

an almost indefinite period under water, even where there is a constant and free access to the salt tides of the ocean.

XIV.—*On Permian Entomostraca from the Shell-Limestone of Durham.* By J. W. KIRKBY. *With Notes on the Species*; by T. RUPERT JONES, F.G.S.

THE descriptions by Mr. Rupert Jones in Professor King's "Monograph of the Permian Fossils of England," form the first notice of Permian *Entomostraca*. In this work Mr. Jones describes several species, principally from the upper beds of the Permian rocks of Durham.* In 1856, Professor King noticed the occurrence of a single species (*Cythere inornata*?) from the Permian limestone near Tullyconnel, in Tyrone.† And in November last year (1858), I made some remarks on some species from the shell-limestone of Tunstall Hill, in the "Annals of Natural History."‡ No other observations have been made on Permian *Entomostraca* in Britain.

In 1854, Dr. Reuss described ten species from the Permian rocks of Germany. They were obtained from the Unter Zechstein of Bleichenbach and Selters, in the Wetterau.§ Some of the species he considered to be new, others to be identical with forms found in the upper Permian beds of Durham.

In the same year six new species were described by Count Alex. Von Keyserling, from the Permian rocks of Russia.||

In 1855, Dr. Richter noticed the occurrence of eight species in the Unter Zechstein of Saalfeld. Among them was one form considered to be new; the rest were referred to species that had been previously described by Jones and Reuss.¶

The following remarks refer more particularly to the *Entomos-*

* "Monograph of Perm. Foss. of England," pp. 58-66.

† "Journal of the Geological Society of Dublin," vol. vii., p. 78.

‡ "Annals and Magazine of Natural History," 3rd series, vol. ii., pp. 317 & 434.

§ "Jahresbericht der Wetterauer Gesellschaft, 1854," pp. 65-70.

|| "Reise durch die Tundren der Samoeden. Dorpat, 1854," pp. 111-113, pl. 4. Permian *Entomostraca* were observed in Russia previous to this date; but the notices of them merely mention the fact of their occurrence, without specific details. See Table of Formations of the Government of Simbirsk of Jaaykow, 1844, Petersb. Miner. Gesellsch.

¶ "Zeitschr. der Deutsch. Geol. Gesellsch.," vol. vii., pp. 526-533.

traca found in the shell-limestone of the Permian formation of Durham, though in some instances materials from the upper limestone of Byers' Quarry have been used in working out specific characters.

The shell or fossiliferous limestone occupies a central position in the calcareous beds of the series. It rests upon the compact limestone, and is overlaid by the cellular or brecciated limestone?, which, in its turn, is superimposed by the crystalline, botryoidal, and earthy, oolitic limestones, which are often grouped as the upper or higher members. *Entomostraca* have only been found in the shell and crystalline limestones in Durham. In Germany, they occur in the Unter Zechstein, which is the equivalent of the compact limestone, both of which have the marl-slate or kupferschiefer for their base. From this it appears that *Entomostraca* occupied a place in the marine fauna of Western Europe from the commencement of the deposition of the Permian limestones, until the last beds of the same were being accumulated. At the same time it is evident that their geographical distribution was not general; for in numerous fossiliferous localities, both in Durham and Germany, their remains are absent. In the shell-limestone, the only locality where they have occurred in any degree of abundance is at Tunstall Hill, and there their distribution is very local. Occasional specimens have also occurred in shell-limestone at Humbleton Hill, and the new Poor House, Bishopwearmouth. In the higher members, their remains have only been found in the crystalline limestone at Byers' Quarry. Further researches may probably discover other localities where they occur, though it is more than likely that their distribution will always be limited to particular spots.

In the limestone of Tunstall Hill, there occur irregular shaped cavities filled with brown or yellow calcareous dust. In some, the contents are simply dust; in others, there are groups of finely preserved fossils intermixed. These cavities, and their contents were first noticed by Mr. Howse, who also observed them in the shell-limestone of Dalton-le-Dale.* It was in one of these

* "Catalogue of Fossils of the Perm. Syst. of Northumb. and Durham," p. 9. By an unfortunate oversight, Silksworth was substituted for Dalton-le-Dale, in the publication of this paper in the "Annals of Natural History."

cavities that I found the bulk² of the specimens which form the subject of these remarks. And it is questionable whether a better matrix for the preservation, and subsequent extraction, of microscopic organisms, than that in which these *Entomostraca* occurred, can be conceived. It has preserved the specimens which it incloses so perfectly, that they almost rival the productions of recent zoology. In some instances, a brush will remove the investing matrix, without the use of other tools. Occasionally the dust is semi-coherent, with nodules or fragments of limestone intermixed; but in this state the embedded fossils are also easily extracted, without much assistance from palæontological instruments. Some of the finest specimens ever taken from the Permian beds in Durham have been got from these cavities, and also some of the rarest species. An analytical examination of the contents of some show very curious results. For instance, in one, I found about one hundred and fifty perfect and imperfect spines of *Cidaris Keyserlingi*, King, and with them but one or two fragments of the plates of that species; in another I got more than one hundred dorsal valves of young individuals of *Strophalosia Goldfussi*, Münst., which were accompanied by only fifteen ventral valves. Of course, in both cases, other species were associated, but the remains of those mentioned were the most prevalent, and, by their abundance, and peculiar mode of occurrence, formed the characteristic feature of the contents of each cavity. Such facts are very puzzling, and would almost seem indicative of a drifting of specimens prior to fossilization—an idea which is scarcely tenable, when the general evidence of the whole fauna is considered.

The majority of the specimens of *Entomostraca* which were found belong to species of *Bairdia*, with scarce, but good, examples of a *Beyrichia*-like species, previously noticed in the upper limestone by Jones, and provisionally referred by him at that time to the genus *Dithyrocaris* of Scouler,* but now recognised as a new genus under the name of *Kirkbya* (see further on). The *Bairdia* generally occurred with united valves, though single valves were not uncommon. The specimens of the latter species

* "Mon. Perm. Foss.," p. 64.

were nearly always in a detached state, only three or four per cent. occurring with the valves connected. The valves of *Bairdia* possess a stronger hinge than those of *Kirkbya*, one valve overlapping the other along the dorsal margin, while the valves of the other appear to have been merely united by membrane. This difference in the mode of hinging seems to explain their manner of occurrence. None of the specimens are worn, or show indications of drifting. The acute extremities of some of the species, and the delicate margins of the detached valves, never present traces of attrition; so that it may be inferred that these *Entomostraca* were original residents in the area where they became embedded and fossilized.

In the calcareous dust which contained the *Entomostraca*, were also a number of specimens of a curious Foraminifer, apparently a species of *Miliola*.* Several species of Mollusca also occurred, as *Productus horridus*, *Spiriferina multiplicata*, *Camarophoria crumena*,† *Crania Kirkbyi*, *Monotis speluncaria*, *Pleurotomaria Verneuli*, &c. The convex valve of a Conchifer appears to have been a popular place of resort with the *Bairdia*, for out of one I procured some dozens of individuals.‡

During the Permian period, the prevailing forms of *Entomostraca* seem to have belonged to two groups—to *Bairdia*, a sub-genus of *Cythere*, and to *Kirkbya*. *Bairdia* is most characteristic of the Permian limestones of Western Europe; in fact, it is unknown as yet in the Permian rocks of Russia. In Germany, it is represented by several varieties, and by a greater number in Durham; five varieties have been met with in the Yorkshire Permian rocks. In the shell-limestone of Durham the *Entomostraca* almost exclusively consist of varieties of this genus, from which it may be inferred that the conditions prevailing during the accumulation of that deposit were highly suitable for their development. *Bairdia* seems to represent the

* This is the same fossil as the *Serpula pusilla* of Geinitz, and the *Spirillina pusilla* of Jones.

† Late *Schlotheimi*.

‡ In aquaria, it is not unusual to see a little host of *Candonæ* and *Cyprides* swarming over and within the shell of a recently dead *Paludina*, or other mollusk. Possibly the little marine *Entomostracous* scavengers were engaged in removing the dead substance of the bivalve mollusk here referred to, and were sepulchred in its closed and buried valves.—T. R. J.

Mesozoic element in this section of the Permian fauna, it being more properly a Mesozoic and Cainozoic form, although it is first met with in Palæozoic rocks. As a connecting link with the older rocks, the generic form typified by *Kirkbya Permiana* and its varieties, may be noticed, as the representative of its more ancient prototypes the *Beyrichia* and *Leperditia*, of the early Palæozoic rocks. This form appears to predominate in Russia: three varieties occur there; another is found in Germany, and two in Durham. According to our present knowledge, only one other species is known as belonging to this genus, namely, an undescribed form from the lower Carboniferous rocks near Glasgow. Consequently, it is pre-eminently characteristic of the upper Palæozoic deposits. Associated with the Permian species belonging to the above groups, are a few forms which have been referred to *Cythere*, *Cythereis*?, and *Cytherella*?, all of which, with one exception, are found in the upper Permian limestone of Byers' Quarry, and some of which also occur in the Unter Zechstein of Germany. At Byers' Quarry these forms are in the ascendant, being seven in a list of twelve species (or varieties) found therein. Species belonging to these groups have also been found in the shell-limestone.

As I have already suggested, the differences observed in the generic affinities of the species of *Entomostraca* found in the shell-limestone and the limestone of Byers' Quarry may indicate some differences in the physical conditions pertaining to the area of deposition of each. And from considerations independent of the evidence offered by these fossils, I am inclined to ascribe it to a difference in depth of the sea or seas of deposition. In regard to the limestone of Byers' Quarry, there seem to be sound reasons for considering it to have originated in water of no great depth—at least not beyond the range of *Algae*, for from the beds of the same quarry I have taken numerous vegetable remains, which undoubtedly belong to that class. There are other facts which appear to support this opinion—which is no new theory, being already broached by Professor King—but which it is needless to detail at present. So far as the origin of the shell-limestone is concerned, there seem to be as good rea-

sons for viewing it as an accumulation in comparatively deep water. Its lithological characters, and the general features of its fauna, favour such an opinion. And though the generic relations of the *Entomostraca* do not offer strong support in either instance, yet, in the case of the shell-limestone, the prevalence of *Bairdiæ* harmonises with the supposition of their habitat having been in deep water, for I am informed by Mr. Jones that recent *Bairdiæ* are often found at great depths. These remarks are made rather as suggestions than positive opinions; for the subject of physical conditions, at the period of deposition of these limestones, is too important and difficult of solution to be treated of incidentally. For the present, I merely suggest that the slight differences observed in the generic features of the two groups of *Entomostraca*, may be due to a difference of depth of the ocean in which they lived.

For the convenience of those who may find fossil *Entomostraca*, or other small organisms, in a similar matrix to that in which the Tunstall specimens occurred, it may be well to add a word or two as to the mode I adopted for extracting the Permian specimens from the calcareous dust. In the first place, I sifted the dust of all the coarser particles—of everything larger than the tenth of an inch; and, from what was left, I took all the very fine dust with another sieve, leaving a residue, among which everything organic could easily be distinguished.* In picking out the organisms, a piece of polished slate—a common school-slate, for instance—is a good area on which to strew a portion of the residue for examination. It is much better to adopt this method than to pick the specimens out of a mass of materials, for by sprinkling a small portion over the slate every individual particle can be recognised, and the organic forms separated from the inorganic, with very little trouble. A pair of blunt forceps are exceedingly useful for picking up the specimens. Of course care is necessary in using it, or injury may result to the specimens; but with caution, and a little skill, the forceps may be used with great delicacy of touch, and with less

* A convenient form of metal sieve for this purpose is described in Mackie's "Geologist," vol. i., p. 249.—T. R. J.

risk than the fingers. Mr. Carpenter recommends the use of the moistened tip of a camel's hair pencil in similar cases; and in instances where the objects sought are extremely delicate, it will be the more preferable instrument; but when the specimens, like the Permian *Entomostraca*, possess a moderate degree of firmness, they may be extracted with greater ease and celerity as above indicated; and when an extensive series of examples is required, expedition is of some value. With the assistance of a common lens, and a pair of moderately good eyes, nothing more is necessary.

In my paper on the Permian *Entomostraca*, in the "Annals of Natural History," (3rd series, vol. ii.), I proceeded, after some prefatory remarks, from which the foregoing are slightly modified, to describe, first, the *Cytheridæ*, arranging the various forms under twelve species; and next, the peculiar *Beyrichia*-like *Entomostraca* which Mr. Jones had formerly referred, first, to *Dithyrocaris*, and afterwards to *Ceratiocaris*: this I provisionally termed a *Leperditia*, stating my belief that it would be found to be characteristic of a new group, closely neighbouring on that of *Leperditia* and *Beyrichia*. Having requested Mr. Jones to supply me with his fully considered opinion on the value of these specific and generic determinations (and proposing to incorporate his remarks with the reprint of my memoir), I have been asked by him to place the description of the *Beyrichia*-like species first, in this paper, as he has been able to get together and work out his material, with respect to this species, much more satisfactorily as yet, than in the case of the *Bairdiæ* and other *Cytheridæ*. He tells me that the identification of the Permian *Entomostraca* is so closely concerned with the correct determination of the Carboniferous species that, until he has made every possible endeavour to have a personal examination of all the Carboniferous forms already described by palæontologists, he cannot do justice to his intended critical examination of the Permian *Cytheridæ*.

A valuable collection of the Carboniferous *Entomostraca* of Ireland has been confided to his care by the kindness of Sir R. Griffith; he has also the permission of Sir R. Murchison to use the Irish and other specimens in the Geological Survey Museum;

some Glasgow specimens of great interest, in the Hunterian Museum, have also been examined by him; and a large collection of British and foreign Carboniferous specimens are in his possession, through the kindness of friends: still he waits for an opportunity (if possible) to study the original specimens from Hof, briefly described by Count Münster. (Jahrbuch, 1830, p. 65.)

Of Permian specimens, he has obtained, through Dr. Richter's courtesy, a series of those from near Saalfeld; and some from Gera, by the gift of Dr. Lieber of that place; besides other specimens from Germany; several from Byers' Quarry, near Sunderland; and the whole of my collection from Tunstall Hill. Still he hopes to see the Wetterau specimens described by Professor Reuss; so as to determine the exact relations of several specific forms. Nor is he without hope of seeing the Uralian specimens collected by Schrenk, and described by Count Keyserling.

Commencing, then, with the *Beyrichia*-like species, and adopting the new generic name proposed by Mr. Jones, I now reproduce the description of it given in the "Annals of Natural History," 3rd series, vol. ii., with some modifications which Mr. Jones has kindly suggested.

KIRKBYA, Jones.

K. PERMIANA, Jones. Pl. X A, figs. 1-9; and plate X, figs. 5-13.

Dithyrocaris Permiana, Jones. "Mon. Perm. Foss.," p. 66, tab. 18, fig. 1.

Ceratiocaris? Permiana, Jones. "Morris's Cat. Brit. Foss.," 2nd edition, 1854, p. 103.

Leperditia? Permiana, Kirkby, 1858, "Ann. Nat. Hist.," 3rd series, vol. ii., p. 434.

Length, 1-20th of an inch; height, 1-45th of an inch.

Carapace oblong-ovate, ark-shaped, equivalve, very convex; valves thick. *Dorsal margin* straight, bounded laterally by flattish, slightly-inclined areas, formed by the depression of the upper region of the valves. *Ventral margin* straight centrally, or very slightly sinuate.

Anterior extremity angulate at its junction with the dorsal margin, and bluntly rounded ventrally: the dorsal angle is sometimes the most prominent; at others a point midway between the margins protrudes most. *Posterior extremity* angulate dorsally, more pointed than the former, the antero-dorsal angle being more projecting, from which a convex line slopes gradually to the ventral margin. From the extreme points of the dorsal margin of each valve proceed two strongly produced rims, or marginal expansions, which become more widely separate as they approach the ventral margin. The *innermost rim* (of single valve) is elevated, and forms a raised reflexed edge round the middle portion of the valve. The *outermost*, or *most ventral rim*, is not reflexed, but projects at a right angle from the ventral portion of the valve; along the inner surface of this rim, which forms the contact margin of the valve, extends a slightly elevated projection, on a plane with the ventral convexity of the valve, and which appears to overlap a similar longitudinal projection in the opposite valve. The outer surface of the valve within the innermost rim is deeply channelled. The *central area* of the valves is protuberant, rising abruptly from the channelled depression just mentioned; dorsally, and towards the posterior extremity, this area is very prominent, or slightly gibbose. *Surface* ornamented with a network of slightly raised, irregularly hexagonal meshes bounding shallow pits, and with slender longitudinal wrinkles (formed when the network has a parallel arrangement of its meshes), which occasionally bifurcate and merge into each other. *Hinge* consisting of the dorsal margins, united by ligament (?) *Lateral contour* ovate, with strongly produced extremities.

This remarkable species does not vary much in marginal outline. The posterior extremity is occasionally rather less pointed than usual, and the anterior extremity varies a little in convexity; the ventral margin also has at times a tendency to become sinuate.

The variation of the posterior extremity is of most importance, as in some cases the slight modification which it undergoes causes it to assume the form of the anterior.

One of the most peculiar characters of this species is the curious marginal rims which bound its free margins, and form so important a feature in its ventral aspect. I have never observed more than two rims on each valve, except in one instance, which was a perfect specimen, having three rims on the right valve, with only two on the left. These rims very much remind one of the exfoliative dilatations of the margins which are seen in some species of Mollusca; but when the mode of growth of the *Entomostraca* is considered, such an idea is found to be untenable; for we must suppose that these animals, like their recent representatives, would increase in size by moulting, and not by marginal increment. The youngest specimens possess the rims in miniature; indeed, all stages of growth are characterised by them, though the older individuals have them most produced. One of my specimens (fig 11, pl. X.) appears to have several fine lines between the outer and inner rims and running parallel to them. The same portion of the valves are occasionally seen to be delicately reticulated after the pattern of the rest of the surface. (Fig. 5c, pl. X. A.)

The central area of the valves is generally very much produced, but more so in some specimens than in others. Sometimes its connection with the marginal portion of the valves is so abrupt as to cause it to appear like a great tubercle; at others it slopes more gradually towards the margin, and wears a less gibbose aspect: this is particularly the case in young specimens. The postero-dorsal region of this area is always the most prominent portion of the valve; and as the central portion of the dorsal region is at times rather depressed, both it and the antero-dorsal angle have there a gibbose appearance. Such specimens assimilate to the *K. (Cythere) Schrenkii** of Keyserling, the equivalent regions of which are extremely gibbose. As the central area varies in prominence in different specimens, so do specimens vary in width, and that very considerably.

* "Reise durch die Tundren der Samoeden, 1854," p. 112, taf. 4, fig. 37.

K. Permiana is not uncommon in the shell-limestone of Tunstall Hill, and in the upper Permian limestone of Byers' Quarry.

K. Permiana seems to be nearly related to the Russian species *K. (Cythere) sticta*, Keyserling.* The latter form has rounder extremities, and its ventral margin more deeply sinuate, and it is apparently more compressed than the former. Some difference also exists in the ornamentation, which in *K. sticta* appears to be very regularly arranged. Both agree, however, in possessing two expanded rims on the free margin of each valve. *K. Roessleri*, Reuss,† of the Unter Zechstein, also corresponds in this respect, and will probably prove to be closely related.

The generic affinities of this species and of its congeners have been until lately involved in some obscurity. When first described by Mr. Jones, from specimens on the limestone slabs of Byers' Quarry, it was referred by him to the genus *Dithyrocaris* of Dr. Scouler. In placing it there, he admitted that it was questionable whether it in reality belonged to that group or not; for his own specimens were not well preserved, nor had the characters of the genus been properly defined by its author; but from the data offered by the imperfect materials in his hands, he thought it possible that it might have some affinity to it, and placed it in that genus provisionally.

Dithyrocaris was originally considered by Dr. Scouler to have a univalve carapace, like *Apus* and other single-valved *Branchiopoda*.‡ He afterwards altered his views, supposing it to be bivalve, like *Cypris*, though differing from that genus in having caudal appendages, protruding from the valves. This opinion was held until 1843, when General Portlock described two new species from the slabs of the Lower Carboniferous rocks of Ireland, and proved that its carapace was univalve, as Dr. Scouler had at first supposed. General Portlock's description of these species, particularly of *D. Colei*, can leave no doubt of the correctness of his views in this respect, and clearly demonstrates that *Dithyrocaris* is a univalve *Entomostracan* — that is, sup-

* "Loc. cit," p. 112, taf. 4, fig. 38.

† "Jahres. Wetterau. Gesell." 1854, p. 70.

‡ "Records of Science," Feb. 1835; and in a paper read before the British Association at Glasgow. See also Jones on *Dithyrocaris*, in Professor King's "Mon. Perm. Foss." p. 64.

posing Dr. Scouler's species belong to the same group, which may be taken for granted until proved to the contrary.

All the examples of *K. Permiana* which came under the notice of Mr. Jones were, as stated before, more or less imperfect, so it may naturally be supposed that great difficulty would occur in attempting to determine the generic affinities of the species to which they belonged. It was evidently owing to this cause that Mr. Jones supposed that it might be a member of *Dithyrocaris*. It is from the perfect state of preservation of my specimens that I have been enabled to offer the preceding remarks in addition to those of Mr. Jones. And as some of the specimens have their valves united and in close juxtaposition, I have also been enabled to prove that the species is a bivalve *Entomostracan*, like *Cythere*, or rather *Beyrichia*, consequently that it has no affinity to *Dithyrocaris*, or to *Ceratiocaris*, to which Mr. Jones afterwards referred it, the closely fitting edges of its carapace, of course, excluding it from that genus.

German and Russian palæontologists have referred congeneric forms to *Cythere*; but, with the exception of being bivalve, they possess no characters to warrant their remaining in that genus.

REMARKS BY T. RUPERT JONES, F.G.S.

The specimens of Magnesian limestone with which Professor King supplied me in 1849, for the obtaining of *Foraminifera* and *Entomostraca*, to be described in the "Monograph of the Permian Fossils of England," yielded numerous casts and indifferently preserved valves of *Entomostraca*, which I could not place with the *Cytheres*, on account of their relative size, shape, and style of ornament, and which I erroneously referred to *Dithyrocaris* (seeing some apparent relation between them and *D. tenuistriatus*). Subsequently I suggested to Mr. Morris, when he was preparing the new edition of his "Catalogue," that these Permian *Entomostraca* should be removed from *Dithyrocaris*, and provisionally placed with the bivalvular *Ceratiocaris*, until we should know more about them. At this time Professor Reuss figured and described an evidently allied form, under the name of *Cythere Roessleri*, from the Lower Zechstein of Bleichenbach; and soon

afterwards Dr. Richter figured and described another, somewhat differing from the foregoing, under the same appellation, from the dark-grey limestone of the Lower Zechstein of the Roth Berg, near Saalfeld, and recognised its probable affinity to the so-called *Dithyrocaris Permiana*.

The numerous fine specimens, however, obtained by Mr. Kirkby from the Magnesian limestone of Tunstall Hill enabled him, last year, to draw up an exact description of these interesting *Entomostraca*; but, thinking that I might have means for a wider comparison than he possessed, and knowing that I had already interested myself in the subject, he most courteously and considerately left to me the determination of the generic alliances; and liberally confided to me all his materials for examination. The result has been that, after a careful comparison of Silurian, Carboniferous, and Permian species of near alliances, I believe that we have, in these peculiar Permian forms, and in a related species from the Lower Carboniferous rocks of Scotland, a distinct generic type not far removed from *Beyrichia*. For this genus I propose the name of *Kirkbya*; for without Mr. Kirkby's industrious researches and acute observation, we should still have wanted the abundant and illustrative materials which we now possess for the natural history of this Permian species.

I had recognised in the figures and descriptions given by Reuss and Richter of their *Cythere Roessleri* an affinity to my so-called *Dithyrocaris Permiana* and *D. glypta*; and, in the autumn of 1857, Dr. Richter favoured me, at Saalfeld, with two specimens of the species which he had described as *Cythere Roessleri* (Reuss); but the finely-sculptured surface of the German specimens offered so strong a contrast to the bareness of the valves from Byers' Quarry, that I gave up the hope of finding more than a consanguinity between these peculiar English and German *Entomostraca*; and I trusted to be able some day to point out that they were neither *Dithyrocaris*, *Ceratiocaris*, nor *Cythere*.

The carapace-valves from Saalfeld had presented to me not only a finely reticulated surface (well figured by Richter), but also a small subcentral sunken oval spot, around the smooth edge of which the meshes of the superficial net-work had a more or less distinct concentric arrangement for a little space. Of this fea-

ture, which is indicated in Richter's figure ("Zeitschrift," vol. vii., pl., 26, fig. 2.), I could not find clear evidence on the specimens which I possess from Byers' Quarry, although a trace of reticulation on one valve, and a slight subcentral circular mark on the casts of others, strengthened my belief that they might belong to the peculiar genus which comprehends the so-called *Cythere Roessleri*.

Mr. Kirkby's specimens from Tunstall Hill, occurring under the circumstances so well described by him (see above), enabled him to set these peculiar *Beyrichia*-like forms again before palæontologists, and this time with full and clear descriptions, accompanied by several sketches ("Annals of Natural History," 3 ser., vol. ii., pl. 11, figs. 5-13). Following Mr. Kirkby's suggestions, assisted by his notes, and carefully studying his numerous specimens, I am now enabled to show them in a lithograph executed by Mr. G. West, with their details elaborated, and in comparison both with the German forms and with the specimens from Byers' Quarry.

Some of the features which I have lately recognized in Mr. Kirkby's specimens are alluded to above in his revised description of the species. I need only add the following remarks.

The sculpture of the surface of the valves is subject to considerable variation as to its distinctness. In the specimens which I have seen from the Zechstein of Saalfeld and Gera, it is very distinct and uniform; the subcentral oval spot is well defined; and the inner border of the innermost of the ventral ridges is strongly marked by a line of small roundish pits (figs. 8*a* and 8*b*; shown also by Richter). A faint trace of this linear punctation I have lately found in a specimen from Byers' Quarry. Not unfrequently the longitudinal boundaries of the hexagonal pits, on the surface of the valves, are strengthened (fig. 2*a*), and occasionally exaggerated (figs. 4 and 6), in which case we get the ridged variety, *K. Permiana*, var. *glypta*, which I named as a species in the "Monog. Perm. Foss." Sometimes a single ridge only is developed on the valve, as in fig. 5*a*. Reuss's *C. Roessleri* (fig. 9) is evidently one of those ridged varieties, and may be distinguished as *K. Permiana*, var. *Roessleri*. Richter's *C.*

Roessleri, with its uniformly sculptured surface, punctured ventral ridge, and well-marked oval spot, may be regarded as a separate variety (*K. Permiana*, var. *Richteriana*).

I quite agree with Mr. Kirkby in his observations on the *K. (Cythere) sticta*, of Keyserling (see above, p. 132), which closely resembles the specimens referred to by Richter to *K. (Cythere) Roessleri*, of Reuss. Nor can I see, in Keyserling's figures, any *specific* differences between his *C. Schrenkii*, *C. sticta*, and *C. grapta*; they are, probably, varieties of *K. Permiana*; and, until we can compare the specimens, we may recognise them as *K. Permiana*, var. *Schrenkii*, *sticta*, and *grapta*.

The other species of *Kirkbya*, with which I am acquainted, has a thick oblong carapace, with its ends nearly uniform in thickness with the central portion. Its ventral border is thick and doubly ridged. The surface of the valves is reticulated, and characterised by two somewhat semicircular ridges, one within the other, their ends touching the dorsal edge. The oval spot is nearly central, and placed at the curve of the inner and smaller ridge. The specimens are in the Hunterian Museum of the Royal College of Surgeons, of London, and were collected and presented to John Hunter by the Rev. Dr. Ure. They are from the lower Carboniferous shales, near Glasgow. I propose to denominate this species *Kirkbya Urei*.

The generic characters of *Kirkbya* may be stated as follows:—

Animal enclosed in a bivalved carapace; carapace equivalved; carapace-valves thick, oblong; anterior and posterior extremities more or less rounded; ends of the dorsal border somewhat acute; ventral border straight in the centre and curved at the ends. Valves usually wider at the caudal than at the cephalic extremity, convex, ridged strongly on the ventral border and at the ends; the ventral edge of one valve (dextral) slightly overlapping that of the other; surface impressed with a small subcentral oval hollow, and more or less ornamented with a reticulate sculpture and ridges. Hinge probably consisting of a simple adaptation of the dorsal edges and their union by membrane.

In the general form, hingement, and mode of overlap, *Kirkbya* resembles *Beyrichia*; and *K. Urei* slightly approaches some

Beyrichiæ (such as *B. Bussacensis*) in the setting on of its ridges. We also see in the figure of *K. Permiana*, var. *Schrenkii*, and occasionally in some of the Durham specimens (see fig. 1a), a tendency to the bilobed condition of the valve, due to the sub-central dorsal furrow, so characteristic of the *Leperditia*. The oval spot, however, the hexagonal reticulation, the long stretching wrinkles and riblets, and the doubly and sometimes trebly ridged ventral margin, are characters not found in *Beyrichia*, and must be regarded as distinctive of a separate generic group.

Lastly, it seems to me probable that the sunken oval spot on the valves may have reference to the place of attachment of the transverse muscle of the animal, and thus represent the variously patterned "muscle-spots" of other bivalved *Entomostraca*.

CYTHERIDÆ.

AMONGST the *Entomostraca* of the shell-limestone none are so plentiful as the *Bairdia*. Of these there are several forms, which somewhat resemble the *Bairdia curta* (M'Coy) of the lower carboniferous rocks of Ireland, and are not very dissimilar to the *B. subdeltoidea* (Münster) of the Cretaceous and Tertiary formations, and of existing seas. These Permian specimens vary considerably among themselves in outline and relative convexity. Several of them were described in the "Annals of Natural History," 3rd series, vol. ii., pp. 324, &c., under the specific names of *B. plebeia* (with three varieties—*elongata*, *Neptuni*, and *compressa*), *B. ventricosa*, *B. Reussiana*, *B. Kingii*, *B. mucronata*, *B. Schaurothiana*, *B. Berniciensis*, and *B. rhomboidea*.

Three other *Cytheridæ*, from the shell-limestone, were also described at the same time as *Bairdia*, viz., *B. reniformis*, *B. Jonesiana*, and *B. truncata*, which, however, are regarded by my friend Mr. Jones as more likely belonging to another sub-genus.

Having asked Mr. T. R. Jones for his opinion on the arrange-

ment which I had proposed for these forms, as above indicated, and shown him all my materials, he recommends me to annul some of my determinations, and to group into the following species (as far as the *Bairdia* are concerned) the forms which I had sorted out as characteristic.

Names now Proposed.	Reference to Plates ix. & x.	Woodcut Outlines.	Names given in the Ann. Nat. Hist.
1. <i>Bairdia plebeia</i> , Reuss.....	Pl. ix. figs 1 & 2.	1	<i>Bairdia plebeia</i> , Reuss.
2. <i>B. plebeia</i> , var. <i>caudata</i>	" fig. 10....	2	<i>B. mucronata</i> , Reuss.
{	" fig. 9.....	3	<i>B. mucronata</i> , Reuss.
	" fig. 12....	4	<i>B. ———</i> n. sp.?
3. <i>B. plebeia</i> , var. <i>amygdalina</i>	" fig. 11....	5	<i>B. mucronata</i> ? Reuss.
4. <i>B. plebeia</i> , var. <i>elongata</i> ...	" fig. 4.....	6	<i>B. plebeia</i> , Reuss. var <i>elongata</i>
5. <i>B. plebeia</i> , var. <i>Neptuni</i> ...	" fig. 5.....	7	<i>B. plebeia</i> , Reuss. var <i>Neptuni</i>
6. <i>B. plebeia</i> , var. <i>Reussiana</i>	" fig. 6.....	8	<i>B. Reussiana</i> , Kirkby.
7. <i>B. plebeia</i> , var. <i>ventricosa</i> ..	" fig. 3.....	9	<i>B. ventricosa</i> , Kirkby.
8. <i>B. Schaurothiana</i> , Kirkby.	" fig. 14....	10	<i>B. Schaurothiana</i> , Kirkby.
9. <i>B. Kingii</i> , Reuss.	" fig. 8.....	11	<i>B. Kingii</i> , Reuss.
10. <i>B. Kingii</i> , var. <i>compressa</i> ..	" fig. 7.....	12	<i>B. plebeia</i> , var. <i>compressa</i> .
11. <i>B. Berniciensis</i> , Kirkby ...	" fig. 15....	13	<i>B. Berniciensis</i> , Kirkby.
12. <i>B. rhomboidea</i> , Kirkby.....	Pl. x. fig. 3.....	14	<i>B. rhomboidea</i> , Kirkby.

From his opportunities of studying the carapace-valves of both recent and fossil *Bairdia*, Mr. Jones appears to have reason for differing from me in the estimate made of the value of some features upon which I had much depended, namely, the relative gibbosity of the valves (shown in the lateral contour), and the amount of ventral overlap. More particularly, my friend's views are at variance with those advanced by me as to the sub-generic relations of what I termed *Bairdia reniformis*, *B. Jonesiana*, and *B. truncata*. These he believes to belong to *Cytherideis*, a sub-genus established by him in 1856, for the reception of several *Cytheres* nearly approaching *Bairdia* in many respects.

For the sake of easier comparison, and to illustrate the gradual development of varietal differences, it has been deemed advisable to introduce a series of carefully executed woodcut outlines of the *Bairdia* above referred to.

CYTHERE, *Müller*.

SUB-GENUS BAIRDIA (*M'Coy*). Jones' "Monograph of the Entomostraca of the Cretaceous Formation of England," p. 22; and "Monograph of the Tertiary Entomostraca of England," p. 51.

Bairdia (genus), *M'Coy*, 1844. "Syn. Char. Carb. Foss. of Ireland," p. 164.

This group was instituted by Professor *M'Coy*, in 1844, for the reception of two species of *Entomostraca*, from the carboniferous rocks of Ireland, which he considered to differ generically from any existing genus.

Mr. T. Rupert Jones, in his "Monograph of the Entomostraca of the Cretaceous Formation of England," 1848, proposed its adoption as a sub-genus of *Cythere*, giving a good definition of its sub-generic characters, which had scarcely been done by *M'Coy*. I attach to it a similar value in these remarks.

Mr. Jones has given further illustrations of the sub-genus in his "Monograph of the Tertiary Entomostraca" (Palæontographical Society, 1856).

Dr. Baird has placed it, as modified by Jones, among his synonyms of *Cythere*. He states that no anatomical difference exists in the animal of those recent species referred to it by Jones, from the animal of *Cythere* proper.* This is certainly a strong point in support of its near affinity with *Cythere*; but still, with its marked peculiarity of carapace, I think it may be fairly entitled to a distinctive term, to mark it from the typical forms of *Cythere*. At least, whether it really be a natural sub-genus or not—supposing such to exist—it is a very convenient group in palæontology, as it serves to mark a number of fossil *Entomostraca* of peculiar character, which have repeatedly held no unimportant position in the economy of ancient faunas.

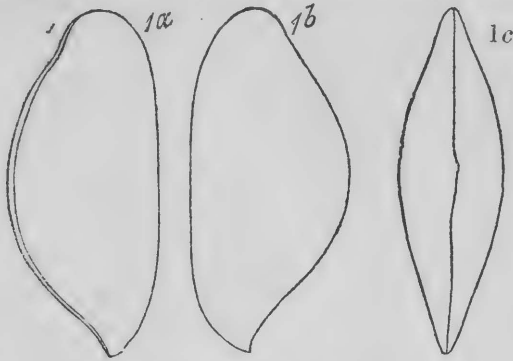
The sub-generic characters of *Bairdia* have already been given by Mr. Jones. The Permian species add little that is new to them, though it may be well to recapitulate the sub-generic features of these forms. They all appear to be smooth; sometimes

* "Natural History of the British Entomostraca" (Ray Society), p. 163.

the carapace is finely pitted, and occasionally hirsute in the recent state. The general form of the majority is somewhat triangular or subpentagonal, though species or varieties having a still more elongate contour occur. The posterior extremity of all is more pointed than the anterior, and it is generally rostrated. The anterior extremity is usually rounded, but sometimes subangulated, and also much wider than the posterior extremity. The ventral margin is always the straightest, though often somewhat sinuated. The dorsal margin is more or less convex centrally, and generally sinuated towards the posterior extremity. In lateral contour* they are lenticular, variously modified, being sometimes almost exactly lenticular; at others, by the extreme position of their greatest diameter, sub-cuneiform. Perhaps the most important generic character of *Bairdia* is its hingement, which is a lapping of the left valve over the right, along the dorsal-margin, and which was first noticed by Mr. Jones. In some Permian varieties, the folding of the valves is relatively great; and in most cases the folding is much greater in the centre than near the extremities. In general this character does not vary much in the Permian species. A central third of the ventral margin of the left valve overlaps an equivalent portion of the right, giving the contact-line of the ventral margins a sinuated appearance. The mode of its overlapping is this:—From each extremity, until approaching the central portion of the ventral margin, the extreme edges of each valve are somewhat produced, and lie against each other in close juxtaposition, like the valves of a conchifer; towards the centre, however, the edges become flattened and bent inwards, forming slight horizontal ledges or flanges, that of the right valve being rather smaller than the other which overlaps it. In no instance does the whole margin of one valve overlap that of the other; in no species is more than one-third overlapped, but sometimes less. The length of margin overlapped, and its width, may occasionally be of use as specific

* The term "lateral contour," is used for the outline which is seen by viewing the carapace ventrally. "Ventral aspect," is used in similar instances by others; but, as it is chiefly the contour of the sides of each valve of the carapace that is referred to when using the term, I think the former better expresses the meaning attached to it.

characters, as also its position, which is not constant, being sometimes nearer one extremity than the other.



BAIRDIA PLEBEIA, Reuss. Pl. IX., figs. 1 and 2, woodcuts 1a, 1b, 1c.

B. plebeia, Reuss. "Jahresbericht der Wetterau. Gesell. 1854," p. 67. Kirkby, "Ann. Nat. His.," 3rd ser., vol. ii., p. 324, pl. X., figs. 1 and 2.

Length, 1-13th of an inch; height, 1-30th of an inch.

Carapace subdeltoid, rather inflated centrally. *Surface* smooth. *Dorsal margin* prominently convex; *postero-dorsal region* sloping abruptly, slightly concave; *antero-dorsal region* sloping more gradually, straight, or slightly concave. *Ventral margin* straight or slightly incurved, more or less convex towards each extremity. *Anterior extremity* obliquely rounded, and rather produced. *Posterior extremity* acute, rostrated. *Lateral contour* regularly lenticular; *greatest diameter* (of lateral contour) two-thirds of the height. *Flange* of ventral margin sub-central. *Dorsal overlap* strong.

B. plebeia enjoys a great latitude of form. Figs. 1 and 2 represent what are considered to be type-specimens. Several of the most important varieties will be separately noticed, and their differences pointed out. The modification of certain specific characters in the most aberrant varieties induced me at first to describe them as distinct species. But on a careful study of a very full series of specimens, I have reduced them to their more appropriate position of varieties. In the correction of these false

determinations, I must acknowledge the kind assistance of Mr. Jones.

Though the surface of this species is described as being smooth, Mr. Jones informs me that he has seen traces of pittings on some specimens from Kamsdorf, Germany; he has also observed similar traces on examples of *B. ampla*, from Hampole, Yorkshire.

When Mr. T. R. Jones described the first-discovered specimens of this species, he referred them to the *B. curta* of M'Coy—a species found in the lower carboniferous rocks of Ireland. Subsequently Dr. Reuss met with more typical specimens in Germany, which he described, and named *Bairdia plebeia*. In the "Annals Nat. Hist." of last year, I identified a group of closely related varieties with Dr. Reuss's species, to which I at the same time referred the specimens described by Mr. Jones. However, on afterwards corresponding with the latter gentleman on the subject, I found that he was still inclined to refer all these specimens to *B. curta*. After some explanation on his part, and further examination on my own, I was disposed to come to the same conclusion. In arriving at this opinion, both Mr. Jones and myself relied upon the accuracy of Professor M'Coy's figures of *B. curta*, for up to this time we had not been able to examine specimens of that species from carboniferous strata. Fortunately, however, before the publication of these remarks, Mr. Jones received the type-specimen of M'Coy, which, when he had carefully extracted it from its matrix, so as to show its true form, proved to be a species distinct from the Permian examples. The figure given by M'Coy ("Syn. Char. Carb. Foss.," Ireland, pl. 23, fig. 6) does not represent the exact outline of the specimen, but as it appeared when partly imbedded in matrix.

In *B. curta*, the anterior extremity is acute, and differs little from the posterior extremity, except in being less produced. In *B. plebeia*, the same feature is always comparatively broad, and more or less blunt; or, to speak more precisely, the gradual antero-dorsal slope, and the quick upturn of the angle, conjoin in giving this extremity what Mr. Jones graphically terms a

"cheese-knife-like form," which holds good, more or less, in all the Permian varieties. It is the marked difference of this feature from its equivalent in *B. curta*, upon which Mr. Jones and myself chiefly rely, in considering *B. plebeia* to be a distinct species.

B. plebeia occurs plentifully in some portions of the shell-limestone at Tunstall Hill, also rarely at Humbleton Hill, and not unfrequently in the upper limestone at Byers' Quarry.

It is found in the Unter Zechstein at Bleichenbach, Selters, Gera, and near Saalfeld,* in Germany.

B. PLEBEIA, var. *CAUDATA*. Pl. IX., figs. 10, 9, and 12; and woodcuts 2, 3, and 4.

B. mucronata, Kirkby. "Ann. Nat. His." 3rd ser., vol. ii., pp. 327-328, pl. X., figs. 9-10. (Not *B. mucronata*, Reuss.)

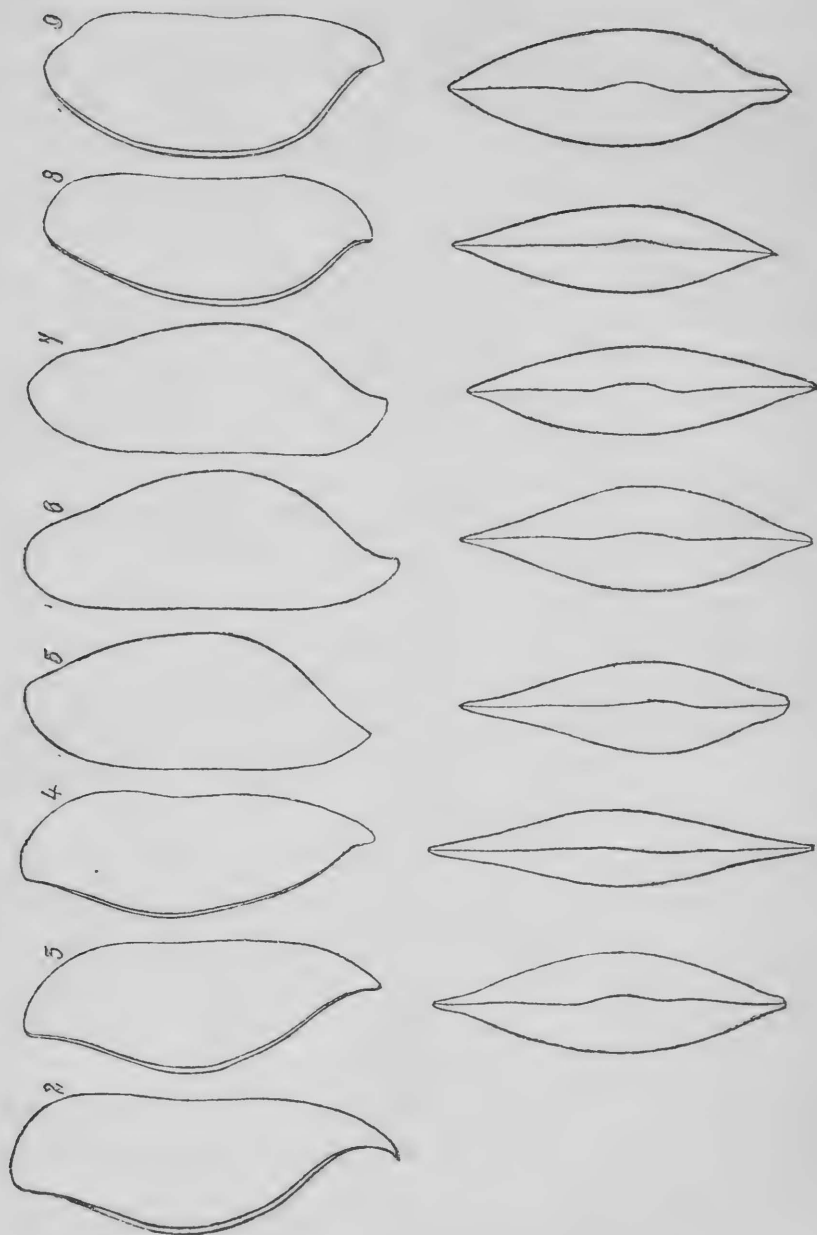
Length, 1-20th of an inch; height, 1-45th of an inch.

Carapace sub-cuneiform; *antero-dorsal region* sloping more gradually than in *plebeia proper*, and forming a sharp angle, with antero-ventral curve, which forms a bold, convex sweep to the ventral margin; *posterior extremity* produced, acutely pointed, and curving upwards; lateral contour lenticular, having the extremities more acute than in type specimens.

Var. *caudata* exhibits the broad cheese-knife-like antero-ventral curve in its greatest development. The length and acuteness of its posterior extremity is also greater than in any other variety of this species. The peculiarity of these features give to it a delicacy of outline which is unequalled among the Permian *Entomostraca*.

In classing this form as a variety of *B. plebeia*, I of course cancel my former identification of it with *B. mucronata*, Reuss,

Dr. Richter, in the "Zeitschr. deutsch. geol. Gesell.," 1855, figured and described some varieties of *B. plebeia*, namely, *B. drupacea* (pl. xxvi., figs. 10-11); *B. geinitziana* (fig. 12); *B. curta* (figs. 13-15). On Mr. Jones addressing Dr. Richter respecting the specimens found at Saalfeld, he was immediately favoured by a suite of specimens and a letter from Dr. Richter, who stated his opinion that his *B. drupacea*, and *B. geinitziana*, were certainly varieties of what he termed *B. curta*. The last appears to be a variety of *B. plebeia*.



which, in all probability, is quite distinct from the present species.

B. PLEBEIA, var. *AMYGDALINA*. Pl. IX., fig. 11; woodcut 5.

B. mucronata?, Kirkby. "Ann. Nat. His.," 3rd ser., vol. ii., p. 327, pl. X., fig. 11. (Not *B. mucronata*, Reuss.)

Carapace sub-ovate; narrow and rounded in front; obliquely acute behind; *antero-dorsal region* gently sloping; *postero-dorsal*, with a rapid slope and slight incurvature; *ventral margin* straight, with a bold curve anteriorly, and a slight curve upwards behind; *lateral contour* shows compressed extremities, especially in front, and a strong convexity a little behind the middle.

B. PLEBEIA, var. *ELONGATA*. Pl. IX., fig. 4; woodcut 6.

B. plebeia, var. *elongata*. "Ann. Nat. His.," 3rd ser., vol. ii., p. 325, pl. X., fig. 4.

Carapace elongate; *postero* and *antero-dorsal* regions sloping gradually; *anterior extremity* somewhat produced; *lateral contour* more compressed than in *B. plebeia proper*.

The present variety is *B. plebeia proper* elongated and compressed; curtail its length and increase its width, and we have the typical form of the species.

B. plebeia, var. *elongata*, is a common form at Tunstall Hill; it also occurs in a magnesian limestone at Hampole, Yorkshire.

B. PLEBEIA, var. *NEPTUNI*. Pl. IX., fig. 5; woodcut 7.

B. plebeia, var. *Neptuni*. "Ann. Nat. His.," 3rd ser., vol. ii., p. 325, pl. X., fig. 5.

Var. *Neptuni* has an elongate carapace, with the greatest convexity of dorsal margin very posteriorly situate; it consequently possesses an abrupt posterior slope, and a very gentle anterior one; its posterior extremity is broadly beaked, and its lateral contour somewhat compressed.

Besides occurring at Tunstall Hill, I have also met with this variety at Hampole, Yorkshire.

B. PLEBEIA, var. REUSSIANA. Pl. IX., fig. 6; woodcut 8.

B. Reussiana, Kirkby. "Ann. Nat. His.," 3rd ser., vol. ii., p. 326, pl. X., fig. 6.

Carapace sub-reniform; *dorsal margin* flatly convex; *ventral margin* sinuated near the centre; *postero-dorsal* region abruptly sloping; *antero-dorsal* region forming a slightly convex slope; *anterior extremity* truncated rather diagonally; *lateral contour* compressed centrally.

Although the var. *Reussiana* differs from *B. plebeia proper*, and most of its varieties, in its sinuate ventral margin, comparatively blunt and high beak, less prominent dorsal margin, and consequently greater length compared with its height, and in its compressed lenticular lateral contour, yet the varieties *Neptuni* and *elongata* link it so closely with *B. plebeia*, and its variety *caudata*, that I prefer to follow Mr. Jones' advice, and regard it as a variety, rather than to keep it distinct as a species.

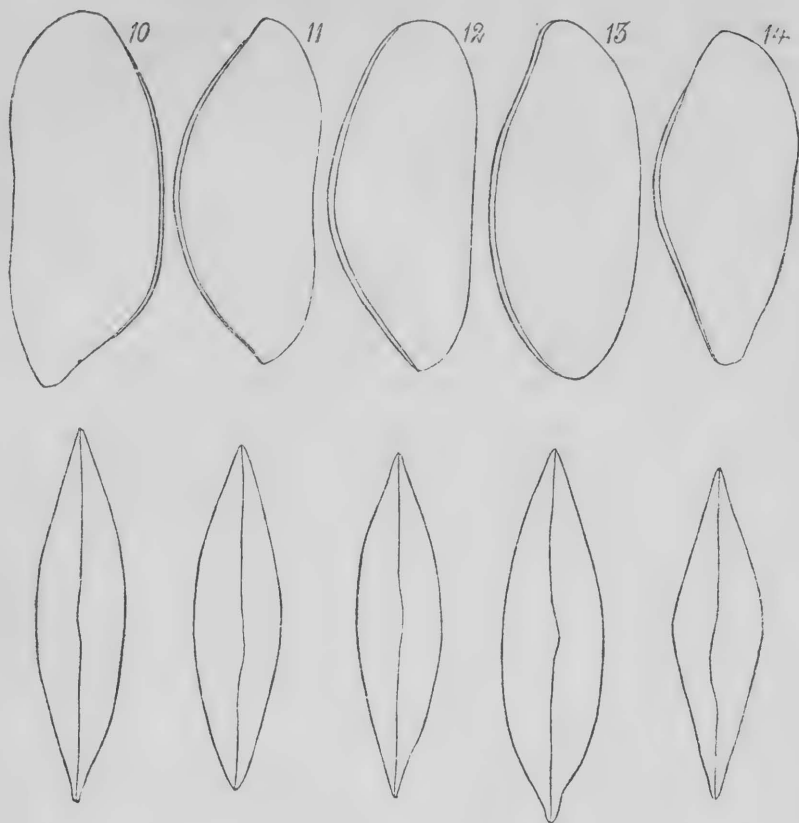
B. PLEBEIA, var. VENTRICOSA. Pl. IX., fig. 3; woodcut 9.

B. ventricosa, Kirkby. "Ann. Nat. His.," 3rd ser., vol. ii., p. 326, pl. X., fig. 3.

Carapace sub-rhomboidal, ventricose; *dorsal margin* flatly convex; *ventral margin* slightly sinuous; *postero-dorsal* region abruptly sloping, concave; *antero-dorsal* region sloping rather less abruptly, convex; *anterior extremity* diagonally truncated, angulate above, rounded below; *posterior extremity* bluntly pointed; *lateral contour* lenticular, ventricose.

I am deterred by Mr. Jones' advice from considering that the ventricosity, blunt produced posterior extremity, and angulated anterior extremity, can essentially separate this form from *Reussiana*, *Neptuni*, and other varieties of *B. plebeia*.

This variety is common at Tunstall Hill. A single specimen occurred to me at Moorhouse, Yorkshire.



B. SCHAUROTHIANA, Kirkby. Pl. IX., fig. 14; woodcut 10.

B. Schaurothiana, Kirkby. "Ann. Nat. His.," 3rd ser., vol. ii., p. 329, pl. X., fig. 14.

Length, 1-18th of an inch; height, 1-40th of an inch.

Carapace sub-hexagonal, rather ventricose dorsally; *dorsal margin* straight centrally; antero-dorsal region convex, sloping gradually to below one-third of height; postero-dorsal region very abrupt, descending two-thirds of height in a right line; *ventral margin* straight, rising abruptly to meet dorsal margin posterior, and very convex anteriorly; *anterior extremity* convex, projecting most in dorsal half; *posterior extremity* angulate, the postero-dorsal region and ventral margin forming almost a right angle; *lateral contour* almost lenticular, the greatest diameter being rather posteriorly situate; *hinge*, strong; *flange* of left ventral margin small, sub-central.

I named this species with great pleasure after Baron von Schaueroth, of Coburg, to whose assiduous researches in the Permian rocks of Germany palæontologists are greatly indebted.

Found rarely in the shell-limestone of Tunstall Hill; also in a magnesian limestone at Hampole.

BAIRDIA KINGII, Reuss. Pl. IX., fig. 8; woodcut 11.

B. Kingii, Reuss. "Jahresbericht der Wetterau. Gesell. 1854," p. 67.

B. Kingii, Reuss, Kirkby. "Ann. Nat. His.," 3rd ser., vol. ii., p. 327, pl. X., fig. 8.

Length, 1-22nd of an inch; height, 1-45th of an inch.

Carapace sub-reniform, with sharp ends; *dorsal margin* arched; *ventral margin* sinuate, becoming rapidly convex at each extremity; *anterior* and *posterior extremities* almost alike, sub-angulate; the posterior a little more angulate than the anterior; *lateral contour* lenticular, slightly concave posteriorly, *greatest diameter* centrally situate; *ventral overlap* extremely slight.

Although I have identified the form just described with *B. Kingii*, Reuss, there exists a little difference in the general outline. Reuss's figure represents the posterior extremity more pointed, and the anterior wider and rounder, than the same features in the Durham form. In other respects they agree.

It may be well to remark that the authenticity of *B. Kingii*, as a species, appears to be somewhat doubtful. Its differences scarcely seem strong enough to keep it without the circle of varieties of *B. plebeia*; but as Dr. Reuss has described it as a species, Mr. Jones and myself accept it as such for the present.

B. Kingii was first observed by Dr. Reuss in the Unter Zechstein of Bleichenbach. It is a rare species in the shell-limestone of Tunstall Hill; and as rare in magnesian limestone at Hampole, Yorkshire.

B. KINGII, var. COMPRESSA. Pl. IX., fig. 7; woodcut 12.

B. Plebeia, var. *compressa*. "Ann. Nat. His.," 3rd ser., vol. ii., p. 325, pl. X., fig. 7.

Convexity of dorsal margin regular; *anterior* and *posterior*

slopes nearly flat; *anterior extremity* less acute than in the typical form; *valves* compressed laterally, the *greatest diameter* being only a little more than half the height.

BAIRDIA? BERNICIENSIS, *Kirkby*. Pl. IX., fig. 15; woodcut 13.

B.? *Berniciensis*. "Ann. Nat. His.," 3rd ser., vol. ii., p. 330, pl. X., fig. 15.

Length, 1-25th of an inch; height, 1-55th of an inch.

Carapace sub-rhomboidal, moderately convex, smooth; *dorsal margin* convex; *antero-dorsal region* slightly concave, sloping gradually one-third of height; *postero-dorsal region* convex, sloping abruptly one-half of height; *ventral margin* somewhat convex; *anterior extremity* obliquely truncate; *posterior extremity* rounded or bluntly pointed; *lateral contour* sub-lenticular, *greatest diameter* posteriorly placed.

Not being able to make out the hingement of this specimen (having found but one), some doubts may exist as to its really belonging to *Bairdia*; but, until we know more of its affinities, it may be well to consider it a member of that group.

BAIRDIA RHOMBOIDEA, *Kirkby*. Pl. X., fig. 3; woodcut 14.

B. rhomboidea, *Kirkby*. "Ann. Nat. His.," 3rd ser., vol. ii., p. 433, pl. XI., fig. 3.

Length, 1-23rd of an inch; height, 1-50th of an inch.

Carapace sub-rhomboidal, protuberant centrally, smooth; *dorsal margin* prominently convex, sloping gradually to each extremity; *ventral margin* convex, more so anteriorly than posteriorly; *anterior extremity* convexly sub-angulate; *posterior extremity* somewhat produced, bluntly pointed; *lateral contour* lenticular; *greatest diameter* central.

Very rare in the shell-limestone of Tunstall Hill.

NOTES ON THE BAIRDIAE FROM TUNSTALL HILL, BY MR. T. RUPERT JONES, F.G.S.

With regard to the majority of the specimens collected by Mr. Kirkby, the valves are so well preserved that every important feature, except the muscle-spots, can be readily distinguished.

This is much more so than with the specimens found in the upper limestone at Byers' Quarry. Owing to this circumstance, we can recognise the peculiar deltoid shape, hingement, and the dorsal and ventral overlap of the sub-genus *Bairdia* in many specimens. A very characteristic suite of these has been selected and figured by Mr. Kirkby, besides some of the *Cytheridæ*, which do not (to me) appear to belong to *Bairdia*.

At first sight it appears easy to sort out several carapaces and valves of the *Bairdiæ* specifically distinct one from another; but, on arranging the specimens (or drawings of them) in series, according to certain modifications of their marginal outline, it becomes a far more difficult task to satisfy one's self where anything like specific boundaries occur between them. The sub-deltoid *Bairdiæ* occur fossil in several formations, and recent in existing seas, and they present many varieties but little different one from another, as far as the valves can show. There may be specific differences of structure in the organs of the animals possessing the several varieties of carapace; but of this we can say nothing, for we know but very little of the animals. Giving the greatest possible value I can to the differences observable in the carapaces of the Permian specimens, I should say that figs. 1 and 2 (pl. IX.), represent the normal form of the *Bairdia plebeia* of Reuss—or at least that well-marked, sub-deltoid form of the species which Dr. Reuss described. Figs. 10, 9, and 12, represent a narrow and acute form of the same species. Figs. 11, 4, 5, 6, and 3, are from specimens which graduate from the sub-deltoid to a sub-oblong form; every grade of the change is readily found. In these varieties the lateral contour varies within certain limits as to the lenticularity of the outline; a strong middle overlap of the ventral margin is nearly always present. Fig. 14 represents a nearly parallelopipedal carapace, in which the approach to rectangularity is carried so far that we seem to have overstepped a specific limit; but even its modification of shape, and greater size, do not give me any great confidence in regarding it as a distinct species.

Until recently I was disposed to consider all the above varieties as belonging to the carboniferous species *Bairdia curta*,

M'Coy. The differences observed between the specimens of Reuss and Kirkby, on the one hand, and the figures and description of Professor M'Coy, appeared to be of less importance than what was necessary to constitute specific distinction. A short time ago I received, by Sir R. Griffith's kindness, the original specimen of *B. curta*; and, when I had carefully worked it out from its matrix, I saw that the exact outline of the species was not represented in M'Coy's figure, and that the points of difference were quite sufficient to warrant *B. curta* and *B. plebeia* being considered distinct species. These differences I have pointed out to Mr. Kirkby, who mentions them in his remarks on *B. plebeia* and its varieties.

The shapes of figs. 8 and 7 (woodcuts 11 and 12) seem to be less readily traced into the contours of any of the varieties of *B. plebeia*, but approximate to each other; and, therefore, I imagine that they may belong to a distinct species. The lateral contour in these two varieties equally show but a slight ventral overlap. Fig. 15 (woodcut 13) is a peculiar form, almost elliptical; it appears, nevertheless, to be a *Bairdia*; and the same may be said of fig. 3, plate X. (woodcut 14).

CY THERE (*Cytherideis*) JONESIANA, Kirkby. Pl. X., figs. 1, 2.

Bairdia gracilis, Reuss. "Jahres. Wetterau Gesell., 1854," p. 65, fig. 3 (fig. 2?).

B. Jonesiana, Kirkby. "Ann. Nat. His.," 3rd ser., vol. ii., p. 432, pl. XI., figs. 1, 2.

Length, 1-25th of an inch; height, 1-55th of an inch.

Carapace reniform, convex, smooth; *dorsal margin* regularly arched; *antero-dorsal region* convex, gradually sloping to anterior extremity; *postero-dorsal region* convex, abruptly sloping to posterior extremity; *ventral margin* sinuate centrally, convex near extremities; *anterior extremity* bluntly rounded; *posterior extremity* obtusely pointed; *lateral contour* compressed oval, the posterior end most acute; *greatest diameter* central, one-third of the length; *flange* of left ventral margin large, being fully one-third of the length.

The chief variation of form shown by this species is in the dorsal margin, which is more prominent in some individuals than in the majority. Fig. 2, pl. X., illustrates this variety.

C. Jonesiana resembles in many respects the *Cythere Geinitziana** of Jones, which appears to be a closely related form. The dorsal margin of the latter, however, is more flatly convex, its posterior extremity is more acutely pointed, and medianly placed, and the sinus of the ventral margin is deeper than the same feature in *C. Jonesiana*. The lateral contour is peculiar also, being ovate, while that of *C. Geinitziana* is a flattened oval, with rather acute extremities. In these particulars it differs from the present species; and I allow them specific value.

Most of the specimens of this species which have occurred at Tunstall Hill are coated with a thin deposit of calcareous matter; and it is not until this is removed that the hingement of the carapace can be detected.

It is not rare in the shell-limestone of Tunstall; it also occurs at Hampole, Yorkshire. In Germany it is found in the Unter Zechstein of Bleichenbach and Selters.

C. Jonesiana is named after my friend Mr. T. Rupert Jones, to whom I am indebted for several courteous communications on Permian *Entomostraca*.

NOTE BY MR. T. R. JONES ON *CYTHERE JONESIANA*, KIRKBY.

C. Jonesiana (Kirkby) and *C. Geinitziana* (Jones) are, without doubt, closely allied to each other, and to the forms termed by Reuss *Bairdia frumentum* and *B. gracilis*. Indeed, there are very many *Cytheres*, both recent and fossil, having modifications of this form of carapace, such as *C. flavida*, *C. angusta*, &c.; and it is often hazardous to distribute the fossil valves into specific groups, there being little except slight differences of marginal outline and lateral contour to be taken as criterions. Still less can we feel satisfied either in distinctions or synonyms, when we have only plain lithographs (in the case of many of the foreign *Entomostraca*) to judge by. For the present, we had better keep provisionally distinct the best marked forms, until we can

* Jones, in "King's Mon. Perm. Foss.," p. 62, pl. XVIII., fig. 4, a, b, c.

see all the specimens side by side, when perhaps some of the now apparent differences will melt away through easy gradations of size and contour.

These *Cytheres*, having a more or less elongate, kidney-shaped outline, have thin valves, like those of *Bairdia*, with internal marginal laminae, and more or less overlapping dorsal and ventral edges; but with this distinction, the two valves are not such unequal contributors to the hinge-line as they are in *Bairdia*. In the latter, the dorsal edge of the right valve is pared down, as it were, and wholly overlapped by the opposite valve; whereas in this other group (*Cytherideis*, "Monog. Tert. Entom. Engl.," p. 46), the right valve is not always overlapped, retains its thickness (it is indeed sometimes thickened), and often presents slight folds or knobs, sufficient, in some instances, to help in marking out one or both ends of the hinge-line on the closed carapace. (See, for instance, "Monog. Cret. Entom.," pl. 6, fig. 18a).

At the same time we must remember that the hingement of these *Entomostraca* is variable, and that in *Cythere proper*, and its sub-genera, there are endless modifications, forming gradual passages from a hingement almost as simple as the mere meeting of the dorsal edges in *Cypris*, to the strongly-toothed hinge-work of the thickest *Cythereis*. In accordance with this variability of hinge, *Cytherideis Jonesiana* is, I may remark, certainly nearer to *Bairdia* in the structure of the hinge-line than many others of the sub-genus. Nevertheless, there is a distinct thickened hinge-line in the specimens before us; it occupies the middle-third of the dorsal border. (Pl. XI., fig. 24c.)

The inclination to develope toothed or notched terminations to the hinge-line, the sub-reniform shape and more obtuse extremities, the less uniform lenticularity of the lateral contour, and a different plan in the arrangement of the "lucid spots" (as far as I have yet had opportunities of noticing), are the characters which separate this group (*Cytherideis*) from its fellow sub-genus *Bairdia*. These characters are not to be always readily distinguished; but when some are present, we may hazard the supposition that the others would appear in well-preserved specimens.

By carefully looking for the distinctions above-mentioned, I believe that many of the *Bairdia* of palæontologists will be found to belong to *Cytherideis*.

The animal of *Cytherideis* (as far as yet studied) appears to be truly a *Cythere*.

The form referred by Dr. Reuss ("Jahres. Wetter. Ges. 1854," p. 65, fig. 3, and possibly fig. 2), to *Bairdia gracilis*, M'Coy, seems to me (as already indicated also by Mr. Kirkby) to be a narrow variety of the species here termed *C. Jonesiana*. I believe that M'Coy's *B. gracilis* (though I have not yet seen the specimen) is a true *Bairdia*; Dr. Richter's specimen of *B. gracilis* ("Zeitsch. Geol. Gesell.," vol. vii., p. 530, pl. 26, figs. 16, 17) also appears to be a *Bairdia*; and I may say the same of the very imperfect specimen from Byers' Quarry, indicated in the "Monog. Perm. Foss.," pl. 18, fig. 7.

CY THERE SUB-RENIFORMIS,* *Kirkby*. Pl. IX., fig. 13.

Bairdia reniformis, Kirkby. "Ann. Nat. His.," 3rd ser., vol. ii., p. 329, pl. X., fig. 13.

Length, 1-35th of an inch; height, 1-75th of an inch.

Carapace sub-reniform, flatly convex, obtuse marginally, smooth; *dorsal margin* almost straight centrally, but slightly inclined towards the anterior extremity; *antero-dorsal region* convex, sloping quickly to anterior extremity; *postero-dorsal region* convex, abruptly falling two-thirds of height; *ventral margin* convex towards extremities, with a rather deep sinus anteriorly situate; *anterior extremity* rounded; *posterior extremity* obtusely pointed; *lateral contour* sub-lenticular, compressed, convex towards the extremities, more so posteriorly than anteriorly; *greatest diameter* central, rather more than one-fourth of length; *hinge* with left dorsal margin moderately overlapping the right.

C. sub-reniformis has some resemblance to *Bairdia Schaurothiana*. It is distinguishable, however, by its more *Cythere*-like

* The term *reniformis* being pre-occupied, I have changed the specific name of this species to *sub-reniformis*.

form. *B. Schaurothiana* has straighter dorsal and ventral margins than the present species; it is more produced anteriorly, and its posterior extremity is angulate; in lateral contour it differs in the acuteness of its extremities, and in the position of its greatest diameter; and its dorsal overlap is decidedly greater.

C. sub-reniformis has only occurred to me at Tunstall Hill, where it is extremely rare.

NOTE BY MR. T. R. JONES ON *CYTHERE SUB-RENIFORMIS*, KIRKBY.

Mr. Kirkby has already noticed his recognition of the *Cythere*-like aspect of the carapace of this species, and its similitude to the recent *Cythere reniformis* and *C. albomaculata*. I cannot think that we have here the carapace of a *Bairdia* or even of a *Cytherideis*. In fact, the carapace reminds us very strongly of *Cythere albomaculata*; and it is only its greater relative length, and some slight differences of marginal outline, that support a specific distinction. The dorsal border appears to me to present a much more definite hinge-line (occupying the middle two-fourths of the dorsal border, pl. XI., fig. 23c) than Mr. Kirkby's figure shows.

CYTHERE AMPUTATA, Kirkby. Pl. X., fig. 4.*

Bairdia truncata, Kirkby. "Ann. Nat. His.," 3rd ser., vol. ii., p. 423, pl. XI., fig. 4.

Length, 1-25th of an inch; height, 1-60th of an inch.

Carapace sub-rhomboidal, obliquely truncated at the extremities, straight on the back, and slightly inflated ventrally at the anterior half, gently swollen near the centre of each valve, and compressed towards the borders; *ventral margin* somewhat sinuate, but almost straight; *antero-dorsal region* nearly straight, sloping to anterior extremity; *postero-dorsal region* slightly convex, sloping abruptly downwards and forwards to the posterior extremity, and parallel with the antero-dorsal border; *dorsal margin* straight, with a sub-angular projection at the anterior hinge, near the anterior extremity, and terminating pos-

* In this figure the margin of the carapace placed uppermost is the ventral, and the lower one is the dorsal,

teriorly in a blunt point; *anterior extremity* prominent, rounded, bordered by a flattened marginal rim; *posterior extremity* diagonally truncate; *lateral contour* somewhat boat-shaped, tapering quickly in front, blunt behind; *greatest diameter* in anterior half, at two-sevenths of length; *contact-line* of valves straight on both ventral and dorsal borders.

A curiously similar but distinct species has been figured and described by K. von Seebach ("Zeitsch. Deutsch. Geol. Gesell. 1857," p. 201, pl. 8, fig. 4), under the name of *Cythere dispar*, from the Keuper of Thuringia.

Mr. Jones tells me that a tertiary species has been named *Cythere truncata*, by Bosquet, so it has been necessary to alter the specific name of the present species, which I have done by substituting *amputata*, as being similarly expressive of the truncated appearance of its posterior extremity.

C. amputata is rather rare in the shell-limestone of Tunstall Hill.

NOTE BY MR. T. R. JONES, ON *CY THERE AMPUTATA*, KIRKBY.

We have here a very interesting and peculiar form, in which the hinge-line is well developed: the anterior hinge, in particular, being strongly marked externally, judging from the cast, which also shows the dorsal margins of the valves peculiarly flattened out. The compressed and obliquely rounded anterior border—the central swelling of the valves—the straight and thin-edged back, and the obliquely truncated hinder end, with its projecting dorsal angle, (the margins of the two extremities being nearly parallel), characterise this species. (See pl. XI., fig. 22.)

Besides the species of *Bairdia*, *Cytherideis*, and *Cythere* proper, already noticed, there appear to be one or two additional forms belonging to the fauna of the shell-limestone, which may subsequently be established as species. Specimens have occurred to me which seem to imply this idea; but owing to a paucity of materials, and in some cases to an apparent affinity to described

species, I have not ventured to specialise them. There was one well-marked individual of triangular contour, which was unfortunately lost after it had been outlined, and which, I have little doubt, was the *Cythere acuta* of Jones; it was minute and exceedingly globose, and had the ventral margin almost straight, and its dorsal margin convex; its extremities were acute and alike.

Before closing my remarks on the Permian *Entomostraca*, I cannot but express how greatly I am indebted to Mr. T. Rupert Jones, for his valuable and ever-ready assistance during my later researches on these fossils. Many of the corrections made in this revise are due to his suggestion. And besides adding notes to the species, from the shell-limestone described by me, he has kindly undertaken to revise his descriptions of those species peculiar to the upper limestone, so that they may be printed along with this paper, and complete the list of *Entomostraca* belonging to the Permian rocks of Durham.

ENTOMOSTRACA FROM THE UPPER PERMIAN LIMESTONE OF BYERS'

QUARRY. BY T. RUPERT JONES, F.G.S.

IN critically examining, at the request of Mr. Kirkby, his collection of *Entomostraca*, from the shell-limestone of Tunstall Hill, my attention was necessarily re-drawn to my figures and descriptions of Permian *Entomostraca*, published in Professor King's "Monograph of the Permian Fossils of England" (Palæont. Soc., 1849); and I find some points on which remarks and amendments may be advantageously made, especially as it appears desirable that the species there described should be again briefly noticed in the completion of an account of the Permian *Entomostraca* of Durham, for the Tyneside Naturalists' Field Club.

The forms described in the monograph as *Dithyrocaris Permiana* and *D. glypta*, have already been re-described by Mr. Kirkby and myself as *Kirkbya Permiana*, in the preceding memoir.

The generic and sub-generic characters of *Cythere* and its subgroups will be found more especially in my "Monograph of the

Cretaceous Entomostraca of England," 1849; in that of the "Tertiary Entomostraca" (Palæont. Soc., 1856); and in Mr. Kirkby's memoir preceding this notice.

I find, on breaking up the remaining fragments of magnesian limestone (from Byers' Quarry), with which Professor King favoured me in 1847-8, and also by reference to my first drawings, that I have some additional materials of which I can make use with advantage in improving and adding to my notices of the species; especially in reminding me of those links of variation which I regarded as existing within the limits of certain species, some of the typical forms of which I gave in my figures.

In my former descriptions of these *Entomostraca*, I doubtfully placed some with *Cythereis* and *Cytherella*. But I think it better to withdraw these provisional references, until we know something more certain of the fossil species, and, in the meantime, I use the genus *Cythere* in its fullest sense. The *Bairdia*, however, are so characteristically featured, that we have seldom any difficulty in determining the individuals belonging to this sub-genus.

By the kindness of Sir R. Griffith, I have been enabled to examine, at my leisure, the specimen on which the species *Bairdia curta* was determined by M'Coy. Mr. Kirkby has already noticed (p. 142) its characteristic features as contrasted with *B. plebeia*.

I regret that it has not yet been in my power to compare the Carboniferous *Entomostraca* described by Count Münster with those before us. It is very desirable that we should have more than a few words of description, as the means of comparison in determining the *C. elongata*.

Dr. Richter having favoured me with a series of specimens from Saalfeld, and also with some remarks on them, I am enabled to correlate his figures with our own.

CYTHERE, Müller.

1. *C. MORRISIANA*, Jones. Pl. XI., figs. 1*a*, 1*b*, 1*c*.

Cythere Morrisiana. Jones, in "King's Monograph Perm. Foss.," p. 61, pl. 18, figs. 2*a*, 2*b*, 2*c*.

Carapace irregularly oblong, convex, smooth; *dorsal* and

ventral borders straight, slightly incurved; *extremities* sub-acute, suddenly depressed; the *anterior* slightly narrower than the *posterior*; *dorsal aspect* elongate oval, compressed at the ends; *anterior* sub-ovate.

This was most probably a true *Cythere*.

From Byers' Quarry and Humbleton. Rare.

2. *C. ELONGATA*, Münster.(?) Pl. XI., fig. 2.

Cythere elongata, Münster. "Jahrbuch f. Min. 1836," p. 65, no. 19; Jones, in "King's Monog. Perm. Foss.," p. 62, pl. 18, fig. 5.

Carapace bean-shaped, smooth, convex; *dorsal* and *ventral borders* slightly incurved at the middle; *extremities* rounded, the *anterior* more obliquely than the *posterior*.

Münster's description of *C. elongata* (from the Bergkalk of Regnitzlosau), is very succinct; but, as far it goes, is applicable to this species. A very similar form (*Cythere proper*) lives in the Mediterranean.

A single specimen, imbedded in a fragment of magnesian limestone, dredged up near the Dogger Bank.

3. *C. KUTORGIANA*, Jones. Pl. XI., figs. 3*a*, 3*b*. Jones, in "King's Monog. Perm. Foss.," p. 62, pl. 18, fig. 6.

Carapace somewhat bean-shaped, or resembling a peach-stone, convex; *dorsal border* elliptical; its contact margin thickened and bearing traces of hinge; *ventral* sinuous; *anterior extremity* obliquely rounded; *posterior* acute.

Fig. 3*b* represents a larger and relatively narrower individual than fig. 3*a*, which was the specimen figured in the "Monog. Perm. Foss." This form of carapace is common among the group of *Cythere proper*.

Not common at Byers' Quarry.

4. *C. GEINITZIANA* Jones. Pl. XI., figs. 4*a*, 4*b*, 4*c*. "King's Monog. Perm. Foss.," p. 62, pl. 6, fig. 46; pl. 18, figs. 4*a*, 4*b*, 4*c*.

Carapace elongate reniform, convex, smooth, slightly punctuated towards the anterior extremity; rounded anteriorly,

bordered with a slight, narrow, raised rim, and somewhat depressed; tapering and more convex posteriorly; *ventral border* sinuous; *dorsal* elliptical, shelving downwards posteriorly to form a sub-acute angle with the ventral border; *dorsal aspect* elongate ovate; *anterior* broadly ovate.

From Humbleton. Very rare.

Dr. Reuss's *Bairdia frumentum* ("Jahresb. Wetter. 1848," p. 68, fig. 8), is not unlike *C. Geinitziana* in outline.

5. *C. BIPPLICATA*, Jones. Pl. XI., figs. 5*a*, 5*b*.

Cythere (*Cythereis*?) *biplicata*. Jones, in "King's Monog. Perm. Foss.," p. 63, pl. 18, fig. 8.

Carapace sub-ovate, convex, bearing two short, longitudinal rounded ridges, near the middle of the valve; *dorsal* and *ventral* borders elliptical; *anterior extremity* rounded; *posterior* acute.

Fig. 5*b* is a larger individual than the one figured in the "Monog. Perm. Foss." (fig. 5*a*), and exhibits a modified form of the plication or slight superficial ridge.

From Byers' Quarry. Rare.

6. *C. INORNATA*, M'Coy. Pl. XI., fig. 6. M'Coy "Syn. Char. Carb. Foss.," p. 167, pl. 23, fig. 18.

Cythere (*Cytherella*?) *inornata*. Jones, in "King's Monog. Perm. Foss.," p. 63, pl. 18, fig. 9.

Cytherella inornata, Richter. "Zeitsch. Deut. Geol. Ges.," vol. vii., p. 529, pl. 26, figs. 6, 7.

Carapace nearly oblong, sub-reniform, smooth, convex; *dorsal border* elliptical; *ventral* almost straight; *anterior extremity* obliquely rounded; *posterior* semicircular.

From Byers' Quarry. Rare.

Dr. Richter has specimens of this species from the Zechstein of the Saalfeld district.

7. *C. NUCIFORMIS*, Jones. Pl. XI., figs. 7*a*, 7*b*, 7*c*.

Cythere (*Cytherella*?) *nuciformis*. Jones, in "King's Monog. Perm. Foss.," p. 64, pl. 18, figs. 11*a*, 11*b*, 11*c*.

Cytherella nuciformis, Reuss. "Jahresb. Wetter. Geo. 1854," p. 68, fig. 9.

Cytherella nuciformis, Richter. "Zeitsch. Deut. Geol. Ges." vol. vii., p. 529, pl. 26, figs. 8, 9.

Carapace oblong-oval, smooth, convex; dorsal and ventral borders elliptical; extremities rounded; anterior depressed, rather narrower than the posterior; dorsal aspect compressed, ovate; anterior oval.

From Byers' Quarry. Rather rare.

Professor Reuss and Dr. Richter have met with this species in the German Zechstein.

This little species has a somewhat similar form to that of *Cytherella Muensteri* (Roemer sp.) of the Chalk and the Tertiary beds. See "Jones' Monog. Tert. Entom.," p. 56. Forms of carapace not very dissimilar to *C. inornata* and *C. nuciformis* occur with other *Cytheres* in the carboniferous limestone of Kilbride, near Glasgow.

8. *C. (Bairdia) PLEBEIA*,* Reuss. Pl. XI., fig. 8.

Cythere (Bairdia) curta, Jones (not M'Coy), in "King's Monog. Perm. Foss.," p. 61.

Bairdia plebeia, Reuss. "Jahresb. Wetter. Gesell. 1854," p. 67, fig. 5a, 5b.

Cythere (Bairdia) plebeia, Kirkby. See above, p. 141.

The specimen here figured is from Byers' Quarry, and has its carapace well preserved. It presents the usual form of the typical *B. plebeia*, with its well rounded antero-ventral border. It was not figured in the "Monog. Perm. Foss."

Specimens of *Bairdia* (*B. plebeia* and its varieties) are not uncommon at Humbleton and Byers' Quarry; but at the latter place, especially, they are very imperfectly preserved.

9. *C. (Bairdia) PLEBEIA*, Reuss. Var. *BREVICAUDA*. Pl. XI., figs. 9a, 9b, 9c.

* Dr. Richter has figured and described some varieties of *B. plebeia* ("Zeitsch. Deut. Geol. Ges.," vol. vii., pl. 26, figs. 10-15), under the name of *Bairdia drupacea*, *B. Geinitziana*, and *B. curta*. Dr. Richter himself has determined that the two former are varieties of the last, which is the synonym for *B. plebeia*, and which we now wish to withdraw.

Cythere (Bairdia) curta. Jones, in "King's Monog. Perm. Foss.," p. 61, pl. 18, figs. 3a, 3b, 3c. (Not *Bairdia curta*, M'Coy.)

Carapace sub-triangular, convex, smooth, sometimes faintly punctate; *dorsal border* arched; *ventral* sinuous; *anterior extremity* produced, rounded on its ventral half, slightly sinuous dorsally; *posterior* broadly angular, its angle nearly equal and median; *dorsal aspect* narrow, acute, oval; *anterior* compressed, oval.

This form agrees with *B. plebeia*, var. *caudata*, in the curved cultrate border of the anterior ventral region, so characteristic of the species; but it presents a strong contrast to the above-mentioned variety, in its being curtailed posteriorly.

10. *C. (Bairdia) PLEBEIA*, Reuss. Var. RHOMBICA. Pl. XI., figs. 10, 11, 12a, 12b.

We have here a variety of *B. plebeia*, in which the long anterior dorsal slope, the obtuse and nearly equal-angled posterior extremity, and the nearly straight ventral margin, passing into the broad but not prominent hatchet-edge of the front ventral region, give a rigid and near rhomboidal aspect to the carapace. This, at least, is the chief feature in fig. 10, and figs. 11 and 12 are placed with it, as differing but little from it except in size.

11. *C. (Bairdia) PLEBEIA*, Reuss. Var. GRANDIS. Pl. XI., figs. 13a, 13b.

Cythere (Bairdia) curta, Jones, in "King's Monog. Perm. Foss.," p. 64, pl. 17, figs. 21, 22. (Not *Bairdia curta*, M'Coy.)

A single cast (from Humbleton), indicates a *Bairdia* of twice the size of the common specimens; but it offers nothing but its greater size to distinguish it from the smaller forms. It is not very dissimilar to *B. affinis*, Morris, "Strzelecki's Phys. Descript. New South Wales, &c." p. 291, pl. 18, fig. 10.

12. *C. (Bairdia) AMPLA*, Reuss. Pl. XI., figs. 14a, 14b, 14c.

Bairdia ampla, Reuss. "Jahresb. Wetter. Ges. 1854," p. 68, figs. 7a, 7b.

Carapace irregularly ovate, showing but little of the triangularity of the *Bairdia*; *dorsal margin* rounded; *ventral* slightly sinuous; *extremities* obtusely angular. The plumpness and large size of the carapace well deserve the name adopted by Dr. Reuss for this species.

It occurs at Byers' Quarry. It has been collected by Mr. Kirkby from the magnesian limestone of Hampole, Yorkshire. Professor Reuss had it from the Zechstein of the Wetterau.

13. C. (*Bairdia*) GRACILIS, M'Coy (?). Pl. XI., fig. 15.

Bairdia gracilis, M'Coy. "Syn. Char. Carb. Foss.," p. 164, pl. 23, fig. 7.

Bairdia gracilis, Jones, in "King's Monog. Perm. Foss.," p. 63, pl. 18, fig. 7.

Bairdia gracilis, Reuss. "Jahresb. Wetter. Ges. 1854," p. 65, fig. 2a, 2b.

Bairdia gracilis, Richter. "Zeitschrift Deut. Geol. Ges.," vol. vii., p. 530, pl. 26, figs. 16, 17.

A cast (from Byers' Quarry), much worn, of a carapace nearly allied to *B. plebeia*, but very much narrower; probably Professor M'Coy's *B. gracilis*.

A form like this has been found in the German Zechstein by Professor Reuss and Dr. Richter.

14. C. (*Bairdia* ?) ACUTA, Jones. Pl. XI., fig. 16.

Cythere (*Bairdia* ?) *acuta*. Jones, in "King's Monog. Perm. Foss.," p. 63, pl. 18, fig. 10.

Carapace sub-triangular, smooth, convex; *dorsal border* rounded, produced; *ventral* nearly straight; *extremities* acute.

From Byers' Quarry. Not very rare.

Mr. Kirkby believes that he has met with this species at Tunstall Hill.

We add a table of Permian Entomostraca, in which are included those species not found in England; the latter are reduced to the nomenclatorial system adopted in the preceding papers.

TABLE OF PERMIAN ENTOMOSTRACA, ILLUSTRATIVE OF THEIR DISTRIBUTION.

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ON PERMIAN ENTOMOSTRACA FROM

NAMES OF GENUS, SPECIES, &c.	DISTRIBUTION.					REMARKS.
	Shell-Limestone, Durham.	Upper Permian Limestone, Durham.	Lower Permian Limestone, Yorkshire.	Zechelein, Germany.	Permian, Russia.	
<i>Kirkbya Permiana</i> , Jones	*	*	*	This is well represented by varieties in Germany and Russia.
———, var. 1. <i>glypta</i> , Jones	*	
———, var. 2. <i>Roessleri</i> , Reuss	*	
———, var. 3. <i>Richteriana</i> , Jones.....	*	*	
———, var. 4. <i>sticta</i> , Keyserling	*	
———, var. 5. <i>Schrenkii</i> , Keyserling	*	
———, var. 6. <i>grapta</i> , Keyserling.....	*	Like a <i>Leperditia</i> in shape.
<i>Cythere? recta</i> , Keyserling.....	*	
<i>Cythere Morrisiana</i> , Jones.....	*	*	{ Found in a fragment of magnesian limestone (containing fossils peculiar to the shell-limestone), which was dredged from near the Dogger Bank. <i>Cyth. elongata</i> was first described by Count Münster, as occurring in the mountain-limestone of Bavaria.
——— <i>elongata</i> , Münster	*?	
——— <i>Kutorgiana</i> , Jones.....	*	
——— <i>biplicata</i> , Jones.....	*	
——— <i>Geinitziana</i> , Jones.....	*	{ <i>Cyth. inornata</i> was described by M'Coy, from the carboniferous shales of Ireland.
——— <i>inornata</i> , M'Coy	*	
——— <i>nuciformis</i> , Jones	*	From the magnesian limestone of Tullyconnell, Tyrone, Ireland.
——— <i>sub-reniformis</i> , Kirkby.....	
——— <i>amputata</i> , Kirkby.....	*	
——— <i>Tyronica</i> , Jones.....	
——— <i>bituberculata</i> , Reuss.....	*	This is somewhat like <i>C. nuciformis</i> , Jones.
——— <i>Richteriana</i> , Jones.....	*	
——— <i>Pyrhæ</i> , Eichwald.....	*	

NAMES OF GENUS, SPECIES, &c.	DISTRIBUTION.					REMARKS.
	Shell-limestone, Durham.	Upper Permian Limestone, Durham.	Lower Permian Limestone, Yorkshire.	Zechstein, Germany.	Permian, Russia.	
<i>Cythere?</i> <i>Cyclas</i> , Keyserling.....				*		{ Somewhat like an <i>Estheria</i> in shape, judging from Keyserling's figure.
<i>Cythere</i> (<i>Cytherideis</i>) <i>Jonesiana</i> , Kirkby	*	*	*	*		
<i>frumentum</i> , Reuss				*		
<i>Cythere</i> (<i>Bairdia</i>) <i>plebeia</i> , Reuss.....	*	*		*		Found by M'Coy in the carboniferous rocks of Ireland.
, var. 1. <i>caudata</i> , Kirkby	*					
, var. 2. <i>amygdalina</i> , Kirkby.....	*					
, var. 3. <i>elongata</i> , Kirkby.....	*		*			
, var. 4. <i>Neptuni</i> , Kirkby.....	*					
, var. 5. <i>Reussiana</i> , Kirkby.....	*					
, var. 6. <i>ventricosa</i> , Kirkby.....	*		*			
, var. 7. <i>brevicauda</i> , Jones		*				
, var. 8. <i>rhombica</i> , Jones.....		*				
, var. 9. <i>grandis</i> , Jones.....	*					
, var. 10. <i>drupacea</i> , Richter				*		
<i>Cythere</i> (<i>Bairdia</i>) <i>ampla</i> , Reuss.....		*	*	*		
<i>gracilis</i> , M'Coy		*				
<i>acuta</i> , Jones.....	*	*				
<i>Schaurothiana</i> , Kirkby.....	*		*			
<i>Kingii</i> , Reuss.....	*			*		
, var. <i>compressa</i> , Kirkby.....	*					
<i>Berniciensis</i> , Kirkby.....	*					
<i>rhomboidea</i> , Kirkby.....				*		
<i>mucronata</i> , Reuss.....				*		

APPENDIX.



To complete our account of Permian Entomostraca, figs. 17—25 are added, as illustrative of species either new or requiring further illustration.

1. CYTHERE (*Bairdia*) PLEBEIA, *Reuss*. Var. CAUDATA, Kirkby.
Pl. XI., figs. 17, 18a—18c.

In this variety (see Mr. Kirkby's description, p. 141) the posterior extremity (the lowest end in the figures) is drawn out into a sharp, upturned point. It is strikingly contrasted with the short-angled hinder extremity in varieties illustrated by figs. 9 and 10, and also with the tapering, but obtuse angle of this extremity in fig. 8. The anterior hatchet-shaped or cheese-knife-like border is broadly developed also in figs. 17 and 18a, even more so than in any of the figures in plate IX. These two specimens are selected from a series forwarded to me by Mr. Kirkby, and collected by him at Tunstall Hill, near Sunderland.

2. C. (*Bairdia*) AMPLA, *Reuss*. Pl. XI., figs. 19a—19f.

The specimen here figured is far more perfect than that shown in fig. 14. This broad, thick, and symmetrical carapace, with its obtuse and almost equal extremities, reminds us, like the other *Bairdia*, of the Scythian bow in its outline. This specimen was collected by Mr. Kirkby from the magnesian limestone of Hampole, in Yorkshire. It exhibits traces of surface-ornament in the form of minute punctation (fig. 17f).

3. C. TYRONICA, spec. nov. Pl. XI., figs. 20a.—20b.

Cythere? inornata, M'Coy. King and Jones, "Journ.
Geol. Soc., Dublin," vol. vii., p. 69, note and p.
78; pl. 1, fig. 13.

I have seen only two single valves of this Entomostracan. They

were found by Professor W. King, at Tullyconnel, near Artrca, county Tyrone, Ireland, and were forwarded by him to me for examination; and sketches of them, with my remarks, were published in Professor King's paper on Irish Permian Fossils in the "Journal of the Geological Society of Dublin," vol. vii., 1856.

The specimens indicate a somewhat almond-shaped carapace, nearly straight on the ventral, and obliquely arched on the opposite border, tapering somewhat anteriorly, and fuller and rounder behind. In shape it approaches *C. inornata*, M'Coy (a Carboniferous species, to which some Permian individuals have been referred, see p. 170), but it is proportionably narrower, and of much greater size. Specific differences are difficult to be satisfactorily recognised in the very similarly shaped carapaces of *Cytheres* of this type, especially in the fossil state; nevertheless, for the sake of registering this Irish Permian form, I propose to term it *Cythere Tyronica*.

4. *C. RICHTERIANA*, spec. nov. Pl. XI., figs. 21*a*—21*c*.

The specimen here figured (from the Zechstein of Koenitz) was placed in my hands some years ago by Professor King, and I take this opportunity of describing it.

Carapace bean-shaped, convex, compressed anteriorly, flattened above and below, smooth, punctate; rounded at the ends; anterior rather narrower than the posterior extremity, and less symmetrically outlined; back faintly arched; ventral border gently sinuate. Valves margined, except along the hinge-line, with a very narrow flattened rim, strongest round the ends. In profile the carapace is acutely ovate or lanceolate; in cross section, sub-quadrate.

This is a well marked species; and I dedicate it with much pleasure to my obliging friend Dr. Richter, of Saalfeld, who has added considerably to our knowledge of palæozoic fossils.

5. *C. AMPUTATA*, *Kirkby*. Pl. XI., figs. 22*a*—22*d*.

This species is described in full by Mr. Kirkby, at p. 155. The figures here given do not essentially differ from those given

in plate X., but define more clearly the features of the anterior extremity with its compressed edge, and the dorsal surface with its hinge-line. We must remember that it is only a cast that we have before us; Mr. Kirkby has collected several specimens of casts with portions of the valves attached, and these remind us that possibly the profile of the carapace itself differs somewhat from that of the cast, especially as regards the attenuated margins.

6. *C. SUB-RENIFORMIS*, *Kirkby*. Pl. XI., figs. 23*a*—23*d*.

These figures are intended more especially to define with accuracy the dorsal overlap in this interesting species. (See p. 155.)

7. *C. JONESIANA*, *Kirkby*. Pl. XI., figs. 24*a*—24*d*, and 25*a*—25*d*.

Here also the artist has given his best attention to the careful delineation of the features shown in the hinge-line of this species, and its smaller variety. (See p. 153.)

EXPLANATION OF PLATE VIII.

Excepting figs. 1*c*, 2*c*, 5*e*, 5*f*, 8*b*, 9*a*, and 9*b*, the figures are magnified 25 diameters. The specimens are from Tunstall Hill, excepting figs. 6-9.

Fig. 1*a* *Kirkbya Permiana*, Jones: left valve.

1 <i>b</i>	"	"	lateral contour, dorsal aspect.
1 <i>c</i>	"	"	reticulation around the oval spot, magnified 50 diameters.
1 <i>d</i>	"	"	lateral contour, ventral aspect.
1 <i>e</i>	"	"	lateral contour, end-view.
2 <i>a</i>	"	"	right valve.
2 <i>b</i>	"	"	right valve, dorsal aspect.
2 <i>c</i>	"	"	oval spot and reticulation, magnified 50 diameters.
2 <i>d</i>	"	"	right valve, ventral aspect.
2 <i>e</i>	"	"	right valve, lateral contour, end-view.
3	"	"	right valve, inner aspect.
4	"	"	var. <i>glypta</i> , Jones: right valve.
5 <i>a</i>	"	"	right valve.

- Fig. 5b *Kirkbya Permiana*, perfect carapace, dorsal aspect.
 5c " " perfect carapace, ventral aspect.
 5d " " perfect carapace, end-view, showing the mode of
 overlap.
 5e " " reticulation, magnified 50 diameters.
 5f " " oval spot, magnified 50 diameters.
 6a " " left valve, not well preserved. From Byers'
 Quarry.
 6b " " left valve, edge-view.
 7 " " var. *glypta*: right valve. From Byers' Quarry.
 8a " " var. *Richteriana*, Jones: left valve. From Saalfeld.
 8b " " var. *Richteriana*: part of surface with punctated
 ridge and oval spot, magnified 50 diameters.
 9a " " var. *Roessleri*, Reuss: right valve. } Copied from
 9b " " edge-view } Reuss's plate.

EXPLANATION OF PLATE IX.

- Fig. 1 *Bairdia plebeia*, Reuss: right valve, magnified 23
 diameters.
 2 *B. plebeia*: left valve of another form, magnified 23
 diameters.
 2a Lateral contour, with contact-line of ventral margins.
 4 & 4a..... *B. plebeia*, var. *elongata*: magnified 23 diameters.
 3 & 3a..... *B. plebeia*, var. *ventricosa*: right valve, magnified 28
 diameters.
 5 & 5a..... *B. plebeia*, var. *Neptuni*: left valve, magnified 25
 diameters.
 6 & 6a..... *B. plebeia*, var. *Reussiana*: right valve, magnified 26
 diameters.
 9, 9a, 10, 12, & 12a, *B. plebeia*, var. *caudata*: right valve, magnified 28
 diameters.
 11 & 11a..... *B. plebeia*, var. *amygdalina*: left valve, magnified 28
 diameters.
 8 & 8a..... *Bairdia Kingii*, Reuss: right valve, magnified 34
 diameters.
 7 & 7a..... *B. Kingii*, var. *compressa*: right valve, magnified 25
 diameters.
 13 & 13a..... *Cythere subreniformis*, Kirkby: right valve, magnified
 40 diameters.
 14 & 14a..... *Bairdia Schaurothiana*, Kirkby: left valve, magnified
 28 diameters.
 15 & 15a..... *Bairdia Berniciensis*, Kirkby: right valve, magnified
 33 diameters.

All from the shell-limestone of Tunstall Hill.

EXPLANATION OF PLATE X.

- Fig. 1..... *Cythere (Cytherideis) Jonesiana*, Kirkby: right valve, magnified 30 diameters.
- 2..... *C. Jonesiana*: a less elongate form, right valve, magnified 30 diameters.
- 2a..... *C. Jonesiana*: lateral contour.
- 3 & 3a *Bairdia rhomboidea*, Kirkby: right valve, magnified 26 diameters.
- 4 & 4a *Cythere amputata*, Kirkby: cast of left valve, magnified 38 diameters, figured with the ventral border upwards.
- 5..... *Kirkbya Permiana*, Jones: right valve, having a smooth surface magnified 26 diameters.
- 6 & 8... *K. Permiana*: right and left valves, showing a
- 7..... *K. Permiana*: left valve of a specimen, showing the reticulation of surface, magnified 30 diameters.
- 9..... *K. Permiana*: left valve of a young specimen, magnified 38 diameters.
- 10 & 11 *K. Permiana*: ventral aspects of two specimens, magnified.
- 12..... *K. Permiana*: dorsal aspect, magnified.
- 13..... *K. Permiana*: interior of right valve, magnified.
- All from the shell-limestone of Tunstall Hill.

EXPLANATION OF PLATE XI.

All the figures are magnified 25 diameters, excepting fig. 19f.

- Fig. 1a, *Cythere Morrisiana*, Jones: right valve—1b, edge-view; 1c, end-view of carapace.
- 2, *Cythere Elongata*, Münster: right valve.
- 3a, *Cythere Kutorgiana*, Jones: showing cast of the left valve, and edges of the right; 3b, larger specimen, showing cast of the right valve, and edges of the left.
- 4a, *Cythere Geinitziana*, Jones: left valve—4b, profile; 4c, end-view.
- 5a, *Cythere biplicata*, Jones: showing cast of the right valve, and the edges of the left; 5b, a larger specimen, with the plication modified; left valve.
- 6, *Cythere inornata*, M'Coy: left valve.
- 7a, *Cythere nuciformis*, Jones: right valve—7b, edge-view of carapace; 7c, end-view.
- 8, *Cythere (Bairdia) plebeia*, Reuss: right valve.
- 9a, ————— *brevicauda*, Jones: 9b, profile of carapace; 9c, end-view.

- Fig. 10, *Cythere (Bairdia) var. rhombica*, Jones: left valve. 11, Inside of the right valve of another specimen.
- 12a, ————— *plebeia*, Reuss: var. small individual, or diminutive rhombical form; left valve—12b, edge-view.
- 13a, ————— var. *grandis*, Jones: right valve cast—13b, edge-view.
- 14a, *Cythere (Bairdia) ampla*, Reuss: showing cast of the right valve, and edge of the left—14b, edge-view—14c, end-view.
- 15, *Cythere (Bairdia) gracilis*, M'Coy: cast, showing the outline of the right-valve.
- 16, *Cythere (Bairdia) acuta*, Jones: left valve.
- 17, *Cythere (Bairdia) plebeia*, Reuss., var. *caudata*, Kirkby: right valve, Sunderland. 18a, another specimen, left valve—18b, profile—18c, end-view.
- 19a, *Cythere (Bairdia) ampla*, Reuss: closed carapace, with right valve upwards, Yorkshire—19b, the same, left valve upwards—19c, ventral aspect—19d, dorsal aspect—19e, end-view—19f, punctation, magnified 50 diam.
- 20a, *Cythere Tyronica*, Jones: right valve, Ireland—20b, profile.
- 21a, *Cythere Richteriana*, Jones: left valve, Germany—21b, profile—21c, end-view.
- 22a, *Cythere amputata*, Kirkby: cast of carapace, with left valve upwards, Sunderland—22b, ventral aspect—22c, dorsal aspect—22d, anterior aspect.
- 23a, *Cythere subreniformis*, Kirkby: carapace, with right valve upwards, Sunderland—23b, ventral aspect—23c, dorsal aspect—23d, end-view.
- 24a, *Cythere Jonesiana*, Kirkby: carapace, with right valve upwards, Sunderland—24b, ventral aspect—24c, dorsal aspect—24d, end-view.
- 25a, ————— smaller variety; carapace, with right valve upwards, Sunderland—25b, ventral aspect—25c, dorsal aspect—25d, end-view.

