

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[THIRD SERIES.]

No. 27. MARCH 1860.

XV.—*On new Fossil Crustacea from the Silurian Rocks.*

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THE Phyllopod group, rather poorly represented in modern seas, was rich in species and genera in palæozoic times, if we are correct in referring to it the numerous bivalved and *Apus*-like forms in mountain limestone and the Silurian strata. The species were of large size, too, compared with living members of the group—the bivalved forms generally larger than *Estheria*, and (if, as is most probable, the great *Posidonia* from the Carboniferous rocks be truly Crustacean) far larger even than *Limnadia*. Numerous smaller species accompany these, of a great variety of forms; and these are only now beginning to be made known by Mr. Rupert Jones and M. Barrande.

Of the forms like *Apus* less is known; but the *Dithyrocaris* of the Scotch coal-shales is pretty generally allowed to be a great Phyllopod, with a carapace not more bent than that of *Apus*, if so much so.

Ceratiocaris, a Silurian fossil, of equal size, was first described by Professor M'Coy in the 'Annals Nat. Hist.' vol. iv. p. 412; and some details were filled up by myself in the 'Quarterly Geol. Journal' for 1856, vol. xii. p. 33. At the time that Prof. M'Coy wrote, only half carapaces were known, and the relations of the animal could not be very clearly made out; but the mucronate anterior and truncate posterior margin, and the fine longitudinal sculpture were figured by him, as well as an anterior tubercle, which he regarded as an eye-spot, but which proves to be the impression of the hard mandibles pressed through the crust. Good specimens were afterwards found in the south of Scotland, at Lesmahago, Lanark, a spot now famous for its rich fossil beds; and these showed the body-rings, telson, and lateral appendages. The appendages had been long known, in a disjointed form, as *Leptocheles*, M'Coy. A restored diagram of the animal was given

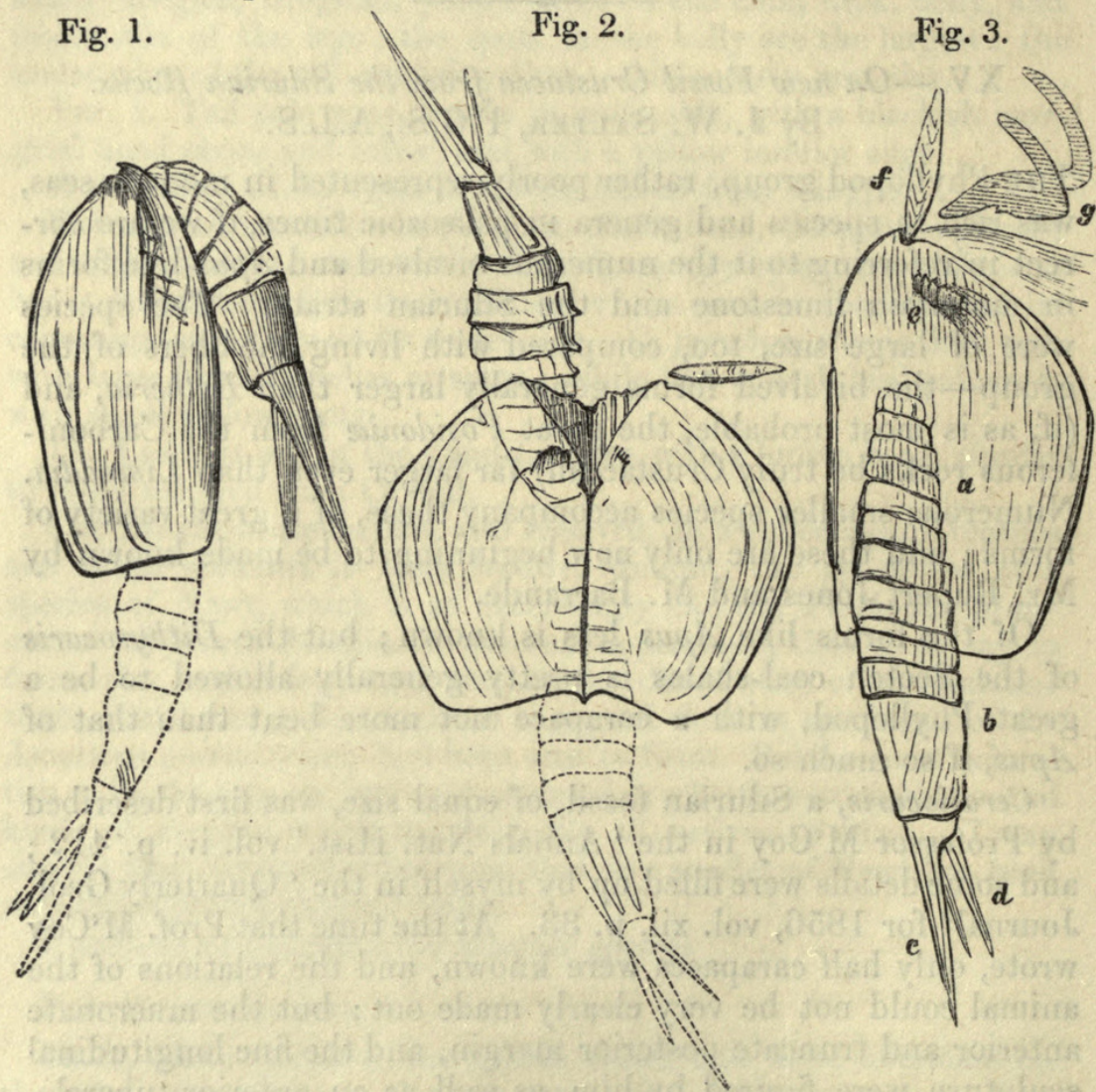
by me in the communication above referred to, which is correct so far as it goes, but now requires additions.

In the second edition of 'Siluria,' 1859, a supposed correction was published by me with respect to the position of the carapace. No specimens had till then been found that had the body-rings actually in connexion with it; but the occurrence of a third specimen (fig. 3.) with all the parts *in situ*, has shown more clearly that the position of the abdomen given in 'Siluria' was not the true one, but that it had been (singularly enough, in both cases) forced forwards, so as to protrude from the anterior end! Figure 3 only has the parts in right position, and all three figures belong to the same species—*Ceratiocaris papilio*.

Fig. 1.

Fig. 2.

Fig. 3.



Ceratiocaris papilio, Salter*.

The three figures show the animal in various postures in the stone:—
Fig. 1. The valves closed, but with the abdomen bent round and protruding from the front of the carapace.

Fig. 2. A specimen similarly distorted, with the valves open. The dotted lines show the proper position in both figures.

Fig. 3. shows all the parts *in situ*, with the jaws, *e*; rostrum, *f*; antennæ (or thoracic appendages?), *g*; *a*, *b*, thorax and abdomen; *c*, telson; *d*, caudal appendages.

* See 'Siluria,' 2nd ed. p. 262, f. 1, 2.

A further exploration in the same rich deposits at Lesmahago, where *Ceratiocaris* occurs in millions (and in these beds no other fossil has yet been brought to light), has disinterred the rostrum *, hard jaws, and also the antennæ or some of the thoracic appendages of the animal. The last are obscure, but were detected by Prof. Huxley, who also found a clearly articulated hinge uniting the two flaps of the carapace. This is a very important character, and will remove *Ceratiocaris* from any very near alliance with *Nebalia*, from which also the solid jaws, like those of *Apus*, and the greatly developed telson, often three times the length of the other caudal appendages, tend further to separate it. In *Nebalia* the telson is reduced to 0, and the appendages are large.

The length of the largest *Ceratiocaris* yet known could not have been less than 15 inches. The characters of the genus may stand as follows:—

CERATIOCARIS, M'Coy, 1851.

Carapace bivalved, united by an articulated hinge; the valves ovate, semioval, or subquadrate, mucronate or uncinatè in front, and more or less truncate behind. Rostrum broad, of a single lanceolate piece. (Head or thorax with obtuse (jointed?) appendages). Body many- (fourteen- or more) jointed, of which five or six segments extend beyond the carapace; the last one longest, and supporting a strong bulbous telson and two shorter appendages. Surface generally lineate, often finely so.

1. *C. papilio*, Salter.

(‘Siluria,’ 2nd ed. 1859, p. 262. f. 1, 2.)

C. 3-4-uncialis, cephalothorace magno, abdomine brevior. Cephalothorax tenuissime striatus, oblongus, antice latior. Annuli corporis numerosi (13 et ultra?), 3-4 ultimi solum liberi, hi quam longi ter latiores, ultimus precedentem quater excedens. Appendices validæ, centralis (telson) longa paullum recurva, costata, laterales latæ.

This beautiful species occurs with the next, but is less common. The much shorter body—scarcely longer (tail included) than the great carapace—easily distinguishes it. We have specimens both with the valves open and closed; and it is this

* The part *f* (fig. 3), supposed to be analogous to the rostrum in *Nebalia* (see Gaimard, Voyage Scandinav. 1845, pl. 40. f. 2 *b*) is generally joined to the carapace of the fossil. It is very closely and beautifully striate, V-fashion, from end to end. It occupies the place where the antennæ might be expected to occur, but is only a single piece. My friend Dr. Kinahan of Dublin suggested that it might prove to be the rostrum; and I fully agree with him. The striation favours this view materially.

species which shows so strange a tendency to invert the position of the abdomen. (See figures 1, 2.)

Locality. Black flags (Upper and Lower Ludlow) at Lesmahago, Lanark. Found by Mr. R. Slimon of that town.

2. *C. stygius*, n. sp.

C. 8-9-uncialis, tenuissime striatus, oblongus, margine ventrali plus minusve angulato. Annuli numerosi, sex ultimi solum liberi, reliqui a cephalothorace tecti. Segmenta libera quam longa bis latiora, ultimum precedens plus dimidio longius. Appendices caudales validæ, centralis longa subrecta costata, laterales latæ.

This of all the species is the most common, and may literally be said to form mountains in Lanarkshire. Large tracts of moorland at and around Nutberry Hill and on the Logan Water and Nethan Water, S.W. of Lanark, are composed of blackish slate, with many stone bands amongst it; and of these shales nearly every slab has some fragment or other of a *Ceratiocaris*, and often they are perfect. Mr. Slimon of Lesmahago has collected them by hundreds, and supplied many museums with them*.

The much greater proportional length of the body-segments, which are not concealed beneath the carapace, will at a glance distinguish the present species from *C. papilio*, to which species its finely striated carapace and the nearly equal length of the appendages closely ally it. It is possible that these two forms may represent different sexes of the same species; but there are at least two varieties of carapace in *C. stygius* itself, one more square and obtuse than the other; and as there are also differences of proportion in the abdominal segments of these varieties, it will be more reasonable to refer such slight differences to sex, and allow the *C. papilio* to rank as a species.

Locality. Lesmahago Hills; Nutberry Hill, as above; in Upper and Lower Ludlow rock.

3. *C. inornatus*, M'Coy.

(Synopsis Foss. Woodw. Mus. pl. 1 E. fig. 4.)

C. modicus; cephalothorax biuncialis, quam latus bis longior, ovato-oblongus, convexus, margine ventrali valde arcuato. Mucro anticus rectus. Superficies lineis remotiusculis interruptis. Telson costatum.

On this species Prof. M'Coy founded the genus.

Its carapace has much the general shape of that of *C. stygius*, but appears to have been far more convex, and has a straight,

* I beg to call attention to Mr. Slimon's beautiful collections of the large and perfect Crustacea (*Pterygoti*, &c.) from these beds, and to recommend him to the notice of all collectors of Silurian fossils.

projecting, anterior mucro. The striation is coarse. We have not found the body-rings; but a fragment of the telson from Kendal shows a ribbed surface.

Locality. Benson Knot, Kendal, in Upper Ludlow rock.

C. ellipticus, M'Coy, *l. c.* pl. 1. fig. 8, appears to be only an incomplete specimen of *C. inornatus*, but probably of a distinct variety. It has all the angles rounded off, or, as I believe, partly concealed in the stone. It is from the same locality.

4. *C. Murchisoni*, M'Coy, sp.

Figured as a fish-defence (*Onchus Murchisoni*) in the 'Silurian System,' 1839, pl. 4. figs. 10, 64*, and described as part of *Pterygotus* (*Leptocheles*) *leptodactylus*, M'Coy, Synops. Woodw. Foss. p. 176. *Ceratiocaris Murchisoni*, 'Siluria,' 2nd ed. pl. 19. fig. 1, p. 263.

C. modicus. Cephalothorax biuncialis, oblongus, convexus, lineis remotis interruptis subrectis ornatus. Abdomen segmento ultimo perstriato. Appendices caudales longæ, subcylindricæ, centralis (*telson*) ad basin bulbosa costaque dorsali percurrente valida; laterales longæ; omnes costatæ.

Of this, the first-discovered species, only numerous fragments are known. Its telson was figured, as above noted, for a fish-defence; and it is indeed difficult, without the microscope, to decide whether some of the hollow spines found in the uppermost Silurian beds be those of Crustacea or Fish. This, however, is quite a clear case. It was determined to be Crustacean by Prof. M'Coy in a paper full of acute observation, published by him in the 'Quarterly Geol. Journal,' vol. ix. p. 12. He, however, thought it to be the long didactyle claw of one of the *Pterygoti*, which he considered closely related to *Limulus*.

Locality. Only in the Upper Ludlow rock and Downton Sandstone, near Ludlow; specimens are in the collections of the Ludlow geologists, and in the Museum of Practical Geology.

5. *C. leptodactylus*, M'Coy, sp.

Pterygotus (*Leptocheles*) *leptodactylus*, M'Coy, Syn. Woodw. Foss. pl. 1 E. figs. 7, 7 a, 7 b (not c, d).

C. pedalis et ultra, elongatus. Cephalothorax longus triangulatus, antice acutus, postice valde rotundatus, latus. Segmenta libera 7-8? subquadrata, lateribus profunde impressa. Appendices longæ striatæ, centralis (*telson*) lateralibus longis vix crassior. Superficies capitis lævis, nisi lineis brevissimis sparsis notata,—segmentorum perstriata.

This is of quite a distinct type from those before described,

* Fig. 63 may be a portion of another species: it is strongly keeled.

having the carapace broad behind and narrowed in front. It is the largest of all the British species, yet probably inferior in size to the great *Ceratiocaris* (*Leptocheles*) *bohemicus* of Barrande* or the *C. Dewii* (*Onchus*, Hall, Palæontology New York, vol. ii. pl. 71). It must have measured a foot when extended. One large and fine specimen, presented to the Museum of Practical Geology by Mr. Alfred Marston, has all the parts *in situ*, and, besides showing the toothed jaws, enables us to connect the numerous scattered relics of the species, and to restore to them the tail-spines figured by Prof. M'Coy. Strictly speaking, the name *leptodactylus* is inapplicable to tail-spines, though appropriate enough when these were regarded as the chelæ of a Limuloid Crustacean. But the advantage of a more accurate name cannot compensate for the introduction of a synonym; and Prof. M'Coy deserves our best thanks for his suggestive notes on this and the previous species. One of his figures, referred to *P. leptodactylus*, belongs to the next species.

6. *C. robustus*, n. sp.

Pterygotus (*Leptocheles*) *leptodactylus*, M'Coy, *l. c.* (in part), pl. 1 E. figs. 7 *c, d* only (one of the lateral appendages).

C. modicus. Telson $2\frac{1}{2}$ -unciale, crassum, costatum, nisi ad basin convexum (haud gibbosum) lævigatum. Costæ in dorso tres tuberculosæ, infra 4-5 læves. Appendices latæ, lanceolatae, planæ, acutæ.

The rows of lateral tubercles found on the telson of several species are particularly conspicuous in this; but they are raised (not sunk) tubercles along the outer costæ in *C. robustus*; and neither they nor the central rib run up upon the convex base. The under side has several ribs. The lateral appendages are remarkably broad and flat, and reach about three-fourths the length of the central one. Some specimens (Lower Ludlow rock) have the points of the telson more attenuated. These may be males, or they may indicate a separate variety. The spines in this rather striking species are remarkably thick and broad.

Loc. Ludlow (in Upper Ludlow rock); in the cabinet of R. Lightbody, Esq. Leintwardine, in Lower Ludlow rock.

7. *C. decorus*.

Phillips, Mem. Geol. Survey, vol. ii. pt. 2. pl. 30. fig. 5.

Very little is known of the species represented by this fragment. It appears nearly smooth and few-ribbed.

Loc. Ludlow rock of Freshwater East, Pembrokeshire.

* Not yet published. M. Barrande has, however, sent several of his beautiful plates to England.

8. *C. ? ensis*, n. sp.

Telson magnum, 6-unciale, compressum, ad basin bulbosum, ensiforme; apice incurvo, margine dorsali crenato-serrato, lateribus planis nisi utrinque costa valida subcentrali ornatis.

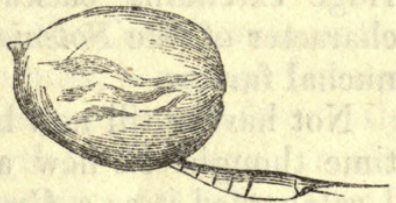
In all probability this is the telson of a remarkable species; for it has the bulbous base; but it is so compressed laterally as to be almost flat, and towards the end is curved down into a sabre-shape. The breadth is greatest near the base, the tip rather blunt. A lateral ridge, nearer the dorsal than the ventral edge, runs two-thirds along each side from the apex, but does not reach the bulbous base.

Locality. Leintwardine, Shropshire; Lower Ludlow rock.

9. *C. vesica*, n. sp.

C. parvulus, biuncialis, lævis, capite pyriformi, inflato, corpore tenuissimo abbreviato. Cephalothorax late ovatus, apice angusto, margine dorsali valde curvo. Segmenta corporis libera 5, quorum ultimum longe maximum. Appendices attenuatæ.

This curious bladder-like species may very likely become the type of a new genus, in which case *Physocaris* would seem appropriate. The posterior edge is not at all truncate, the dorsal margin is much curved, and the anterior end narrowed and with a small beak.



Cerat. (*Physocaris*) *vesica*.

10. *C. cassia*, n. sp.

C. sesquiuncialis, oblongus, striatus, corpore brevissimo. Cephalothorax oblongus, antice rotundior, postice truncatus falcatus, lineis subrectis remotiusculis. Segmentum ultimum (solum liberum) corporis angustum, appendicibus brevibus.

The oblong shape of this obscure fossil would not be quite sufficient to found a species on, though it distinguishes it from most others. The greatly abbreviated body, showing but one (?) joint beyond the carapace, and with very short appendages, is a better character.

Loc. Lower Ludlow rock, Leintwardine.

One other fossil must be noticed here, as it has figured prominently in the original description of the genus by M'Coy. The *C. solenoides* of that author (*l. c.* pl. 1 E. fig. 5) is really a species of *Solen* or an allied genus, as I at first supposed and classed it accordingly as *Solenomya*, *Cultellus*, or an allied genus. (See Prof. Sedgwick's *Lists of Kendal Fossils*: Wordsworth's 'Letters on the Lakes,' 1843-1846, Appendix.) I have nowhere given it

the specific name (as Prof. M'Coy supposed) of *Cultellus? rectus*, but I accept the term; and as the *subgenera* of *Solen* are not very likely to be found in Silurian rocks, it had better be called *Solen rectus*. It is perhaps quite as much like *Ceratosolen*.

Prof. M'Coy has rejected it from this society, and figured it with the form and lineation of *Ceratiocaris*, with a thickened ventral margin and with an eye-spot. A careful examination of fresh specimens convinces me, however, that he has been mistaken in these characters.

Moreover, the general form is so like that of one of the *Solenidæ*, that it would seem to require something more than close criticism to refer it to anything else. The anterior side is rounded off, and the posterior truncate. There is even a slight fold along the dorsal margin—a character very common in bivalve shells; and lastly, there are a few concentric ridges of growth on the posterior side, while the disk only is occupied with close and numerous striæ parallel to the edge. These striæ have apparently misled Prof. M'Coy, who supposed that they covered the whole surface, as in *Ceratiocaris*. Moreover the internal oblique ridge extending backwards from the beak is no uncommon character of the *Solenidæ*. Prof. M'Coy supposed it to be the nuchal furrow.

Not having till now had access to good specimens, I for some time thought its new association with Crustacea correct; and I catalogued it as a *Ceratiocaris* in 'Siluria,' 2nd ed. Appendix, p. 538; it is, however, necessary to restore it to the Mollusca.

I believe there are other forms of the genus even in Britain, besides these nine or ten species which have all turned up in the course of a year or two. Abroad, still larger specimens have been found in Upper Silurian rocks. M. Barrande has figured the tail-spines of three species, of which his *Leptoc. bohemicus* has the greatest resemblance to our *C. Murchisoni*; and, as above noted, a large species, *C. Dewii*, has been figured as a fish-defence by Hall, from the Niagara limestone of New York. Our own Dudley limestone contains one species; but the metropolis of this curious Silurian 'shrimp' is in the Lower Ludlow rock, where it keeps company with *Pterygoti* and other large Crustacea. It appears not to have been a long-lived genus, for as yet none have been detected below the Wenlock limestone or above the Upper Ludlow rock. I should perhaps except a fragment of a large carapace sent me from the Llandeilo flags? of Dumfries by my friend Prof. Harkness. But the rock and the fossil both bear such a suspicious resemblance to the specimens of *C. stygius*, that I wait for better evidence before admitting the existence of the genus so far back in time. However, a much

smaller species occurs in the black anthracite shales of Dumfriesshire, which are generally believed to be of Lower Silurian age. It is the

11. *Ceratiocaris aptychoides*.

(*Dithyrocaris aptychoides*, Salter in Quart. Geol. Journ. vol. viii. pl. 21. fig. 10)—a minute species.

Locality. Duffkinnell, Dumfriesshire. Prof. Harkness.

This would appear to belong to the Llandeilo flags; but it is possible the age of the formation may be more accurately given by the fossil, and the black anthracite shales may not have the antiquity they at present claim.

On the whole, about fifteen species have been recorded of this interesting genus, which combines to some extent the characters of *Nebalia* and of *Limnadia*. It will doubtless form the type of a distinct family.

With *Ceratiocaris*, in the south of Scotland, is associated another and still larger form, which I will now describe.

DICTYOCARIS.

More plentiful in fragments than even the *Ceratiocaris*, in the shales and sandstones of the Lesmahago hills, is a great Crustacean, apparently of very thin texture, whose carapace frequently measures from 9 inches to a foot in length! This rivals in size the great *Pterygoti*, among which its remains are often found. The anterior termination of the carapace has not been seen; its posterior edge is truncate, as in *Ceratiocaris*, and with a strong marginal furrow; and its ventral border must have been so produced as to give it a subtriangular outline. Some fragments of body-rings found with it may indicate its relationship to *Ceratiocaris*, from which its simply bent (not bivalved) shield distinguishes it.

The entire surface of the carapace is marked with hexagonal reticulations $\frac{1}{50}$ th of a line in diameter, of which the areas are convex, and the bounding lines sunk on the exterior aspect. This would, I think, indicate the ornament to be connected with the structure of the carapace rather than to be a mere external sculpturing. As no films can be obtained thick enough to furnish a section for microscopic examination, the point cannot be ascertained.

There are probably two, if not more species. I describe only one at present.

DICTYOCARIS, n. g., 1860.

Carapace ample, bent along the dorsal line, but not two-valved, largely reticulate, the area of the reticulations being convex.

The shape of the carapace is rudely triangular, pointed or rounded in front, truncate and produced behind, and margined along the hinder and ventral edges by a strong furrow. Body — ?

In this giant Phyllopod, the two laminæ (inner and outer surfaces) of the carapace are clearly separable from each other. Both show the coarse reticulation. The anterior end, though evidently attenuated, is not perfect in our specimens; and I can only provisionally give a restoration of the form at *a*. A fragment of the surface is added, natural size and magnified, to show the coarse reticulations.

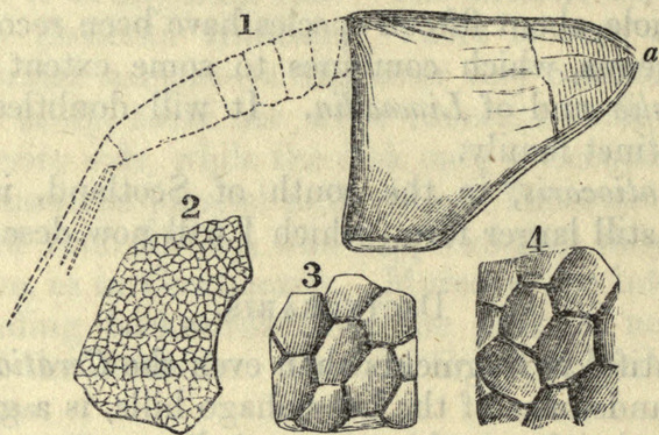


Fig. 1. *Dictyocaris*, about $\frac{1}{8}$ th natural size. The body is a restoration.

Fig. 2. The surface, natural size.

Fig. 3. Ditto, magnified, external: the areæ convex.

Fig. 4. Cast of ditto upon the stone: the areæ concave.

D. Slimoni, n. sp.

D. magnus, sesquipedalis et ultra. Cephalothorax triangulatus. Segmenta corporis — ?

Locality. Upper and Lower Ludlow rock, Lesmahago, Larnark. Very abundant in the latter formation, but chiefly in fragments.

Another species (if not more) occurs in the Ludlow rocks of the Pentland Hills, where it was found last summer by myself, in company with A. Geikie, Esq., of the Geological Survey of Scotland. I propose to call it *D. Ramsayi*. It will be described in the Memoirs of the Geological Survey.

This genus is more like *Nebalia* than is *Ceratiocaris*, inasmuch as it has a simply bent, not bivalved, carapace. But without the telson and other parts it cannot be associated with that group, and must for the present be placed near to the *Ceratiocaridæ*.



Salter, John William. 1860. "XV.—On new fossil Crustacea from the Silurian Rocks." *The Annals and magazine of natural history; zoology, botany, and geology* 5, 153–162.

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