 1, From 930 yards north-west of Plas-yn-glyn, 1 mile north-north-east of Llanrhaiadr-ym-Mochnant, A 46861, internal mould of ventral valve, $\times 2$. 2, From 130 yards north of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant, plastic mould of A 46862, internal mould of ventral valve, $\times 2$. 3, 4, 5, From 200 yards north-north-west of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant. 3, Plastic mould of A 46859 *b*, external mould of dorsal valve, $\times 2$. 4, A 46859 *a*, internal mould of dorsal valve, $\times 2$. 5, Plastic mould of A 46860, internal mould of dorsal valve, $\times 2$.
- Figs. 6–10. *Horderleyella subcarinata* sp. nov. 6, 9, From 80 yards north of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant. 6, Plastic mould of A 46864, paratype 1, internal mould of dorsal valve, $\times 2$. 9, A 46866, paratype 4, internal mould of ventral valve, $\times 4$. 7, 8, From 200 yards north-north-west of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant. 7, A 46863 *a*, holotype, internal mould of dorsal valve, $\times 2$. 8, A 46863 *b*, paratype 2, external mould of dorsal valve, $\times 2$. 10, From 35 yards north of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant, A 46865, paratype 3, internal mould of ventral valve, $\times 3$.
- Figs. 11–15. *Parastrophinella costata* sp. nov. 11, 12, From 80 yards north of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant. 12, 11, Normal and posterior views of A 35415, paratype 3, internal mould of dorsal valve, $\times 4$. 13, 14, From 35 yards north of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant. 13, A 46876, paratype 1, internal mould of ventral valve dissected to show form of the spondylium, $\times 4$. 14, A 46877, holotype, internal mould of ventral valve, $\times 4$. 15, From 200 yards north-north-west of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant, A 46875 *a*, paratype 2, internal mould of dorsal valve, $\times 4$.
- Figs. 16, 17. *Rostricellula triangularis* Williams. 80 yards north of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant. 16, A 46878, internal mould of dorsal valve, $\times 4$. 17, Plastic mould of dorsal valve, $\times 4$.
- Figs. 18–21. *Dalmanella parva* Williams. 200 yards north-north-west of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant. 18, A 46856, internal mould of ventral valve, $\times 6$. 19, A 46854 *a*, external mould of dorsal valve, $\times 4$. 20, A 46854 *b*, internal mould of dorsal valve, $\times 4$. 21, Plastic mould of dorsal valve, $\times 4$.

well defined. Adductor impressions only faintly impressed in gerontic specimens. Ribbing deeply impressed on internal moulds of both valves.

Ventral interior: umbonal region deep with dental lamellae well marked, diverging moderately anteriorly. Diductor scars generally obscure, occasionally seen as subcordate scars not enclosing the adductors.

Remarks. At Llandeilo this species is abundant in the rocks of the Upper Llanvirn and Lower Llandeilo as high as the Transition Sub-zone of Williams (1953). In the Berwyns it is abundant throughout the Upper Llandeilo. It is easily recognized on account of its constant small size. There do not appear to be any differences between the Berwyn and the Llandeilo area specimens.

Dalmanella cf. *lepta* (Bancroft)

Plate 22, figs. 18, 19

1945 *Wattsella lepta*, Bancroft, p. 193, pl. 22, figs. 4-7, pl. 23, fig. 4.

Material. Four moulds of the interior and one of the exterior of the dorsal valve.

Locality. SJ 12272807, 80 yards north of Nant, 1 mile north of Llanrhaidr-ym-Mochnant, Montgomeryshire.

Horizon. Upper Llandeilo, Calcareous Shale.

Description. Exterior: wider than long, semi-elliptical with long hinge-line, greatest width anterior to hinge-line, dorsal valve gently convex with shallow median sulcus, interarea low, apsacline, notothyrium open. Ribbing not fully known, but with strong development of internals. Ventral valve unknown.

Dorsal interior: notothyrial platform small with bilobed cardinal process and shaft, also small. Brachiophores lobe-shaped with well developed supporting plates which show as strongly convergent pre-socket lines in internal moulds. Sockets small with fulcral plates. A broad median ridge passes a short distance forward from the notothyrial platform before dying out on the median sulcus. It is about one-quarter of the length of the valve. Adductor scars faintly impressed on either side of the median ridge. Ribbing strongly impressed peripherally and gradually becoming fainter towards the cardinalia.

Ventral interior: unknown.

Remarks. A small number of specimens from the Berwyns resemble this species of Bancroft's rather than the much commoner *D. parva* and *P. immatura*. Internally the dorsal valve shows Bancroft's 'wattsellid' organization. The horizon of *D. lepta* is much higher, Lower Longvillian in the Caradoc, so that this material is rather problematical.

Genus PAUCICRURA Cooper 1956

Paucicrura immatura (Williams)

Plate 21, figs. 1-5

1949 *Resserella immatura*, Williams, p. 165, pl. 8, figs. 1-4, text-figs. 1 a, b.

Lectotype (here selected). Geological Survey Museum, London, GSM 75233, internal mould of dorsal valve, Williams, 1949, pl. 8, fig. 1.

Material. Internal and external moulds of dorsal and ventral valves, eighty-five specimens in all.

Localities. Most exposures in the Iwrch Valley and Llangynog Inliers, especially at Quarry, SJ 12582848, 960 yards north-west of Plas-yn-glyn, 1 mile north-north-east of Llanrhaiadr-ym-Mochnant, Montgomeryshire.

Horizon. Upper Llandeilo, Calcareous Ash, Limestone, and Calcareous Shales.

Description. Exterior: transverse, subrectangular with some specimens rather longer. Hinge-line straight, greatest width anterior to the hinge-line. Moderately biconvex, the ventral valve more so, the dorsal valve with a weak median sulcus. Delthyrium and notothyrium open, the latter partly or wholly filled by the cardinal process. Interareas low with the ventral greater than the dorsal. Ribbing fine, multicostate, sector III greater than sectors I and II. Concentric growth-lines present but usually well spaced out. (The small exopunctae of Williams's material were not seen, but this may be due to preservation.)

Dorsal interior: notothyrial platform small with cardinal process consisting of myophore and shaft, the former in large specimens being bilobed (Pl. 21, fig. 4), otherwise simple but thickened in more mature individuals. Bounded laterally by small diverging brachiophores with crural pits that are filled in in more mature individuals. Fulcral plates with small, quite deep sockets. Supporting plates small, rapidly convergent to join the median ridge. Notothyrial platform continued forward by a median ridge for one-third to half the length of the shell. Adductor scars moderately deeply impressed posteriorly and terminating sharply anteriorly, but vaguely laterally. Ribbing prominent at the periphery and continued more faintly to the muscle scars.

EXPLANATION OF PLATE 22

The photographs are of natural external and internal moulds and of plastic moulds made from these. They are unretouched, but the specimens were lightly coated with ammonium chloride before being photographed.

- Figs. 1-4. *Salopia* cf. *salteri* (Davidson). 35 yards north of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant. 1, 2, A 46857 *a*, normal and posterior views of internal mould of dorsal valve, $\times 3$. 3, A 46857 *b*, external mould of dorsal valve, $\times 3$. 4, A 46858 *a*, internal mould of ventral valve, $\times 3$.
- Figs. 5-10. *Parastrophinella parva* sp. nov. 5, 6, 9, 10, From 200 yards north-north-west of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant. 5, A 46874, paratype 4, internal mould of dorsal valve, $\times 3$. 6, A 46870, holotype, internal mould of ventral valve, $\times 3$. 9, Plastic mould of A 46872, paratype 2, internal mould of ventral valve, $\times 4$. 10, Plastic mould of A 46873, paratype 3, external mould of ventral valve, $\times 3$. 7, 8, From 80 yards north of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant, A 46871, oblique and normal view of paratype 1, internal mould of ventral valve, dissected to show spondylium and median septum, $\times 3$.
- Figs. 11-16. *Rafinesquina simplex* sp. nov. 11, 14, 15, From 400 yards north-north-east of Siambr, 3 miles west of Llanrhaiadr-ym-Mochnant. 11, A 46885, paratype 1, internal mould of ventral valve, $\times 1$. 14, Plastic mould of A 46884, paratype 2, internal mould of dorsal valve, $\times 1.3$. 15, Plastic mould of A 46886, paratype 3, internal mould of ventral valve, $\times 1$. 12, 13, From 200 yards north-north-west of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant, plastic moulds of A 46887 *a, b*, holotype, external and internal moulds of incomplete ventral valve, $\times 1$. 16, From 960 yards north-west of Plas-yn-glyn, 1 mile north-north-east of Llanrhaiadr-ym-Mochnant, A 35416, paratype 4, external mould of ventral valve, $\times 1.5$.
- Fig. 17. ?*Skenidioides* sp. 80 yards north of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant, A 46847, internal mould of dorsal valve, $\times 3$.
- Figs. 18, 19. *Dalmanella* cf. *lepta* (Bancroft). 80 yards north of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant. 18, Plastic mould of A 46852, external mould of dorsal valve, $\times 4$. 19, Plastic mould of A 46853, internal mould of dorsal valve, $\times 4$.

Ventral interior: delthyrium moderately deep; hinge-line with teeth with weak crural fossettes and supported by slightly divergent dental lamellae which are continued forward as boundaries to the muscle scars. Apex of delthyrium thickened by a pedicle callyst (Pl. 21, fig. 1). Muscle scars well defined, narrow adductors with ? a median ridge, bounded by the elongate, flabellate diductors extending beyond and enclosing the adductors, and having muscle tracks anteriorly. Ribbing marked at the periphery and less marked up to the muscle scars.

Remarks. This material is not identical with *P. immatura* from Llandeilo, but differs in minor respects only. Exteriously the ribbing agrees with the Llandeilo material in having sector III greater than I and II. As has been pointed out by Williams (1949) the reverse is the case in the Caradocian species. Internally the brachiophores are less slender than in Williams's material while in mature material they are much thicker. Along with this thickening the crural pits become lost although still present in juvenile specimens. The dorsal muscle scars are still not well defined, but the ventral scars are well developed as is the pedicle callyst. The pre-socket line in dorsal interior moulds reflects the presence or absence of the crural pits, being sinuous where these are present and straight where absent in the mature individuals.

The Berwyn material shows advances from the Lower Llandeilo stage of development towards that of Caradocian species.

Family HETERORTHIDAE Schuchert and Cooper 1931, emended Bancroft 1945

Subfamily HARKNESSELLINAE Bancroft 1928

Genus HORDERLEYELLA Bancroft 1928

Horderleyella subcarinata sp. nov.

Plate 21, figs. 6-10

Derivation of name. Latin, *sub-*, near, *carinatus*, a keel, from the prominent median ridge in the ventral valve.

	Length (mm.)	Breadth (mm.)	Depth (mm.)
<i>Holotype.</i> A 46863a, Pl. 21, fig. 7. Internal mould of dorsal valve.	18	16	3.5
<i>Paratypes.</i> 1. A 46864, Pl. 21, fig. 6. Internal mould of dorsal valve	13	19	4
2. A 46863b, Pl. 21, fig. 8. External mould of dorsal valve	..	16	4
3. A 46865, Pl. 21, fig. 10. Internal mould of ventral valve	9	12.5	2.5
4. A 46866, Pl. 21, fig. 9. Internal mould of ventral valve	5	6	1.5

Material. Dorsal and ventral external and internal moulds, twenty-four specimens.

Type Localities. Holotype and paratype 2, SJ 12172815, 200 yards north-north-west of Nant; paratypes 1 and 4 from SJ 12272807, 80 yards north-north-west of Nant; paratype 3 from SJ 12262802, 35 yards north of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant, Montgomeryshire.

Horizon. Upper Llandeilo, Calcareous Shale.

Diagnosis. Has a delicate cardinal process and delicate fulcral plates in the dorsal valve. In the ventral valve there is a sharp fold and internally a subpentagonal muscle scar.

Description. Exterior: shape weakly harknesselloid without prominent ears, cardinal angles obtuse and close to 90° with a few specimens acute and close to 90°. Biconvex, hinge-line straight. Dorsal valve with well developed median sulcus bordered by rounded folds narrowing posteriorly; ventral valve with a median fold, often quite sharp, with small sulci and then folds outside these. There is a regular development of intercostellate pores. Ribbing: a strong development of sector III is present in the dorsal valve and is much greater than sectors I and II together. Branching is more internal than external.

Dorsal interior: elevated notothyrial platform passing anteriorly into a broad median septum. Cardinal process of a slender myophore and shaft, almost a simple plate and extending most of the length of the notothyrial platform. Stout brachio-phores make an angle of about 60° bisected by the cardinal process, with well developed inner supporting plates and very delicate fulcral plates. These are separated by narrow deep crural pits. Dental sockets fairly short and quite deep. Deep adductor pits on either side of the median septum; weak ridges outside the adductor muscle scars may be extensions of the supporting plates. This feature is well seen in internal moulds. Anterior limit of the adductor scars ill defined.

Ventral interior: delthyrium deep; divergent dental plates with a low ridge extending beyond and bounding the muscle scars which are subpentagonal in outline with only a very slight tendency towards bilobation. Parallel-sided adductor scar bounded on either side by triangular diductors, both (?) being ridged by ribbing. The inside of both valves shows ribbing right up to the cardinalia.

Remarks. Differs from *H. convexa* Williams 1949 which has a weak ventral carina, a 'stout' cardinal process, fairly massive fulcral plates, and impressions of the ribbing limited to the periphery of both valves internally. *H. plicata* Bancroft 1928 has the valves considerably less convex, the ventral carina less well developed and the cardinal process more massive, but otherwise is not unlike this species. *H. corrugata* Bancroft 1945 may not have the median and lateral folds in some specimens, and the myophore and shaft are resorbed into a single massive body practically filling the space between the brachio-phores. Crural pits are very fine or absent at maturity and the ventral muscle scar is subtrigonal. *H. lata* Williams 1949 is consistently rather wider, length/breadth ratio 0.58 compared with 0.70 for this species, and the fulcral plates are quite robust. It does, however, have the same fine cardinal process, and the form of the shell is similar while the ribbing is impressed over most of the interior of the dorsal valve at least. A single interior of a ventral valve of *Horderleyella* from the Derfel Limestone (Whittington and Williams 1955) does resemble this species but the anterior of the muscle scar is curved forward rather than having a re-entrant as in this species.

This species falls rather precisely between the Llanvirn species *H. lata* and the Caradoc species *H. plicata*, having the fine cardinal process of the former and, apart from the cardinal process and the ventral carina, being otherwise similar to the latter. The ribbing is more like *H. lata*, having a greater development of internal rather than external branching.

Family LINOPORELLIDAE Schuchert and Cooper 1931

Genus SALOPIA Whittington and Williams 1955

Remarks. Whittington and Williams (1955) consider that *Salopia* may be descended from

the Draboviinae of Bohemia, a subfamily appearing in the Arenig and becoming abundant in the Llandeilo and Caradoc. In the absence of the demonstration of punctation in the subfamily they prefer to put *Salopia* in the Linoporellidae on the basis of the punctation and the cruralium in the dorsal valve.

Since then Cooper (1956) has described the genus *Laticrura* from the Caradocian of North America, and it seems to be a similar but more specialized genus; in particular in the brachiophores which have an S-shaped cross-section.

Whittington and Williams remark on the absence of convergent supporting plates beneath the brachiophores of the Draboviinae with the exception of *Giraldiella*. They then demonstrate that *Giraldiella* cannot be retained in the subfamily since it is impunctate. However, *Drabovinella ulrichi* Havlíček 1950 has, as can be clearly seen in his plate 12, fig. 14, markedly convergent supporting plates for the brachiophores, so much so that they join the median septum and in effect form a cruralium comparable to the structure seen in *Salopia*. The development of a cruralium from the more usual state of organization seen in the Draboviinae seems to be simply a matter of degree of convergence of the supporting plates beneath the brachiophores, and the species of *Drabovinella* referred to above lies in an intermediate position between the more usual *Drabovinella* condition and the condition seen in *Salopia* where the cruralium is well developed.

If one can accept that the Draboviinae are to be included in the Schizophoriidae, which must be governed by the demonstration of punctae in the Draboviinae, then the descent of *Salopia* from the Draboviinae seems quite possible. Similarly *Laticrura* may also be descended from this Bohemian stock. The Upper Llandeilo occurrence of *Drabovinella* and now of *Salopia* would not disagree with this, while *Laticrura* is first known in the Lower Caradoc. It is possible that *Salopia* might be ancestral to *Laticrura*.

Salopia cf. *salteri* (Davidson)

Plate 22, figs. 1-4

1871 *Orthis salteri*, Davidson, p. 255, pl. 36, figs. 31-34.

1955 *Salopia salteri* (Davidson), Whittington and Williams, p. 409, pl. 38, figs. 43-46.

Lectotype (here selected). Geological Survey Museum, London, GSM 11228, internal mould of the dorsal valve; Davidson 1871, pl. 36, figs. 33, 33a.

Material. Dorsal and ventral external and internal moulds, one of each. Since these lie only 2 inches apart on the same bedding plane they may have been the valves of the same individual.

Locality. SJ 12262802, 35 yards north of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant, Montgomeryshire.

Horizon. Upper Llandeilo, Calcareous Shale.

Description. Exterior: wider than long, strongly biconvex with the greater convexity in the ventral valve, finely multicostellate, dorsal valve with sulcus and ventral with weak fold anteriorly. Very long interarea in ventral valve, (?) delthyrium and notothyrium open. Anterior margin gently uniplicate.

Dorsal interior: cardinal process not preserved, but median ridge extending anteriorly from its position is present and this is continued beyond the cruralium by a strong median ridge running three-quarters the way to the anterior margin. Brachiophores fairly

large, supported laterally by the fulcral plates which separate deep sockets, and anteriorly by long supporting plates converging to form a large cruralium which is supported anteriorly by the median septum or ridge mentioned above. Large adductor scars on either side of the median septum. Ribbing present peripherally.

Ventral interior (incomplete): delthyrium large, teeth simple with large dental plates descending to the floor of the valve, but not running far to the anterior. Muscle area about one-fifth the width of the valve, but not clearly seen owing to poor preservation. Ribbing faintly marked peripherally.

Remarks. The main difference observed between this material and the type of the species is the absence of the fold in the anterior margin of the dorsal valve. Since, however, the Berwyn material is little more than one-third of the size of Davidson's material it seems possible that it was still too small to have developed an anterior fold. It possesses the dorsal sulcus seen in the more posterior parts of the type material. In all other respects the Berwyn material answers closely to this species as far as can be observed.

Superfamily TRIPLESIIACEA Cooper 1944
Family TRIPLESIIDAE Öpik 1932
Genus OXOPLECIA Wilson 1913

Diagnosis. Surface covered with plications or striae, with increase by interpolation and bifurcation; large, triangular, slightly concave cardinal area in the ventral valve; broad, usually flat deltidium; cardinal process shorter than in *Triplesia*; long beak in the ventral valve. Type species *O. calhouni* Wilson 1913.

Remarks. The genus was set up by Wilson for ribbed *Triplesia* with fold and sulcus, but it appears to have been overlooked and species that clearly should belong to this genus have been placed in Foerste's genus *Cliftonia*. *Cliftonia* Foerste 1909 was also set up for ribbed *Triplesia* but which were externally with 'the appearance of a small *Atrypa*'. An example of this is *Cliftonia andersoni* Reed 1917 which has a marked fold and sulcus. It clearly should be assigned to the genus *Oxoplecia*.

Oxoplecia nantensis sp. nov.

Plate 20, figs. 15-19

Derivation of name. Latin termination *-ensis*, from Nant, the farm adjacent to the locality of the holotype.

	Length (mm.)	Breadth (mm.)	Depth (mm.)
<i>Holotype.</i> A 46922, Pl. 20, fig. 18. Internal mould of dorsal valve	5	9	3
<i>Paratypes.</i> 1. A 46867, Pl. 20, figs. 15, 16. Internal mould of ventral valve	11	13	3
2. A 46868, Pl. 20, fig. 19. External mould of ventral valve	10	11	3.5
3. A 46869, Pl. 20, fig. 17. Internal mould of dorsal valve	9	17	6

Material. Internal and external moulds of dorsal and ventral valves, fifty-eight specimens in all.

Type localities. Holotype from SJ 12172815, 200 yards north-north-west of Nant; paratype 2 from SJ 12272807, 80 yards north of Nant; 1 mile north of Llanrhaiadr-ym-Mochnant; paratypes 1 and 3 from SJ 12852846, 930 yards north-west of Plas-yn-glyn, 1 mile north-north-east of Llanrhaiadr-ym-Mochnant, Montgomeryshire.

Horizon. Upper Llandeilo, Calcareous Ash, Limestone, and Calcareous Shale divisions.

Diagnosis. *Oxoplectia* with sharp plication in the dorsal valve, sulcus in the ventral valve to give a paraplicate anterior commissure; well developed costate and imbricate ornament, divergent dental plates in ventral valve.

Description. Exterior: shell transversely elliptical to subquadrate, biconvex, the dorsal valve more strongly convex than the ventral, hinge-line less than width of the shell, cardinal angles obtuse to rounded. Ventral valve with a strong median sulcus with a flat floor and steep sides increasing in width anteriorly and ending in a tongue fitting into the fold in the dorsal valve. Interarea triangular, high and curved over the hinge-line. Dorsal valve with a sharp fold, more swollen than the ventral valve, with the umbo curved over the hinge-line. Interarea small, steeply inclined and triangular; lateral lobes of the valve somewhat swollen. Ribbing: 7-9 ribs in the ventral sulcus and 13-16 on either side, 3-5 ribs on the dorsal fold and 12-14 laterally. The surface is covered by a fine concentric ornament of closely packed imbricate lines or ridges.

Dorsal interior: stout cardinal process forking (base only seen), short divergent rod-like brachiophores; anterior and posterior adductor scars rounded and separated by low, short, transverse ridges, the scars lie on either side of the median ridge.

Ventral interior: delthyrium open except for a small, strongly curved deltidium at the apex. Teeth small with divergent dental plates descending to the floor of the valve, and extending for a very short distance forward. Muscle scars not seen on floor of the valve.

Remarks. This species most closely resembles *Oxoplectia andersoni* (Reed 1917) but that species differs in the following respects: the ventral valve is more inflated and has a much longer tongue in the anterior commissure, it has fewer ribs and a higher ventral interarea. *O. plicata* Cooper 1956 is also similar, but has only four ribs in the sulcus and has eighteen laterally, the sulcus is also wider at the anterior margin, being about half the total width in adult shells. In the dorsal valve the fold does not originate until about one-third of the length of the valve. *O. mutabilis* Whittington and Williams 1955 from the Derfel Limestone is less transverse and has a wider fold with more ribs in the dorsal valve.

This is possibly the earliest record of *Oxoplectia* so far described in this country, but Williams (1953) records '*Cliftonia*' sp. from the Lower Llandeilo and Upper Llanvirn of the Llandeilo district. The genus makes its first appearance in North America in beds of Upper Llandeilo age, the Whistle Creek and Lincolnshire Limestone formations in Virginia (Cooper 1956, pp. 169, 170).

Superfamily SYNTROPHIACEA Ulrich and Cooper 1936
Family PARASTROPHINIDAE Ulrich and Cooper 1938, emended St. Joseph 1941
Genus PARASTROPHINELLA Schuchert and Cooper 1931

Parastrophinella parva sp. nov.

Plate 22, figs. 5-10

Derivation of name. Latin *parva*, small, on account of the very small size of this species.

	Length (mm.)	Breadth (mm.)	Depth (mm.)
<i>Holotype.</i> A 46870, Pl. 22, fig. 6. Internal mould of ventral valve	8	6.5	1.5
<i>Paratypes.</i> 1. A 46871, Pl. 22, figs. 7, 8. Dissected internal mould of ventral valve	7	8	1.5
2. A 46872, Pl. 22, fig. 9. Internal mould of ventral valve	8.5	9.5	2
3. A 46873, Pl. 22, fig. 10. External mould of ventral valve	6.5	7.5	1.5
4. A 46874, Pl. 22, fig. 5. Internal mould of dorsal valve	5.5	5	1.5

Material. Dorsal and ventral internal and external moulds, total 54 specimens.

Type localities. Holotype and paratypes 2, 3, and 4, SJ 12172815, 200 yards north-north-west of Nant; paratype 1, SJ 12272807, 80 yards north of Nant, 1 mile north of Llanrhaidr-ym-Mochnant, Montgomeryshire.

Horizon. Upper Llandeilo, Calcareous Shales.

Diagnosis. Two to eight coarse costae at the anterior margin; ventral interior with well developed median septum, and dorsal interior with long, slightly divergent outer plates.

Description. Exterior: both valves strongly convex, narrow hinge-line with greatest width two-thirds the way forward, the anterior rounded and the posterior almost pointed. Anterior commissure multiplicate. Ventral interarea apsacline towards orthocline and curved over hinge-line; dorsal interarea anacline towards orthocline, also curved; flattened areas present. Surface almost smooth with a few concentric corrugations; anteriorly there are two to eight coarse costae or plications.

Dorsal interior: deep notothyrial cavity with slight secondary thickening on the floor especially towards the posterior. This appears to constitute a sessile cruralium. Brachial supports or outer plates long, vertical and diverging very slightly forwards, about a quarter to one-fifth the length of the valve. The anterior ending of these above the floor of the valve is unknown. Very small and short inner plates are present. Sockets small; fulcral plates unknown. No cardinal process seen. Muscle scars seen at the anterior end of the outer plates, and divided into two, each consisting of a long narrow scar diverging beyond the plates and outside that there may be a short feathered scar.

Ventral interior: teeth (?) small, supporting plates convergent to form a spondylium which is sessile at the posterior, but which rises forwards on a median septum eventually being sharply upturned at its anterior end. The median septum continues forward for a short distance beyond the end of the spondylium. Length of the spondylium one-quarter to one-fifth the length of the valve. Faint muscle scars are present as striations along the length of the spondylium.

Remarks. The presence of what appears to be a sessile cruralium distinguishes this material from *Camerella* which has a cruralium duplex. A difficulty about placing this species in the Parastrophinidae is the absence of a fold and sulcus. All the other evidence, however, suggests placing the species in *Parastrophinella*. It clearly does not belong in *Branconia* which has a strong septum in both valves. The ribbing is quite different from

Anastrophia although the form of the spondylium agrees. In the dorsal interior it is not known whether the sockets are deep as in that genus, or whether there are wing-like processes on the outside of the outer plates. A low ridge is not present between the outer plates as in *Anastrophia*, but the adductor muscle scars agree. From *Parastrophina*, this material differs in not having a strong median septum in the dorsal interior, and in having the spondylium sessile for part of its length in the ventral interior.

Within *Parastrophinella*, *P. lenticularis* (E. Billings 1866) is less globose but has a spondylium, sessile for most of its length and sometimes raised on a septum anteriorly. The cardinalia are strongly alate with long slightly convergent outer plates forming a sessile cruralium. This is a condition not unlike the Welsh material but differing in the convergent outer plates among other points. *P. latiplicata* (Hall and Clarke 1894) is externally similar, but has a septum in the dorsal interior; this condition is also seen in *P. multiplicata* (Hall and Clarke 1894); while in *P. divergens* (Hall and Clarke 1894) the outer plates are convergent and the shell is more transverse. *P. ops* (Billings 1865) is thought by St. Joseph (1941) to be a synonym of *P. reversa* (Billings 1857) which is costate with the costae reaching a considerable distance back on the shell. There is also a prominent fold and sulcus with a deep anterior plication and internally there are also several differences.

This material appears to resemble to some extent the new genus *Parallelasma* Cooper (1956) from the Pratt Ferry Formation, Alabama. That it should do so is interesting indeed since it is the earliest known genus of the Pentameridae (Cooper 1956).

Points of resemblance are: the paucicostate exterior and the multiplicate anterior commissure, though there is no evidence in the Welsh material for the elaboration of the anterior commissure seen in Cooper's genus. In the dorsal interior of the Welsh material the cruralium is almost vestigial and in this resembles the appearance of *Parallelasma* with its long slender brachiophore plates.

Points of difference are: the long deep sockets and large fulcral plates of *Parallelasma* and, of course, the unique anterior commissure. Although uncertain, Cooper believes the muscle scars of the dorsal valve of *Parallelasma* to lie within the notothyrial cavity. This is a point of great importance in the distinction between the pentamerid and syntrophid organization.

Whether this material could be regarded in any sense as ancestral to the *Parallelasmatidae* is open to considerable doubt, especially when the two occur so far apart geographically. The resemblance is there and in time *Parastrophinella parva* occurs a short time before *Parallelasma petagonum* Cooper (1956), the only known species.

In 1932 Schuchert and Cooper suggested that the Pentameracea might be derived from the Camerellidae, which have since had the *Parastrophinidae* split off from them by Ulrich and Cooper (1936 and 1938). It may be suggested that the *Parastrophinidae* and in particular the genus *Parastrophinella* might be ancestral to the *Parallelasmatidae*.

Parastrophinella costata sp. nov.

Plate 21, figs. 11-15

Derivation of name. Latin, *costata*, having many lines of rib-like ridges; on account of the many ribs in this species.

	Length (mm.)	Breadth (mm.)	Depth (mm.)
<i>Holotype.</i> A 46877, Pl. 21, fig. 14. Internal mould of ventral valve	4.5	7	2
<i>Paratypes.</i> 1. A 46876, Pl. 21, fig. 13. Dissected internal mould of ventral valve	6	7	2
2. A 46875a, Pl. 21, fig. 15. Internal mould of dorsal valve	5	6	2
3. A 35415, Pl. 21, figs. 11, 12. Internal mould of dorsal valve	5	6	2

Material. Dorsal and ventral internal moulds, and dorsal external mould, 11 specimens in all.

Type localities. Holotype and paratype 1 from SJ 12262802, 35 yards north of Nant; paratype 2, SJ 12172815, 200 yards north-north-west of Nant; paratype 3, SJ 12272807, 80 yards north of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant, Montgomeryshire.

Horizon. Upper Llandeilo, Calcareous Shale.

Diagnosis. Very small size, large number of ribs, 13–22, spondylium mainly sessile but with very short median septum anteriorly.

Description. Exterior: both valves strongly convex, hinge-line narrow, greatest breadth half to two-thirds the way forward. Anterior slightly convex almost straight, sides convex at first then tapering almost straight to the umbones. Anterior commissure uniplicate, sulcus in the ventral valve and weak fold in the dorsal. Ventral interarea apsacline towards orthocline; dorsal interarea curved, anacline towards orthocline. Surface smooth posteriorly except for a small number of concentric corrugations. Anteriorly 13–22 costae which extend about one-third the way to the umbo.

Dorsal interior: notothyrial cavity deep and without a cardinal process, with little or no secondary thickening on the floor, making the presence or absence of a cruralium almost impossible to detect. Two long outer plates are parallel or very slightly divergent and are about one-third the length of the valve. They have external alae but are otherwise not known above the floor of the valve. Crura (?) short, sockets fairly large, no fulcral plates. Muscle scars not known. Ribbing seen on the peripheral one-third anteriorly.

Ventral interior: teeth small with strong dental plates which form a large spondylium, sessile for most of its length, but rising anteriorly where there is a very short median septum. The spondylium extends for almost half the length of the valve but does not rise far above the floor at the anterior. Muscle scars not seen. Ribbing is strongly marked at the anterior.

Remarks. The almost completely sessile nature of the spondylium precludes this species being placed in either *Parastrophina* or *Anastrophia*. Apart from being much more convex in both valves this material is quite similar to *P. lenticularis* (Billings 1866); points of similarity include the spondylium, sessile for most of its length, alate cardinalia, and not too prominent fold and sulcus.

Superfamily RHYNCHONELLACEA Schuchert 1896
Family CAMAROTOECHIDAE Schuchert and Le Vene 1929
Genus ROSTRICELLULA Ulrich and Cooper 1942

Rostricellula triangularis Williams

Plate 21, figs. 16, 17

1949 *Rostricellula triangularis*, Williams, p. 235, pl. 11, figs. 15-18, text-fig. 5.*Lectotype* (here selected). Geological Survey Museum, London, GSM 75229, internal mould of dorsal and ventral valves interlocked. Williams, 1949, p. 235, text-fig. 5.*Material*. Three dorsal internal and one dorsal external moulds.*Locality*. SJ 12272807, 80 yards north of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant, Montgomeryshire.*Horizon*. Upper Llandeilo, Calcareous Shale.*Description*. Exterior: about as wide as long, dorsal valve strongly convex with a gentle fold. Surface ornament of twelve strong radiating plications.

Dorsal interior: hinge-line short and curved; a median septum passes forwards on to one of the plications. Posteriorly the septum splits to pass round a very small septalium which does not contain a cardinal process. The sides of the septalium pass up into the crural bases. Outside these are very tiny sockets. The inside of the valve is heavily impressed by the ribbing.

Ventral valve not known.

Remarks. Apart from being even smaller than the Llandeilo district material there do not appear to be any differences.

	<i>Length</i> (mm.)	<i>Breadth</i> (mm.)
Llandeilo material	8.5	10
Berwyn material	4	3

Superfamily PLECTAMBONITACEA Cooper and Williams 1952

Family PLECTAMBONITIDAE Kozłowski 1929

Subfamily SOWERBYELLINAE Āpik 1930

Genus SOWERBYELLA Jones 1928

Sowerbyella antiqua Jones

Plate 23, figs. 11-15

1928 *Sowerbyella antiqua*, Jones, p. 419, pl. 21, figs. 7-11.*Lectotype* (selected by Spjeldnaes 1957). Geological Survey Museum, London, GSM 32152b, Jones 1928, pl. 21, fig. 11.*Material*. Dorsal and ventral internal and external moulds, total about 800 specimens.*Localities*. Almost every exposure of the Llandeilo in the Iwrch Valley, Rhaiaadr Valley, and Llangynog Inliers.*Horizon*. Upper Llandeilo, Calcareous Ash, Limestone and Calcareous Shale.*Description*. After Jones 1928. Exterior: shell small, outline semicircular, the posterior margin slightly curved. The ventral valve moderately convex, the dorsal valve weakly concave, the umbo small and erect. Surface covered by rounded threads, five or six in

1 mm.; every second or third slightly more prominent than its neighbour, but no clear differentiation into sets.

Dorsal interior: the muscle area is slightly raised above the level of the rest of the interior, especially at its anterior margin. The crural bases are very short; the median septum does not extend to the cardinal process; the submedian septa are well defined, but the transverse septa are absent. Each muscle impression is clearly divided by a longitudinal ridge. The whole muscle area is traversed also by coarse longitudinal ridges and furrows which are less prominent than the characteristic septa.

Ventral interior: there are two very short diverging muscle impressions, each divided by a faint longitudinal groove. The adductor impressions cannot be distinguished. Obscure papillae occur over most of the interior.

	Ventral valve (mm.)	Ventral valve (mm.)	Dorsal valve (mm.)
Width	8.9	10.8	8.9
Length	4.5	7.0	5.1
Width/length	0.50	0.65	0.56

(Figures after Jones 1928, p. 419.)

Remarks. Williams (1949) set up the variety *S. antiqua llandeiloensis* and the following differences from *S. antiqua* were cited: externally the ribbing is finer with primaries developed, seven to eight ribs/mm. with every fourth or fifth accentuated. The outline is

EXPLANATION OF PLATE 23

The photographs except fig. 11 are of natural external and internal moulds and of plastic moulds made from these. They are unretouched, but the specimens were lightly coated with ammonium chloride before being photographed.

Figs. 1-10. *Macrocoelia llandeiloensis* (Davidson). 1-7, From Quarry, 125 yards south-east of Brynglas, 450 yards east of Llan Mill, 1 mile west of Lampeter Velfrey, Pembroke. 1, 2, GSM 87336 B, internal mould of ventral valve and plastic mould, $\times 1.4$. 5, GSM 87336 A, internal mould of dorsal valve, $\times 1.5$. 3, 4, Normal and posterior views of plastic mould of dorsal valve, showing cardinal process and chilidium, $\times 1.5$. 6, GSM 87336 C, external mould of dorsal valve, $\times 1.5$. 7, GSM 87336 D, external mould of ventral valve, $\times 2$. 8, 10, From 400 yards east-north-east by north of Carnedd-y-forwyn, 2 miles north of Llanrhaiadr-ym-Mochnant. 8, A 46892, internal mould of ventral valve, $\times 1.5$. 10, Plastic mould of A 46889, internal mould of dorsal valve of gerontic individual, $\times 1.5$. 9, From 100 yards south-west of Tyn-y-llwyn, $2\frac{1}{2}$ miles north-west of Llanrhaiadr-ym-Mochnant, A 46890, fragmentary internal mould of dorsal valve, $\times 1.5$.

Figs. 11-15. *Sowerbyella antiqua* Jones. 11, From 100 yards south-south-west of Tyn-y-llwyn, $2\frac{1}{2}$ miles north-west of Llanrhaiadr-ym-Mochnant, A 46883, exterior of ventral valve, $\times 3$. 12, From 35 yards north of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant, A 46880, internal mould of ventral valve, $\times 3$. 13-15, From 80 yards north of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant. 13, Plastic mould of A 46881, internal mould of ventral valve, $\times 3$. 15, 14, A 46882, internal mould and plastic mould of dorsal valve, $\times 3$.

Figs. 16, 17. ?*Dactylogonia* sp. 200 yards north-north-west of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant. 16, 17, Normal and side views of plastic mould of A 46888, internal mould of dorsal valve, $\times 2$.

Fig. 18. ?*Cyrtonotella* sp. 35 yards north of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant, normal and side view of plastic mould of A 46850, external mould of ventral valve, $\times 3$.

semi-oval and the hinge-line is winged. The size is considerably greater. Internally all characters are emphasized with reference to *S. antiqua*, e.g. the umbonal region of the ventral valve is deeper, the elevation of the muscle area in the dorsal valve is greater and the pustules are larger.

Dimensions of *S. antiqua llantheiloensis* Williams (after Williams 1949, p. 234):

	Ventral Ext. (mm.)	Dorsal Ext. (mm.)	Ventral Int. (mm.)	Dorsal Int. (mm.)
Length	8.0	7.0	8.0	7.0
Width	15.5	14.0	17.0	14.0
Length/width	0.47	0.50	0.51	0.50

S. antiqua llantheiloensis is very abundant in the Llandeilo district where it marks a definite horizon in the Lower Llandeilo.

In the Llandeilo of the Berwyn Hills, *S. antiqua* is an abundant species and the size ranges from that given by Jones to that given by Williams. Recently Spjeldnaes (1957) has stated that *S. antiqua llantheiloensis* Williams is a distinct species which he calls *S. llantheiloensis*. Since this is in disagreement with the findings of the present work, a re-examination of *Sowerbyella antiqua* Jones and *Sowerbyella antiqua llantheiloensis* Williams has been made. The results are given below. They are based on an examination of the type material of both the species and its variety from the Geological Survey Museum, London, topotype material of both and some 800 specimens at present attributed to '*S. antiqua*' from the Berwyn Hills, North Wales.

External characters: Williams states that the variety has a semi-oval outline while Jones states that the species has a semicircular outline. Williams's dorsal interior GSM 75269 is distinctly semicircular nevertheless. There is a considerable degree of variation in his material and in that of Jones, and also in the topotype material of both; both contain semicircular and semi-oval specimens.

The ribbing in Jones's material answers to his description, but the more prominent ribs are more persistent towards the umbo than is apparent from his description. The ribbing is not dissimilar to that described by Williams. The material from the Berwyn Hills suggests that there is a complete range of variation from that described by Jones to that described by Williams.

Ventral interior: Williams states that the septal groove dividing the adductor impressions is more prominent in his variety than it is in the species described by Jones. Jones states that the adductor scars cannot be distinguished. It seems likely that Williams meant the septal groove dividing the diductor scars and not the adductor scars. On the interior of the shell this is a slight ridge lying between two shallow grooves. It is not always present though it does occur on both type specimens. The slightly divergent dental lamellae occur in both forms.

Dorsal interior: the muscle scar is essentially the same in both the species and the variety even in considerable detail apart from the slightly raised anterior mentioned by Williams. Again the Berwyn material suggests that there is a range between the two.

Spjeldnaes (1957) points out that there are oval smooth ridges not composed of pseudopunctae in *S. antiqua* Jones. Examination of Jones's material shows that these do not extend to the anterior of the muscle scar, but are seen only laterally. A weak ridge

extends from the anterior of this ridge backwards and inwards towards the cardinal process. This would appear to be the oval area referred to by Spjeldnaes, but exactly the same two ridges are to be seen on the muscle scar in Williams's variety. The anterior of the muscle scar in both the species and the variety is coarsely pseudo-punctate. A strong median septum is present in both, and is, in both, bordered by two submedian septa almost immediately adjacent to it.

Conclusion. The two should be united as a single species containing within it the variation from Jones's original material to that subsequently described by Williams, since the two seem to merge without any hard and fast distinction being possible.

Superfamily STROPHOMENACEA Schuchert 1896
Family LEPTAENIDAE Cooper 1956
Genus DACTYLOGONIA Ulrich and Cooper 1942

Remarks. Spjeldnaes (1957) regards the genus as synonymous with *Oepikina*, but the following differences may be noted: *Dactylogonia* has a more strongly pustulose interior, a smaller ventral muscle scar and is more strongly geniculate.

?*Dactylogonia* sp.

Plate 23, figs. 16, 17

Material. Internal and external moulds of one dorsal valve.

Locality. SJ 12172815, 200 yards north-north-west of Nant, 1 mile north of Llanrhaidr-ym-Mochnant, Montgomeryshire.

Horizon. Upper Llandeilo, Calcareous Shale.

Description. Exterior: dorsal valve only. Gently concave and strongly geniculate, rather wider than long with the greatest width at about half-way forward. Geniculation at about three-fifths way forward, greatest depth at about half-way forward. Anterior profile gently concave until the geniculation, then steeply bent towards the dorsal valve. Cardinal angles obtuse, interarea not known. Costellate with every third or fourth rib accentuated.

Dorsal interior: cardinal process bifid, standing sharply above the floor of the valve, cleft to its base, the two parts being some distance apart. Lateral ridges not prominent, extending forwards from the small brachiophores as ridges round the posterior part of the adductor scars. Muscle scar raised slightly anteriorly, radially fluted with two pairs of radial ridges moderately well developed, the more median pair being rather weaker; scar about three-eighths the length to the geniculation. There is a slight pit at the posterior end of each of the adductor scars on either side of the weak median ridge and immediately anterior to the lobes of the cardinal process. The anterior and posterior adductor scars are not separable; the scar is frilled anteriorly and laterally. The remainder of the interior of the valve is strongly pustulose as far as the geniculation, beyond there it is less densely pustulose. At the geniculation there is a submarginal thickening and this is radially fluted.

Remarks. There is a considerable resemblance to *D. obtusa* Cooper and the differences seem quite small so far as the dorsal valve goes. The American species has the cardinal

process smaller and has more strongly developed adductor ridges. In almost all other respects the two dorsal valves are similar.

Without further material nothing more can be said about resemblances. The genus has not previously been recorded outside North America where it is quite widely distributed in rocks of this and slightly later age.

Family STROPHOMENIDAE King 1846
Subfamily STROPHOMENINAE Williams 1953
Genus RAFINESQUINA Hall and Clarke 1892

Rafinesquina simplex sp. nov.

Plate 22, figs. 11–16

Derivation of name. Latin *simplex*, simple or plain.

	<i>Length</i> (mm.)	<i>Breadth</i> (mm.)	<i>Depth</i> (mm.)
<i>Holotype.</i> A 46887 <i>a, b</i> , Pl. 22, figs. 12, 13. Incomplete external and internal mould of ventral valve	17+	40	3
<i>Paratypes.</i> 1. A 46885, Pl. 22, fig. 11. Internal mould of ventral valve	32	38	5
2. A 46884, Pl. 22, fig. 14. Internal mould of dorsal valve	23	30	1
3. A 46886, Pl. 22, fig. 15. Internal mould of ventral valve	32	30	3
4. A 35416, Pl. 22, fig. 16. External mould of ventral valve	30	24	3

Type localities. Holotype from SJ 12172815, 200 yards north-north-west of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant; paratypes 1, 2, and 3 from SJ 07762642, 400 yards north-north-east of Siambr, 3 miles west of Llanrhaiadr-ym-Mochnant, Montgomeryshire, paratype 4 from SJ 12582848, 960 yards north-west of Plas-yn-glyn, 1 mile north-north-east of Llanrhaiadr-ym-Mochnant, Montgomeryshire.

Material. Internal and external moulds of dorsal and, much more commonly, ventral valves, sixty specimens in all.

Horizon. Upper Llandeilo mainly in Calcareous Ash, less commonly in Limestone and Calcareous Shale divisions.

Diagnosis. Typical of the genus, with weakly ridged ventral muscle scar, broad shallow peripheral ridge in both valves, greatest width at the hinge-line and with a small pseudo-deltidium.

Description. Exterior: wider than long, almost semicircular in appearance, greatest width at the hinge-line with cardinal angles 70°–90°, sides and anterior rounded. Plano- or slightly concavo-convex, the ventral valve gently and uniformly convex. Ornament of fine costellae, increasing by splitting; the primary costellae cease to be prominent after about 15 mm. from the umbo and the costellae are then almost equal in size. At 15 mm. from the umbo five to seven secondaries occur between the primary costellae. Concentric wrinkles on the shell absent, but extremely fine concentric ornament of the shell can be seen in well preserved material. Ventral interarea apsacline, becoming almost

catacline laterally, about 2 mm. high with well developed growth-lines. Wide delthyrium with small arched apical pseudo-deltidium. Dorsal interarea low, anacline, chidium present.

Dorsal interior: cardinal process bifid on a very slightly elevated notothyrial platform. Brachiophores short, narrow and small, lying very close to the cardinal process and with very small sockets lateral to them. Passing antero-laterally from the brachiophores are two low ridges, one on either side, and these join posteriorly with a low median ridge in front of the cardinal process to give the anchor-shaped mass characteristic of the rafinesquinids. There is a suggestion of a second pair of lateral ridges anterior to the first pair and nearer the mid-line. Adductor scars present as vague depressions on either side of the median ridge. They appear to be separated into anterior and posterior scars by ill defined transverse ridges. There is, round the periphery, a faint thickening of the shell, and also peripherally a faint impression of the ribbing.

Ventral interior: teeth large with short divergent dental plates, continued for a short distance anteriorly as boundaries to the deeply impressed muscle scar which consists of two subtriangular diductor scars bounding laterally a narrow adductor scar, divided down the middle and broadening slightly anteriorly. The anterior of the muscle scars slightly frilled and the surface of the scars with radial ridges. Scar about two-fifths the length of the valve. The inner surface of some specimens shows the ribbing weakly; in others there is a coarse pustulose surface especially near the periphery where the pustules show a radial arrangement. A broad gentle sub-peripheral ridge is present. Vascular sinuses not seen.

Remarks. The material most closely resembles *R. expansa* (Sowerby) which can, however, be distinguished from this species on the following grounds: the ventral muscle scar is prominently ridged; the vascular sinuses are prominent on the ventral interior; there is no sub-peripheral thickening on either valve; the greatest width is one-third to half-way forward from the hinge-line; the delthyrium appears to be open and a pedicle callyst is present posterior to the muscle scar.

The contemporary *Macrocoelia llandeiloensis* (Davidson) can at once be distinguished by the much larger ventral muscle scar and the adductor ridges in the dorsal valve.

This is an early species of *Rafinesquina* coming before the common occurrence of the genus in the Caradoc. The genus is said to occur at various areas of Llandeilo outcrop but nothing is known of these occurrences at present.

Genus MACROCOELIA Cooper 1956

Macrocoelia llandeiloensis (Davidson)

Plate 23, figs. 8-10

1871 *Strophomena compressa* var. (?) *llandeiloensis*, Davidson, p. 316, pl. 46, figs. 11-14.

Material. Sixty-four specimens, mainly ventral valves, both external and internal moulds.

Localities. SJ 11952879, 400 yards east-north-east by north of Carnedd-y-forwyn, 1½ miles north of Llanrhaiadr-ym-Mochnant, Montgomeryshire; SJ 07762642, 400 yards north-north-east of Siambur, 3 miles west of Llanrhaiadr-ym-Mochnant, and many other outcrops in all three inliers of Llandeilo rocks.

Horizon. Upper Llandeilo, Calcareous Ash division only.

Remarks. The material collected in the Berwyns Llandeilo corresponds closely with the topotype material of this species, described in the Appendix. The following differences were noted. The Berwyn material has the ribbing slightly more marked on the interior of the valves; the adductor ridges are rather more prominent in the dorsal valve, this being a greatly accentuated feature in thickened, old specimens; the sub-peripheral ridge is slightly more prominent, another feature that is accentuated in old thick specimens.

The species is a long ranged one, first appearing in Upper Llanvirn rocks in the Llandeilo District (Williams 1953) and persisting little changed as far as the Upper Llandeilo of the Berwyns. It is also recorded by Whittard (1931) from the Welsh Borders.

APPENDIX

Description of *Macrocoelia llandeiloensis* (Davidson) based on topotype material in the collections of the Geological Survey, London, specimen GSM 87336 A, B, C, D. It has not been possible to trace the specimens on which Davidson's description was based.

Macrocoelia llandeiloensis (Davidson)

Plate 23, figs. 1-7

1871. *Strophomena compressa* var. (?) *llandeiloensis*, Davidson, p. 316, pl. 46, figs. 11-14.*Material.*

	<i>Length</i> (mm.)	<i>Breadth</i> (mm.)	<i>Depth</i> (mm.)
Pl. 23, figs. 3-5, GSM 87336A. Internal mould of dorsal valve .	22	26.5	1.5
Pl. 23, figs. 1, 2, GSM 87336B. Internal mould of ventral valve .	25.5	29	3
Pl. 23, fig. 6, GSM 87336C. External mould of dorsal valve .	16	20	1
Pl. 23, fig. 7, GSM 87336D. External mould of ventral valve .	12	16	1.5

Locality. SN 14501413, quarry, 125 yards south-east of Bryn-glas, 450 yards east of Llan Mill, 1 mile west of Lampeter Velfrey, Pembroke.

Horizon. About 30 feet above the base of the Llandeilo of this area.

Diagnosis. As for the genus, but with very fine adductor ridges in the dorsal valve, a small pedicle callyst in the ventral valve; weakly concavo-convex with neither valve strongly curved.

Description. Exterior: about medium size for the genus, weakly concavo-convex, almost plano-convex. Hinge-line straight, cardinal angles $100^{\circ} \pm 10^{\circ}$, sides and anterior curved with greatest width about a third of the way forward from the hinge-line; width/length: 6/5. Ventral valve most strongly convex near the umbo and only gently so anteriorly and laterally, interarea low apsacline. Dorsal valve most strongly concave near the umbo, almost plane anteriorly and laterally; interarea low anacline, almost as large as that in the ventral valve; ornament of fine costellae without marked differentiation into primary and secondary; concentric ornament practically absent, little more than weak growth-lines.

Dorsal interior: cardinal process bifid, tapering posteriorly, on a raised notothyrial platform, and abutting against the arched chilidium. Brachiophores very small, defining

moderate-sized sockets outside them. Low ridges extend for a short distance antero-laterally from the brachiophores and also form part of the notothyrial platform. The median ridge of the notothyrial platform is extended anteriorly as a very low, wide, gentle ridge for about one-quarter length of the valve. Two radial dorsal lateral ridges are present on either side of a weak median ridge which lies between one-quarter and half-way towards the anterior margin. A more lateral pair of ridges lie about one-quarter of the way to the antero-lateral margin and are inclined at about 30° to the mid-line. The boundary of the adductor scars is ill defined but probably lies along the slightly elevated area on which the radial dorsal lateral ridges occur. These ridges though distinct are not prominent in this material. A subperipheral ridge is present and this is weakly fluted radially. It is less well developed in the dorsal valve than in the ventral. Posteriorly it swings towards the mid-line before merging with the hinge-line just lateral to the sockets.

Ventral interior: delthyrium open, teeth large with small, strongly divergent, dental plates which pass forward into weak ridges bounding the posterior margin of the very large muscle scar. The muscle scar extends for about half the length and two-thirds of the breadth of the valve. It consists of two large radially ridged diductor scars bounding the long narrow adductor scars which posteriorly are divided by a low median ridge that becomes finer anteriorly before splitting into a double ridge which persists for the rest of the length of the scar. At the posterior of the muscle scar is a small pedicle callyst. Peripherally there is a ridge of shell material. This is radially fluted and beyond it the ribbing of the shell is well marked. The ribbing cannot be made out inside this ridge though weak radial ridges similar to those on the muscle scar do occur. Fine pseudopunctae can be seen on the inner surface of the shell; they are not arranged in any regular pattern and form a dense mat. Traces of the vascular system can be seen in the postero-lateral corners of the ventral valve.

Remarks. The genus *Macrocoelia* is very similar to *Oepikina* Salmon, but the presence of weak adductor ridges in the dorsal valve, together with the ridge in the adductor scar and the open delthyrium in the ventral valve serve to place this species in the former genus. The genus is known from the contemporary rocks in the Appalachian region as is *Oepikina* which also occurs in the contemporary beds in Estonia.

REFERENCES

- BANCROFT, B. B. 1928. The Harknessellinae. *Mem. Manchr. lit. phil. Soc.* **72**, 173–96, pl. 1, 2.
 — 1945. The brachiopod zonal indices of the Stages Costonian to Onnian in Britain. *J. Paleont.* **19**, 181–252, pl. 22–38.
 COOPER, G. A. 1956. Chazyan and related brachiopods. *Smithsonian Misc. Coll.* **127**, 1–1245, pl. 1–269.
 DAVIDSON, T. 1871. British Fossil Brachiopoda. 3, Devonian and Silurian Species, Pt. 7. *Palaont. Soc.* **24**, 249–397, pl. 38–50.
 FOERSTE, A. G. 1909. Fossils from the Silurian Formations of Tennessee, Indiana and Kentucky. *Bull. sci. Labs. Denison Univ.* **14**, 61–116, pl. 1–4.
 — 1914. Notes on the Lorraine Faunas of New York and the Province of Quebec. *Ibid.* **19**, 247–339, pl. 1–5.
 — 1920. The Kimmswick and Plattin Limestones of northeastern Missouri. *Ibid.* **19**, 175–224, pl. 1–3.
 HAVLIČEK, V. 1950. The Ordovician Brachiopoda from Bohemia. *Rozpr. Ustr. Ust. Geol. Praha.* **13**, 1–133, pl. 1–13.

- JONES, O. T. 1928. *Plectambonites* and some allied Genera. *Mem. Geol. Surv. Palaeont.* **1**, 367-527, pl. 21-25.
- KAY, M. 1958. Ordovician Highgate Springs sequence of Vermont and Quebec and Ordovician Classification. *Amer. J. Sci.* **256**, 65-96.
- MCEWAN, E. D. 1919. A study of the brachiopod genus *Platystrophia*. *Proc. U.S. nat. Mus.* **56**, 383-448, pl. 42-52.
- ÕPIK, A. 1930. Brachiopoda Protremata der Estländischen Ordovizischen Kukuruse-Stufe. *Acta Univ. dorpat. (tartu.)* **17**, 1-262, pl. 1-26.
- REED, F. R. C. 1917. The Ordovician and Silurian Brachiopoda of the Girvan District. *Trans. roy. Soc. Edinb.* **51**, 795-998, pl. 1-24.
- SAINT-JOSEPH, J. K. 1941. The brachiopod family Parastrophinidae. *Geol. Mag.* **78**, 371-401.
- SALMON, E. S. 1942. Mohawkian Rafinesquinae. *Jour. Paleont.* **16**, 564-603, pl. 85-87.
- SCHUCHERT, C. and COOPER, G. A. 1932. Brachiopod Genera of the Suborders Orthoidea and Pentamerioidea. *Mem. Peabody Mus. Yale.* **4**, 1-270, pl. 1-29.
- SPIJELDNAES, N. 1957. The Middle Ordovician of the Oslo Region, Norway. 8, Brachiopods of the Suborder Strophomenida. *Norsk. geol. Tidsskr.* **37**, 1-214, pl. 1-14.
- STUBBLEFIELD, C. J. 1939. Some Devonian and supposed Ordovician fossils from southwest Cornwall. *Bull. Geol. Surv.* **2**, 63-71, pl. 4.
- ULRICH, E. O. and COOPER, G. A. 1936. New Genera and Species of Ozarkian and Canadian brachiopods. *J. Paleont.* **10**, 616-31.
- 1938. Ozarkian and Canadian Brachiopoda. *Spec. Pap. geol. Soc. Amer.* **13**, 1-323, pl. 1-57.
- WEDD, C. B., SMITH, B., KING, W. B. R. and WRAY, D. A. 1929. Explanation of Sheet 137. The Country around Oswestry. *Mem. Geol. Surv.* 1-234.
- WHITTARD, W. F. 1931. The geology of the Ordovician and Valentian rocks of the Shelve Country, Shropshire. *Proc. Geol. Ass.* **42**, 322-39, pl. 10, 11.
- WHITTINGTON, H. B. and WILLIAMS, A. 1955. The fauna of the Derfel Limestone of the Arenig District, North Wales. *Phil. Trans. roy. Soc. Ser. B*, **238**, 397-430, pl. 38-40.
- WILLIAMS, A. 1949. New Lower Ordovician brachiopods from the Llandeilo-Llangadock District. *Geol. Mag.* **86**, 161-74, 226-38, pl. 8, 11.
- 1953. Geology of the Llandeilo District, Carmarthenshire. *Quart. J. Geol. Soc. London*, **108**, 177-208, pl. 9.
- WILSON, A. E. 1913. A new brachiopod from the base of the Utica. *Bull. Victoria Mem. Mus.* **1**, 81-86, pl. 8.

A. ROY MACGREGOR
Department of Geology,
The University,
St. Andrews, Fife.



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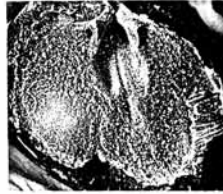
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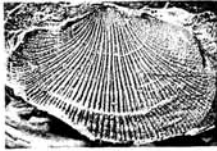
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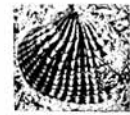
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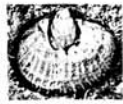
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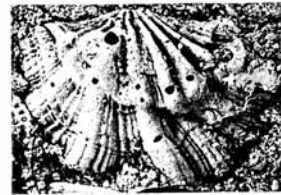
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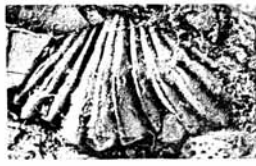
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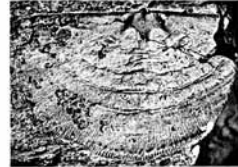
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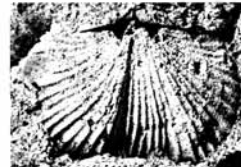
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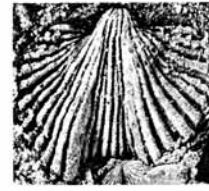
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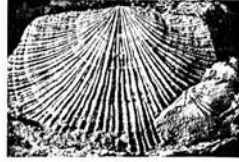
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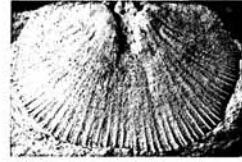
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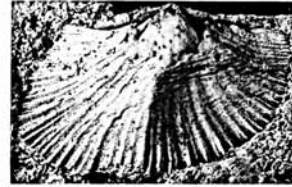
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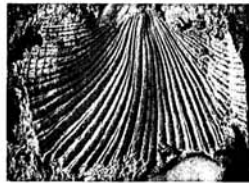
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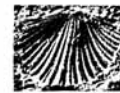
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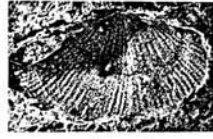
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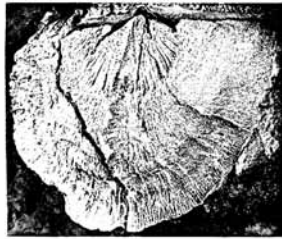
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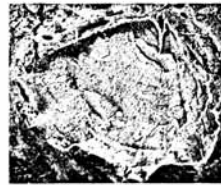
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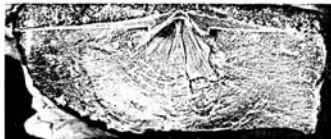
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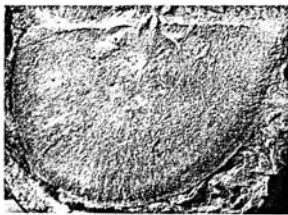
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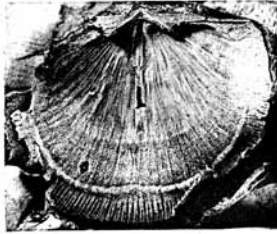
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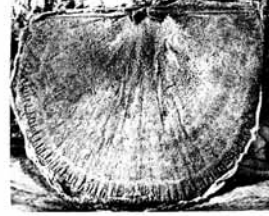
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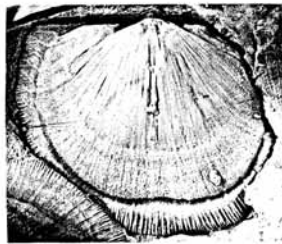
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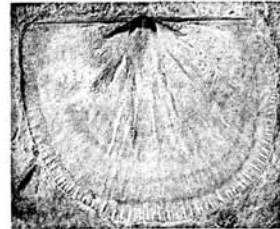
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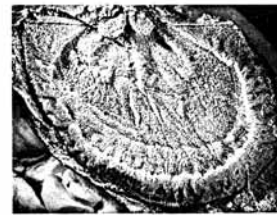
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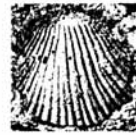
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