

XXX.—Notes on the Palæozoic Bivalved Entomostraca. No. IX.
Some Silurian Species. By Prof. T. RUPERT JONES, F.G.S.,
and Dr. H. B. HOLL, F.G.S.

[Plates XIV. & XV.]

THE specimens about to be described were obtained mostly from the calcareous bands of the Woolhope and Wenlock strata near Malvern; and, having for the most part retained their shells, they afford better materials for the determination of species than many of the small Bivalved Entomostraca obtained elsewhere from the Silurian rocks. Some of the well-preserved Silurian Entomostraca found in the neighbourhood of Malvern have been already sorted out and described by us as *Primitia*, in the 'Annals of Nat. Hist.' ser. 3. vol. xvi. pp. 414–425.

[The measurements of the specimens described are given in a Table at p. 227.]

1. *Cythere corbuloides*, sp. nov. Pl. XV. figs. 4 *a*–4 *e*,
figs. 5 *a*, *b*.

Carapace somewhat egg-shaped, swollen posteriorly, inequivalved, subtriangular in every aspect. Sometimes the right valve and sometimes the left is larger than the other. In fig. 4 *c* the left valve is more convex in its upper portion than the other, rising far above it at the dorsal margin; and the right valve has an oblong outline in side view, with rounded ends. In other specimens, as in fig. 4 *a*, the right valve is large and high. The outline of the larger valve forms a scalene triangle with the upper angle replaced by a bold curve, and the lateral (terminal) angles, especially the anterior corner, less rounded: thus the ventral margin is flattish and the back highly arched, with a steeper downward slope backwards than forwards. Some specimens occur in which there is less inequality of the valves, but the left valve seems usually the larger one.

The hinge-line is straight, about two-thirds the length of the valve, is overhung by the umbo-like convexity of the larger valve, and in the smaller valve its middle third is accompanied by a narrow parallel depression. The ventral margin of each valve is sometimes slightly lipped at the posterior angle (fig. 4 *d*).

The ventral profile of the carapace is broadly ovate, with the narrow end suddenly sharp; the end view (fig. 4 *e*) is broadly cordate, with the apex upwards.

The great inequality of the valves in these specimens is exceptional among Bivalved Entomostraca, especially among the *Cytheræ*, with which and their congeners, in other respects, this species has its alliances. *Leperditia gibbera*, belonging to another group, has a protuberance in the postero-dorsal region of the left valve; but it projects laterally, not vertically; and *Leperditia arctica* has a slight swelling all along the dorsal region of its left valve. It is possible that, both in these cases and with the species under notice, the dorsal swelling characterizes female individuals.

As pointed out to us by our friend Mr. G. S. Brady, this species has much similarity, in some features of its carapace, to *Xestoleberis depressa*, Sars, an existing member of the *Cytheridæ* which is found in the British seas down to about 60 fathoms (see G. S. Brady's "Monograph of Recent British Ostracoda," in the 'Linnean Soc. Transact.' vol. xxvi. p. 438, pl. 27. figs. 27-33). We prefer, however, to retain the generic term "*Cythere*," even if it be in a more extended sense than ought to be applied to living groups, for the sake of convenience to geologists.

We have specimens of *Cythere corbuloides* from the Wenlock Limestone of Croft's Quarry, near Malvern; from the Wenlock Shale of the railway-tunnel, near the Wych, Malvern, where it is not uncommon; and from the calcareous bands of the Woolhope beds, at the same place.

A young (or small male) individual (figs. 5 a, 5 b), from the Woolhope beds, is smaller and less convex than the others, but has all the essential characters seen in them, including even a predominating dorsal convexity of the left valve, though to a slight extent. Its lateral profile is much more nearly oblong, and its end view is nearly circular; but its ventral aspect is still acute-ovate, like that of the others.

2. *Cythere Grindrodiana*, sp. nov. Woodcut, fig. 1.

Carapace small, subcylindrical, long-ovate in outline, rounded at the ends, but tapering more at one end than the other; dorsal and ventral borders nearly, if not quite, equal in their convexity. End view circular.



Fig. 1. *Cythere Grindrodiana*.
Left valve. (Magnified about 20 diameters.)

This approaches the living *Cytheridea elongata*, Brady, and other living and fossil forms in shape; but there is no evidence of specific identity. Dr. Grindrod, F.G.S., of Malvern, after whom it is named, has found three or four specimens of this species in the Woolhope Shales of West Malvern, as casts, sometimes with a thin film of the carapace remaining.

The other known Silurian *Cytheræ* are:—

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| <i>Cythere Baillyana</i> , J. & H. | } From the Caradoc beds of
Kildare &c., Ann. N. H. ser. 4.
vol. ii. pp. 54–62 (1868). |
| — <i>Jukesiana</i> , J. & H. | |
| — <i>Harknessiana</i> , J. & H. | |
| — <i>Wrightiana</i> , J. & H. | |
| — <i>Aldensis</i> , M'Coy. | |
| — ? <i>siliqua</i> , Jones. From the Trenton Limestone of
Canada, described as a <i>Cytheropsis</i> (Ann. N. H. ser. 3. vol. i.
p. 249, pl. 10. fig. 6). | |

Other so-called *Cytheræ* and *Cytherinæ* from Silurian rocks, such as *C. sublævis*, Shumard, *C. alata*, De Verneuil, *C. subrecta*, Geinitz (not Portlock), and *C. cylindrica*, Hall, belong probably to *Leperditie* and cognate genera.

Bairdia Phillipsiana, sp. nov. Pl. XIV. figs. 7 *a, b, c*.

Carapace subfalciform, with obliquely rounded, tapering, almost equal ends, highly arched back, and faintly incurved ventral border. The left valve very much overlaps the other, especially on the dorsal edge. Profile acute-oval.

This almost symmetrical *Bairdia* (in lateral aspect not unlike the recent British *B. fulva*, described by Mr. G. S. Brady in his "Monograph of the Recent British Ostracoda," Trans. Linn. Soc. vol. xxvi. p. 474, pl. 28. fig. 21) is from the Wenlock Limestone of Croft's Quarry, near West Malvern, but is not common; and we name it after Prof. John Phillips, F.R.S., who years ago shed much light on the geology and fossils of the Malvern district.

A very similar form to this (and probably identical) occurs in a piece of a drifted Scandinavian block of Silurian Limestone from near Breslau.

The other Silurian *Bairdiæ* are—*Bairdia Murchisoniana*, *B. Griffithiana*, and *B. Salteriana*, from the Caradoc beds of Kildare, described by us in Ann. N. H. ser. 4. vol. ii. p. 58 (1868), and *Bairdia protracta*, Eichwald, Leth. Rossica, livr. vii. (1866,) p. 1338, pl. 52. fig. 19, from the Coral-limestone (Upper-Silurian) of Kamenetz-Podolsk.

THLIPSURA*, gen. nov.

A Cytheroid carapace, indented on its anterior third by a variable and evanescent pit, and posteriorly by a deeper and permanent depression, characterizes the Silurian specimens which we have to place by themselves in this new generic group.

* So called in allusion to the compression of the posterior extremity: *θλίψις*, pressure, and *οὐρά*, tail.

1. *Thlipsura corpulenta*, sp. nov. Pl. XV. figs. 1 *a, b, c, d*.

Carapace short, thick, and high; ovate in side view, nearly oblong in profile, and subquadrate in end view. Valves narrowing and compressed at the anterior edge; convex behind, but pinched-in suddenly with an obliquely longitudinal median sulcus (nearly half the length of the valve), and ending with a thick projecting posterior lip or rim. This conformation of the posterior third of the carapace sometimes gives its ventral profile (fig. 1 *b*) a tripartite aspect, when the marginal rim is strong and distinct from the convexity on each side. The end view also is peculiar (fig. 1 *d*), on account of the lateral impress of the furrow on either valve. This caudal notch is liable to some variation, being either broad or narrow, with either straight or curved edges, which are more sharply defined in some specimens than in others. In one of the large specimens from the Woolhope series we have seen a small, shallow, pear-shaped depression a little in advance of and below the centre of the valve; and there is, in an individual of medium size from the Wenlock beds, an anterior notch, short and obliquely transverse, just in front of the centre of the valve. *Thlipsura corpulenta* varies as to the relative proportions both of the carapace and its pits and notches.

Several large specimens have been obtained from the calcareous bands at the base of the Woolhope series, near Malvern, where it is not uncommon. Dr. Grindrod has collected this species in the Woolhope Shales of West Malvern (laminated mudstones full of Polyzoa and small Brachiopods), in which it is rather common. It is common also in the lower beds of the Wenlock Shale, and less frequent in the Wenlock Limestone.

2. *Thlipsura tuberosa*, sp. nov. Pl. XV. figs. 2 *a, b, c*.

This is nearly related to *Th. corpulenta*, but is more oval than ovate in outline, less oblong in profile, and is characterized by a somewhat compressed ventral margin, and by a prominent boss, on each valve, defined by two slight parallel transverse sulci, rather in advance of the middle of the valve. The sides of the caudal furrow are rather more elevated, as distinct though faint ridges, than is shown in our figure.

This specimen (unique) is from the base of the Wenlock Shale, Elton Lane, near Ludlow. The shell has been dissolved away in its matrix to a thin film, and broken through at the central eminences.

3. *Thlipsura V-scripta*, sp. nov. Pl. XV. figs. 3 *a, b, c*.

This also is related to *Th. corpulenta*, but it is much smaller,

more neatly ovate in outline, and narrower behind. The surface of the carapace is smooth and regularly convex, but impressed distinctly with the two sets of notches, of which the anterior is liable to disappear in *Th. corpulenta*. The caudal notch consists of two oblique pits, usually meeting posteriorly, and forming a subtriangular depression, V-shaped, with the apex pointing backwards, but not reaching the border. The anterior notch is just in front of the middle of the valve, transverse, and equal in length to about a third of the valve's height (or breadth).

Only single valves have been found. The figured specimen is neatly ovate, smoothly convex, with the hinder notch chevron-shaped; suboblong in profile, and nearly circular in end view (if the valves were united).

Rare in the Wenlock Limestone of Croft's Quarry, near Malvern.

This form is not at first sight very dissimilar to some larger and more convex specimens, from the base of the Wenlock series; but the latter have the single caudal furrow of *Thlipsura corpulenta*, they are smaller and neater, and in one instance the transverse anterior notch is plainly seen, though not so well defined as in the little species before us. We have already mentioned that one of the larger specimens (from the Woolhope beds) shows a trace of the anterior notch.

It may be that the chevron notch is lost by the growth of the individual, one of its arms enlarging into the great single furrow of the large forms; but we have not yet found any intermediate stage of growth, and therefore propose to recognize the small form as a distinct species, which has both the anterior and posterior notches notably distinct and peculiar.

CYTHERELLINA, gen. nov.

In the Upper Silurian strata both of Gothland and Britain occur numerous transversely indented casts of little subtriangular Bivalved Entomostraca, to which one of us, in 1855, gave the name of *Beyrichia siliqua*, under the supposition that some of these bisulcate casts (in Scandinavian limestone) were *Beyrichiæ*, though of unusual aspect. The supposed "marginal rim" was supplied by the broken edge of the *imbedded shell*, as will be understood by the reader if he looks at figs. 6 *a, b, c, d*, upside down, comparing them with the older figure, Ann. Nat. Hist. ser. 2. vol. xvi. pl. 5. fig. 22. The appearance of the calcareous cast was sufficiently deceptive to mislead until specimens were found in a different limestone (from near Malvern), which presented both outer tests and internal casts, of different tints and texture, and indubitably related to each

other, showing that the outside of the shell is *smooth*, and its interior moulded with the undulated contours that we see on the very common *casts* above mentioned. The undulations of the surfaces of the casts are caused by two oblique transverse sulci, of variable depth and width, rather nearer to the anterior (narrow) than to the posterior or boldly convex extremity, and deepest and broadest on the convex (dorsal) edge. The space between the two furrows is marked out more or less plainly as an obliquely oblong, suboval, or roundish lobe; but whether faint or strong, it has no corresponding elevation on the outside of the shell; nor have the furrows on the cast anything to indicate them externally.

The smooth, bean-like exterior (now recognized) entirely distinguishes the form under notice from *Beyrichia*; and even the furrows in the cast ought to be largest near the straight, and not at the convex margin, for a true Beyrichian character.

Of existing genera, *Cytherella* is the only one that has its carapace-valves smooth externally and excavated on their inner face. The form under notice has a thick shell, as is usual with *Cytherella*; but the internal hollowings in the shell, giving rise to the three obscure lobes of the cast, differ much in shape from those of *Cytherella*; whilst the valves are less oblong and more convex than those of this last-mentioned genus; the overlap of the left valve and the incurved ventral edge are also distinctive. We therefore propose a new genus for its reception, with the name *Cytherellina*, and with the following definition, limited by want of material:—

Carapace-valves elongate, convex, smooth, thick, excavated internally with undulating contours.

Cytherellina siliqua, Jones, sp. Pl. XIV. figs. 1–6.

Beyrichia siliqua, Jones, Ann. Nat. Hist. ser. 2. vol. xvi. p. 90, pl. 5. fig. 22 (1855).

A subcylindrical, smooth, bean-shaped Cytheroid carapace, boldly convex behind, somewhat tapering in front, incurved at the anterior third of the ventral border; strongly and gracefully arched on the back, with a rapid slope to the front. The dorsal arching varies to some extent in different individuals. The left valve overlaps the other on the ventral margin, and in some degree also on the anterior and posterior borders.

Carapace-valves elongate-ovate, contracted at one end (anterior), boldly rounded at the other; arched on the back, nearly straight below; internally thickened by two oblique, transverse, low ridges near the centre (or, conversely, impressed

with three unequal shallow excavations), giving rise to a three-lobed cast, which has to some extent the appearance of a *Beyrichia*.

Individuals vary considerably in their relative proportions, and in the depth of the internal excavations of the valves.

The casts of this peculiar species occur in great numbers in the Woolhope Shale near Malvern; but amongst several dozen specimens in this bed, collected by Dr. Grindrod, we have detected only one or two with shells. In the bluish-grey limestone, however, at the base of the Upper Ludlow beds at Hales End, near Malvern, shelled specimens occur in profusion. As above intimated, the Scandinavian specimens, referred to in the 'Annals Nat. Hist.' 1855, though casts, have remains of the shells attached.

Cytherellina siliqua is abundant also in the calcareous bands at the base of the Woolhope beds near the Wych, Malvern; and several large specimens (which we regard as varietal, var. *grandis*) were obtained from the engine-shaft of the railway-tunnel at that place (fig. 1). Some were also got from the base of the Wenlock Shale in that tunnel.

Fig. 2 represents a specimen of medium size, with less convex back and rather more convex sides than fig. 1; such are not uncommon in the Aymestry Limestone at Chance's Pitch, Malvern.

Var. *tersa* (fig. 3) is smaller and more oblong than either fig. 1 or fig. 2, but otherwise it has very much the same features. It is from the Wenlock Limestone near Malvern.

Var. *ovata* (fig. 4), though of relatively large size and closely resembling fig. 1 in general aspect, is higher, shorter, and rather less convex at the ends. It may have been an individual of the other sex. From the base of the Wenlock Shale in the tunnel near Malvern.

Fig. 5 *a* and figs. 6 *a*, *b*, *d*, *e*, are from the Upper Ludlow Limestone of Hales End, near Malvern, and have the most common size and features. Fig. 6 *c* is from the drifted Scandinavian limestone, found near Breslau.

ÆCHMINA*, gen. nov.

Carapace-valves thick, straight at the hinge-line, rounded at the ends, convex at the ventral border, and outdrawn at the surface into a broad-based and sharp-pointed hollow cone, which either involves all the surface, or (as far as at present known) rises from the postero-dorsal or from the centro-dorsal region.

A less pronounced example of this out-drawn condition of

* From αἶχμη, a sharp point.

the surface of the valves is seen in *Cythere* [*Æchmina?*] *umbo-nata*, Williamson, from the Chalk (Monograph Cretac. Entom. Pal. Soc. 1848, pl. 2. fig. 3), in which the sharp boss is somewhat variable in its position, though mainly affecting the postero-ventral region.

1. *Æchmina cuspidata*, n. sp. Pl. XIV. fig. 8, and woodcut, fig. 2.

Carapace-valve suboblong, convex and produced at the middle (towards the postero-dorsal region) into a stout sharp spike; dorsal edge straight, ventral edge elliptical; one end more broadly rounded than the other.

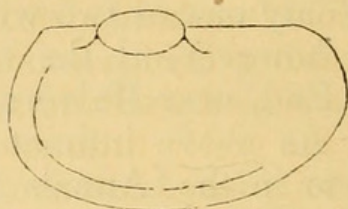


Fig. 2. *Æchmina cuspidata*.

Right valve: the spine is broken. (Magnified about 20 diameters.)

We have here evidently a very close approximation to Professor James Hall's *Cytherina* [*Æchmina*] *spinosa* (Palæont. New York, vol. ii. p. 317, pl. 67. figs. 17-21), from the Niagara Shale at Lockport, in the State of New York; but the latter is more quadrate in outline and somewhat depressed at the root of the spine, which, though nearly central, is near the dorsal margin.

The fragment figured obliquely in Pl. XIV. fig. 8, and more definitely shown in the woodcut, fig. 2, is from the Wenlock Limestone of Croft's Quarry, near West Malvern.

2. *Æchmina clavulus*, sp. nov. Woodcut, fig. 3.

This is smaller and relatively shorter than the foregoing, and has nearly all the surface of the valve taken up with the root of the great spike or spine, which is proportionally larger than that in *Æ. cuspidata*.

Found in the Wenlock Limestone, with the last mentioned.

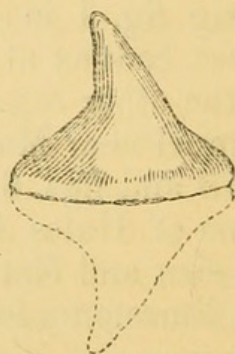


Fig. 3. *Æchmina clavulus*.

Both valves, one of them restored. (Magnified about 20 diameters.)

- Beyrichia intermedia*, sp. nov. Pl. XV. fig. 7.

Carapace-valve small, convex, suborbicular (length to height as 4 to $3\frac{1}{2}$); ventral edge semicircular, ends boldly curved, one rather less so than the other; dorsal edge indicated by the straight portion of the margin and by two short unequal furrows widening out from near the central surface of the valve

into the depressed area along the straight edge, thus forming three unequal lobes on the dorsal region, the rest of the valve's surface remaining smoothly convex, bordered by a narrow depressed rim.

The shape of the valve is that common among *Primitia*; but, though the sulci are too short for those usually characteristic of *Beyrichia* (excepting *B. Wilckensiana*, Jones, Ann. Nat. Hist. ser. 2. vol. xvi. pl. 5. figs. 17 & 18), yet we are unwilling to admit a bisulcate form among the "*Primitia*" until further evidence proves the necessity of breaking down the provisional limitation of that genus. In the meantime we regard the pretty little specimen before us as an intermediate form, as its name intimates.

Our figured specimen is from the Aymestry Limestone of Chance's Pitch, Malvern, where specimens are not uncommon; and some few casts of apparently the same species occur in Woolhope Shale from near Malvern, in Dr. Grindrod's collection.

1. *Primitia lenticularis*, sp. nov. Woodcut, fig. 4 *a, b, c*.

Carapace smooth or slightly rugose (perhaps from weathering), convex, nearly ovate; elliptically rounded below, decidedly arched above, unequally rounded at the ends; the larger (posterior) extremity with a marginal rim and compressed; ventral border slightly lipped. Dorsal aspect elongate-ovate, rather compressed in front of the centre, and acute posteriorly. End view subacute-oval.

This is near to *P. ovata*, J. & H. Ann. Nat. Hist. ser. 3. vol. xvi. p. 423, pl. 13. fig. 13, and *P. obsoleta*, J. & H. *loc. cit.* fig. 12, both Scandinavian. It is shorter, however, more convex, and more ovate (being higher as 32:30, and shorter as 43:45) than the former, and it has a posterior marginal rim, with very little of it continued on to the ventral border; it has also a different edge view, being less compressed anteriorly. From *P. obsoleta* it differs in having an arched dorsum, much less marginal rim, a more central convexity, and no trace of dorsal sulcus.

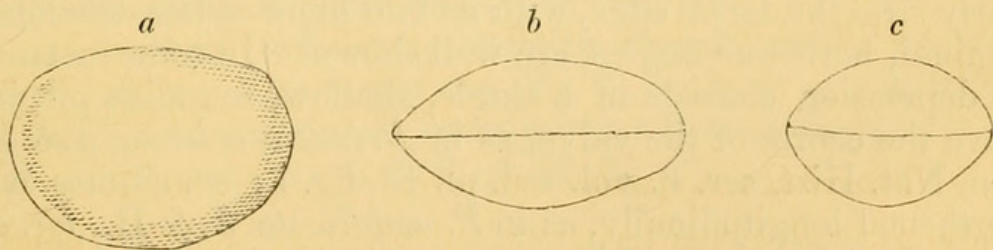


Fig. 4. *Primitia lenticularis*: *a*, carapace, showing the right valve; *b*, dorsal view of carapace; *c*, end view of carapace.
(Magnified 20 diameters.)

Common in the calcareous beds at the base of the Woolhope beds near Malvern.

2. *Primitia bipunctata*, Salter, sp. Woodcut, fig. 5.

Beyrichia bipunctata [Salter, MS.], Catalogue Foss. Mus. Pract. Geol. 1865, p. 16.

Mr. J. W. Salter, F.G.S., long ago supplied one of us with specimens of black Llandeilo Flagstone (from Hellpool, Wye-forth, near Builth, in South Wales), bearing numerous impressions and casts of minute subquadrate Entomostracan valves, each having two little pits near the straight edge. The features are obscure, and the specific characters necessarily indefinite; but we wish to place this little Lower-Silurian form on record, with a figure, among its allies.

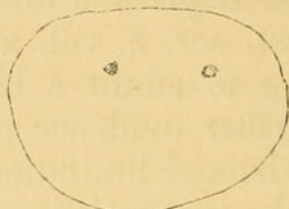


Fig. 5. *Primitia bipunctata*.
Outline of right valve, from a sealing-wax cast of an impression.
(Magnified about 20 diameters.)

About a year since, George Reece, Esq., Secretary and Curator of the Worcester Museum, submitted to us for examination a small piece of greenish micaceous shale, collected by himself from the Ludlow beds of Abberley (probably from the middle or Aymestry part of the series), containing Polyzoa, small Brachiopods, one valve of *Primitia ovata*, J. & H., two or three of *P. renulina*, J. & H., and several valves of a semi-circular *Primitia*, small and white, of rather variable shape (much crushed), marked with either a single pit, a slight longitudinal sulcus, or two distinct pits near the straight margin. The bipunctate condition reminded us of Mr. Salter's *Beyrichia bipunctata* from Builth; but, on careful examination, we find that the *two pits* are due to the wearing away of some of the valve-substance where it is most convex on either side of the single, longitudinal, furrow-like pit in *Primitia umbilicata*.

Figs. 6 *a* and 6 *b* (Pl. XV.) indicate two of the most distinct of the little specimens, whereby the varying curve of the extremities and ventral border, and the unequal sinuosity of the nearly straight dorsal edge, with its two more or less developed, terminal, horn-like angles, are well shown. In some instances the depression consists of a single, shallow, roundish pit, just above the centre of the valve, as in *Primitia cristata*, J. & H., Ann. Nat. Hist. ser. 3. vol. xvi. pl. 13. fig. 1; sometimes it is lengthened longitudinally, as in *P. umbilicata*, J. & H., *loc. cit.* fig. 2; and frequently this seems to divide into two more or less distinct pits. Fig. 6 *a* shows the extreme condition of the double pit, with a trace only of the longitudinal depression between them. The many stages of variation observable in

this little group of specimens do not permit us to divide these different conditions, even as varietal, as they really point to an identity with *Primitia umbilicata* aforesaid.

Figs. 6 *c* and 6 *d* represent some associates of *P. umbilicata* in the specimen belonging to the Worcester Museum, and were at first thought to be possibly varieties of the foregoing; but their more oblong profile, the relatively higher position of the pit, and its being continued upward as a dorsal sulcus, clearly place these specimens, though differing somewhat in relative height (or breadth), in an already described species, our *P. renulina* (Ann. Nat. Hist. *l. c.* fig. 5).

A suboval *Primitia* also occurs in the same morsel of fossiliferous shale, and seems to be (though not fully exposed) *P. ovata*, J. & H. (Ann. Nat. Hist. *l. c.* fig. 13), hitherto known only in the drifted Scandinavian limestone.

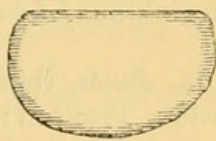
We also recognize an oval *Primitia* in a sandy micaceous shale of the Upper Ludlow series, abounding with small Brachiopods, from Newton Lane, Bradnor Hill, given to one of us some years back by the late Mr. R. Banks, of Kington. It is larger and more oblong-oval than the figured specimen of *P. ovata*; but otherwise it seems to be of the same species.

We may here refer to the existence of two small *Primitiæ* in the Olenus-shales of Shineton*. These we observed in the Cambridge Museum, when examining Prof. M'Coy's *Cythere Aldensis* preserved there (Ann. Nat. Hist. ser. 4. vol. ii. p. 60).

Fig. 6.



Fig. 7.



Figs. 6 & 7. *Primitiæ* in the Shineton Shales. Cambridge Museum.
(Magnified about 20 diameters.)

They are casts, and are shown by woodcuts, figs. 6 & 7, but do not exhibit sufficiently definite characteristics for exact determination. The larger one (fig. 7) is about $\frac{5}{100}$ inch long, $\frac{4}{100}$ high, and somewhat resembles our *P. matutina* (Ann. Nat. Hist. ser. 3. vol. xvi. p. 418, pl. 13. fig. 7).

* The "Shineton Shales" are mentioned by Mr. Salter, in the 'Geological Magazine,' vol. iv. p. 203 (May 1867), as the lowest beds at the Wrekin, and equivalent to "the top of the Llandeilo Flags proper." Shineton or Sheinton is three miles and a half north by west from Much-Wenlock, Shropshire.

3. *Primitia excavata*, sp. nov. Pl. XV. figs. 10 *a*, 10 *b*, 10 *c*.

Valves suborbicular, nearly semicircular on the ventral edge, straight on the short dorsal margin, with nearly equal angles for the well-marked anterior and posterior slopes. This outline is exaggerated in contrast with that of the somewhat Leperditoid *Primitia pusilla*, J. & H., Ann. Nat. Hist. ser. 3. vol. xvi. pl. 13. fig. 11, but is essentially similar. The faint dorsal sulcus of the latter, also, is represented here by an oblique antero-dorsal pit, deep and narrow, with a raised anterior border; and the flattish smooth surface of *P. pusilla* is replaced by an excavated area, broadly semicircular, sculptured with a reticulation of irregular hexagonal pattern. The broad raised margin of this area is longitudinally striated (fig. 10 *c*), and slopes down suddenly outside to the edge of the valve (fig. 10 *a*).

This species is from the Woolhope Limestone, west of the Wych, near Malvern, but is very rare, our specimen being unique.

Primitia excavata has its valves depressed, like those of *Kirkbya* and *Moorea*; but it has neither the outline of the former nor its definite ridges; and it differs from the latter in the presence of a dorsal or subcentral pit, and in the absence of a definite marginal ridge. It more resembles such a *Primitia* as *P. pusilla* (above mentioned), with a surface not only depressed but excavated; and, indeed, unless we were to make a provisional genus for its reception, it is near this form that we must place it.

LIST OF THE KNOWN PRIMITIÆ.

Upper-Silurian Primitiæ.

- Primitia Beyrichiana*, Jones & Holl, Ann. N. H. s. 3. xvi. 422. Wenlock; Sweden.
 — *concinna*, Jones, ibid. xvi. 424. Wenlock; Gothland, Dudley, and Nova Scotia: Trenton; Canada.
 — *consobrina*, Barrande, MS., Thes. Sil. 200. Stage F. f. 2 (Upper Silurian); Konieprus, Bohemia.
 — *cristata*, J. & H. An. N. H. s. 3. xvi. 420. Wenlock; Malvern.
 — *excavata*, J. & H. (in the present paper). Woolhope; Malvern.
 — *lenticularis*, J. & H. (in the present paper). Woolhope; Malvern.
 — *mundula*, Jones, An. N. H. s. 3. xvi. 419. Wenlock; Sweden and Malvern.
 — *muta*, J. & H. ibid. xvi. 425. Wenlock; Beechey Island.
 — *oblonga*, J. & H. ibid. xvi. 423. Wenlock; Sweden.
 — *obsoleta*, J. & H. ibid. xvi. 423. Wenlock; Sweden.
 — *ovata*, J. & H. ibid. xvi. 423. Ludlow; Abberley and Kington: Wenlock; Sweden.
 — *pusilla*, J. & H. ibid. xvi. 424. Wenlock; Malvern*.

* This is from the Upper, and not from the Lower Silurian, as stated inadvertently, Ann. Nat. Hist. ser. 3. vol. xvi. p. 416.

- Primitia renulina*, J. & H. *ibid.* xvi. 419. Ludlow; Abberley: Wenlock; Malvern.
- *Roemeriana*, J. & H. *ibid.* xvi. 422. Wenlock; Malvern.
- *rugulifera*, Jones, *ibid.* xvi. 419. Wenlock; Beechey Island.
- *semicircularis*, J. & H. *ibid.* xvi. 424. Wenlock; Sweden.
- *seminulum*, Jones, *ibid.* xvi. 418. Wenlock; Montgomery.
- *sigillata*, Jones, *ibid.* xvi. 418. Wenlock; Beechey Island.
- *tarda*, Barrande, MS., Thes. Sil. 200. Stage F. f. 2 (Upper Silurian); Konieprus, Bohemia.
- *tersa*, J. & H. An. N. H. s. 3. xvi. 421. Wenlock; Malvern.
- *trigonalis*, J. & H. *ibid.* xvi. 421. Wenlock; Malvern.
- *umbilicata*, J. & H. *ibid.* 420. Ludlow; Malvern, Abberley.
- *variolata*, J. & H. *ibid.* 418. Woolhope; Malvern.
- —, var. *paucipunctata*, J. & H. *ibid.* 419. Woolhope; Malvern.

Lower-Silurian Primitiæ.

- Primitia bicornis*, Jones, An. N. H. s. 3. xvi. 420. Caradoc; Harnage, Shropshire.
- *bipunctata*, Salter, MS. (in the present paper). Llandeilo; Builth, South Wales.
- *concinna*. See above.
- *gregaria*, Barrande, MS., Thes. Sil. 200. Stage D. d. 5 (Lower Silurian); Königshof, Bohemia.
- *Logani*, Jones
- —, var. *leperditoides*, Jones { An. N. H. s. 3. xvi. 417. Calci-
ferous Sandrock; Canada.
- —, var. *reniformis*, Jones {
- *Maccoyii*, Salter, sp., *ibid.* s. 4. ii. 55. Caradoc; Ireland, Westmoreland, and Scotland.
- *matutina*, J. & H. *ibid.* s. 3. xvi. 418. Caradoc; Shropshire.
- *nana*, J. & H. *ibid.* xvi. 420. Caradoc; Harnage, Shropshire.
- *prunella*, Barrande, MS., Thes. Sil. 200. Stage D. d. 1, 5 (Lower Silurian); Vosek, Mt. Kosow, Bohemia.
- *rugosa*, Jones, An. N. H. s. 4. ii. 55. Trenton; Canada.
- *Salteriana*, J. & H. *ibid.* s. 3. xvi. 417. Caradoc; Sholes Hook, Pembrokeshire, Wannamois.
- *Sancti-Patricii*, J. & H. *ibid.* s. 4. ii. 56. Caradoc; Ireland.
- *semicordata*, J. & H. *ibid.* s. 3. xvi. 417. Caradoc; Sholes Hook, South Wales.
- *simplex*, Jones, *ibid.* 417. Caradoc; Harnage, Shropshire: Llandeilo; Bussaco, Portugal.
- *Solvensis*, Jones, *ibid.* s. 4. ii. 55. Lingula-flags; Solva, South Wales.
- *strangulata*, Salter, sp., *ibid.* s. 3. xvi. 416. Caradoc; Lancashire, Wannamois.
- —, var. *α*, Jones, *ibid.* xvi. 417. Caradoc; Pembrokeshire.
- —, var. *crenulata*, Schmidt, Untersuch. p. 196. Caradoc; Borkholm and Paggar.

KIRKBYA, Jones.

In 1859 the genus *Kirkbya* was instituted for the reception of some peculiar Entomostracous valves, found in Permian and Carboniferous strata, which had been doubtfully and unsatisfactorily referred to some cognate genera. (See Kirkby and Jones "On Permian Entomostraca," Transact. Tyneside

Nat. Field Club, vol. iv.) Since then, several other *Kirkbyæ* have been recognized in the Carboniferous formations. (See Jones and Kirkby's papers in the Ann. Nat. Hist. ser. 3. vol. xviii. pp. 42, 43, 45, 49, and Transact. Geol. Soc. Glasgow, vol. ii. pp. 216 &c.)

In this genus the carapace-valves are compressed (flattish), thick, oblong, impressed with a subcentral pit and raised into ridges, some concentric with the margin, associated sometimes with longitudinal riblets or wrinkles, and often accompanied by a reticulate ornament. In shape the valves are suboblong, usually higher behind than before; the extremities more or less rounded, but one often much more obliquely than the other; the dorsal border is straight, and its ends are subacute; the ventral border is nearly straight in its middle third, and boldly curved at the ends; the hinge is simple. The ventral edge of the dextral valve overlaps slightly that of the other. The subcentral pit or sulcus is sometimes above and sometimes below the median line of the valve, and varies greatly in its relative size.

Kirkbya, having relationships with *Beyrichia*, *Primitia*, *Moorea*, and *Leperditia*, is one of the *Leperditiadæ* (see Ann. Nat. Hist. 1856, ser. 2. vol. xvii. p. 99). To *Leperditia* it is related through *Beyrichia* and *Primitia*. In general form, hingement, ventral overlap, and even sometimes in a faint bilobation of the surface, the valves of *Kirkbya* resemble those of *Beyrichia*; but the double and sometimes threefold ventral rims, and especially the subcentral pit and the longitudinal riblets, distinguish them. The ventral ridges to some extent, and the pit, have their analogues in *Primitia*; but this genus generally presents convex forms; and when flattish, its valves, though sunken in *P. excavata*, have not any costation. *Moorea* presents flattish valves, marginally ridged, but without any subcentral pit or dorsal furrow (see further on, p. 225).

Kirkbya fibula, sp. nov. Pl. XV. figs. 9 a, 9 b.

Valves oblong, with three of the borders more or less rounded; rather short, flat, bearing a well-marked marginal rim, which in some specimens dies away on the upper border, where the subcentral pit deeply notches the dorsal region somewhat towards the anterior angle; and in others it is strong on the dorsal and dies away along the anterior border. A neatly defined longitudinal ridge, slightly sigmoid in outline, and thickest at its middle part, traverses the depressed surface of the valve somewhat obliquely, within the marginal ridge, from near the postero-dorsal angle to the middle of the anterior border, and at its junction with this it bends a little downwards. Near

the middle of the valve it touches the lower end of the narrow dorsal sulcus above mentioned. The marginal ridge is in some specimens acute, and in others it scarcely rises above the general surface of the valve.

In a bed of grey micaceous limestone in the Upper Ludlow rocks at Hales End, three miles north-west of Malvern; it is not uncommon.

The other known forms of *Kirkbya* are—

Kirkbya permiana, Jones, in King's Monog. Perm. Foss. (Pal. Soc.), 1851, p. 66, pl. 18. fig. 1; Trans. Tyneside Field Club, vol. iv. p. 129, pl. 8. figs. 1-3. Permian and Carboniferous; Britain.

—, var. *glypta*, Jones, Monog. Perm. l. c. fig. 12; Trans. Tynes. l. c. figs. 4-7. Permian; Britain.

—, var. *Richteriana*, Jones, Trans. Tynes. l. c. fig. 8. Permian; Germany.

—, var. *Roessleri*, Reuss (sp.), Jahresb. Wetter. Ges. 1854, p. 70, fig. 11; Trans. Tynes. l. c. fig. 9. Permian; Germany.

—, var. *Schrenkii*, Keyserling (sp.), in Schrenk's Reise Nord. Russl. &c. p. 112, pl. 4. fig. 37. Permian; North Russia.

—, var. *sticta*, Keys. (sp.), ibid. fig. 38. Permian; North Russia.

—, var. *grapta*, Keys. (sp.), ibid. fig. 39. Permian; North Russia.

(Some, if not all, of these may be distinct species; for the soft parts may have varied more than the carapaces.—T. R. J.)

— *annectens*, J. & K. MS., An. N. H. s. 3. xviii. 42, &c.; Trans. Geol. Soc. Glasgow, ii. 220. Carboniferous; Ireland and Britain.

— *costata*, M'Coy, sp., Synops. Carb. Foss. Ireland, p. 165, pl. 23. fig. 11; An. N. H. l. c. p. 43. Carboniferous; Ireland and Britain.

— *Eichwaldiana*, J. & K. MS., Trans. Geol. Soc. Glasgow, ii. 221. Carboniferous; Britain.

— *oblonga*, J. & K. MS., ibid. p. 221. Carboniferous; Britain.

— *plicata*, J. & K. MS., ibid. p. 221. Carboniferous; Britain.

— *Scotica*, J. & K. MS., ibid. p. 220. Carboniferous; Britain.

— *spinosa*, J. & K. MS., ibid. p. 220. Carboniferous; Britain.

— *striolata*, Eichwald, sp., Leth. Ross. livr. vii. p. 1348, pl. 52. fig. 14. Carboniferous; Russia.

— *umbonata*, Eichwald, sp., ibid. p. 1347, pl. 52. fig. 10; Trans. Geol. Soc. Glasgow, ii. p. 221. Carboniferous; Russia.

— *Urei*, Jones, Trans. Tynes. Nat. Field Club, iv. 136; Trans. Geol. Soc. Glasg. ii. 220. Carboniferous; Britain.

MOOREA, Jones & Kirkby, MS.

During an examination some time since of a series of bivalved Entomostraca collected by Mr. Charles Moore, F.G.S., from the contents of some fissures in the Carboniferous Limestone of Somersetshire and elsewhere, Messrs. Jones & Kirkby discriminated a few specimens having simple, thick, flattened carapace-valves, longer on the dorsal than the ventral margin, without any subcentral pit, and ornamented with narrow, rounded ridges, following more or less closely and completely the marginal contour. Some *Kirkbyæ* are but

slightly convex, and bear superficial ridges, both circular and longitudinal (such as *Kirkbya fibula*, fig. 9, and *K. costata*, M'Coy, sp.); but all have some trace of a subcentral pit or notch, and the group is therefore distinct. These new forms were referred to in the Quart. Journ. Geol. Soc. vol. xxiii. (1867) pp. 494, 523, and 559, as *Moorea obesa* and *M. tenuis*, Jones, MS. (once with a misprint of *obtusa* for *obesa*). We have now to notice another and still older* species of this ancient family of Entomostraca, the members of which seem (as far as the carapace is concerned) to present closely related genera, linking together *Leperditia*, *Primitia*, *Beyrichia*, *Kirkbya*, and *Moorea* by various gradations and resemblances in the structure of the valves. Knowing that existing Entomostraca, with mutually similar carapaces differ among themselves as to essential limb-characters, we feel more and more inclined to lay stress on differences in the features of the fossil valves, and to keep distinct all well-marked forms remaining from among the almost lost tribes of these little primæval Crustacea.

Moorea silurica, sp. nov. Pl. XV. figs. 8 *a*, 8 *b*.

Carapace-valves subovate, one-third longer than high, slightly convex, polished, but coarsely punctate, and bearing a raised marginal rim. Dorsal edge straight; dorsal corners rounded. Ventral border presenting a nearly true segment of a circle. Ends somewhat obliquely rounded, nearly equal in outline. A stout elevated ridge runs along nearly the whole margin of the valve. It may be said to begin on the hinder edge, which is depressed, but strongly lipped by the marginal rim standing out sharply backwards; it thickens on the ventral border, is very thin anteriorly, and rises high along the dorsal region, until it turns suddenly downwards, to lose itself in the general surface of the posterior third of the valve.

In some individuals the raised rim above the ventral border is but faintly marked; in others the marginal rim is strongly developed, both above and below, and almost meets behind.

Only single valves have been met with; but in its ventral aspect the carapace was probably somewhat like a compressed orange-pip, partly split at one end. The greatest convexity is about the centre of the valves.

The ventral border of the figured valve (fig. 8 *b*, probably the right and overlapping valve) is flattened suddenly by the

* I do not fall in with Mr. Charles Moore's belief that the Entomostraca above referred to are of Liassic age, and were deposited in the fissures from the sea of that period, but rather believe them to have been derived by degradation from the fissured limestone.—T. R. J.

projection of the marginal rim, and by being turned inwards for a considerable depth. Its extreme edge has for most of its length a delicate raised rim, which, however, passes outwards and backwards to join the great marginal ridge, where the latter projects as a thick, sharp-edged crest along the posterior edge of the valve. Somewhat analogous features may be traced in *Primitia cristata*, J. & H., Ann. Nat. Hist. ser. 3. vol. xvi. pl. 13. fig. 1.

The dorsal border of *Moorea silurica* is indented along its marginal ridge, so as to form with its fellow, if similarly constructed, a narrow elliptical depression at the back, along the hinge-line, as in *P. cristata* above alluded to.

Our specimens were found in a band of micaceous limestone in the Upper Ludlow rocks, with *Kirkbya fibula*, at Hales End, Malvern, where it was not uncommon.

Table of Measurements in thousandths of an inch.

Name.	Reference.	Length.	Height.	Thick- ness.
<i>Cythere corbuloides</i> , <i>sp. n.</i>	Pl. XV. f. 4, p. 211	41	32*	35
— <i>Grindrodiana</i> , <i>sp. n.</i>	woodcut, f. 1, p. 212	24†	11	10 ?
<i>Bairdia Phillipsiana</i> , <i>sp. n.</i>	Pl. XIV. f. 7, p. 213	53	33‡	26
<i>Thlipsura corpulenta</i> , <i>sp. n.</i>	Pl. XV. f. 1, p. 214	50	30	33
— <i>tuberosa</i> , <i>sp. n.</i>	„ f. 2, p. 214	43	23	19
— <i>V-scripta</i> , <i>sp. n.</i>	„ f. 3, p. 214	32	20	16
<i>Cytherellina siliqua</i> , <i>var. grandis</i> , <i>nov.</i>	Pl. XIV. f. 1, p. 217	83	42	39
— — (ordinary variety)	„ f. 2, p. 217	53	24	26
— —, <i>var. tersa</i>	„ f. 3, p. 217	33	17	16
— —, <i>var. ovata</i>	„ f. 4, p. 217	70	45	40
— <i>siliqua</i> , <i>Jones</i> , <i>sp.</i> (ordinary var.)	„ f. 6, p. 217	53	24	?
— — „ (another specimen)	„ f. 5, p. 217	46	20	?
<i>Æchmina cuspidata</i> , <i>sp. n.</i>	Pl. XIV. f. 8, & woodcut, f. 2, p. 218	58	33	?
— <i>clavulus</i> , <i>sp. n.</i>	„ f. 3, p. 218	47	38	?
<i>Beyrichia intermedia</i> , <i>sp. n.</i>	Pl. XV. f. 7, p. 218	22	17	?
<i>Primitia lenticularis</i> , <i>sp. n.</i>	woodcut, f. 4, p. 219	44	33	24
— <i>umbilicata</i> , <i>J. & H.</i>	Pl. XV. f. 6, p. 220	37	27	?
— <i>bipunctata</i> , <i>Salter</i>	woodcut, f. 5, p. 220	50	37	?
— <i>excavata</i> , <i>sp. n.</i> §	Pl. XV. f. 10, p. 222	33	25	22
<i>Kirkbya fibula</i> , <i>sp. n.</i> §	„ f. 9, p. 224	32	20	14
<i>Moorea silurica</i> , <i>sp. n.</i> §	„ f. 8, p. 226	38	27	24

* Large valve.

† Another specimen, found lately, measures $\frac{1}{1000}$ inch in length, and $\frac{2}{1000}$ in height.

‡ Smaller valve, $\frac{2}{1000}$ inch.

§ The thickness in the last three species is obtained by doubling the thickness of the single valve.

EXPLANATION OF THE PLATES.

PLATE XIV.

[The specimens are magnified 20 diameters.]

- Fig. 1.* *Cytherellina siliqua*, Jones, sp., var. *grandis*, from the Woolhope beds near the Wych, Malvern: *a*, perfect carapace, showing the right valve; *b*, ventral view; *c*, end view (posterior).
- Fig. 2.* *C. siliqua*, Jones, sp. (common variety), from the Aymestry Limestone of Chance's Pitch, Malvern: *a, b, c*, as the foregoing.
- Fig. 3.* *C. siliqua*, var. *tersa*, nov., from the Wenlock Limestone near Malvern: *a, b, c*, as the foregoing.
- Fig. 4.* *C. siliqua*, var. *ovata*, nov., from the base of the Wenlock Shale near Malvern, showing the right valve.
- Fig. 5.* *C. siliqua*, Jones, sp. (common variety): *a*, right valve; *b*, edge view; *c*, end view. From the base of the Upper Ludlow beds, Hales End, Malvern.
- Fig. 6 a, b, d.* The same; casts with and without remains of the valve: *e*, diagram of the edge view of cast and valve. From the same place.
- Fig. 6 c.* The same: cast of left valve. From drifted Scandinavian Limestone.
- Fig. 7.* *Bairdia Phillipsiana*, sp. nov., from the Wenlock Limestone near Malvern: *a*, perfect carapace, showing the right valve and the overlapping edges of the left valve; *b*, ventral aspect; *c*, end view (anterior).
- Fig. 8.* *Æchmina cuspidata*, gen. et sp. nov.; a fragment from the Wenlock Limestone of Croft's Quarry, near Malvern. (See also woodcut, fig. 2.)

PLATE XV.

[Fig. 10 *c* magnified 100 diameters; all the others are magnified 20 diameters.]

- Fig. 1.* *Thlipsura corpulenta*, gen. et sp. nov.; from the base of the Woolhope beds, near Malvern: *a*, perfect carapace, with right valve outwards; *b*, ventral view; *c*, dorsal view; *d*, hind end view.
- Fig. 2.* *Thlipsura tuberosa*, sp. nov.; from the base of the Wenlock Shale, Elton Lane, Ludlow: *a, b, c*, as the foregoing. (The specimen has lost some of the thickness of its carapace-valves.)
- Fig. 3.* *Thlipsura V-scripta*, sp. nov.; from the Wenlock Limestone, Croft's Quarry, Malvern: *a*, left valve; *b*, ventral view; *c*, end view.
- Fig. 4.* *Cythere corbuloides*, sp. nov.; from the Wenlock Limestone, near Malvern: *a*, right valve; *b*, perfect carapace, with its right valve outwards; *c*, dorsal view; *d*, ventral view; *e*, posterior view.
- Fig. 5.* The same, smaller individual; Woolhope beds near Malvern: *a*, perfect carapace, right valve outwards; *b*, end view (posterior).
- Fig. 6 a, b.* *Primitia umbilicata*, J. & H.; from Middle (?) Ludlow beds, Abberley. Two valves, showing different conditions of the sub-central depression, owing to crush and weathering.
- Fig. 6 c, d.* *Primitia renulina*, J. & H.; from Middle (?) Ludlow beds, Abberley. Two casts (with some remains of shell) of somewhat varying valves.
- Fig. 7.* *Beyrichia intermedia*, sp. nov.: a right (?) valve. Aymestry Limestone, Chance's Pitch, Malvern.

- Fig. 8. *Moorea silurica*, sp. nov.; from the Upper Ludlow beds, Hales End, Malvern: *a*, right valve; *b*, ventral view.
 Fig. 9. *Kirkbya fibula*, sp. nov.; from the Upper Ludlow beds, Hales End, Malvern: *a*, right valve; *b*, ventral view.
 Fig. 10. *Primitia excavata*, sp. nov.; from the Woolhope Limestone, near Malvern: *a*, left valve; *b*, ventral view; *c*, portion of the depressed area and of its border, highly magnified.

XXXI.—*On the Species of Veneridæ found in Japan.*

By ARTHUR ADAMS, F.L.S. &c.

MY list of the Japanese species of the *Venus* tribe is a tolerably long one; but only a few unrecorded species were met with, Reeve and Sowerby both being occupied with seeking out and describing every member, however obscure, of this beautiful family just on my arrival in England. *Meretrix lusoria* and its varieties form a favourite article of diet among the poorer classes of Japan; they call it “Famaguri Hamongudi;” and great heaps of the shells are often found near their houses. It affords them also amusement. From the thousands of odd valves they select numerous pairs which are both marked with a similar pattern, and, sitting round in a circle on their mats, one throws a number of shells down promiscuously; and the object of the simple game is to select pairs of similarly marked valves quicker than any one else!

The habitat of *Chione cardioides*, in the British Museum Catalogue by M. Deshayes, is “Mare Antillarum,” and that of *C. histrionica* “America centralis;” but these may be errors.

Fam. **Veneridæ.**

Subfam. *VENERINÆ.*

Genus *VENUS*, Linn.

1. *Venus lamellaris*, Schum., Rve. Conch. Syst. pl. 68. f. 4.
V. cancellata, Chemn. (non Lam.).
V. reticulata, var., Lam.
V. subrostrata, Gray.
Dosina Lamarckii, Gray.
Hab. Seto-Uchi, Kuro-Sima.
2. *Venus toreuma*, Gld. Exp. Shells, 1850, p. 84; Sow. Thes. Conch. pl. 161. f. 187–189.
V. crebrisulca, Sow. (non Lam.).
V. Jukesii, Desh. Cat. Conch. Brit. Mus. 1853.
Hab. Gotto Islands, 48 fathoms; Satanomosaki, 55 fms.



Jones, T. Rupert and Holl, H B. 1869. "XXX.—Notes on the Palæozoic Bivalved Entomostraca. No. IX. Some Silurian species." *The Annals and magazine of natural history; zoology, botany, and geology* 3, 211–229.

<https://doi.org/10.1080/00222936908695920>.

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